Water Quality Index Assessment of Groundwater in Todaraisingh Tehsil of Rajasthan State, India-A Greener Approach

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Abstract: This study deals with the statistical analysis and study of water quality index to assess hardness of groundwater in Todaraisingh tehsil of Tonk district of Rajasthan state. The study has been carried out to examine its suitability for drinking, irrigation and industrial purpose. The presence of problematic salts contains in groundwater due to local pollutants and affected the groundwater quality adversely. The estimated values were compared with drinking water quality standards prescribed by B.I.S. It was found that drinking water is severely polluted with hardness causing salts. This study reveals that people dependent on water sources of the study area are prone to health hazards of contaminated water and quality managements to hardness urgently needed.

Keywords: Water Quality Index, Potable Water, Hardness, Greener approach.

Introduction

Rajasthan is India's largest state with an area of 3,42 km², which is 10.41% of the total area of our country and with an estimated population of 54 million spread over its 41,583 villages, which is 5.5% of nation's population but being just 1% of the total water sources of the country. Due to the scarcity of the surface water in Rajasthan¹⁻³, 70% of its population is dependent on groundwater resources for drinking, irrigation and other purposes. Water is not only essential for the lives of animals and plants but also occupies a unique position in industries. It is used for irrigation⁴, sanitation, power and steam generation⁵, air-conditioning, navigation, ecological and afforestation needs^{6,7} and recreation. It is also used as a coolant in power and chemical plants. In addition, water is widely used in other fields like production of paper, sugar, steel, atomic energy⁸, textile, chemicals⁹ and ice¹⁰.

Water is the first need of all vital life processes, hence called “Liquid of Life”. According to Greek medieval philosophy, matter consists of four elementary substances namely water, air, stone and fire. Indian medieval also opines that the matter is composed of five Panch Mahabhut (Five elementary substances) namely water, air, light (fire), earth (stone) and sky (space). Among the all known plants only earth is blessed by these all five elements. So, distinctive properties (physical, chemical and biological) of water and its essential role in the life supporting systems are our earth’s most important characteristics, and no other living planet in the universe according to Bourne. Water is absolutely essential for healthy living. It plays an indispensable role in the life of every species that survive in this world and required by all living organisms for their existence improper management causing availability and quality of water¹¹⁻¹³ Water is universal solvent so it has the capability to dissolve nearly all natural compounds. So alarming salts contain in ground water due to local pollutants and affected the groundwater quality adversely¹⁴⁻¹⁵ In recent years an alternative approach based on statistical has been used to develop mathematical relationship for comparison of physicochemical parameters¹⁶. It is parameter of water quality used to describe the effect of dissolved minerals (Mostly Calcium and magnesium) and suitability of water for domestic, industrial and drinking use. Minerals cause deposits of scale in hot water pipes and they also interfere with the lathering action of soap. According to degree of hardness it is classified as soft water (0-75 mg/L), moderately (75-150 mg/L), hard water (150-300 mg/L) and above 300 mg/L is very hard water¹⁷. Hardness of drinking water is a problem found in both ground & surface water and may cause too many problem in human physiological system and domestic & industrial purpose. So attention on hardness of water and its management has become need of hour.

About the study area

Tonk district is located in north eastern part of the state bordering Jaipur in north, Swaimadhopur in the east, Bundi & Bhilwara in south & Ajmer in the west. Tonk is known for its unity among Hindu and Muslims for which it is same time called as “Hindu Muslims Ekta ka Maskan”. The history of Tonk is very old it was called as Nawabi- Nagari “Tonk”. The Tonk is also known as the “Lucknow of Rajasthan” due to its elegance. Tonk is popular among tourists for its Magnificent Mosques, Mansion and havelis. In the ancient time Tonk was ruled by the tribes of “pathans” from Afghanistan. The old town boasts of the architecture prevalent in Mughal era. The focal point of Tonk is the Suneri Kothi, Hathibhata and Juma Masjid.

If hardness is in unlimited concentration than it may cause disease and such water is known as impure water and it should not be used as drinking water. In Tonk district geographically a ground strip, in the base of Aravali series contains fluorspar CaF_2 , $3\text{Ca}(\text{PO}_4)_2$ and fluorapatite (CaF_2). Some districts viz Jalore, Sirohi, Pali, Bhilwara, Tonk, Ajmer and Alwar¹⁸⁻²³ are in high concentration of water quality parameters due to this ground strip of Aravali series^{15,24}. The main object of this study is to identify and analyze hardness of water of rural area of Todaraisingh area of Tonk district.

Experimental

20 Water samples were collected from tube well, open well and hand pumps out of these five samples were collected from each direction of Todaraisingh Tehsil of Tonk. Samples examined for total hardness²⁵, Ca^{+2} as CaCO_3 & Mg^{+2} as CaCO_3 as per standards methods prescribed in APHA²⁶. The statistical analysis has been performed using standard methods²⁷.

Water quality index

The concept of WQI first proposed by horten²⁸. Water quality index indicate single number like a grade that express overall water quality index at certain area and time. It gives general idea of the possible problem with water in a particular region to public.

Calculation of water quality index (WQI)

In the first step, unit weight (Wi) was calculated by using the following formula:

$$W_i = k/S_i$$

Where k = proportionality constant, Si = Standards desirable value of parameter.

In second step the sub index (Qi) was calculated by using

$$Q_i = 100[(V_i - V_o) / (S_i - V_o)]$$

Where Vi = Concentrate of parameter in analyzed water, Si = Standards desirable value of parameter, Vo = Actual value of this parameter in pure water (for pure water Vo = 0 for hardness).

By using first and second step WQI was calculated by using following formula

$$WQI = \sum W_i Q_i / \sum W_i$$

Water quality index scale is as follows:

WQI	0 – 25	26 – 50	51 – 75	76 - 100	Above 100
Water quality	Excellent	good	poor	Very poor	Unsuitable

Results and Discussion

In this study, a total of twenty water samples from groundwater of Todaraisingh area of Tonk district of Rajasthan (India) were analyzed for water quality. In this five samples collected from each side of Tehsil for study and were analyzed for total hardness (TH) and compared with BIS standards. It has been found that total hardness range in the area was from 150 to 1350 mg/L. In the north direction TH range was 220 to 810 mg/L, in east direction TH range was 330 to 1350 mg/L, in west direction TH range was 200 to 970 mg/L & in south direction TH range was 390 to 1070 mg/L. The total average TH in the study area was 595 mg/L. In north direction average TH was 606 mg/L which is over than BIS, ISI & WHO standards. In east direction average total hardness was 680 mg/L which is more than BIS, ISI & WHO limit and in west direction maximum value of TH was 970 mg/L & minimum value was 150 mg/L and average value was 464 mg/L which is over than prescribed limit and in south direction maximum value was 1070 mg/L & minimum value was 390 and average was 630 mg/L, it is also more than BIS, ISI & WHO standards (Table 1).

Table 1. Comparison of TH content in the groundwater of the study area with drinking water standards

Parameter	ISI standards		WHO standards		No of sample exceeding permissible limit	% of sample exceeding permissible limit
	HDL	MPL	HDL	MPL		
T.H.	300	600	200	600	8	40
Ca ⁺²	75	200	75	200	15	75
Mg ⁺²	30	150	30	150	14	70

HDL - Highest Desirable Level; MPL - Maximum Permissible Level

In Todaraisingh Tehsil maximum value of TH was 1350 mg/L and minimum value was 150 mg/L and maximum average value was 680 mg/L and minimum average value was 464 mg/L and all analyzed value of total hardness of different site in each direction of Todaraisingh area of Tonk district are show in Tables 2-6.

Table 2. WQI in north direction of tehsil

Parameters	Site-I	Site- II	Site-III	Site-IV	Site-V	Average	BIS standard	Wi	Qi	Q _i Wi	WQI
T H, mg/L	760	570	810	670	220	606	300	0.003	202	0.60	202
Ca Hardness,mg/L	456	342	526	435	132	378.2	75	0.0133	504.26	6.70	503.75
Mg Hardness, mg/L	304	228	284	235	88	227.8	30	0.0333	759.33	25.28	759.15

Table 3. WQI in east direction of tehsil

Parameters	Site-I	Site- II	Site-III	Site-IV	Site-V	Average	BIS standard	Wi	Qi	Q _i Wi	WQI
T H, mg/L	1350	590	560	580	330	680	300	0.003	226.6	0.67	226.6
Ca Hardness, mg/L	810	384	450	377	198	443.8	75	0.0133	591.73	78.70	591.72
Mg Hardness, mg/L	540	206	110	203	132	238.2	30	0.0333	794	26.44	793.99

Table 4. WQI in west direction of tehsil

Parameters	Site-I	Site- II	Site-III	Site-IV	Site-V	Average	BIS standard	Wi	Qi	Q _i Wi	WQI
T H, mg/L	970	150	200	200	800	464	300	.003	154.6	0.46	154.6
Ca Hardness, mg/L	630	90	130	120	480	290	75	.0133	386.66	5.14	386.46
Mg Hardness, mg/L	340	60	70	80	320	174	30	.0333	580	19.31	579.87

Table 5. WQI in south direction tehsil (All results are in mg/L)

Direction	North	East	West	South
WQI	202	226.6	154.6	210
Water Quality	Unsuitable	Unsuitable	Unsuitable	Unsuitable

Table 6. WQI of Todaraisingh area of Tonk

Parameters	Site-I	Site- II	Site-III	Site-IV	Site-V	Average	BIS standard	Wi	Qi	Q _i Wi	WQI
T H, mg/L	1070	390	530	500	660	630	300	.003	210	0.63	210
Ca Hardness, mg/L	695	300	370	340	396	420.2	75	.0133	560.26	7.45	560.15
Mg Hardness, mg/L	375	90	160	160	264	209.8	30	.0333	699.33	23.28	699.09

Conclusion

In this study we have analyzed twenty water samples from various sources including hand pumps, tube well and open well of different areas in each direction of Tehsil Todaraisingh of Tonk District. Results shown in the tables were not within the limit as per the BIS, ISI & WHO standards. The observed range of WQI was 154.6 to 226.6 in Todaraisingh area of Tonk. It has been found that the WQI of west direction of Todaraisingh area was lowest and WQI of east direction of Todaraisingh area was highest. In this area water quality of drinking water sources were not suitable for drinking purpose as well as domestic purpose. Highest priority should be given to water quality monitoring and the indigenous technologies should be adopted to make water fit for drinking after treatment.

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