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Chemical Properties of Groundwater in Bhiloda Taluka Region, North Gujarat, India

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Abstract: Groundwater is one of the most useful water sources. Contamination of such water source is a big problem creating health hazards. In this present study we have collected groundwater samples from different places of Bhiloda taluka of Sabarkantha district (North Gujarat) India. These samples have been assessed on the basis of various qualitative parameters. The results of physico-chemical study of water samples from 13 bore wells in Bhiloda taluka are presented. The water quality parameters such as; pH, electrical conductivity (EC), total dissolved salts (TDS), calcium and magnesium, sodium, potassium, carbonate, bicarbonate, chloride, sulphate, fluoride, sodium adsorption ratio (SAR), residual sodium carbonate (RSC) and soluble sodium percentage (SSP) were estimated.

Keywords: Groundwater, Contamination, SSP, RSC, SAR, TDS, EC

Introduction

Quality of water is an important consideration in any appraisal of salinity or alkali conditions in an irrigated area. Nearly all irrigation water that have been used successfully for a long period have a conductivity value less than 2250 mmhos/cm. Water of higher conductivity may be used with suitable amendments and precautions, but under normal conditions they are harmful to the soil structure and their continuous use will result in salinity hazard, with ultimate effect on plant growth. This deterioration of the soils is judged from the ratios of soluble sodium percentage (SSP), sodium adsorption ratio (SAR) and residual sodium carbonate (RSC).

Experimental

All the thirteen water samples were examined for electrical conductivity, pH and the proportion of various cations and anions. The chemical analysis was carried out using following standard procedures. The results of chemical analysis of water samples are given in Table 1. The results show the different ratios to judge the quality of this water from irrigation view points.

Materials and methods

The groundwater samples were collected from 13 bore wells in selected stations of Bhiloda taluka region. The samples were collected as per the standard methods recommended by APHA¹. 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

pH

The pH value ranges between 8.0 and 9.4. The lowest value is observed in Jayla and the highest in Reetoda villege (Table 1). It is observed that 76% of the water samples lie in the range of 6.5 – 8.5 prescribed by Bureau of Indian Standards.

Electrical conductivity (EC)

Electrical conductivity is a useful tool to evaluate the purity of water maximum electrical conductivity is recorded in sunokh (3342 μ mhos/cm) and the minimum EC at Jinava (231 μ mhos /cm). The result indicates that almost all the water samples are within the permissible limits of 2250 μ mhos/cm except at sampling locations *viz.*, Sunokh (3442 μ mhos/cm), Madhtimba (2739 μ mhos/cm), Padara (3304 μ mhos/cm) and Jayla (3281 μ mhos/cm).

Total dissolved solid (TDS)

The TDS of the water samples ranged from 145 mg/L to 1910 mg/L. The ISI standard for dissolved solid is up to 500 mg/L and the maximum permissible quantity⁸ 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 and Mg⁺² hardness

Ca⁺² and Mg⁺² cause by far the greatest portion of the hardness occurring in natural waters. Hardness of the water is objectionable from the viewpoint of water use. The Ca⁺² + Mg⁺² Values of the water samples from 3.1 to 12.3 meq/L. The lowest value of 3.1 meq/L from sunokh where the highest value of 12.3 meq/L was recorded in water samples from kebava. 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 groundwaters of Bhiloda taluka ranges from 0.5 meq/L (Jinava) to 32.87 meq/L (Sunokh) (Table 1). About 61% of the water samples show sodium higher than the permissible limit of 50 ppm (9 meq/L) in irrigation water prescribed by BIS (1983).

Potassium

In the present study of all the water samples have potassium higher than the permissible limit of 0.5 meq/L as prescribed by BIS and ranges from 0.00 meq/L (Jinava) to 0.03 meq/L (Bhatera).

Bicarbonate

The values of HCO_3^- in the water samples varied from 2.90 to 15.00 meq/L (Table 1). The lowest value of 2.90 meq/L was observed in the water sample obtained from Jinava where as the highest value of 15.00 meq/L was observed in Jayla 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 padara (19.5 meq/L) and the lowest at Bhatera (1.00 meq/L). High chloride content in groundwater can be attribute to lack of under ground drainage system and bad maintenance of environment around the sources.

Fluoride

Fluoride content of groundwater samples of the study areas ranges from 0.20 to 1.10 ppm. Maximum⁷ 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 bellow 0.5 ppm causes dental caries and higher concentration beyond 1.5 ppm causes dental and skeletal fluorosis.

Sulfates

High sulfate contest of 3.0, 1.3 and 0.8 meq/L was recoded at Vijapur, Jayla and Khokhara respectively. The presence of high concentration of sulfates 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 cation (Table 1). The SAR values varied from 0.37 to 26.40. 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 carbonate (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 -6.60 to 12.20.

Soluble sodium percentage (SSP)

The soluble sodium percentage (SSP) values of the water samples of Bhiloda taluka ranged from 12.2 to 91.4. The lowest value of 12.2 per cent was observed in Jinava whereas the highest values of 94.4 per cent was recorded in a water sample from Sunokh Village further the data revealed that about 61.53 per cent of the water samples have high values (>60) of SSP.

Table 1. Physico – chemical characteristics of groundwater in Bhiloda taluka (N. Gujarat)

S.No.	pH	EC μ mhos/ cm	TDS mg/L	Ca ⁺² + Mg ⁺² meq/L	Na ⁺ meq/L	K ⁺ meq/L	CO ₃ ⁻² meq/L	HCO ₃ ⁻¹ meq/L	Cl ⁻ meq/L	F ⁻ ppm	SO ₄ ⁻² meq/L	SAR meq/L	RSC	SSP %
1	8.62	1023	560	5.8	5.08	0.03	1.3	6.8	2.8	0.30	0.0	2.98	2.3	46.52
2	9.20	3442	1910	3.1	32.87	0.01	1.1	14.2	17.5	0.34	2.6	26.40	12.2	91.36
3	9.40	1945	1040	4.8	15.56	0.01	1.4	6.3	10.5	0.44	0.8	10.04	2.9	76.39
4	9.00	2739	1456	4.2	26.30	0.00	1.6	10.7	14.0	0.24	1.0	18.15	8.1	86.23
5	8.41	2006	1078	7.9	12.00	0.02	1.2	6.6	11.0	0.24	3.0	6.04	-0.1	60.24
6	8.60	3304	1715	6.7	24.87	0.02	1.4	11.9	19.5	0.26	0.0	13.59	6.6	78.73
7	8.80	231	145	3.6	0.50	0.00	0.6	2.9	3.6	0.30	0.0	0.37	-0.1	12.19
8	8.65	1189	660	3.8	9.78	0.01	1.0	9.6	2.0	1.10	0.0	7.10	6.8	71.96
9	8.68	614	350	4.1	4.50	0.03	1.6	4.9	1.0	0.22	0.0	3.14	2.4	52.14
10	8.80	1620	940	12.3	7.50	0.03	0.9	4.8	8.5	0.20	0.5	3.02	-6.6	37.82
11	8.00	3281	1880	4.6	29.78	0.02	1.2	15.0	16.0	0.52	1.3	19.64	11.6	86.57
12	8.45	1831	1070	3.5	15.30	0.02	1.3	6.3	11.0	0.39	0.8	11.57	4.1	81.30
13	8.75	640	410	3.2	3.39	0.01	1.1	4.1	2.2	0.56	0.0	2.68	2.0	51.36

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