Research Article

Hardness of Groundwater Resources and its Suitability for Drinking Purpose

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ABSTRACT
Groundwater is one of the most important finite natural resource for human life. Hardness of groundwater in Karha river basin area has particular importance because of geological reasons. This area is under arid to semi-arid region. An investigation was carried out by collecting groundwater samples for two seasons Pre-monsoon (PRM) and Post – monsoon (POM) (February 2011 to December 2011) to decipher hydrochemistry and determination of hardness of groundwater & its suitability for drinking purposes. The water is neutral to alkaline in nature with pH ranging from 6.5 to 8.6. Higher electrical conductivity was noted in village Nepatwalan. During (PRM) Total hardness (TH) ranges between 30 to 2027 mg/l with an average of 616 mg/l representing 29 % of the samples exceed the permissible limit of Indian Standard Specifications for Drinking Water, IS: 10500 -1993 (600 mg/l). According to the Water Quality Association, water is considered "hard" when the measured hardness exceeds 120 mg/L. Hard water can cause calcium carbonate scale deposits in automated watering systems, which can lead to drinking water valve leaks and other operational problems. It is inferred that, both the seasons recorded higher TH as permanent hardness and it is not suitable for drinking and other domestic purposes.

Keywords: Groundwater, Electrical Conductivity, Total Hardness, Drinking Water Standards.

1. INTRODUCTION

Water is a basic necessity of life, not only for people but for every type of plant and animal as well (WHO). Water shortage have becomes an increasingly serious problem in India, especially in the arid and semi-arid regions of the country due to vagaries of monsoon and scarcity of surface water.

Groundwater quality data gives important clues to the geologic history of rocks and indications of groundwater recharge, movement and storage (Walton 1970). Assessment of groundwater quality is necessary and immediate task for present and future groundwater quality management. Groundwater quality, in turn, depends on a number of factors, such as general geology, degree of chemical weathering of the various rock types, quality of recharge water and input from sources other than water- rock interaction (Domenico 1972); (Schuh et al 1997); (Todd et al 1980); (Dhok et al 2011). Such factors and their interaction with each other, results in a complex groundwater quality (Hussein 2004). Various publications have concentrated on groundwater quality monitoring and evaluation for domestic and industrial activities.

Total Hardness (TH) of groundwater is very important parameter in determining the groundwater quality for domestic purpose. The objective of the present paper was to assess Hardness of groundwater and its suitability for domestic purpose in the Karha river basin area.

2. MATERIAL AND METHODS

2.1 Study Area

The study area lies between 18º3′ to 18°12′, north latitudes and 74° 13′to 74° 30′ east longitudes. It is located at an altitude of 538 meters above means sea level. The river originates from Saswad in Pune District. Ground water samples from

different seventeen Tube wells and Open wells of Karha river basin area are selected randomly and by considering the topography of the study area (APHA 1995) (Fig. 1).

2.2 Sample Collection and analysis

Water samples from the selected sites (Table 1) were collected for two different seasons pre-monsoon and post-monsoon. Each sample was collected in a good quality polyethylene bottle of one-litre capacity. Samples were analyzed in the laboratory for the major ions chemistry employing standard method (APHA 1995). The results are tabulated in Table 2 and 3.

3. RESULTS AND DISCUSSION

3.1 Physico-chemical parameters of groundwater

The physicochemical composition of the groundwater samples were analyzed and the results with Maximum, Minimum and Average parameters are given in table 2 and 3. The pH ranges from 6.75 to 8.5 and 6.5 to 8.6 with an average 7.6 and 7.6 during Pre-monsoon and Post – monsoon which indicated the alkaline nature of groundwater.

Electrical Conductivity (EC) is the most important parameter of water to indicate Total Dissolved Solids and its suitability for domestic purpose. The EC varies from 490 to 10300 µS/cm and 510 to 9580 µS/cm during PRM and POM respectively. Higher was noted during PRM when compared with POM. Very high (>3000) EC concentration is prominent was predominantly found along full stretch of the stream of the study area.

3.2 Total Hardness

The range of calcium concentration in the groundwater is dependent on solubility of $CaCO_3$, sulphates and very rarely chlorides. The solubility of $CaCO_3$ depends upon the partial pressure of CO_2 in the atmosphere (Pawar, 1996). Under such conditions, freshwater can contain 20 to 30 ppm of Ca at saturated level. Calcium ranges from 10 to 290.6 mg/l during PRM due to dissolution of $CaCO_3$ during recharge (Datta et al 1996). The Mg ranges from 1.2 to 420.7 and 2.3 to 270 mg/l with an average 100 and 86.1 mg/l during PRM and POM respectively.

Total hardness of water is a measure of dissolved Ca and Mg in water expressed as CaCO3 (Mitra et al. 2007), in present study we found that Bicarbonates range from 159 to 769 in PRM and 148 to 730 mg/l in POM. Chloride is higher during PRM (2449 mg/l) due to leaching of upper layer of soil in dry climates (Srinivasamoorthy et al 2008), higher SO_4^- is noted during POM season (2788mg/l). Water hardness has no known adverse effects; however, some evidence indicates its role in heart disease (WHO 2008). According to the Water Quality Association, water is considered “hard” when the measured hardness exceeds 120 mg/L. According to the Indian Standard Specifications for Drinking Water, IS: 10500 -1993 (ISS: 10500, 1993) the desirable limit of salts hardness for drinking purpose is 300 mg/l, and maximum permissible limit is 600 mg/l.

The TH is calculated by using the formula,

$$TH = (\text{ppm of Ca} \times 2.496) + (\text{ppm of Mg} \times 4.118)$$

Hard water is unsuitable for domestic use and it is a measure of the Ca^{2+} and Mg^{2+} content expressed in equivalent of calcium carbonate. During PRM and POM, total hardness (TH) ranges between 30 to 2028 mg/l with an average of 616, representing (29%) of the groundwater samples exceeding the maximum permissible limit (Fig 2). It is inferred that, in both the seasons water samples indicated records higher TH as permanent hardness.

4. CONCLUSION

The groundwater quality in Karha river basin area has been evaluated for its their chemical composition and suitability for domestic purpose. Higher EC values are C confined along up stream, central and downstream full stretch of the stream indicating the dominance of natural and agricultural activities. Higher hardness is noted in central part of the study area like village Karhati. 29 % water samples are under hard to very hard categories and not suitable for drinking purposes.

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Table 1: List of groundwater sampling sites

S.No.	Sampling Sites	S.No.	Sampling Sites	S.No.	Sampling Sites
1	Ambi	7	Jalgaon Supe	13	Baramati
2	Morgaon	8	Anjangaon	14	Malad
3	Tardoli	9	Karhawagaj	15	Gunawadi
4	Baburdi	10	Nepatwalan	16	Dorlewadi
5	Karhati	11	Barnanpur	17	Songaon
6	Jalgaon Kp	12	Medad		

Table 2: Water Analysis Data of Pre Monsoon (Summer 2011)

Sampling Sites	PH	EC	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	TH	Suitability for drinking
		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
1	7.71	580	12.0	32.8	390	92	180	165	Suitable
2	8.04	580	30.1	20.7	342	71	155	160	Suitable
3	8.5	1800	32.1	21.9	232	120	153	170	Suitable
4	7.56	1700	20.0	30.4	256	213	255	175	Suitable
5	6.75	8920	118.2	420.7	573	2449	2300	2027	unsuitable
6	7.1	6500	264.5	297.9	305	1835	725	1887	unsuitable
7	7.16	4000	172.3	138.6	354	916	950	1001	unsuitable
8	7.49	1150	24.0	52.3	244	178	302	275	Suitable
9	7.25	1850	60.1	49.9	159	298	365	355	Suitable
10	7.0	10300	290.6	243.2	476	2201	950	1726	unsuitable
11	7.58	800	18.0	29.2	354	103	160	165	Suitable
12	8.38	8050	262.5	271.2	512	2442	850	1771	unsuitable
13	7.3	1350	10.0	1.2	622	78	156	30	Suitable
14	8.11	1150	12.0	12.2	769	149	186	80	Suitable
15	7.4	490	36.1	17.0	415	170	208	160	Suitable
16	8.19	730	10.0	38.9	281	298	318	185	Suitable
17	7.76	910	20.0	20.7	443	71	121	135	Suitable
Min	6.75	490	10.0	1.2	159	71	121	30	
Max	8.5	10300	290.6	420.7	769	2449	2300	2027	
Avg	7.60	2992	81.9	100	396	687	490	616	

Table 3: Water Analysis Data of Post Monsoon (Winter 2011)

Sampling Sites	PH	EC	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	SO_4^{2-}	TH	Suitability for drinking
		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
1	7.9	510	15.0	33.0	372	86	132	173	Suitable
2	8.3	560	27.2	18.2	326	69	105	143	Suitable
3	8.6	1750	32.0	20.0	214	118	147	162	Suitable
4	7.8	1620	21.0	28.0	267	211	240	168	Suitable
5	6.5	7850	120.0	260.0	559	2400	2788	1370	unsuitable
6	7.3	6300	250.0	270.0	301	1689	1880	1736	unsuitable
7	7.4	3900	169.0	128.0	345	890	1102	949	unsuitable
8	7.3	1280	21.0	50.2	232	163	264	259	Suitable
9	7.1	1920	56.0	49.5	148	298	367	344	Suitable
10	7.4	9580	260.0	239.0	490	2124	2071	1633	unsuitable
11	7.4	905	22.0	29.0	352	102	256	174	Suitable
12	8.2	6080	240.0	250.0	570	2360	2300	1629	unsuitable
13	7.5	1310	10.2	2.3	590	70	164	35	Suitable
14	8.3	1105	12.2	13.6	730	147	180	86	Suitable
15	7.1	610	35.0	16.2	402	165	209	154	Suitable
16	8.1	790	10.0	38.0	270	290	315	181	Suitable
17	7.6	970	18.0	19.0	442	69	102	123	Suitable
Min	6.5	510	10.0	2.3	148	69	102	35	
Max	8.6	9580	260.0	270.0	730	2400	2788	1736	
Avg	7.64	2767	77.6	86.1	389	662	742	548	

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