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PHYSICO-CHEMICAL CHARACTERISTICS OF GROUNDWATER OF SOME VILLAGES OF DAG BLOCK IN JHALAWAR DISTRICT OF RAJASTHAN STATE (INDIA)

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ABSTRACT

Physico-chemical characteristics of groundwater of Dag Block of Jhalawar district have been studied. Water samples from the hand-pumps of 15 villages were collected and analysed for physico-chemical parameters like temperature, pH, electrical conductivity, total dissolved solids, total hardness and concentrations of ions like chloride, fluoride, nitrate, sulphate, sodium, and potassium. The results were compared with the drinking water standards of ISI (10500-91) and WHO (1973). The study indicates the need for periodic monitoring of groundwater for physico-chemical characteristics in study area. A systematic calculations were made to determine the correlation coefficient 'r' amongst the parameters and the study showed a positive and significant correlation of TDS with TH, Cl^- and SO_4^{-2} ion concentrations, whereas, TH shown good correlation with Cl^- ion concentrations.

Keywords: Physico-chemical characteristics, groundwater, correlation co-efficient, monitoring, hand-pumps.

INTRODUCTION

Water is important to the mechanics of the human body and the body cannot survive without it. Water quality is essential for the well being of all people, the quality of water can be affected by different pollutants such as, chemical, biological and physical. Contaminates such as bacteria, viruses, heavy metals, nitrate and salt have found their way into water supplies, the water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water[1].

In rural arid and semi arid regions, where well managed water transportation system and related infrastructures are not available, groundwater serves as chief source of drinking water. Groundwater is an excellent reservoir of water but as rivers, lakes and streams are influenced by natural and human factors, groundwater is also facing the same situation around the world. Human activities, hydrological aspects and characteristics of recharged water affect the quality of groundwater. As groundwater is used in high extent, some troubles are created such as water logging, land subsidence, lowering of water table, sea water intrusion in coastal aquifers and deterioration in water quality[2]. Groundwater is a very sensitive topic which has significance not only at local level, but at global level also[3-5]. Similar to other countries, issue of groundwater has become an issue of importance for the progress of India. Unrestricted exploration of groundwater and excessive use of fertilizers and pesticides make possible the infiltration of detrimental constituents to the groundwater. Domestic and industrial waste also defiles groundwater[6]. As a result, groundwater becomes unhygienic[7-8].

Hence a continuous monitoring on groundwater becomes mandatory in order to minimize the groundwater pollution and have control on the pollutants[9].

This study involves the determination of physical and chemical parameters of groundwater of Dag Block at different villages. The objective of this study is to assess the present water quality, through analysis of some selected water 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 recommended by ISI and WHO.

EXPERIMENTAL

Study area

Jhalawar district located in the south-east of Rajasthan, between the longitudes of 75^0 27' 35" to 76^0 56' 48" East and latitudes of 23^0 45' 20" to 24^0 52' 17" North, adjoining the neighbouring state of Madhyapradesh. The entire Dag Block are occupied by deccan traps. In Dag Block thickness of basalt is more than 200 meter. Groundwater in weathered basalt occurs under water table condition. Thickness of weathering in basalt ranges maximum up to 20 meter. Ground water in compact basalt occurs under water table condition in the joints and fractures. The groundwater resource of the Dag Block is heavily exploited, mainly by abstraction for agriculture use.

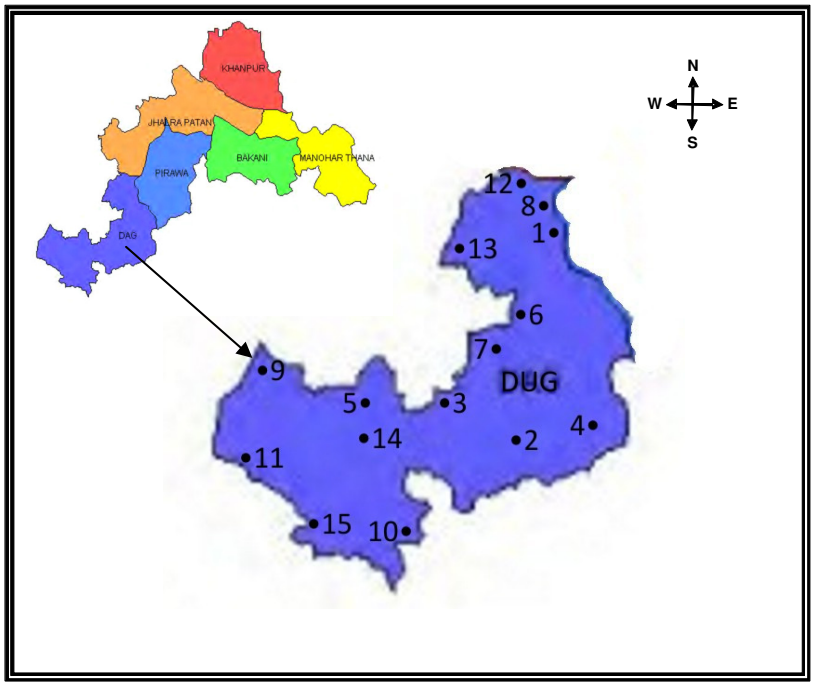

Fig.-1: Location Map of the Sampling Points in Dug Block of Jhalawar District (Rajasthan)

Methodology

Groundwater samples were collected from the hand-pumps of 15 villages of Dag Block in 2010-2011. Samples were collected in clean polythene bottles pre-washed with dilute hydrochloric acid and rinsed three to four times with the water samples before the samples were stored at a temperature below 4^0c prior to analysis in the laboratory. The physico-chemical parameters such as pH, TDS, EC, Cl^-, NO_3^-, SO_4^{-2} and F^- were determined by using standard methods[10]. Sodium and potassium were determined by Flame photometric methods (systronic -128). Specific reagents were used for the analysis and double distilled water was used for preparation of solutions. Sample locations are shown in the Fig.-1.

RESULTS AND DISCUSSION

In the studied localities groundwater was free from color and odor. The physico-chemical characteristics of the analyzed water sample have been presented in Table 1. The data revealed that there was a considerable physic-chemical variation in the examined samples. The variations were not only in the samples collected from different localities, but the samples collected from the same locality were also having considerable variations in water quality. This may be due to the irregular distribution of the rocks or due to the difference in the depth of hand-pump installations. A comparison of the depth of the hand-pump installation indicated that deep installations were better than the shallow installations with respect

to the water quality in the study area. Since shallow hand-pumps draw water from the top most bearing structure, which is most liable to contamination by various natural as well as anthropogenic sources percolating in the vicinity and taking with it minerals, etc. In the study area,

Temperature (T) in ^{0}C
Temperature is an important biologically significant factor, which plays an important 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 an important ecological factor and provides an important piece factor and piece of information in many type of geochemical equilibrium or solubility calculation[9]. The pH values of water samples varied between 6.68 to 9.05. The sampling points S_{15} showed high pH values.

Electrical Conductivity (EC)
It is an indicator of the degree of mineralization of water. It depends upon concentration and degree of dissociation and migration velocity of ions in the electric field. In the present investigation it varies from 1000 µs/cm. to 3600 µs/cm. The electrical conductivity is correlated with total dissolved solids[12].

Total Dissolved Solids (TDS)
TDS is the concentrations of all dissolved minerals in water indicate the general nature of salinity of water. In the present study TDS value ranged from 310 mg/l to 1030 mg/l. The sampling points S_6 and S_9 showed higher range of TDS than desirable limits of 1000 mg/l. TDS in groundwater originate from natural sources, sewage, urban run-off and industrial wastes[13].

Total Hardness (TH)
Hardness in water is due to the natural accumulation of salts from contact with soil and geological formations or it may enter from direct pollution by industrial effluents. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both. In the present study TH varied 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^+)
Sodium concentrations were found in between 7.99 mg/l to 65.33 mg/l. which found within WHO limit.

Potassium (K^+)
The major source of potassium in natural fresh water is weathering of rocks but the quantities increase in the polluted water due to disposal of wastewater[11]. Potassium content in the water samples varied from 7.98 to 68.32 mg/l.

Chloride (Cl^-)
Chloride salts are widely distributed in underground water in varying concentrations. The origin of chloride in water is due to the diverse 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 ground 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 is well within the WHO and ISI permissible limits.

Table-1: Concentrations of the Physico-chemical Characteristics of the Groundwater Samples from the Hand Pumps of Dag Block

S. No.	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
1	S_1	Awar	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
2	S_2	Dag	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
3	S_3	Deogarh	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
4	S_4	Dori	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
5	S_5	Guradiya Jhala	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
6	S_6	Guradiya Kalan	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
7	S_7	Harnawada	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
8	S_8	Karawan	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
9	S_9	Para Peepli	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
10	S_{10}	Rampura	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
11	S_{11}	Rawan Gurari	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
12	S_{12}	Silehgarh	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
13	S_{13}	Singhpur	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
14	S_{14}	Sunari	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
15	S_{15}	Unhel	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
16		ISI		-	7.0-8.5	1400	1000	500	200	-	250	1.5	50	200
17		WHO		-	6.5-8.5	-	500	300	200	-	250	1.0	45	200

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

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]. 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 hand-pump to hand-pump. Higher values of certain parameters at certain hand-pumps indicate the unfitness of water for drinking purpose. Hence, it suggested that ground 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.

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