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GROUNDWATER QUALITY EVALUTION FOR DRINKING PURPOSE IN SOME AREAS OF BAYAD, SABARKANTHA DISTRICT (N. GUJ.) INDIA

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ABSTRACT

Ground water quality is an essential ingredient for a healthy population. In the present work, study of drinking water samples for 18 water sources wells in the Bayad field has been carried out. The purpose of this study was to ascertain the quality of water from these sources. The physical properties such as pH and total dissolved solids (TDS) showed the range of pH (7.24-7.80) and TDS (744.0-1008.6) mg/L, which is within the permissible limits of World Health Organization (WHO). The measurements of total hardness (TH), SO_4^{2-}, PO_4^{2-}, Cl^- Na^+, K^+, Ca^{2+} and Mg^{2+} have also been measured.

Key words: Ground water quality, Heavy elements, Total dissolved solids, Sodium adsorption ratio.

INTRODUCTION

Increasing water pollution causes not only the deterioration of water quality but it also threatens human health and the balance of aquatic ecosystems, economic development and social prosperity[1].

Water is important to the mechanics of the human body and the body cannot work without it. Water quality is essential for the wellbeing of all people. The quality of water can be affected by different pollutants such as, chemical, biological and physical. contaminants such as bacteria, viruses, heavy metals, nitrate and salts find their way into water resources. The water pollution occurs, when a body of water is adversely affected due to the addition of large amounts of undesired materials to the water. The sources of water pollution are categorized as being a point source or non- point source of pollution. Point sources means,

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when the polluting substance is emitted directly into the water way while, a non- point source means, when there is a runoff of pollutants into a water way[2].

Water plays a vital role in human life. The consequence of urbanization and industrialization leads to spoil the quality of water. For agricultural purposes, ground water is explored in rural areas especially in those areas, where other sources of water like dam, river or a canal is not available. During last decade, it has been observed that the ground water gets polluted drastically because of increased human activities[3,4]. Consequently, number of cases of water borne diseases have been seen causing health hazards[5,7]. So, basic monitoring of water quality has become necessary to observe the demand and pollution level of ground water[8]. A good number of water analysis experiments are regularly conducted by different groups of chemists and biologists all across the country[2,4,9-13].

Fig. 1: Study area

The natural water analysis for physical and chemical properties including trace element contents is very important for public health. These studies form a main part of pollution studies in the environment[1,2,6-11,14-17]. The determinations of these parameters in drinking water have been performed using classical analytical techniques including titrimetry, gravimetry and modern instrumental techniques such as atomic absorption

spectrometry (AAS), inductively coupled plasma-mass spectrometry (ICP-MS), UV-Vis spectro-photometry, etc.

The people of North Gujarat region have been facing potable water crisis due to inadequate rains. In Gujarat, ground water is considered as the first water source for irrigation and other uses. The climate of the Bayad plain can be described as being hot, windy and arid with humidity; air temperature is over 43°C in the period from May to September. The source of drinking water in Sabarkantha area is only ground water, The aim of this study was to investigate the quality of the ground water. Samples were collected from the Bayad wells. Chemical and physical characteristics were analysed.

In all, about 18 samples of water were examined for electrical conductivity, pH and the proportion of various cations and anions. The chemical analysis was carried out following standard procedures. Chemical analysis data of the water samples are given in Table 1. It presents different ratios to judge the quality of these water samples from irrigation viewpoints.

EXPERIMENTAL

Materials and methods

The ground water samples were collected from 18 bore wells in selected stations of Bayad taluka region. The samples were collected as per the standard methods recommended by APHA (1995)[18]. Before water sampling, all the double-stoppered polythene containers were cleaned and rinsed thoroughly with water samples to be analyzed. The physico-chemical analysis was done using the standard methods.

RESULTS AND DISCUSSION

The physical, chemical and bacteriological parameters exhibited considerable variations from sample to sample. All the measurements were carried out in the vicinity of temperature 30^{o}C.

The observations are summarized in the Table 1. The results are also analysed graphically (Figs. 1-10). Instead of plotting the values of parameters individually against the samples, it was thought appropriate to plot some of the interrelated values together against the samples.

Table 1: Physico–chemical characteristics of drinking water in Bayad taluka (N. Gujarat)

Site No.	Location/ Villages	pH	TDS mg/L	Cond. m mhos /cm	Ca^{2+}+ Mg^{2+} meq/L	Na^{+} meq/L	K^{+} meq/L	CO_3^{2-} meq/L	HCO_3^{-} meq/L	RSC	SAR meq/L	SSP {%}	Cl^{-} meq/L	F^{-} mg/L	SO_4^{2-} mg/L	PO_4^{3-} mg/L
1	Dharmdi Wata	8.67	880	1.390	3.6	15.69	0.10	0.8	7.7	4.9	11.69	80.92	8.2	1.4	200.0	33.2
2	Talavadi	7.68	1670	2.860	9.8	23.48	0.20	0.4	9.0	-0.4	10.61	70.13	21.0	0.27	210.0	36.0
3	Dalpatpura	8.15	1330	2.240	5.4	21.04	0.18	0.5	6.8	1.9	12.80	79.04	14.6	0.29	189.5	43.4
4	Bhaipura	7.95	750	1.168	3.6	12.60	0.11	0.2	9.5	6.1	9.39	77.25	7.0	0.56	130.8	24.2
5	Laxmipura	8.24	810	1.260	3.5	13.69	0.10	0.6	8.1	5.2	10.35	79.18	7.2	1.00	96.3	18.3
6	Badarpura	8.00	770	1.186	4.0	11.39	0.11	0.5	8.0	4.5	8.05	73.48	7.0	0.91	89.4	31.2
7	Ahmadpura	8.52	570	0.896	4.5	5.39	0.09	0.7	4.5	0.7	3.60	54.01	6.4	0.59	67.8	21.8
8	Odha	7.71	680	1.068	5.6	6.22	0.09	0.4	8.2	3.0	3.72	52.23	6.4	0.77	71.2	31.8
9	Navi Chojan	7.86	300	0.474	3.6	1.56	0.09	0.2	2.4	-1.0	1.16	29.71	3.4	0.46	65.3	20.6
10	Leripurakampa	7.91	610	0.951	6.0	4.67	0.05	0.3	4.4	-1.3	2.70	43.56	7.4	0.41	135.0	22.9
11	Dakhaneswar	7.79	410	0.642	4.8	2.94	0.03	0.4	4.0	-0.4	1.90	37.84	4.4	0.43	160.8	35.5
12	Bayad	7.94	1530	2.360	7.8	21.04	0.12	0.4	8.5	1.1	10.65	72.65	18.2	1.20	175.0	29.3
13	Adana Chappara	8.06	1060	1.660	6.9	14.87	0.06	0.5	8.9	2.5	8.00	68.12	12.1	1.50	38.9	39.3
14	Sundarpura	8.03	910	1.447	4.0	15.69	0.07	0.7	12.5	9.2	11.09	79.40	6.6	2.60	77.5	33.0
15	Radodara	7.82	1440	2.360	10.5	17.82	0.08	0.5	9.0	-1.0	7.78	62.75	18.2	0.77	101.0	37.3
16	Ranechi	7.66	1900	3.220	21.7	17.39	0.05	0.3	4.0	-17.4	5.28	44.43	30.4	0.34	140.3	26.0
17	Amarapura	7.37	1460	2.500	24.0	5.15	0.05	0.2	5.3	-18.5	1.49	17.64	23.2	0.14	189.8	16.0
18	Pusari	7.61	740	1.162	9.2	5.00	0.06	0.3	6.6	-2.3	2.33	35.06	8.4	0.26	137.3	4.5

Table 2: Standards of physical and chemical water quality

Prescribed by the Bureau of India Standard (IS: -10500:1991)			Prescribed by ICMR (1975)			
Characteristic or Parameters	**Required desirable limit**	**Permissible limit in the absence of alternate source**	**Highest desirable level**	**Maximum permissible level**	**USPH Standard**	**Onland for irrigation (IS: 3307-1974)**
TDS (mg/L)	500	2000	500	1500	500	2100
pH Value	6.5 to 8.5	No relaxation	7.0 to 8.5	6.5 to 9.2	6.0 to 8.5	6.5 to 9.0
Calcium (mg/L)	75	200	75	200	100	-
Magnesium (mg/L)	30	100	-	-	30	-
Chlorides (mg/L)	250	1000	200	1000	250	600
Sulphate (mg/L)	200	400	200	400	250	1000
Percent sodium	-	-	-	-	-	60
Fluoride (mg/L)	1.0	1.5	1.0	1.5	1.5	-
Phosphate (mg/L)	-	-	-	-	0.1	-

Based on the these tabulated values and the figures, the following observations are made. It is observed that the pH of the water was slightly alkaline (7.6 to 8.3) and only minor fluctuation in pH was recorded. The pH levels were within the limits set for domestic use as prescribed by APHA.

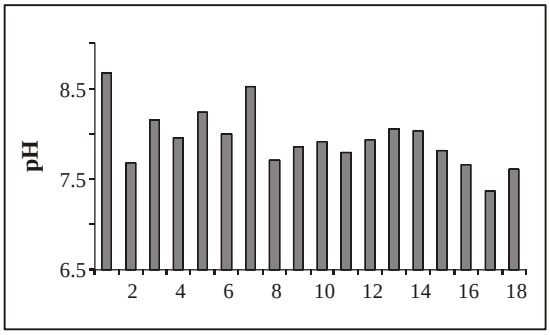

Fig. 1: Variation of pH

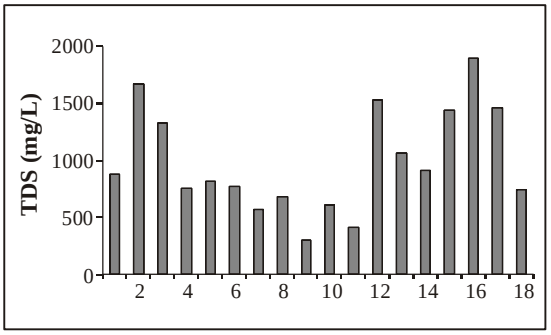

Fig. 2: Variation of total dissolved solids (mg/L)

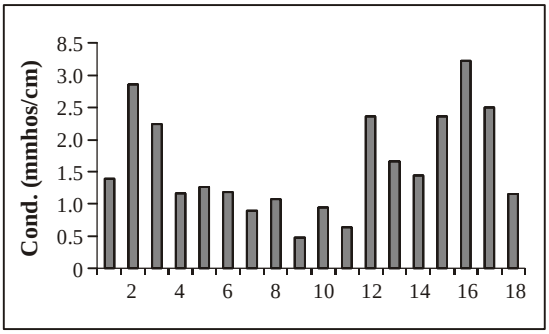

Fig. 3: Variation of conductivity (mmhos/cm)

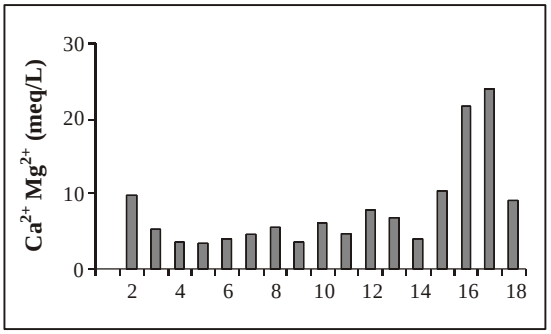

Fig. 4: Variation of Ca^{2+} and Mg^{2+} (meq/L)

The WHO has suggested a limiting value of 500 mg/L of TDS for potable water. In the present investigation, this limit is crossed i.e. 500-1670 mg/L of the samples. However, in the sample No. 2 (Talavadi), the TDS value is about to reach the maximum permissible limit (1670 mg/L). The water of the remaining samples have reasonable values of TDS (480– 500 mg/L). These values are acceptable for domestic use and agricultural purposes.

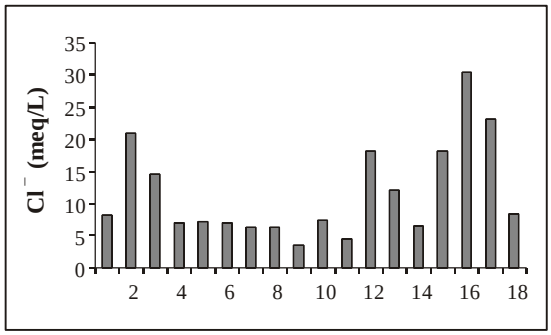

Fig. 5: Variation of chloride content (mg/L)

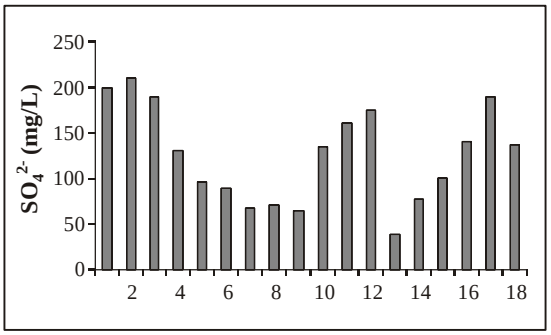

Fig. 6: Variation of sulphate content (mg/L)

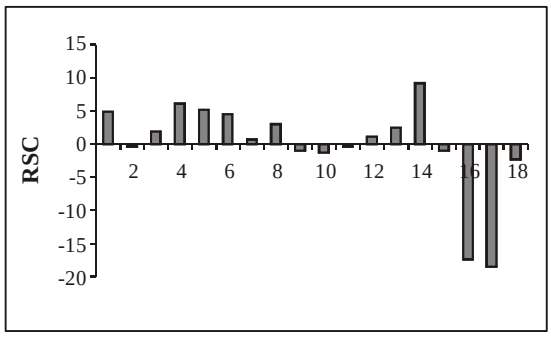

Fig.7: Variation of residual sodium carbonates

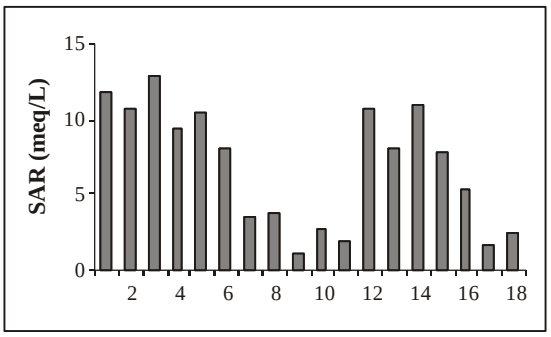

Fig. 8: Variation of sodium adsorption ratio (meq/L)

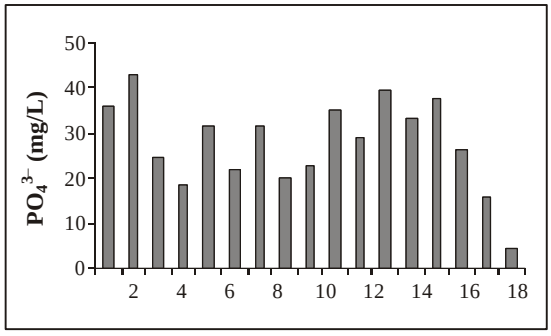

Fig. 9: Variation of phosphate content (mg/L)

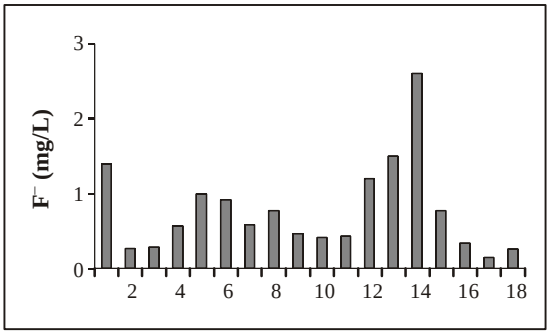

Fig. 10: Variation of fluoride content (mg/L)

The summation of calcium hardness and magnesium hardness is regarded as the total hardness of water. In the present investigation, it has been observed that the calcium and magnesium concentration of the samples has registered a high value of calcium magnesium hardness (3.5-24.0 meq/L) (Tables 1 and 2), The values of TH (Total hardness) were in the range 0.2-1.0 meq/L. The hardness scale has shown value more (23.48 meq/L) for sample No. 2. So water is very hard. These minerals in water can cause some day-to-day problems, as they react with soap and produced a deposit called “soap curd”.

A significant presence of anions like chloride and sulfate was also observed in the water samples under investigation. It has been reported that greater amount of sulfate in drinking water causes diarrhea. The chloride and sulfate amounts in the samples ranged from 3.4-30.4 meq/L and 38.9-210.0 mg/L, respectively. Here, it was observed that the sulfate concentration in the samples fall well within the prescribed limit, but the chloride content is much higher than the permitted values of WHO[19] and ISI.

The sodium and potassium ions were investigated in drinking water samples. Their concentrations were in the range of (1.56-23.48 meq/L) and (0.03-0.20 meq/L), respectively. These results were within the permissible limits by WHO[19]. The relatively high concentration of phosphate ions may be due to the effect of phosphate fertilizers used in the cultivation.

The values of HCO_3^- in the water samples varied from 2.4 to 12.50 meq/L. The lowest value of 2.40 meq/L was observed in the water sample obtained from Navi Chojan, where as the highest value of 12.50 meq/L was observed in Sundarpura Village. All the samples were far below the permissible limit of 120 meq/L.

Fluoride content of ground water samples of the study areas ranged from 0.14 to 2.70 mg/L. Maximum allowable limit is 1.5 ppm (WHO, 1984)[19]. It is under permissible limit. Small concentration of fluoride in drinking water has some beneficial effect also on human body. Low concentration of fluoride below 0.5 ppm causes dental caries and higher concentration beyond 1.5 ppm causes dental and skeletal fluorosis

The suitability of the well and bore well water samples was judged by determining the SAR value and these were categorized under different irrigation classes on the basis of salinity and alkalinity hazards. Sodium adsorption ratio (SAR) was computed by using values of water soluble cation (Table 1). The SAR values varied from 1.16 to 12.84 meq/L.

The data revealed that about 54% of the water samples of the taluka under study have low values (< 10.0).

Residual sodium carbonates (RSC) were computed by using values of anions of sodium (CO_3^{-2} and HCO_3^{-1}) and cations (Ca^{2+} + Mg^{2+}), where the ionic concentration is in meq/L. The RSC values varied from –18.50 to 9.20. The soluble sodium percentage (SSP) values of the water samples of Bayad taluka ranged from 17.64 to 80.92 percent. The lowest value of 17.64 per cent was observed in Amarapura whereas the highest values of 80.92 per cent was recorded in a water sample from Dharmdi Wata Village. Further, the data revealed that about 61.53 per cent of the water samples have high values (> 60) of SSP.

CONCLUSION

(i) The analytical data of TDS, chloride ion and sodium ion concentrations were in the permissible limit by WHO,

(ii) (ii) The concentration of sulphate ion was higher than the permissible limit given by WHO and

(iii) (iii) The concentration of fluoride ion was higher than the permissible limit given by WHO.

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