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Physicochemical parameters and statistical analysis of groundwater of some places of northwest agro-climatic zone of Gujarat state of India

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ABSTRACT

Groundwater is a natural resource for drinking water. Like other natural resources, it should be assessed regularly and people should be made aware of the quality of drinking water. For the present study, various samples of groundwater were collected from the different locations of northwest agro-climatic zone of Gujarat state of India and analysed for their physicochemical parameters like temperature, turbidity, electrical conductance (E.C.), pH, total dissolved solids (TDS), alkalinity and concentrations of ions like chloride, fluoride, calcium, magnesium, nitrate and nitrite. Its quality was compared with drinking water specifications IS : 10500, 1991(reaffirmed in 1993). To analyse with statistical point of view, correlation co-efficients (r), mean and standard deviations were also calculated for these parameters.

Key words: Physicochemical parameters, water quality standards.

INTRODUCTION

Water is a source of life. Life cannot be imagined without the existence of water. Today, on our dear planet, the earth, water has very crucial and noteworthy role to play for the mankind and living creatures. Essential matter i.e. water is available to human beings as water in rivers, lakes, streams, groundwater, soil moisture and vapour form [1].

Generally, groundwater is water found beneath the ground surface in the soil pores and in the fractures of rocks. It is a good reservoir of water. As rivers, ponds and streams are influenced by natural and human factors, groundwater is also facing the same situation around the world. Human activities, hydrologic aspects and characteristics of recharged water affect the quality of groundwater. Variations in climate, change in temperature and precipitation have direct influence on groundwater levels and quality [2,3]. Like other countries, groundwater is also a question of immense importance for India [4]. The increase in population of India exerts a great stress on natural resources like groundwater. Unrestricted exploration of groundwater and excessive use of fertilizers and pesticides make possible the infiltration of harmful constituents to the

groundwater. Domestic waste, industrial waste and garbage also pollute groundwater [5]. Thus, groundwater becomes contaminated [6,7].

Table-1: Values of physicochemical parameters

Parameter	a	b	c	d	e	f	g	Mean	Standard deviation	Standard limits (IS: 10500:1992)	
										Acceptable desirable limit	Maximum permissible limit
Temp ^{0}C	24	25	25	24	24	24	24	24.29	0.49	-	-
Turbidity(NTU)	2	1	1	3	3	2	2	2.00	0.82	5	10
E.C.(ms cm^{-1})	2.01	1.94	1.68	4.57	4.90	1.82	2.40	2.76	1.38	-	-
pH	8.30	8.65	7.90	8.22	7.85	8.45	8.10	8.21	0.29	6.5-8.5	No relaxation
TDS(mg/l)	1342	970	1100	2880	2960	1310	1334	1699.43	845.29	500	2000
Cl^{1-} (mg/l)	324	376	410	1434	1475	692	398	729.86	509.06	250	1000
Total Alkalinity(mg/l)	339	143	176	129	232	293	375	241.00	97.23	200	600
F^{1-} (mg/l)	1.07	1.00	0.91	1.30	1.31	0.99	1.28	1.07	0.12	1.0	1.5
Ca^{2+} (mg/l)	65	91	112	175	198	76	62	111.29	54.48	75	200
Mg^{2+} (mg/l)	44	82	96	108	187	61	28	86.57	52.52	30	100
NO_3^{1-} (mg/l)	1.09	0.94	1.01	2.49	2.76	1.45	0.87	1.52	0.78	45	100
NO_2^{1-} (mg/l)	0.13	0.09	0.12	0.14	0.15	0.17	0.13	0.13	2.49	-	-

In 21st century, still in India, majority of population is dependent on groundwater for drinking purpose as groundwater is ultimate and key water resource for them. Besides this, groundwater is used for agricultural and industrial applications in most of the parts of India.

Water which is used for drinking purpose must possess good level of purity. If the groundwater used for drinking and other domestic activities is contaminated, it creates threat to the public health. Hence, periodical evaluation of water quality requires serious attention. Like the other natural resources, protection and proper management of groundwater is also a need of time [8]. Ignorance of environment and improper management may lead to the people towards the scarcity of drinking water [9].

MATERIALS AND METHODS

Gujarat, a state of India is divided into seven agro-climatic zones on the basis of the climatic conditions. The present study is related to the groundwater quality of some places of the northwest agro-climatic zone of Gujarat. In this zone, agriculture and dairy production are the major economic activities. Wheat, Bajara, Juwar and Cotton are the main crops which are cultivated here. Water scarcity is a common problem in the hot days of summer. Rainfall is very limited and generally determines the income of the landowners and agricultural labourers. Drought is not a new phenomenon to the people of this zone. From this zone, groundwater samples of bore wells were collected in December-January, 2008 .The samples were collected from the different locations like : (a) Diyodar, (b) Shihori, (c) Thara, (d) Dhima, (e) Vav, (f) Tharad, (g) Bhabhar. These samples were collected, preserved and analysed for various parameters such as temperature, turbidity, electrical conductance, pH, total dissolved solids, alkalinity and concentrations of ions like chloride, fluoride, calcium, magnesium, nitrate and nitrite by the standard methods as described in the literature [10-19].

Table-2: Correlation Matrix

Parameter	Temp ^{0}C	Turbidity (NTU)	E.C. (ms cm^{-1})	pH	TDS	Cl^{1-}	Total Alkalinity	F^{1-}	Ca^{2+}	Mg^{2+}	NO_3^{1-}	NO_2^{1-}
Temp ^{0}C	1.000											
Turbidity(NTU)	-0.837*	1.000										
E.C.(ms cm^{-1})	-0.474	0.871*	1.000									
pH	0.154	-0.340	-0.436	1.000								
TDS	-0.537	0.910**	0.985**	-0.454	1.000							
Cl^{1-}	-0.452	0.851*	0.947**	-0.372	0.969**	1.000						
Total Alkalinity	-0.573	0.088	-0.303	-0.085	-0.279	-0.392	1.000					
F^{1-}	-0.642	0.519	0.381	-0.185	0.313	0.167	0.546	1.000				
Ca^{2+}	-0.123	0.637	0.898**	-0.499	0.895**	0.919**	-0.596	0.138	1.000			
Mg^{2+}	0.032	0.455	0.751	-0.489	0.736	0.787*	-0.549	-0.032	0.928**	1.000		
NO_3^{1-}	-0.471	0.859*	0.940**	-0.382	0.970**	0.989**	-0.356	0.316	0.918	0.815*	1.000	
NO_2^{1-}	-0.762*	0.654	0.326	-0.278	0.447	0.495	0.367	0.197	0.216	0.164	0.511	1.000

** Correlation is significant at the 0.05 level (2-tailed).*
*** Correlation is significant at the 0.01 level (2-tailed).*

RESULTS AND DISCUSSION

Values of different parameters are shown in Table-1. Quality of these water samples is compared with Indian Standards specifications for drinking water : IS : 10500 :1992(reaffirmed in 1993). Turbidity is an important factor for characterisation of water [20]. Clear water contains low turbidity level while muddy water contains high turbidity level. For all the water samples, turbidity was in the range of 1 to 3 NTU (Nephelometric Turbidity Unit). It indicates absence of suspended and colloidal matters like decomposed vegetation, sewage, sediments in the samples. High values of electrical conductivity exhibits large amounts of salts dissolved in water. This kind of property is not desired because it makes water unsuitable for drinking purpose. Electrical conductivity of these water samples varied from 1.68 to 4.90 ms cm^{-1}.

Generally, pH values of groundwater are fluctuating in the range of 3 to 10 [21]. pH values of water samples were found in the range of 7.85 to 8.65. Only one water sample (b) was slightly above the tolerance limit for pH which is 6.5 to 8.5. Thus, pH values (>7) are indicative of alkaline nature of water.

TDS values for the samples varied from 970 to 2960 mg/l. For TDS, IS:10500,1992 suggests 500 mg/l as the desirable limit while 2000 mg/l as the permissible limit in the absence of alternate source. Here, all the samples showed TDS values which were very high and exceeding desirable limit. High TDS decrease the quality and affect the taste of water [22]. If TDS value is more than 500 mg/l, it may cause gastro intestinal irritation.

Chloride content in water may be due to the minerals like mica, apatite and from the liquid inclusions through the igneous rocks [23]. In drinking water, higher chloride content may lead to laxative effects [24]. The chloride contents of these samples lie in the range of 324 to 1475 mg/l. According to IS: 10500 : 1992, tolerance limit of chloride is 250 mg/l. Two samples (d and e) were beyond maximum permissible limit of chloride content.

If alkalinity value in drinking water is higher than 200 mg/l, the taste of the water becomes unpleasant. In the water samples, total alkalinity was from 129 to 375 mg/l. Thus, all the samples were in the prescribed tolerance limit (200-600 mg/l).

Presence of large amount of fluoride (> 1.5 mg/l) is associated with dental and skeletal fluorosis, while inadequate amount of fluoride (<1.0 mg/l) is associated with dental carries. In groundwater, fluoride is found in different concentrations [25-30]. The F^{1-} concentration in samples was from 0.91 to 1.31 mg/l which is not violating permissible limit (1.0-1.5 mg/l) indicated by IS:10500, 1992.

Calcium is a chief constituent of different types of rocks. It is a cause for hardness in water. Similarly, magnesium is also responsible for hardness of water. In the samples, Ca^{2+} concentration ranged from 62 to 198 mg/l, while Mg^{2+} content was found from 28 to 187 mg/l.

In groundwater, nitrate may result due to livestock facilities, agrochemicals and sewage disposal [31-33]. Increasing presence of nitrate in water is a big threat to the public health. The nitrate rich water is not fit for drinking [34, 35]. Excess of nitrate in drinking water may become the cause of methemoglobinemia (blue baby syndrome) [36]. In water samples, NO_3^{1-} concentration was in the range from 0.87 to 2.76 mg/l, while NO_2^{1-} concentration was found from 0.09 to 0.17 mg/l.

Statistical Analysis

Mean and standard deviation are found for the values of physicochemical parameters and are shown in Table-1. Correlation analysis is useful for the measurement of the strength and statistical significance of the relation between two or more water quality parameters. Hence, it is a helpful tool for the promotion of research [37, 38]. The correlation coefficients(r) were calculated and correlation matrix is obtained [39-46]. Here, r is a dimensionless index which is in the range of -1.0 to +1.0 inclusive and exhibits the extent of a relation between variables. The correlation coefficients are listed in Table-2. High positive correlation was found between E.C. and turbidity, TDS and turbidity, Cl^{1-} and turbidity, nitrate and turbidity, E.C. and TDS, E.C. and Cl^{1-}, E.C. and Ca^{2+}, NO_3^{1-} and E.C., Cl^{1-} and TDS, Ca^{2+} and TDS, NO_3^{1-} and TDS, Ca^{2+} and Cl^{1-}, NO_3^{1-} and Cl^{1-}, Ca^{2+} and NO_3^{1-}, Mg^{2+} and Ca^{2+}, Mg^{2+} and NO_3^{1-}, while high negative correlation was observed between temperature and turbidity.

CONCLUSION

The present study has led to conclude that the quality of water samples studied were acceptable from the majority of physicochemical characteristics but as TDS was high in all the samples, the water should be treated properly before its usage as drinking water to avoid possible adverse effects. Therefore, public should be made aware of drinking water quality.

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