

Assessment of ground water quality of Bhavnagar region (Gujarat)

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This paper assessed ground water quality of Bhavnagar region for determining its suitability for drinking purposes. Ground water samples, collected from 12 different locations of Bhavnagar region for winter, summer and post monsoon seasons, revealed that pH of all samples was neutral to slight alkaline. Turbidity of all samples was within permissible limit. Total dissolved solids, total hardness, fluoride, chloride and chromium were beyond permissible limit in some samples. In most samples, iron was beyond permissible limit. Zinc, copper and manganese were within permissible limit.

Keywords: Bhavnagar region, Drinking water, Heavy metals, Physico-chemical parameters

Introduction

Many villages in Saurashtra, Gujarat, India, are facing water quality problem as well as drinking water shortage, specially during summer season. Adults and children of this region are suffering from health problems due to consumption of contaminated water. This paper assesses ground water quality of Bhavnagar region for determining its suitability for drinking purposes.

Materials and Methods

Ground water samples, collected from 12 different locations of Bhavnagar region from various ground water sources for winter, summer and post monsoon seasons, were analyzed for physico-chemical parameters (pH, conductivity, turbidity, total dissolved solids, suspended solids, chloride, alkalinity, sulphate, hardness, nitrate, fluoride, sodium, potassium and heavy metals) using standard methods¹.

Results and Discussion

Analysis of ground water samples for summer, post monsoon and winter seasons (Table 1) gave pH (7.1-8.4), indicating slight alkalinity. Total dissolved solids (TDS) varied between 410 mg/l at Padva for post monsoon season to 4240 mg/l at Akavada for summer season. TDS is beyond permissible limit (PL) in some

samples. A high value of TDS reduces water utility for drinking, irrigation and agriculture purposes². Increase in TDS is mainly due to seawater intrusion and increase in salts³ (carbonates, bicarbonates, sulphate, calcium, chloride, sodium, potassium and other ions). Electrical conductivity was recorded highest at Akvada (8.11 mS/cm) for summer season and lowest at Padva (0.80 mS/cm) for post monsoon season. Turbidity (1-9 NTU) was within permissible limit (10 NTU). A maximum suspended solid was recorded at Koliyak (116 mg/l) for post monsoon season and minimum (11 mg/l) at Malanka and Akvada for post monsoon season. Alkalinity ranged between 242 mg/l at Bhumbhli to 704 mg/l at Akavada for winter season exceeding desirable limit (DL) (200 mg/l) in all water samples. Alkalinity (150 mg/l) has been found conducive to productivity of water bodies. Total hardness of water samples varied from 56 mg/l at Padva to 1758 mg/l at Koliyak for winter season. Total hardness in water samples from Bhumbhli and Koliyak were beyond PL (600 mg/l) for all three seasons.

Concentration of sulphate ions was minimum (22 mg/l) at Padva for post monsoon season and maximum (525 mg/l) at Bhumbhli for winter season. Sulphate was within PL (400 mg/l) except samples of Bhumbhli for winter, summer and post monsoon season, Koliyak for summer season and Malanka for winter season. High concentration of sulphate has laxative effect⁴, which is enhanced when sulphate is consumed with magnesium. Water containing magnesium sulphate (1000 mg/l) acts as

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Table 1 — Percent of ground water samples in relation with desirable and permissible limits*

S.N.	Parameter	DL	PL	Summer			Post Monsoon			Winter		
				WD	BD	BP	WD	BD	BP	WD	BD	BP
1	Turbidity, NTU max	5	10	83.3	16.7	Nil	75	25	Nil	50	50	Nil
2	pH value	6.5-8.5	NR	All values in range								
3	Total hardness (as CaCO ₃)	300	600	33.3	16.7	50	66.6	16.7	16.7	33.33	33.33	33.33
4	Iron (Fe), mg/l, max	0.3	1.0	Nil	Nil	100	100	Nil	Nil	Nil	8.3	91.7
5	Chlorides (Cl), mg/l, max	250	1000	25	25	50	25	58.3	16.7	25	50	25
6	Dissolved solids, mg/l, max	500	2000	Nil	42	58	8.0	75	17	Nil	58	42
7	Copper (Cu), mg/l, max	0.05	1.5	75	25	Nil	100	Nil	Nil	100	Nil	Nil
8	Manganese (Mn), mg/l, max	0.1	0.3	100	Nil	Nil	91.7	8.3	Nil	91.7	8.3	Nil
9	Sulphate (SO ₄), mg/l, max	200	400	33.3	50	16.7	83.3	8.3	8.3	58.3	25	16.7
10	Nitrate (NO ₃), mg/l, max	45	100	100	Nil	Nil	100	Nil	Nil	100	Nil	Nil
11	Fluoride (F), mg/l, max	1.0	1.5	25	25	50	41.7	33.3	25	25	16.7	58.3
12	Cadmium (Cd), mg/l, max	0.01	NR	All values in non detectable range								
13	Lead (Pb), mg/l, max	0.05	NR	91.7	8.3	100	Nil	75	25			
14	Zinc (Zn), mg/l, max	0.5	1.5	100	Nil	Nil	100	Nil	Nil	100	Nil	Nil
15	Chromium (Cr ⁶⁺), mg/l, max	0.05	NR	58.3	41.7	83.3	16.7	100	Nil			
16	Alkalinity, mg/l, max	200	600	Nil	91.7	8.3	Nil	100	Nil	Nil	83.3	16.7

*As per IS: 10500, 1991; WD, within desirable; BD, beyond desirable; BP, beyond permissible; DL, desirable limit; PL, permissible limit; NR, no relaxation

purgative in human adults. Sulphate anions can be removed by ion exchange resin methods⁵.

Chloride varied between 106 mg/l at Padva for post monsoon season to 2065 mg/l at Akavada for summer season. It was beyond PL in samples collected from Ghogha and Koliyak village for all three seasons. Sodium and potassium were observed between 178-1280 mg/l and 0.1-48 mg/l respectively. Concentration of nitrate was minimum (0.2 mg/l) at Nesvad for winter season and maximum (8.1 mg/l) at Koliyak for summer; all nitrate samples were within DL (45 mg/l). Excessive concentration of nitrate in drinking water is considered hazardous for infants causing methemoglobinaemia⁶. Fluoride concentration of water samples was minimum (0.3 mg/l) at Nesvad for winter and post monsoon season and maximum (4.6 mg/l) at Bhumbhli for summer season. In some samples, fluoride was observed beyond PL. High concentration of fluoride causes dental fluorosis^{7,8}, while low concentration causes dental caries. Hence it is essential to maintain moderate concentration of fluoride in drinking water (0.8-1.0 mg/l).

Iron (0.07-1.8 mg/l) was beyond PL in most of the samples. Zinc, copper and manganese were within PL and cadmium was in non-detectable range in all ground water samples. Chromium and lead were beyond PL in some of the ground water samples. There is an increased risk of lung cancer of workers exposed to high levels of

chromium⁹. Lead poisoning symptoms usually develop slowly with intestinal cramps, peripheral nerve paralysis anemia and severe fatigue^{10,11}.

Conclusions

Analysis of ground water samples collected from various locations of Bhavnagar region revealed that water quality parameters (turbidity, manganese, zinc, and copper) were within PL as per IS –10500 standard. However, TDS, total hardness, chloride fluoride and chromium were observed beyond PL in some samples. Iron was beyond PL in most samples. Ground water in Bhavnagar region requires precautionary measures before drinking so as to prevent adverse health effects on human beings.

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