Assessment of Groundwater Quality of District, Jaipur, Rajasthan, India

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Abstract: Rajasthan is a state of India with severe climatic conditions that result in poor quantity and quality of water in this area. The main source of drinking water in Jaipur district of Rajasthan is open bore wells and closed bore wells. In the present research paper a study is carried out to assess the ground water quality in Jaipur, district, Rajasthan, India using Water Quality Index. For the study, 149 water samples were collected from open bore wells and closed bore wells of 16 different regions of the study area. Physio-chemical parameters selected for study included pH, electrical conductivity, temperature, TDS, total hardness, Cl-, F-, turbidity, BOD and alkalinity. The average water quality parameters in the entire study period are considered for calculating the WQI and from the results obtained, it is inferred that that no sampling location has excellent groundwater quality for consumption. Out of 16 sampling stations, water samples of four of the sampling stations namely Sanganer, Kothputli, Chomu and Shahpura were reported to have water samples which fall in good category. Whereas the water samples of remaining eight stations were not found suitable for drinking because they fall under category poor, very poor and unfit according to WQI. This study will enable the planners to take necessary steps in improving the water quality and extracting groundwater in Jaipur District.

Keywords: Groundwater quality, Physio-chemical parameters, Jaipur district, WQI

1. INTRODUCTION

In rural communities of India and mainly Rajasthan, ground water is the main source of water for drinking due to non availability of surface water. Considering the fact that, rural communities are mostly small and scattered over large area the most economic source of potable water is groundwater [1-4]. As per government documents, Rajasthan is one of the highest endemic states suffering from presence of high amount of contaminants in the underground water in most of the districts [5-7]. Due to presence of contaminants beyond the permissible limit of BIS, many successfully drilled bore wells have been closed down for human consumption and it has caused economic loss to the country [8-11]. For better management of groundwater resources in Rajasthan, a study of occurrence of contaminates mainly fluoride, chloride etc and their distribution in the groundwater in the region is needed. Thus key aim of this research paper is to gain an insight into the presence of various contaminates in groundwater in Jaipur district of Rajasthan with focus on the occurrence, genesis and their distribution in water and quality of water.

2. EXPERIMENTAL DETAILS

2.1 Sampling Points

Ground water samples were collected from open and closed bore wells from 16 villages of Jaipur District in clean and rinse bottles with proper care. The samples were collected from open bore wells and closed bore wells, with four to five samples from each type of source. Thus eight -ten samples from each region and a total of 149 samples were collected. The samples were collected randomly from pre fixed points up to a period of minimum one year. Table-1 lists the sources of sampling sites and detail statistics of samples collected.

2.2 Sampling Method

Sampling using grab sampling method was carried out manually for collecting ground water samples. Samples were collected in glass bottles of 500 ml capacity with stopper. Before collection of samples, bottles were washed with 2% nitric acid and thoroughly rinsed with distilled water two times, dried and then preserved in a clean place. At the time of sample collection the bottles were filled leaving no air space, and was then sealed to prevent any leakage. Each sample bottle was properly marked with self-adhesive labels mentioning information including - sample number, sample type, date and time of collection, place of collection, and type of sample source.

Table 1 Sampling Sites and Statistics of Sample Collected

Sample No.	Location	Number of samples collected	
		Open bore well	Closed bore well
S1	Jagatpura	4	5
S2	Snaganer	5	4
S3	Chakshu	4	4
S4	Viratnagar	4	5
S5	Kotputli	5	5
S6	Sitapura	4	5
S7	Bassi	5	5
S8	Jamwa Ramgarh	5	5
S9	Sambhar	5	5
S10	Chomu	4	4
S11	Dudu	5	4
S12	Mauzambad	4	5
S13	Shahpura	5	5
S14	Amber	5	5
S15	Jhotwara	5	4
S16	Phagi	5	5
	Total samples	**74**	**75**

2.3 Physico Chemical Analysis

The physico-chemical analysis was performed following standard methods. The brief details of analytical methods and equipment used in the study are given in the table- 2.

Table 2 : Parameters and Methods Employed for Measurement Physiochemical Analysis

S. No	Parameter	Methodology	Unit
1	pH	pH meter	-
2	Electrical Conductivity	Digital conductivity meter	mhos/cm
3	Temperature	Thermometer	^{o}C
4	TDS	Digital conductivity meter	mg/L
5	Total Hardness	With EDTA volumetrically	mg/L
6	Chloride	With AgNO3 volumetrically	mg/L
7	Fluoride	UV-visible spectrophotometer	mg/L
8	Alkalinity	With HCl volumetrically	mg/L
9	BOD	Winkler's Method	ppm
10	Turbidity	Nephlometer	NPU

3. WATER QUALITY INDICES

The water quality indices is a good tool to evaluate the level of water pollution. An index number is assigned mathematically combining all water quality parameters and output is given in a generalized form which can be readily understood and describes the quality of water. In the present study Weighted Arithmetic Index has been adopted to assess the status of existing water quality and to identify the physico-chemical parameters causing pollution. In Weighted Arithmetic Index an index number is assigned by mathematically combining all water quality parameters and output is given in a generalized form which can be readily understood and describes the water quality, thereby giving idea about impact of human activity on water quality. To initiate, weightage for various water quality parameters is calculated by keeping inverse of its BIS value for that particular parameter [12-13]. Table-3 provides the information about water quality parameter, their BIS standards and weightage.

$$Wi \propto 1 / Si$$

$$Wi = K / Si$$

Where, K = constant having value 1.1589

Further if Va and Vi are actual and ideal values of water quality parameters present in the water sample then rating is calculated using following equation:

qi (water quality rating) = {[(Va-Vi) / (Si -Vi)]*100}

WQI (Water Quality Index) = $\sum$qiWi

For all parameters ideal value is zero except for pH and DO [14]. On the basis of water quality index different water samples are categorized as given in table-4.

Table 3 : Assigned Value of Weightage factor (in mg/l except for pH)

Parameter	Standard Value (Sn&Si)	Assigned Weightage Factor (Wi)
pH	**7.5**	**0.1545**
Alkalinity	400 mg/l	0.0028
TDS	500	0.0023
Chloride	250 mg/l	0.0046
Fluoride	1.5 mg/l	0.7726
Turbidity	10 NTU	0.1158
BOD	7.0 mg/l	0.1655
Electrical Conductivity	1800 µS/cm	0.0006
Total Hardness	300	0.0038
Temperature	-	-

Table 4 : Categorization of Water Quality as per WQI

Water Quality Index (WQI)	Quality Of Water
0-24	EXCELLENT
25-49	GOOD
50-74	POOR
75-100	VERY POOR
>100	UNFIT FOR DRINKING

Table 5 : Physico-Chemical Characteristics Ground Water Samples

Sample code	Parameter	pH	Alkalinity	TDS	Cl^-	F^-	Turbidity	BOD	EC	HD	Temp
Open Bore Well											
S1	**Jagatpura**	7	303	326	163	1.3	8	5.1	1200	200	29.6
S2	**Sanganer**	7	203	275	125	1	7	4.9	1060	173	28.6
S3	**Chakshu**	8	387	1768	269	1.7	12	7.7	2475	421	30.4
S4	**Viratnagar**	9	524	765	230	1.2	12	8.9	1843	276	29.3
S5	**Kotputli**	6	112	134	75	0.8	7	3.2	921	145	27.9
S6	**Sitapura**	8	332	330	179	1.8	9	5.7	1350	239	30.5
S7	**Bassi**	7	225	243	128	0.9	8	4.9	1089	158	29.3
S8	**Jamwa ramgarh**	7	310	387	182	1.8	9	5.3	1321	225	28.5
S9	**Sambhar**	9	210	1986	241	1.6	11	8.5	1994	209	26.8
S10	**Chomu**	7	295	284	126	0.8	7	4.4	1164	152	26.8
S11	**Dudu**	7	450	826	260	1.9	12	7.5	1996	397	28.6
S12	**Mauzambad**	8	303	383	187	1.2	9	5.6	1368	260	27.6
S13	**Shahpura**	7	171	178	73	0.9	7	3.7	895	141	29.6
S14	**Amber**	8	315	350	152	1.7	9	6.2	1273	232	28.7
S15	**Jhotwara**	9	359	1549	289	1.2	11	8.3	837	285	28.9
S16	**Phagi**	9	471	1153	283	1.6	13	7.4	2106	145	27.9
Closed Bore Well											
S1	**Jagatpura**	7	314	303	147	1.4	9	5.3	1300	202	27.8
S2	**Sanganer**	7	220	283	126	1.2	8	4.4	1175	162	28
S3	**Chakshu**	8	368	1076	262	1.7	12	7	2010	375	30.2
S4	**Viratnagar**	8	500	680	240	1.3	11	7.1	1963	200	28.7
S5	**Kotputali**	7	189	102	52	0.9	7	3.2	909	127	27.4
S6	**Sitapura**	7	320	360	183	1.7	8	5.4	1298	238	29.4
S7	**Bassi**	7	252	240	126	0.7	7	4.1	1073	182	28.7
S8	**Ramgarh**	8	342	380	189	1.6	9	6	1361	129	28.6
S9	**Sambhar**	8	277	2000	257	1.9	12	6.8	2012	220	26.9
S10	**Chomu**	8	297	273	143	0.9	8	5.3	1043	176	26.7
S11	**Dudu**	8	496	863	259	1.7	11	7.6	2076	346	28.5
S12	**Mauzambad**	7	301	324	166	1.3	9	5.9	1375	235	27.5
S13	**Shahpura**	7	118	180	100	0.8	7	3.8	954	127	28.5
S14	**Amber**	8	326	343	160	1.6	9	5.7	1364	245	29
S15	**Jhotwara**	7	321	1835	285	1.9	11	7.1	959	254	29.4
S16	**Phagi**	7	418	1074	282	1.9	12	8.1	1976	196	27.8

4. RESULTS AND DISCUSSION

Based on physico-chemical analysis, assessment of quality of groundwater and calculate its appropriateness for drinking is one of the objectives of the present study. Samples collection from open bore well and closed bore well have been analyzed for ten water quality parameters and analytical results reported in table 5.

4.1 Analysis of Water Quality Index

Values of Water Quality Index obtained on the basis of calculations done for open and closed bore well are mentioned in table-6. Results show that WQI value for open bore well samples is in the range of 32.48 to 163.21and for closed bore well samples is in the range 35.14 to 166.62.

Table 6 : WQI Values for Open and Closed Bore well Ground Water Samples.

S. No.	Station	Open Borewell	Close Borewell
1	Jagatpura	69.19	76.76
2	Sanganer	46.84	48.14
3	Chakshu	150.73	144.07
4	Viratnagar	97.07	102.15
5	Kotputali	32.48	54.71
6	Sitapura	95.94	97.66
7	Bassi	70.86	60.61
8	Ramgarh	96.56	98.4
9	Sambhar	163.21	166.62
10	Chomu	49.26	48.35
11	Dudu	138.5	144.33
12	Mauzambad	101.73	95.76
13	Shahpura	33.59	35.14
14	Amber	98.1	94.07
15	Jhotwara	97.27	93.15
16	Phagi	145.17	149.71

The average water quality parameters in the entire study period are considered for calculating the WQI for all over the study period. As per the results obtained (Table- 8) for 16 sampling stations, water samples of four of the sampling stations namely Sanganer, Kothputli, Chomu and Shahpura were reported to have water samples which fall in good category. Whereas the water samples of remaining eight stations were not found suitable for drinking because they fall under category poor, very poor and unfit according to WQI. From the results, it is also seen that the water quality index varies from a minimum value of 34.37 (Shahpura) to a maximum value of 164.92 (sambhar) for the study area of Jaipur District. Majority of the sampling points have groundwater samples in the category very poor and unfit for drinking and have WQI in the range 75 to 100 and >100 respectively. Table- 8 summarizes the information mentioning different sampling points of Jaipur district with varying values of WQI. Pie chart (Figure-1) shows the percentage variation of different categories of waters. These results will enable the planners to take necessary steps in extracting groundwater in Jaipur District.

Table 7 : Classification of water in the study area as per WQI

S. No.	Station	Σ(Wi x Qi)=WQI	Classification as per WQI
1	Jagatpura	72.98	Poor
2	Sanganer	47.49	Good
3	Chakshu	147.40	Unfit for drinking
4	Viratnagar	99.61	Very poor
5	Kotputali	43.60	Good
6	Sitapura	96.80	Very poor
7	Bassi	65.74	Poor
8	Ramgarh	97.48	Very poor
9	Sambhar	164.92	Unfit for drinking
10	Chomu	48.81	Good
11	Dudu	141.42	Unfit for drinking
12	Mauzambad	98.75	Very poor
13	Shahpura	34.37	Good
14	Amber	96.09	Very poor
15	Jhotwara	95.21	Very poor
16	Phagi	147.44	Unfit for drinking

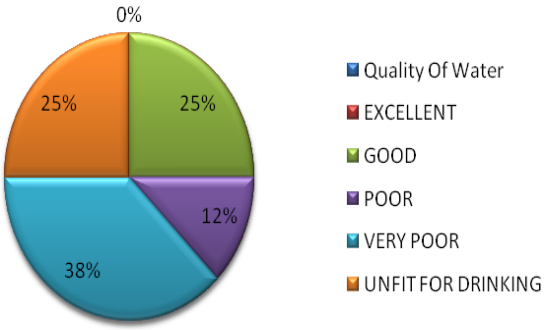

Figure 1: Percentage representation of WQI classification for the entire study period

4.2 Analysis of Water Quality Parameters

Table-8 shows analysis of various water quality parameters like pH, alklanity, TDS, F-, Cl-, Turbidity and Electrical Conduction. From the data it is clear that quality parameters water of stations viz. Viratnagar, Jhotwara, Kotputli, Phagi, Sambhar, Chaksu and Dudu are not as per recommended limits. So they need special attention.

Table 8: Analysis of water quality parameters in the study area

S.NO	Parameter	Station	Open Bore Well	Close Bore Well	Result
1	pH	Viratnagar	9.3	7.5	High
		Jhotwara	8.7	7.3	High
		Phagi	8.9	7.2	High
2	Alklanity	Kotputli	189 mg/L	112 mg/L	Less
		Shahpura	118 mg/L	171 mg/L	Less
		Viratnagar	500 mg/L	525 mg/L	High
3	TDS	Sambhar	1986 mg/L	2000 mg/L	High
		Jhotwara	1549 mg/L	1835 mg/L	High
		Phagi	1074 mg/L	1153 mg/L	High
4	Cl^-	Jhotwara	289 mg/L	285 mg/L	High
		Phagi	283 mg/L	282 mg/L	High
5	F^-	Sambhar	1.6 mg/L	1.9 mg/L	High
		Jhotwara	1.2 mg/L	1.9 mg/L	High
		Phagi	1.6 mg/L	1.9mg/L	High
6	Turbidity	Chaksu	12 NTU	12 NTU	High
		Viratnagar	12 NTU	11 NTU	High
		Phagi	13 NTU	12 NTU	High
7	EC (µS/cm)	Sambhar	1994	2012	High
		Phagi	2106	1976	High
		Dudu	1996	2076	High

5. CONCLUSION

Results of Water Quality Index calculation and analysis of water quality parameters conclude that groundwater of Chakshu, Sambhar, Dudu and Phagi regions are completely unfit for drinking purposes. Six major regions of study area namely Viratnagar, Sitapura, Ramgarh, Mauzambad, Amber and Jhotwara were declared as very poor groundwater source. Although remedial measures are being taken by central and state government, but are not satisfactory enough. WQI study helped in drawing meaningful information for understanding and dealing with alarming status of ground water resources in Jaipur district.

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