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CHEMICAL AND PHYSICAL PROPERTIES OF GROUND WATER IN HIMATNAGAR TALUKA, GUJARAT (INDIA)

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ABSTRACT

Study of the ground water quality in Sabarkantha is an essential ingredient for a healthy population. In this research, study of drinking water samples for twenty water sources wells in the Himatnagar field has been carried out. The purpose was to ascertain the quality of water from these sources. The physical properties such as pH, electrical conductivity (EC) and total dissolved solids (TDS), showed the variation of pH (7.24-7.80),TDS (744.0-1008.6) mg L-1, within the permissible limits of World Health Organization (WHO). The total hardness (TH), $SO_4^{-2,}$ $PO_4^{-3,}$ Cl^-, Na^+, K^+, Ca^{+2} and Mg^{+2} have been measured.

Key words: Groundwater, Himatnagar, Heavy elements, Chemical, Physical analysis.

INTRODUCTION

Water is important to the mechanics of the human body and the body cannot work without it. Water quality is essential for the well being 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 supplies. The water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water. The sources of water pollution are categorized as being a point source or non-source point of pollution. Point sources mean, when the polluting substance is emitted directly into the waterway while, a non- point sources mean, when there is runoff of pollutants into a water way[1].

Water plays a vital role in human life. The consequence of urbanization and industrialization spoil the water. For agricultural purposes, ground water is explored in rural areas especially in those areas, where other sources of water like dam and river or a canal is

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not available. During last decade, this is observed that the ground water gets polluted drastically because of increased human activities[2,3]. Consequently, number of cases of water borne diseases have been seen, which causes health hazards[4-6]. So, basic monitoring on water quality has been necessitated to observe the demand and pollution level of ground water[7]. A good number of water analysis experiments are regularly conducted by different groups of chemists and biologists across the country [8-11].

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 Himatnagar plain (Fig. 1) 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 is only ground water. The aim of this study was to investigate the quality of the ground water. Samples were collected from the Himatnagar wells. Chemical and physical characteristics were determined analytically.

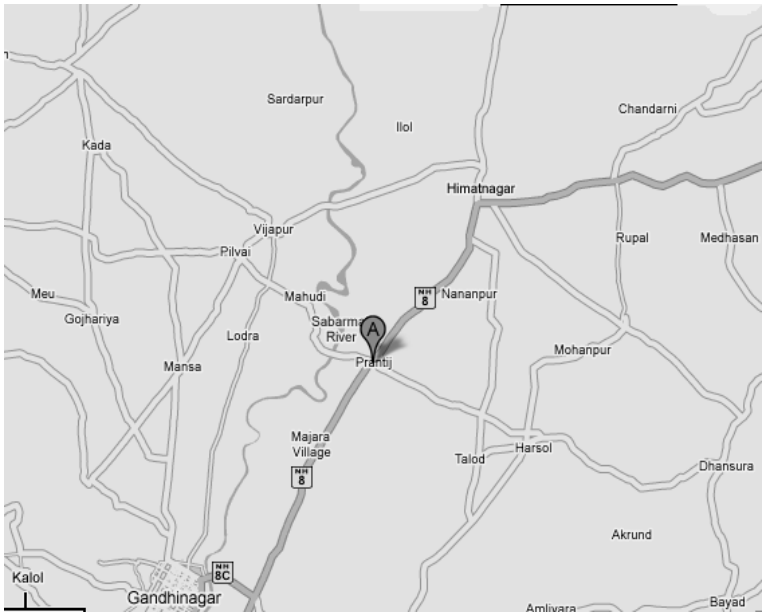

Fig. 1: Map of Himatnagar taluka of Gujarat

In all, about 20 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 of the water samples is given in Table 1, which presents different ratios to judge the quality of these waters from irrigation view points.

Table 1 (a): Physico-chemical characteristics of ground water in Himatnagar taluka (N. Gujarat)

Samp. No.	Location/ Villages	pH	TDS (mg/L)	Cond. (mmhos/ cm)	$Ca^{2+} + Mg^{2+}$ (meq/L)	Na^{+} (meq/L)	K^{+} (meq/L)	CO_3^{-2} (meq/L)
1	Abawad	7.75	375	0.735	4.3	14.09	0.02	0.2
2	Lalpur	7.90	442	0.863	7.2	8.35	0.03	0.5
3	Pipdikampa	8.08	228	0.466	3.5	5.48	0.01	0.4
4	Dhandha	8.00	557	1.091	8.1	7.56	0.27	0.5
5	Kankrolkampa	8.19	224	0.441	3.2	4.69	0.01	0.2
6	Kump	8.74	831	1.627	2.7	5.34	0.03	1.0
7	Vamoj	8.00	510	0.997	3.6	4.85	0.01	0.5
8	Vavdi	8.28	496	0.976	5.7	3.87	0.01	0.6
9	Gambhoi	7.91	1320	2.600	6.0	18.95	0.03	0.4
10	Khanusha	8.13	383	0.751	3.8	3.87	0.02	0.6
11	Khed	8.18	323	0.634	4.0	3.91	0.03	0.5
12	Gayatirkampa	7.79	321	0.631	5.5	4.86	0.05	0.4
13	Surajpura	7.64	370	0.722	6.1	6.00	0.04	0.5
14	Karanpur	8.65	888	1.740	3.4	16.74	0.03	1.0
15	Kaneyol	8.16	374	0.733	3.6	4.13	0.03	0.4
16	Khadhol	7.91	448	0.874	7.2	15.69	0.02	0.5
17	Rampura	7.63	508	0.997	7.6	5.21	0.04	0.4
18	Mor.dungara	8.16	387	0.765	5.7	5.48	0.02	0.4
19	Chanpalanar	8.26	420	0.824	3.5	4.61	0.04	0.6
20	Kesherpura	9.01	843	1.658	3.2	4.35	0.02	1.4

Table 1 (b): Physico-chemical characteristics of groundwater in Himatnagar taluka (N. Gujarat)

Samp. No.	Location/ Villages	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	Abawad	6.8	2.7	9.61	76.53	3.2	0.78	130.0	96.2
2	Lalpur	7.2	0.5	4.40	53.59	4.0	0.49	109.8	96.5
3	Pipdikampa	3.5	0.4	4.14	60.96	2.4	0.50	74.6	50.0
4	Dhandha	7.0	-0.6	3.76	47.46	4.8	0.21	154.1	95.0
5	Kankrolkampa	3.0	0.0	3.71	59.37	2.0	0.49	56.4	95.0
6	Kump	11.8	10.1	4.60	66.17	8.0	0.48	149.9	100
7	Vamoj	10.0	6.9	3.61	57.33	4.0	0.49	208.4	87.2
8	Vavdi	5.8	0.7	2.29	40.40	5.0	0.78	127.4	105
9	Gambhoi	5.5	-0.1	10.94	75.86	20.0	0.49	95.4	61.2
10	Khanusha	6.5	3.3	2.81	50.32	4.0	0.79	61.9	24.0
11	Khed	3.2	-0.3	2.76	49.24	3.6	0.46	61.9	32.0
12	Gayatirkampa	4.5	-0.6	2.93	46.68	3.0	0.32	92.4	40.0
13	Surajpura	5.0	-0.6	3.43	49.42	3.4	0.44	242.0	37.2
14	Karanpur	12.8	10.4	12.84	82.99	8.4	2.10	201.2	31.9
15	Kaneyol	5.6	2.4	3.08	53.22	3.6	0.70	177.8	44.3
16	Khadhol	7.2	0.5	8.27	68.48	4.0	1.40	202.1	23.9
17	Rampura	4.0	-3.2	2.67	40.54	6.0	0.58	225.4	34.1
18	Mor.dungara	6.2	0.9	3.25	48.93	3.6	0.99	162.0	36.0
19	Chanpalanar	5.4	2.5	3.48	56.56	4.0	0.65	124.6	33.2
20	Kesherpura	11.4	9.6	3.44	57.46	8.0	1.50	126.4	60.3

Materials and methods

The ground water samples were collected from 20 bore wells in selected stations of Himatnagar taluka region. The samples were collected as per the standard methods recommended by APHA (1995)[12]. 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 (Dhyan Singh and P.N. Pandey, 1998).

RESULTS AND DISCUSSION

The following data present the ground water quality status of Prantij taluka.

pH : The pH value ranges between 7.50 – 8.5. The lowest value is observed in Sadoliya and the highest in Anararpur (Table 1). It is observed that 76 % of the water samples lies in the range of 7.5 – 8.2 prescribed by Bureau of Indian Standards.

EC: Electrical conductivity is a useful tool to evaluate the purity of water. Maximum electrical conductivity is recorded is Ganbhoj (2.600 mmhos/cm) and the minimum EC at Kankrolkampa (0.441 mmhos/cm). The result indicates that almost all the water samples are within the permissible limits of 2.250 mmhos/cm

TDS: The TDS of the water samples ranged from 224 mg/L to 1320 mg/L. The ISI standard for dissolved solid is up to 500 mg/L and the maximum permissible quantity[13] is 2000 mg/L (WHO, 1994). The TDS values of all the water samples of the selected places are under permissible limit of 2000 mg/L.

Ca^{2+} + Mg^{2+} Hardness

Ca^{2+} + Mg^{2+} cause by far the greatest portion of the hardness occurring in natural waters. Hardness of the water is objectionable from the view point of water use. The Ca^{2+} + Mg^{2+} values of the water samples from 2.7 to 8.1 meq/L. The lowest value of 2.7 meq/L from Kump where the highest value of 8.1 meq/L was recorded in water samples from Dhandha. The values of total hardness of 77% samples are within the permissible range. The highest desirable limit of total hardness is 6.0 meq/L (300 mg/L) (ICMR 1975).

Sodium

Sodium content of the ground waters of Himatnagar taluka ranges from 3.87 meq/L (Vavdi) to 18.95 meq/L (Ganbhoj) (Table 1). About 61% of the water samples show sodium

higher than the permissible limit of 50 ppm (9 meq/L) in irrigation water as prescribed by BIS (1983).

Potassium

In the present study, all the water samples have potassium higher than the permissible limit of 0.5 meq/L as prescribed by BIS and ranges from 0.01meq/L (Kankrolkampa) to 0.27meq/L (Dhandha).

Bicarbonate

The values of HCO_3^- in the water samples varied from 3.00 to 12.80 meq/L (Table 1). The lowest value of 3.00 meq/L was observed in the water sample obtained from Kankrolkampa where as the highest value of 12.80 meq/L was observed in Karanpur village. All the samples are far below than the permissible limit of 120 meq/L.

Chloride

It is observed that around 53% of the samples have chlorides higher than the permissible limit of 10.0 meq/L. The highest concentration of chlorides was recorded in Ganbhoj (20.0 meq/L) and the lowest at Kankrolkampa (2.00 meq/L). High chloride content in ground water can be attributed to lack of under ground drainage system and bad maintenance of environment around the sources.

Fluoride

Fluoride content of ground water samples of the study areas ranges from 0.21 to 2.10 mg/L Maximum[14] allowable limit is 1.5 ppm (WHO, 1984). It is under permissible limit. Small concentration of fluoride in drinking water has beneficial effect 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.

Sulphates

High sulphate content of 208.40, 242.0 and 225.10 mg/L was recoded at Vamoj Surajpura and Rampura, respectively. The presence of high concentration of sulphates in the study area can be attributed the discharge of domestic sewage and littering of organic wastes in the region.

Sodium adsorption ratio (SAR)

The suitability of the well and bore well water samples was judged by determining the SAR value and they 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 S cation (Table 1). The SAR values varied from 2.29 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)

Residual sodium carbonates (RSC) was computed by using values of water 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 –3.20 to 10.40 (Table 1).

Soluble sodium percentage (SSP)

The soluble sodium percentage (SSP) values of the water samples of Himatnagar taluka ranged from 40.40 to 82.99. The lowest value of 40.40 per cent was observed in Vavdi whereas the highest values of 82.99 per cent was recorded in a water sample from Karanpur village. Further the data revealed that about 61.53 per cent of the water samples have high values (> 60) of SSP.

Table 2: Rating of different parameters in water

Parameter	Acidic	Normal	Saline	Alkaline
PH	< 7.00	7.00 to 7.50	7.50 to 8.50	> 8.50
	Good	**Safe**	**Marginal**	**Unfit**
E.C. (mmhos cm^{-1})	< 0.250	0.250 to 0.750	0.750 to 2.250	> 2.250
	Low	**Medium**	**High**	**Very high**
SAR	< 10.0	10.0 to 18.0	18.0 to 26.0	> 26.0
	Safe	**Marginal**	**Doubtful**	
RSC ($meqL^{-1}$)	< 1.25	1.25 to 2.50	>2.50	

Table 3: Standards of physical and chemical water quality

		Prescribed by the Bureau of Indian Standard (IS: 10500:1991)			Prescribed by ICMR (1975)		
Sr. No.	**Characteristic Or Parameters**	**Requirement desirable limit**	**Permissible limit in the absence of alternate source**	**Highest desirable level**	**Maximum permissible level**	**USPH Standard**	**Onland for irrigation (IS: 3307 1974)**
1	TDS Mg/L	500	2000	500	1500	500	2100
2	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
3	Calcium mg/L	75	200	75	200	100	-
4	Magnesium mg/L	30	100	-	-	30	-
5	Chlorides mg/L	250	1000	200	1000	250	600
6	Sulphate mg/L	200	400	200	400	250	1000
7	Percent sodium	-	-	-	-	-	60
8	FluoRide mg/L	1.0	1.5	1.0	1.5	1.5	-
9	Phosphate mg/L	-	-	-	-	0.1	-

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