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Assessment of Physico-chemical Status of Groundwater Samples of Dholpur District, Rajasthan, India

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Abstract

In the present study efforts has been made to assess the extent of water pollution due to the excess use of fertilizers and pesticides in agriculture and its impact on ground water quality of three different dug wells in Dholpur district of Rajasthan, India. The different Physico chemical parameters like pH, Temperature, TDS, Conductivity, Nitrate, Sulphate, Dissolved oxygen Hardness, sodium, Potassium, Chlorides and chemical oxygen Demand were determined. The present study reveals that water quality of the selected sampling station is within the limit prescribed by WHO and can be used for domestic purpose.

Keywords: groundwater, physico-chemical parameters, sampling sites

1. Introducation

Water is extremely essential for survival of all living organism. The quality of water is vital concern for mankind since it is directly linked with human welfare. In India, most of the population is dependent on groundwater as the only source of drinking water supply. Groundwater is believed to be comparatively much clean and free from pollution than surface water (Akinbile & Yusoff, 2011). But prolonged discharge of industrial effluents, domestic sewage use of fertilizers and pesticides, waste dump causes the groundwater to become polluted and creates health problems (Ramakrishnaiah et al., 2009). The problems of groundwater quality are much more acute in the areas which are densely populated, thickly industrialized, excess use of pesticides and fertilizers in rural area and shallow ground water tablets. The rapid growth of urban areas has further affected groundwater quality due to overexploitation of resources and improper waste disposal practices. Hence there is always a need for concern over the protection and management of groundwater quality.

Considering the above aspects of groundwater contamination, the present study was undertaken to investigate the possible impact on the groundwater quality of some dug wells of Dholpur district of Rajasthan. Thus, in this paper an attempt has been made to assess the physical and chemical properties of groundwater.

2. Study Area

Dholpur District has an area of 3084 km². The Chambal River forms the southern boundary of the district, across which lies the state of Madhya Pradesh. The district is bounded by the state of Uttar Pradesh on the east and northeast, by Bharatpur District of Rajasthan on the northwest, and Karauli District of Rajasthan on the west. People with basic occupation agriculture utilize Groundwater for farming, domestic and for drinking purpose. Literature survey reveals that no water quality management studies has been carried in this region, hence the present study was planned and undertaken.

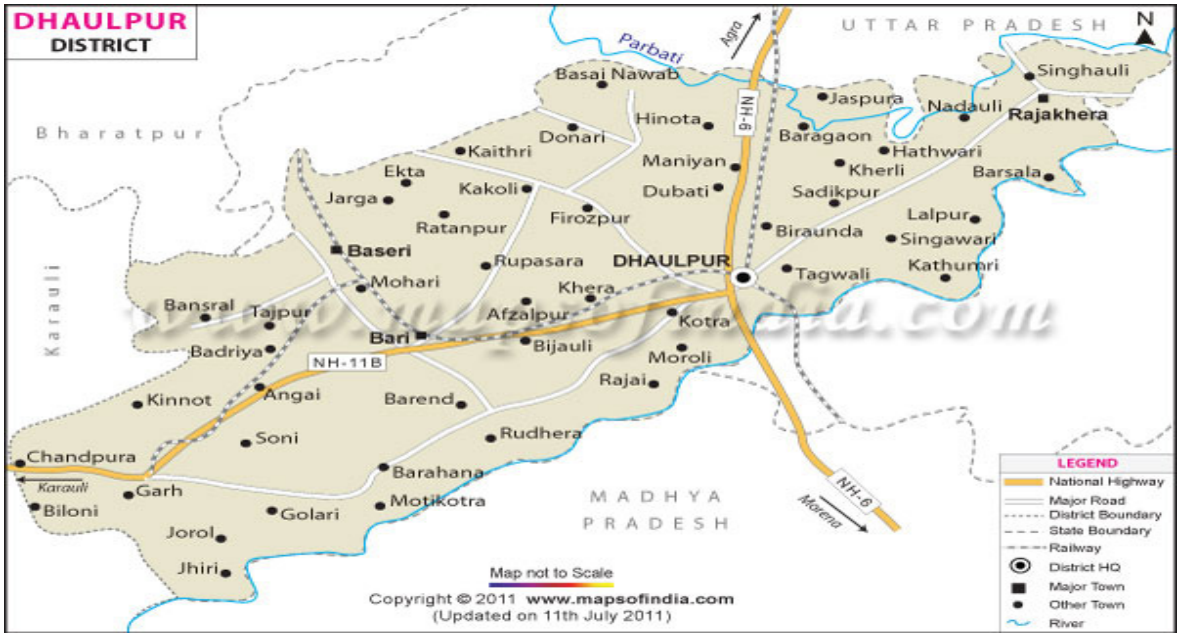


Figure 1. Map of study area

3. Materials and Methods

3.1 Survey and Sample Collection

Survey was conducted during the months of January, February and March (winter season) and August, September, October (rainy season) of year 2011 of the sixteen different areas all around Dholpur District, Rajasthan.

Table 1. Name of location in Dholpur District used for water sampling

S.No.	Sampling Area	S.No.	Sampling Area
1	Ramkunj Colony	6	Santar Road
2	Kachari	7	Girraj Colony
3	Melaground	8	Sitaram Colony
4	Near LIC Office	9	Vaishnu Devi
5	Nihalganj Colony	10	Purana Saray

3.2 Physico-chemical Analysis

All the samples were analyzed for the following physicochemical parameters; Temperature, pH, Electrical Conductivity (EC), Total Dissolved Solid (TDS), Total Alkalinity(TA), Chloride, Total Hardness(TH), Ca hardness, Mg hardness, Dissolved Oxygen (DO), Chemical Oxygen Demand(COD), Nitrate, Sulphate, Fluoride. The physicochemical analysis of water samples were carried out in accordance to standard analytical methods [APHA] (2005).

All the samples were collected in three liter capacity polythene bottle having doubly stopper. Prior to the collection, the well cleaned sample bottles were rinsed thoroughly with the sample water to be collected. After collecting the samples, the bottles were immediately closed tightly.

In case of open wells the samples were collected from a depth of about one meter from the upper surface of water (Patil & Patwari, 2003). Each sample bottle was clearly labeled with a permanent marker and relevant details were recorded. All the sample bottles were sealed and brought to the laboratory as soon as possible after protecting them from direct sunlight during transportation. Then so collected from wells in and around the area of investigation for two season from Jan to March and August to October (winter and rainy) 2011 respectively.

All the samples were preserved by diluting with HNO_3 solution and these water samples were analyzed within 24 to 48 hrs after collection.

Table 2. List of chemical parameters and their test methods

S.No.	Parameters	Unit	Test Methods
1	Temperature	℃	Thermometric Method
2	pH	-	Digital pH-meter
3	Total Dissolved Solids	Mg/L	Digital Conductivity-meter
4	Electrical Conductivity	Siemens/cm^2	Digital Conductivity-meter
5	Dissolved Oxygen (DO)	Mg/L	Winkler Method
6	Chemical Oxygen Demand (COD)	Mg/L	Open Reflux Method
7	Chloride	Mg/L	Argentometric Method
8	Sulphate	Mg/L	Nepthalometrically
9	Total Alkalinity	Mg/L	Volumetrically by silver nitrate titrametric method using potassium oxalate as indicator
10	Total Hardness as $CaCO_3$	Mg/L	EDTA Method
11	Nitrate	Mg/L	Phenol Disulfonic method
12	Fluoride	Mg/L	Spectrophotometric Method
13	Nitrogen	Mg/L	Kjeldahl's Method

The Physico-chemical analyses of groundwater samples were carried by instrument and non-instrumental method as per given Table 2. The elemental analysis carried out by digital Flame Photometer in the laboratory of Jayoti Vidyapeeth Women's University, Jaipur. All the reagents used for the analysis were AR grade and double distilled water used for preparation of solutions.

4. Result and Discussion

The Physico-chemical analysis of the groundwater samples of two sampling sites of Dholpur district ofRajasthan was carried and their average values of seasonal variation are presented in Table (3) and (4).

Temperature: Temperature is basically important for its effect on chemical and biological reaction in the organisms living in water (Morrison et al., 2001). A rise in the temperature of water leads to the speeding up of the chemical reactions in water, reduces the solubility of gases and amplifies the taste and adours (Trivedi & Goel, 1984). The average temperature varied within the range of 25.0℃ to 28.9℃.

pH: pH is measure of intensity of acidity or alkalinity of water [9-10]. All chemical and biological reactions are directly dependent upon the pH of water system (Rao, 2006). In our finding pH varied between 6.73 to 8.08. Maximum pH was recorded at S8 in rainy and minimum at S4 in winter season; which was well within the permissible limit prescribed by WHO (1993).

Total Dissolved Solids (TDS): Total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and Nitrates of Calcium, Magnesium, Sodium, Potassium, Manganese, organic matter salt and other particles (Siebert et al., 2010). In the present finding TDS value varied from 968 ppm to 2206 ppm. Maximum TDS recorded at S1 in winter and minimum at S9 in rainy.

Electrical Conductivity: The electrical conductivity of water depends upon the concentration of ions and its nutrient status. Based on electrical conductivity values the water quality can be classified as poor, medium or good (Gulta, Sunita, & Saharan, 2009). In the present investigation maximum conductivity was observed at S2 in winter and minimum at S5 in rainy.

Dissolved Oxygen: Dissolved oxygen is important parameters in water quality assessment and reflects the physical and biological process prevailing in the water. The DO values indicate the degree of pollution in water bodies (Rajmohan & Elango, 2005). DO values in the present finding varied from 3.2 to 6.8. Maximum and minimum recorded at S3 in rainy and at S7 in winter season respectively.

Table 3. Physico-chemical parameters of groundwater at Dholpur district, (average value) in winter & rainy Season

S.No.	Parameter	Average Value of S1		Average Value of S2		Average Value of S3		Average Value of S4		Average Value of S5	
		Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy
1	Temp (℃)	27.5	28.5	27.5	28.0	26.5	29.0	25.5	28.9	27.0	28.9
2	pH	6.78	7.02	7.83	7.95	7.23	7.83	6.73	7.12	7.23	7.84
3	TDS (mg/L)	2206	1736	1009	1033	1217	1205	1112	1023	1520	1720
4	Conductivity (μmho/cm)	2480	2340	3240	2840	1490	1428	1732	1642	1589	1369
5	Dissolved Oxygen (mg/L)	5.6	5.2	4.7	5.8	4.9	6.8	5.1	5.8	5.8	6.6
6	COD (mg/L)	6.7	7.2	5.2	6.3	3.7	4.5	3.7	4.7	3.3	4.6
7	Chloride (CaCO3 mg/L)	125.7	112.6	134.6	128.6	127.3	126.5	132.2	127.2	143.2	136.5
8	Total Hardenss (CaCO3 mg/L)	1036	960	660	509	1204	980	668	604	484	438
9	Total Alkalinity (CaCO3 mg/L)	692	723	559	569	1289	1328	768	772	498	526
10	Nitrogen (mg/L)	8.6	7.6	6.7	5.9	7.8	5.8	6.8	5.0	7.8	6.3
11	Sulphate (mg/L)	13	16	72	83	10	11	46	43	65	71
12	Nitrate (mg/L)	76.9	73	77.3	60	74.1	60	74.1	20	36.7	62
13	Fluoride (mg/L)	0.09	0.72	0.02	1.0	0.05	1.05	0.22	4.56	0.04	0.58

Table 4. Physico-chemical parameters of groundwater at Dholpur district, (average value) in winter & rainy Season

S.No.	Parameter	Average Value of S6		Average Value of S7		Average Value of S8		Average Value of S9		Average Value of S10	
		Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy	Winter	Rainy
1	Temp (℃)	26.5	28.5	27.3	28.2	27.2	28.5	26.5	27.9	27.5	28.8
2	pH	7.61	7.63	7.12	7.66	7.23	8.08	7.23	7.45	7.21	7.66
3	TDS (mg/L)	2106	1926	1236	1105	1205	1125	1026	968	1658	1596
4	Conductivity (at 25^0Cμmho/cm^2)	2380	2210	2520	2360	1658	1529	1896	1640	1586	1428
5	Dissolved Oxygen (mg/L)	3.5	6.8	3.2	6.7	4.3	5.3	2.8	4.7	5.6	5.2
6	COD (mg/L)	3.3	4.2	3.0	5.0	1.9	3.2	3.0	5.2	6.3	8.5
7	Chloride (CaCO3 mg/L)	127.2	122.6	144.2	138.3	129.3	128.5	142.6	137.9	123.2	116.5
8	Total Hardenss (CaCO3 mg/L)	1136	998	650	589	1206	1023	669	645	496	458
9	Total Alkalinity (CaCO3 mg/L)	662	726	645	469	1035	960	965	1252	569	653
10	Nitrogen (mg/L)	8.3	7.3	6.5	5.9	7.5	6.9	6.4	5.3	7.3	6.5
11	Sulphate (mg/L)	48	57	12	16	37	47	76	81	48	50
12	Nitrate (mg/L)	66.9	77	71	38	73.6	71	73	81	73.6	81
13	Fluoride (mg/L)	0.05	0.95	0.02	3.72	0.02	0.54	0.01	0.38	0.23	1.63

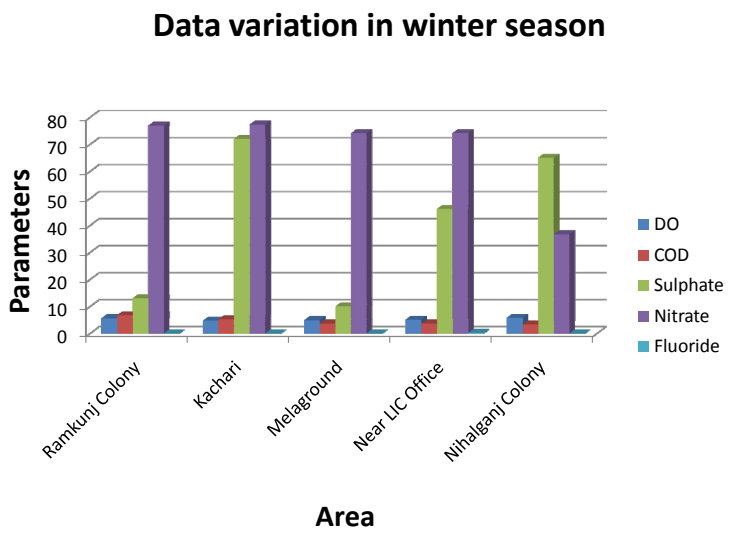
Chemical Oxygen Demand (COD): Chemical oxygen Demand determines the oxygen required for chemical oxidation of organic matter. COD values may be attributed to the amount of dissolved oxidizable organic matter including the non-biodegradable matter present in it (Siebert et al., 2010). In our present investigation COD varied in the range of 1.9 to 7.2 ppm.

Chlorides: Chloride contents in fresh water are largely influenced by evaporation and precipitation. Chloride ions are generally more toxic than sulphate to most of the plants and are best indicator of pollution (Rao, 2006). In present finding maximum chloride concentration were recorded at S7 in winter and minimum at S1 in rainy season.

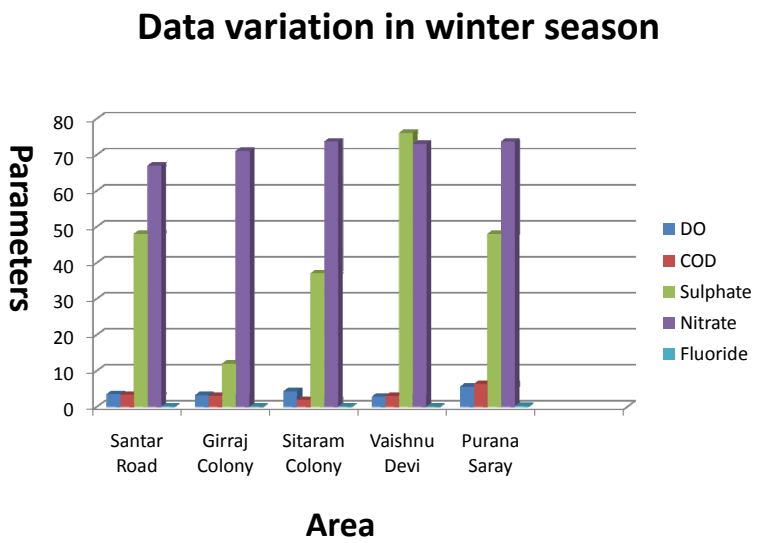
Chloride concentration in water samples varied from 112.6 ppm to 144.2 ppm. These value are under the permissible limit according to WHO.

Sulphate: In the present study, sulphate concentration was found to be in the range between 10 to 83 ppm. Minimum at S3 in winter while maximum at S2 in rainy season.

Hardness: Hardness is the property of water which prevents lather formation with soap and increases the boiling point of water. Hardness of water mainly depends upon the amount of calcium or magnesium salt or both. In our findings hardness value varied from 438 ppm to 1206 ppm, which are beyond the permissible limit as prescribed by WHO.



(Analysis of parameters in different areas)



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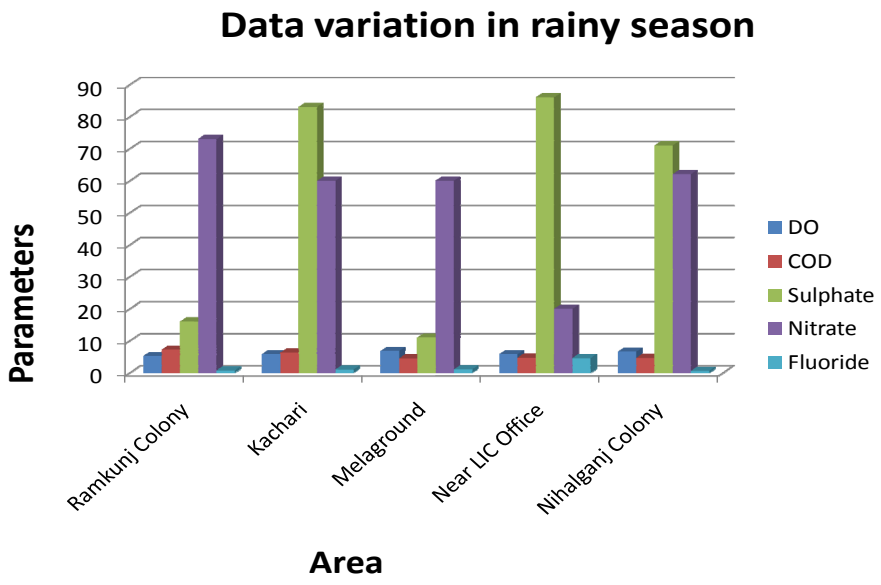

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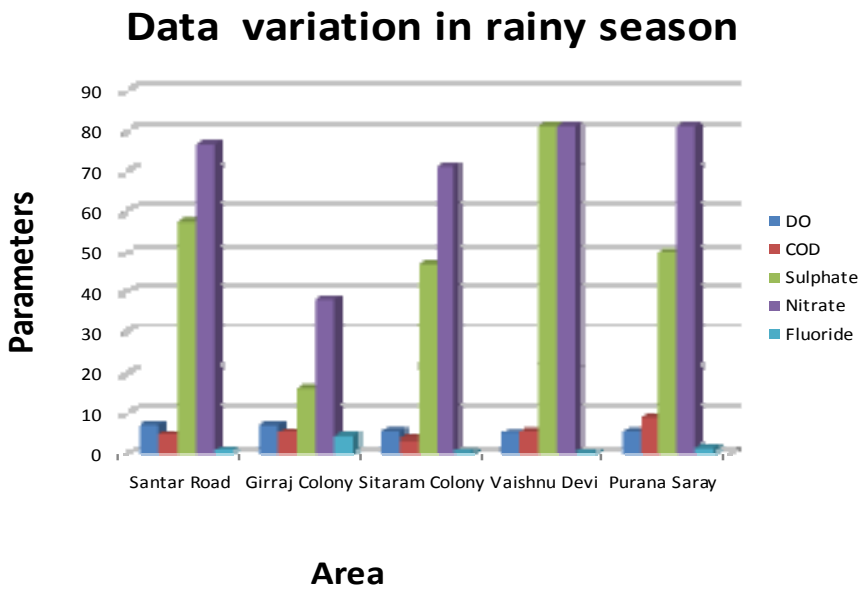

(Analysis of parameters in different areas)

Total Alkalinity: Alkalinity ranges from 498 to 1289 mg/lit. All the values of Alkalinity are beyond the Permissible limit of WHO (1993). Alkalinity is the cause of Carbonate and Bi –carbonate.

Table 5. Range in value of Physico-chemical parameters in the groundwater of study area and WHO & ISI standard

S.No.	Parameters	Units	Range in study	WHO	ISI
1	pH	-	6.73-8.08	6.5-8.5	6.5-8.5
2	Electrical Conductivity	Micro mho/cm	1369-3240	1400	-
3	Chloride	Mg/L	112.6-144.2	250	1000
4	Fluoride	Mg/L	0.02-4.56	1.5	2.0
5	Nitrate	Mg/L	20-81	45	100
6	Total Hardness	Mg/L	438-1206	500	600
7	Alkalinity	Mg/L	498-1289	120	600
8	TDS	Mg/L	968-2206	1200	2000
9	DO	Mg/L	3.2-6.8	6.0	3
10	Sulphate	Mg/L	10-83	400	-

5. Conclusion

The study was undertaken to assess the quality of ground water samples of Dholpur District of Rajasthan. A Physico-chemical analysis of groundwater samples were carried monthly, considering certain important parameters like Temperature, pH, TDS, Conductivity, DO, COD, Cl^-, SO_4^{2-} and total Hardness etc. The present study reveals that maximum parameters of the study area do not exceed the permissible limit prescribed by WHO (1993). The groundwater satisfies the need of the villager's in the vicinity of study area.

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