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Qualitative Analysis of Subsurface Water Quality in Challakere Taluk, Karnataka, India

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ABSTRACT

Rural India relies mainly on groundwater for drinking and agriculture. Unsustainable withdrawal of groundwater has led to the spectra of depleting the problem of water scarcity. The available groundwater quality is not only contaminated by hazardous pathogenic germs and anthropogenic substances but also geogenic substances is adversely affect the water supply of many regions. The groundwater of Challakere taluk had many threats such as anthropogenic activities, quality deterioration by agricultural activities and over exploitation and also persistence of continuous drought condition. This paper mainly addresses the physico-chemical concentration of 30 groundwater samples during August 2009 in Challakere taluk, Karnataka (India). The results of all the findings are discussed in details which reflect the present status of the groundwater quality of the study area. Groundwater is extremely important to the future economy and growth of rural India. If the resource is to remain available as high quality water for future generation it is important to protect from possible contamination. Hence it is recommended that suitable water quality management is essential to avoid any further contamination.

Keywords: *Groundwater quality analysis, Challakere, Subsurface Water Quality, Karnataka*

INTRODUCTION

Rural India relies mainly on groundwater for drinking and agriculture. Villages once relied on sources like wells, lakes, ponds and streams for their water needs. Contamination of most surface water sources has rendered them unfit for consumption. And also increase in water demand by an increasing population has necessitated resource to tapping groundwater. Unsustainable withdrawal of groundwater has led to the spectra of depleting the problem of water scarcity. Every human society, be it rural or urban, industrially or technologically advanced, disposal of waste exceeds the limit of natural scavenging or removal process, they are bound to effect the normal functioning of the ecosystems and consequently they bear an adverse effect on the biota (Miller, 1984).

Supplying inhabitants with safe and clean drinking water is one of the most common problems in developing countries like India, especially in arid and semi-arid regions. The available groundwater quality is not only contaminated by hazardous pathogenic germs and anthropogenic substances but also geogenic substances are adversely affects the water supply of many regions. The groundwater of Challakere taluk had many threats such as anthropogenic activities, quality deterioration by agricultural activities and over exploitation and also persistence of continuous drought condition .With this background an effort has been made to know the quality of groundwater in this region.

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MATERIALS AND METHODS

Study area

Challakere is a taluk head quarter comes under Chitradurga district, Karnataka state. It has a geographical area of 194.380 sq. kms. It comprises 39 Grama Panchayats and 308 villages with a total population of 2,54,093 as per 2001 census. As a whole, the terrain is not uniform thought parallel chains of hills, mostly bare and stony separated by narrow kanivas and the average elevation of about 500.M msl (Gazetteer of India, 1981).

Meteorology

The climate of Challakere taluk comes under drought prone area. The precipitation and distribution of rainfall in study area is highly erratic. The annual average rainfall is 650mm received over 40 rainy days. It varies from as low as 620 mm in the east and as high as 750 mm in west. About 2/3rd of the geological area of Challakere taluk receives less than 700 mm of annual rainfall. The study area had been receiving rainfall mainly from southwest monsoon and slightly from northeast monsoon. Most of the rainfall over this area is contributed by a very poor intensity of rainfall events. The monthly mean temperature ranges from 8.0 to 48°C.

Analysis of the samples

The groundwater samples from the 30 sampling sites were collected and analyzed during August 2009. Groundwater samples from the sampling sites were collected from the bore wells. Initially the water was allowed to run for 15 minutes in order to flush out stationary water. Further, the sample bottles were also flushed with water before the samples were collected. The parameters of water such as, total dissolved solids, electrical conductivity and pH were analyzed on the spot with the help of water analysis kit (Elico). The remaining parameters were analyzed in the laboratory. Hence, the water was carried to the laboratory in suitable inert bottles. The samples were analyzed using analytical method of APHA (1995) and all analysis was done in triplicate.

RESULT AND DISCUSSION

Water analysis was carried out, by taking 10 parameters, which are very essential to know the water qualities for drinking purpose. The findings of the present investigation are summarized in Table 1, and it has been compared with BIS 1998 drinking water standards, Table 2 which provides the comprehensive picture of the physico-chemical characteristics of groundwater in the study area.

Turbidity (TUR)

In the present study the turbidity values ranged between 0.10 and 60 NTU. The BIS (1998) acceptable limit for turbidity is 25 NTU. It is proved from the present study, 12% of total number of samples cross their permissible limit with reference to the BIS (1998) standards. It is observed from the results that these parameters which crossed their permissible limit were unfit for drinking purposes. It causes health problems like gastro-intestinal disorders, headache and also associated with respiratory diseases (Maiti, 1982).

pH

In the present investigation, pH values found to be 6.7 to 8.7. The recommended value of pH for drinking purposes is between 6.5 and 8.5 (BIS, 1998). In the present study all the water samples analyzed are all well within the safer limits except in few sampling stations. However, higher values of pH hasten the scale formation in water heaters and reduce the germicidal potential of chlorine (Mohapathra and Purohit, 2000).

Electrical conductivity (EC)

The values of electrical conductivity ranged between 90 µmhos/cm to 2100 µmhos/cm. Nevertheless, Higher the concentration of acid, base and salts in water, higher will be the EC. The variability of EC could be explained to the natural concentration of ionised substances present in water (Kataria and Jain, 1995). However the higher values of electrical conductivity (>2000 µmhos/cm), may be due to long residence time and well lithology.

Total dissolved solids (TDS)

It is justified from the analytical report for TDS values ranges from 92 mg/L to 1990 mg/L and values shows that were well with in the permissible limit. However, groundwater chemistry changes as the water flows through the subsurface and the increase in geological environment and dissolved solids and major ions. Chebotarev (1985), Ramababu and Somashekara Rao (1986) and Joseph (2001) expressed the dissolution of soil particles containing minerals under slightly alkaline condition, favour the TDS concentration in groundwater. However TDS concentration above the permissible limit (1500 ppm) causes gastrointestinal irritation (Shankar and Muttukrishnan, 1994).

Total hardness (TH)

Total hardness levels varied from 80 mg/L to 750 mg/L, associated with a mean value of 727.36 mg/L. The BIS (1998) acceptable limit for total hardness is 600 mg/L. In the present study, revealed that 52 % of total number of water samples cross the permissible limits of BIS

Table 1. Groundwater quality data of physico-chemical parameters of the study sites during August 2009

Sam. No.	TUR	pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Cl^{-}	Alk	F^{-}
S1	1.1	8.1	1136	750	750	291	170	451	537	1.0
S2	0.7	7.9	1699	990	750	210	104	700	700	1.0
S3	0.10	7.3	1100	670	444	165	125	445	172	1.7
S4	36	8.1	1315	815	735	234	160	425	260	1.7
S5	41	8.3	633	421	395	165	110	330	184	0.9
S6	60	6.7	595	370	505	168	39	565	194	0.9
S7	2.1	8.7	1125	705	732	275	9.4	426	615	0.6
S8	1.3	8.4	955	606	695	206	21	163	119	0.7
S9	1.6	7.6	1469	950	712	430	25	650	700	0.7
S10	1.4	6.7	90	92	80	76	13	35	116	0.4
S11	1.8	7.2	210	121	177	131	16	37	130	0.5
S12	0.3	7.6	1047	636	594	124	63	241	110	0.4
S13	0.2	6.8	227	138	270	145	37	110	60	0.6
S14	1.3	7.3	1278	758	6 70	220	108	553	130	0.7
S15	10.9	8.0	1373	830	743	180	115	367	96	0.6
S16	0.6	7.3	242	147	385	103	57	346	87	0.7
S17	1.0	7.1	805	482	625	135	102	467	110	0.8
S18	0.6	8.1	2100	990	732	137	131	547	132	0.9
S19	0.10	7.1	603	362	456	122	66	183	144	1.0
S20	0.9	7.2	466	280	400	105	32	285	110	1.7
S21	2.4	6.7	486	286	460	132	92	69	168	0.9
S22	26	6.7	778	467	623	305	128	70	86	1.0
S23	1.1	7.7	923	554	644	47	110	251	68	0.8
S24	3.1	7.2	1037	622	610	127	100	206	91	0.9
S25	0.2	7.4	987.5	593	570	177	91	266	180	1.6
S26	0.2	8.4	840	520	695	139	84	177	82	1.1
S27	3.4	7.8	545	315	700	395.5	168	670	145	0.8
S28	1.6	7.9	360	260	595	83.9	63	200	79	1.5
S29	0.2	8.2	252.5	150	660	289	170	700	138	1.7
S30	0.10	7.7	324	195	370	76	23	124	44	0.9

All parameters are expressed in mg/L, except pH, turbidity (NTU) and electrical conductivity (μmhos/cm)

Table 2. Comparison of Groundwater quality data with Drinking water Standard (BIS, 1998)

Sl. No.	Parameters	BIS (1998)		Observed values	
		P	E	Minimum	Maximum
1	Turbidity	5	25	0.10	60
2	pH	6.5	8.5	6.7	8.7
3	EC	-	-	90	2100
4	TDS	500	1000	92	990
5	Total hardness	300	600	80	750
6	Calcium	75	200	76	430
7	Magnesium	30	100	13	170
8	Chloride	250	1000	35	700
9	Alkalinity	200	600	60	700
10	Fluoride	0.3-1.2	1.5	0.4	1.7

Note : P = Permissible limit, E = Excessive limit
All parameters are expressed in mg/L, except pH, turbidity (NTU) and electrical conductivity (μmhos/cm)

(1998) drinking water standards. Owing to fact that higher amount of hardness in the study area comes mainly from the leaching of igneous rock and carbonate rocks (dolomite, calcite and limestone). Water containing the soluble salts of calcium and magnesium such as chlorides, sulphates and bicarbonates are also governs the quality of water (Ramaswamy and Rajaguru, 1991). The adverse effects of total hardness are formation of kidney stone and the heart diseases (Sastry and Rathee, 1998). Nevertheless, groundwater chemistry is controlled by the composition of its recharge components as well as by geological and hydrological variations (Narayana and Suresh, 1989).

Calcium (Ca^{2+})

Present investigation reports stated for calcium values ranged from 76 mg/L to 430 mg/L, with a mean value of 184.99 mg/L. The BIS (1998) acceptable limit for calcium is 200 mg/L. However, in the present study 30% of water samples cross the permissible limit. Presence of higher amount of calcium in the study area may be due to groundwater receives the calcium minerals leached from the rocks and other deposits like limestone, dolomites, calcite, gypsum, amphiboles, feldspar, and clay minerals leaching or weathering of igneous rocks. Sewage and domestic waste are also important sources of calcium (Mishra and Saxena, 1989).

Magnesium (Mg^{2+})

Investigation report reveals for the magnesium values ranged from 3.5 mg/L to a 170 mg/L .however, BIS (1998) acceptable limit for magnesium is 100 mg/L and in the present study 65% of the groundwater samples crossed the permissible range. Magnesium arises principally from the weathering of rocks contain ferro-magnesium minerals and some carbonate rocks. High concentration of magnesium proves to be diuretic and laxative (Schroeder 1960).

Chloride (Cl^-)

Chloride is also one of the important parameter to know the quality of water. Anthropogenic sources of chlorides include fertilizer, road salt, human and animal waste. Concentration of chlorides is considered to be an indicator of organic pollution of animal origin (Kumara, 2002).

Here, Chloride values ranged from 35 mg/L to 700 mg/L. In the present investigation, the values of chloride for all the sampling sites are with in the permissible range as prescribed by BIS (1998) drinking water standards. However, dissolving of the soil constituents had contributed the chloride into the groundwater and also the soil characteristics play an important role in contributing the chloride content in the groundwater (Shivasankaran, 1997).

Total alkalinity

In the present study tOtal alkalinity values ranged from a 60 mg/L to 700 mg/L. The BIS (1998) acceptable limit for total alkalinity is 600mg/L. In the present study, the data revealed that 10% of water samples in the study area crossed the permissible limit. When alkalinity of water exceeds the permissible limits, it is likely to produce incrustation sediment deposits, difficulties in chlorination, certain physiological effects on human systems etc. (Raviprakash and Rao, 1989). The constituents of alkalinity result from dissolution of mineral substances in the soil and atmosphere contributes to alkalinity in groundwater (Mittal and Verma, 1997).

Fluoride (F^-)

In the present investigation, fluoride values varied from 0.4 mg/L to 1.7 mg/L the BIS (1998) acceptable limit for fluoride is 1.5 mg/L. In the present study, 15% of total number of water samples in present investigations has crossed the permissible range as prescribed by BIS (1998) drinking water standards. Degree of weathering and leachable fluoride in terrain is of great significance for the fluoride present in groundwater than the mere presence of fluoride bearing minerals in rocks (Kumar *et al.*, 2000).

Intake of excess fluoride causes dental, skeletal and non-skeletal fluorosis. The non-skeletal fluorosis can be observed such as gastrointestinal complaints, intermittent diarrhoea and flatulence in expectant and lactating mothers hardworking young adults and children. Therefore, fluorosis has been considered as one of the incurable diseases. Hence, prevention is the only solution for the disease (Hem, 1985).

CONCLUSION

Currently carried research investigation should give more precise answer on influence of geomorphological condition than anthropogenic activities in the examined groundwater samples of the study area. Local geological settings may supports the increasing concentration of physico-chemical characteristics in groundwater. The factors like slow circulation, longer period of contact between aquifer and water, dissolving of minerals at the time of weathering, residential time, drainage pattern and surface water link. Porosity of the soil and rock also alters the characteristics of the groundwater. The high level contents of the parameters observed may be minimized if the groundwater is recharged with the available water in the rainy season. This not only dilutes the constituents of the groundwater but also raises the groundwater level that depletes due to large-scale exploitation.

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