International Journal of
Research in Chemistry and Environment
Available online at: www.ijrce.org
ISSN 2248-9649

Research Paper

Physico-Chemical Characteristics of Underground water Quality of Some Villages of Jhunjhunu District of Rajasthan, India

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(Received 30th July 2015, Accepted 25th September 2015)

Abstract: *Physico-chemical characteristics of underground water of Some Villages of Jhunjhunu District of Rajasthan, India have been studied. Water samples of the 15 villages from Jhunjhunu District of Rajasthan were collected and analysed for physico-chemical parameters like electrical conductivity, pH, temperature, total hardness, total dissolved solids, and concentrations of ions like sodium, potassium, fluoride, chloride, nitrate and sulphate. The result were compared with the drinking water standards of WHO (1973) and ISI (10500-91). The study indicates the need for monitoring of underground water for physico-chemical characteristics in study area. An efficient calculations were made to calculate the correlation coefficient 'r' along with the parameters and the study give an idea about the positive and significant correlation of TH with TDS, SO_4^{-2} and Cl^- ion concentrations, while TH show outstanding correlation with Cl^- ion concentrations.*

Keywords: Underground water, Correlation co-efficient, Physico-chemical characteristics.

Introduction

Water is important to the functioning of the human body and the human body cannot survive without it. Water quality is necessary for all the people, the quality of water can be affected by different pollutants such as, physical, chemical and biological. Pollutants like viruses, bacteria, salt, nitrate and heavy metals have found their method into water supplies, the water pollution occur when a body of water is badly affected due to the presence of huge amounts of pollutants to the water [1]. In rural area the arid and semi arid zones, where well managed water transportation system and linked infrastructures are unavailable, groundwater serves as principal source of drinking water.

Groundwater is an excellent reservoir of water but as lakes, streams and rivers are influenced by human and natural factors, groundwater is also face the same situation around the world. Hydrological aspects, human activities and characteristics of recharged water influence the quality of groundwater. As groundwater is used in large amount, some difficulty are created such as lowering of water table, water logging, land subsidence, sea water intrusion in coastal deterioration and aquifers in water quality [2].Groundwater is most sensitive topic which has importance not only at local level, but also at global level [3-5]. Similar to other countries, the issue of groundwater has become a problem of significance for the development of India. Unlimited exploration of groundwater and extreme use of pesticides and fertilizers make probable the access of determine the constituents to the groundwater. Industrial and domestic waste also affected groundwater [6]. As a result, groundwater becomes unhealthy [7-8] Hence a constant monitoring on groundwater becomes compulsory in order to reduce the groundwater pollution and control the pollutants [9]. This study involves the determination of physical and chemical parameters of groundwater of Jhunjhunu District of Rajasthan of different villages. The purpose of this study is to determine the water quality, through analysis of selected water samples, quality parameters like temperature, pH, EC, TH, TDS, Na^+,

K^+, Cl^-, F^-, NO_3^-, SO_4^{-2} and compare the results with the standards values suggested by ISI and WHO.

Material and Methods

About Jhunjhunu District

Jhunjhunu District is one of 33 Districts of Rajasthan State. The administrative head quarter of Jhunjhunu District is in Jhunjhunu. It is Located 164 KM South towards State capital Jaipur. Population of Jhunjhunu District is about 2139658. It is 12th Largest District in the State by population.

Geography and Climate Jhunjhunu District

Jhunjhunu District is Located at Latitude-28.1, Longitude-75.3. Jhunjhunu District is sharing border with Bhiwani District to North, Churu District to west, Sikar District to South. It is sharing Border with Haryana State to the North. Jhunjhunu District occupies an area of approximately 5928 square kilometers. It has 420 to 278 meters elevation range. This District belongs to Hindi Belt of India.

Climate of Jhunjhunu District

It is Hot in summer. Jhunjhunu District, The highest day temperature is in summer between 24°C to 46°C. Average temperatures of January is 15°C , February is 18°C , March is 25°C , April is 31°C , May is 36°C .

Demo Graphics of Jhunjhunu District

The People Jhunjhunu District Speaks Rajasthani and Hindi. Jhunjhunu District is divided into 9 Tehsils, Panchayats, and 887 Villages.

Census 2011 of Jhunjhunu District

The total population of Jhunjhunu district is about 2139658 according to census 2011. Females are 1042397 and Males are 1097261. Literate people are 1415598 among total. Its total area is about 5928 km². It is the 12th largest district in the state by Population. But it is the 22nd Largest District in the state by Area, 213rd Largest District in the Country by Population, 3rd highest District in the State By literacy rate and 263rd highest District in the Country By literacy rate. Its literacy Rate is about 74.72

Study area

Jhunjhunu district of Rajasthan is located in the extreme north eastern part (bordering Haryana state) of Rajasthan State and lies between 27°38′ & 28°31′ north latitudes and 75°02′ &76°06′ east longitudes. It covers 5928 sq.km. of geographical area. The administrative set up of the district is given below.

Jhunjhunu district is covered under mainly basin of Sekhawati and north western area falls under the outside the basin i.e. having inland drainage. The area is drained mainly by River Kantli. The area in the south eastern part is drained by River Singhana and a minute area in south western corner of district is drained by Nala Budhi. The south and east of hill ranges in area of Khetri is drained by River Dohana. All the rivers/Nalas are temporary in nature and flows in response to heavy rainfall during monsoon session. Being a desertic landscape particularly in north eastern and north western part of district has inland drainage

Rajasthan is the largest state in the country in terms of geographic spread. It has 342,239 lakh Sq kms area, being largest state of the country having 10.41 % of the country's area and 5.5% of nation's population but has less water resources i.e. 1% of the country's resources. The state has extreme geographical and climatic condition and it suffers both the problems of quality and quantity of water.

Methodology

Groundwater samples were collected from Jhunjhunu District of Rajasthan. Samples were collected in clean polythene bottles and rinsed three to four times with the water samples before the samples were stored at a temperature below 4^0C before analysis in the laboratory. Physical and chemical parameters such as pH, TDS, EC, Cl^-, NO_3^-, SO_4^{-2} and F^- were calculated by standard methods [10]. Potassium and Sodium were calculated by Flame photometer methods (systronic -128). Specific chemicals were used for the analysis and double distilled water was used for preparation of solutions. Sample locations are shown in the Figure 1.

S. No.	Sub-division	Tehsil	Block	Area (sq.km.)
1	Chirawa	Chirawa	Chirawa	493.04
			Surajgarh	779.09
2	Jhunjhunu	Jhunjhunu	Alsisar	827.15
			Jhunjhunu	751.90
3	Khetri	Buhana	Buhana	651.14
		Khetri	Khetri	819.44
4	Nawalgarh	Nawalgarh	Nawalgarh	696.80
5	Udaipurwati	Udaipurwati	Udaipurwati	867.28

Figure 1: Study area

Results and Discussion

In studied areas the groundwater was free from odor and color. The physico-chemical characteristics of water sample analyzed have been presented in Table 1. The data revealed that there was an extensive physic-chemical variation in the analyzed samples.

The variations were not only in the samples collected from different localities, but the samples collected from the same locality were also having extensive variations in water quality. This is due to irregular distribution of rocks or due to difference in depth of water resources installed. A comparison of the depth of the water resources installation indicates that the deep installations were superior to the shallow installations with respect to the water quality in the study area. Since shallow water resources draw water from the top most bearing structure, which is responsible to contamination by various natural in addition to anthropogenic sources percolating in the locality and taking with it minerals, etc.

Temperature (T) in ^{0}C

Temperature plays a vital role in the metabolic activities of the organism [11]. The temperature was ranging from 26.6 ^{0}C to 30.5 ^{0}C during the study period.

pH

pH is considered as most important environmental factor which provides an important factor and information in many type of solubility, calculation or geochemical equilibrium [9]. pH values of water samples were varied between 6.68 to 9.05. The sampling points S_{15} showed high pH values.

Electrical Conductivity (EC)

The electrical conductivity is an indicator of the degree of mineralization of water. Which depends upon degree of dissociation, concentration and migration velocity of ions in the electric field? In the study it varied from 1000 µs/cm. to 3600 µs/cm. The electrical conductivity is correlated with total dissolved solids [12].

Total Dissolved Solids (TDS)

TDS means the concentrations of all dissolved minerals in water which show the salinity of water. In the study TDS value varied between from 310 mg/l to 1030 mg/l.

The sample points S_6 and S_9 showed higher range of TDS than desirable limits of 1000 mg/l. TDS in groundwater originate from sewage, natural sources, urban run-off and industrial wastes [13].

Total Hardness (TH)

Total Hardness of water is due to the natural accumulation of salts from contact with soil or it may enter from direct pollution by industrial effluence. The hardness of water generally depends upon the quantity of calcium or magnesium salts or both. In the study TH differ from 58.34 mg/l to 312.76 mg/l. The values for sample from point S_9 and S_{15} were higher than the ISI prescribed limit [14].

Sodium (Na^+)

The concentrations of Sodium are varied between 7.99 mg/l to 65.33 mg/l. which found within the WHO limit.

Table 1: Physico-chemical Characteristics and Concentrations of Underground water Samples of Some Villages of Jhunjhunu District of Rajasthan, India

Sample No.	Sample Location		T^0C	pH	EC µs/cm	TDS mg/l	TH mg/l	Na^+ mg/l	K^+ mg/l	Cl^- mg/l	F^- mg/l	NO_3^- mg/l	SO_4^{-2} mg/l
S_1	Pilani	Min.	27.5	7.18	1300	440	98.78	42.66	50.88	62.3	0.52	6.7	10.5
		Max.	29.5	7.32	1600	490	127.98	56.21	58.42	74.8	0.61	12.8	24.2
		Average	28.4	7.27	1400.7	470.6	115.36	51.34	55.89	71	0.56	8.9	16.3
S_2	Chirawa	Min.	26.6	7.44	2000	710	181.91	41.54	42.41	245.5	0.19	6.4	30.1
		Max.	30.2	7.81	2400	770	211.23	52.44	51.75	275.3	0.25	13.3	41.4
		Average	27.9	7.72	2022.9	746.8	200.54	48.49	46.78	269.8	0.23	8.2	35.6
S_3	Surajgarh	Min.	27.1	7.33	1000	320	73.96	17.22	11.56	10.9	0.88	55.3	7.5
		Max.	29.9	7.51	1100	380	89.44	29.65	19.18	35.4	0.95	68.2	14.8
		Average	28.2	7.46	1084.2	345.3	81.63	22.78	15.69	14.2	0.93	65.4	9.5
S_4	Buhana	Min.	26.7	6.95	1800	640	100.65	29.77	10.61	112.2	0.92	13.4	17.4
		Max.	29.8	7.18	2000	700	128.57	47.24	18.98	139.1	0.99	20.5	28.5
		Average	27.8	7.1	1946.3	667.9	119.51	39.63	15.72	127.8	0.96	16.1	21.2
S_5	Singhana	Min.	27.1	7.62	2600	920	222.65	40.12	49.49	260.6	0.39	21.6	48.2
		Max.	30.4	7.84	3000	980	246.87	53.66	58.17	301.3	0.46	32.9	58.9
		Average	28.8	7.73	2776.5	952.4	237.64	49.74	55.89	298.2	0.42	28.5	55.3
S_6	Khetri	Min.	26.6	7.96	2800	970	232.97	12.89	10.96	284.9	0.53	37.7	44.1
		Max.	29.5	8.27	3600	1030	254.12	21.73	17.91	315.2	0.58	49.1	53.7
		Average	28.3	8.18	2844.3	991.5	246.32	16.77	13.21	310.3	0.56	45.2	50.8
S_7	Baggar	Min.	26.9	7.15	1900	700	155.77	27.12	39.54	355.4	0.61	21.2	37.8
		Max.	30.1	7.44	2300	750	178.62	39.79	48.11	381.2	0.67	35.5	49.9
		Average	28.5	7.32	1958.4	728.8	168.55	34.39	44.86	377.6	0.63	29.5	45.3
S_8	Jhunjhunu	Min.	27.4	6.82	1000	310	64.97	7.99	12.72	56.3	0.85	9.8	8.4

		Max.	30.2	7.09	1100	360	87.34	10.84	18.29	66.8	0.91	17.3	16.3
		Average	28.6	6.95	1081.3	346.2	78.53	9.89	15.65	63.9	0.89	11.4	12.8
S_9	Mandawa	Min.	26.9	7.65	2700	960	286.47	54.67	41.94	272.9	0.68	6.8	46.2
		Max.	29.7	7.85	3400	1010	312.76	65.33	52.87	290.1	0.73	10.1	57.8
		Average	28.4	7.73	2792.4	982.1	305.82	60.34	47.82	286.4	0.71	7.5	54.3
S_{10}	Udaipurwati	Min.	27.2	6.69	2500	890	249.21	50.97	40.75	131.5	0.18	65.1	41.4
		Max.	30.1	6.86	2900	940	277.28	59.22	50.63	152.4	0.24	77.8	53.5
		Average	28.7	6.77	2559.1	911.4	265.35	54.57	45.67	148.3	0.21	72.2	49.9
S_{11}	Nawalgarh	Min.	26.8	6.96	1900	680	187.22	35.11	42.21	132.3	0.69	58.9	35.3
		Max.	29.9	7.17	2100	720	218.45	49.82	52.76	147.8	0.76	72.4	48.2
		Average	28.6	7.8	1998.2	702.3	201.68	41.33	48.95	142	0.73	67.2	41.5
S_{12}	Gudha	Min.	27.5	7.36	2000	710	200.34	51.55	59.99	184.4	0.26	44.8	17.3
		Max.	30.4	7.55	2200	760	232.66	62.67	68.32	212.8	0.31	53.4	27.9
		Average	29.3	7.48	2045.8	736.6	215.59	58.22	64.34	201.3	0.29	50.2	24.5
S_{13}	Mukundgarh	Min.	27.2	6.68	2400	850	186.66	11.32	28.24	181.9	0.15	3.8	16.5
		Max.	30.1	6.85	2500	890	216.78	22.66	36.78	200.1	0.22	11.5	28.6
		Average	28.9	6.79	2410.9	877.8	201.56	17.78	32.53	192.3	0.19	5.9	22.8
S_{14}	Dundlod	Min.	27.7	7.81	1100	360	58.34	9.18	6.01	65.6	0.34	8.2	10.2
		Max.	30.5	8.02	1300	410	71.66	18.21	10.71	82.8	0.39	16.5	20.1
		Average	29.1	7.92	1246.7	389.9	65.58	11.24	7.98	78.3	0.36	10.4	16.3
S_{15}	Bissau	Min.	26.7	8.79	2600	900	280.36	20.44	26.89	285.6	0.68	58.9	18.4
		Max.	29.8	9.05	2700	940	306.11	35.26	35.66	309.5	0.74	66.6	28.5
		Average	28.4	8.98	2601.2	922.3	298.48	26.67	31.24	305.8	0.72	62.5	25.9
S_{16}	ISI		-	7.0-8.5	1400	1000	500	200	-	250	1.5	50	200
S_{17}	WHO		-	6.5-8.5	-	500	300	200	-	250	1.0	45	200

Potassium (K^+)

The major source of potassium in natural fresh water is weathering of rocks but the quantity increases in the polluted water due to disposal of wastewater [11]. The concentrations of Potassium content in the water samples varied from 7.98 to 68.32 mg/l.

Chloride (Cl^-)

Chloride salts are generally dispersed in underground water in changeable concentrations. The origin of chloride in water is due to the different source such as weathering and leaching of sedimentary rocks and soils, infiltration of seawater, domestic and industrial waste discharge, etc. Excess chloride in potable water is not particularly harmful and the criteria set for this anion are based primarily on portability and high corrosiveness. Chloride exceeding 250 mg/l imparts salts taste to water and causes laxative effects [15]. In the present analysis, chloride concentration was found in the range of 10.9 mg/l to 381.2 mg/l. The values are within the limit except water sample collected from sites S_2, S_5, S_6, S_7, S_9 and S_{15}.

Fluoride (F^-)

Fluoride is a geochemical contaminant and natural sources account for most of the fluoride in surface and underground water. Its concentration is dependent on solubility of fluoride containing rocks. Intake of excess fluoride causes skeletal and dental fluorosis. The non skeletal fluorosis due to continuous intake of fluoride containing water, air and agricultural produce [12]. Fluoride content of the study area in the present investigation is ranged from 0.15 mg/l to 0.99 mg/l. which are well within the WHO and ISI permissible limits.

Nitrate (NO_3^-)

Nitrate in water is due to domestic activities and agricultural runoff which dissolved in rain water leaches into the wells [16]. The presence of nitrate in drinking water has adverse effects on health above 50 mg/l. The nitrate content in the study area varied in the range 3.8 mg/l to 72.4 mg/l and found below permissible limit of ISI, except samples from sampling point S_3, S_6, S_{10}, S_{11}, S_{12} and S_{15}.

Sulphate (SO_4^{-2})

Sulphate occurs naturally in water as a result of leaching from gypsum and other common minerals[3]. Discharge of industrial wastes and domestic sewage tends to increase its concentration. The sulphate concentration varied between varied between 7.5 mg/l to 58.9 mg/l and found within the prescribed limit [17].

Statistical analysis

In statistics, correlation is a broad class of statistical relationship between two or more variables. Hence, it can be considered as a normalized measurement of covariance.

The correlation study is useful to find a predictable relationship whip can be exploited in practice. It is used for the measurement of the strength and statistical significance of the relation between two or more water quality parameters. Hence, it is a helpful tool for the promotion of research activities[18-19].

Table 2: Correlation Matrix

Parameters	T	pH	EC	TDS	TH	Na^+	K^+	Cl^-	F^-	NO_3^-	SO_4^{-2}
T	1.000										
pH	-0.089	1.000									
EC	0.008	0.298	1.000								
TDS	0.003	0.270	0.994*	1.000							
TH	0.045	0.381	0.928*	0.935*	1.000						
Na^+	-0.039	-0.1070	0.378	0.396	0.482	1.000					
K^+	0.259	-0.081	0.345	0.384	0.484	0.844*	1.000				
Cl^-	-0.057	0.424	0.768*	0.796*	0.728*	0.243	0.348	1.000			
F^-	0.509	0.134	-0.337	-0.369	-0.314	-0.244	-0.422	-0.247	1.000		
NO_3^-	0.096	0.267	0.174	0.170	0.310	0.089	0.088	-0.009	0.101	1.000	
SO_4^{-2}	-0.013	0.167	0.809*	0.805*	0.751*	0.471	0.429	0.732*	-0.269	0.172	1.000

Significant at 5% level, r > 0.649

It can put forward possible causal of mechanistic relationships of research work. The correlation coefficients (r) were calculated and correlation matrix was obtained [18-20]. The values of correlation coefficients are listed in Table 2. The negative correlations were found in 15 cases between Temperature and pH, Temperature and Na^+, Temperature and Cl^-, Temperature and F^-, Temperature and SO_4^{-2}, pH and Na^+, pH and K^+, EC and F^-, TDS and F^-, TH and F^-, Na^+ and F^-, K^+ and F^-, Cl^- and F^-, Cl^- and NO_3^-, F^- and SO_4^{-2}. Some of the highly significant correlations were discernible between EC and TDS, EC and TH, EC and Cl^-, EC and SO_4^{-2}, TDS and TH, TDS and Cl^-, TDS and SO_4^{-2}, TH and Cl^-, Na^+ and K^+, Cl^- and SO_4^{-2}. Poor positive correlation was found between Temperature and K^+,pH and EC, pH and TDS, pH and TH, pH and Cl^-, pH and F^-, pH and NO_3^-, pH and SO_4^{-2}, EC and Na^+, EC and K^+, EC and NO_3^-, TDS and Na^+, TDS and K^+, TDS and NO_3^-, TH and Na^+, TH and K^+, TH and NO_3^-, Na^+ and Cl^-, Na^+ and SO_4^{-2}, K^+ and Cl^-, K^+ and SO_4^{-2}, F^- and NO_3^-, NO_3^- and SO_4^{-2}. Very negligible positive correlation was observed between Temperature and EC, Temperature and TDS, Temperature and TH, Temperature and NO_3^-, K^+ and NO_3^-, Na^+ and NO_3^-.

Conclusion

Water is indispensable not only for the existence of the mankind but also for human development and healthy functioning of eco-system. The overall study of physico-chemical parameters in the present investigation indicates that the quality of underground water varies from Place to Place. Higher values of certain parameters at certain hand-pumps indicate the unfitness of water for drinking purpose. Hence, it suggested that underground water source in the study area be monitored before the use for domestic and drinking purposes. It also suggested that more emphasis should be given to reduce TDS, TH, Cl^- contents and NO_3^- contents, where ever these crosses the limits of ISI standards.

Acknowledgement

The authors are thankful to the Director, B K Birla Institute of Engineering & Technology, Pilani (Raj.) for providing necessary research facilities.

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