Ultra Scientist Vol. 24(2)B, 355-362 (2012).

Evaluation of open well water quality of Bakani Tehsil in Jhalawar District (Rajasthan), India

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(Acceptance Date 31st July, 2012)

Abstract

Water samples from the open wells of selected 15 grampanchyates in Bakani tehsil of Jhalawar district, Rajasthan State, India were collected, physico-chemical parameters were determined using standard analytical procedure. The results of the physico-chemical analysis were obtained in the following range; Temperature (26.6-31.7^{o}C), pH(6.76-9.14), EC(1300-6300µscm^{-1}), TDS (310.1890 mg/1), TH (81.21-758.67 mg/1), Na^{+} (9.2-69.2 mg/1), K^{+}(10.6-71.2 mg/1), Cl^{-}(19.8-666.7 mg/1), F^{-}(0.27-1.72 mg/1), NO_3^{-} (25.6-99.3 mg/1) and SO_4^{-2}(7.2-69.5mg/1). The result were compared with the drinking water standards of ISI (10500-91) and WHO (1973). pH, TDS, Th, Cl^{-}, F^{-} and NO_3^{-} were found to be beyond permissible standards, while Na^{+}, K^{+}, SO_4^{-2} were recorded within the limit. These water bodies are not suitable for domestic and drinking purposes, so that possible remedial measures should be adopted for these water resources of some grampanchayats in Bakani tehsil.

Key words : Physicochemical parameters, Open wells, Remedial measures.

Introduction

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life[1]. Fresh water is finite resource, essential for agriculture, industry and even human existence, without fresh water of adequate quantity and quality, sustainable development will not be posssibile[2]. There is an extensive literature, which stresses deterioration of water quality[3-6]. Water reflects the composition of water as affected by natural cause and man's cultural activities expressed in terms of measurable quantities and related to intended water use[7]. The composition of surface and groundwater is dependent on natural factors (geological, topographical, meteorological, hydrological and biological) in

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the drainage basin and varies with seasonal difference in runoff volumes, weather conditions and water levels[8].

Water quality monitoring has a high priority for the determination of current conditions and long term trends for effective management. The supply of safe water has a significant impact on the anticipation of water transmissible diseases[9]. The abundance of organic compounds, radionuclides, toxic chemicals, nitrites and nitrates in water may cause unfavorable effects on the human health especially cancer, other human body malfunctions and chronic illnesses[10]. Therefore, it is necessary to frequently monitor water quality, used for drinking purposes[11].

In Bakani teshil, drinking water comes from groundwater and surface water including rivers and reservoirs. The free style way of disposal of agricultural, industrial and domestic effluents into natural water bodies may cause serious contamination. Run off from agricultural land and saline seeps subjects the most vulnerable water pollution to increased. Salinity, so the freshwater of open wells are highly affected.

The objective of this study is to assess the present water quality, through analysis of some selected water quality parameters like Temperature, pH, EC, Total Hardness, TDS, SO_4^{2-}, F^-, NO_3^-, Cl^-, Na^+, K^+ and to compare the results with the standards values recommended by WHO.

Material and Methods

Study area : Jhalawar district is located

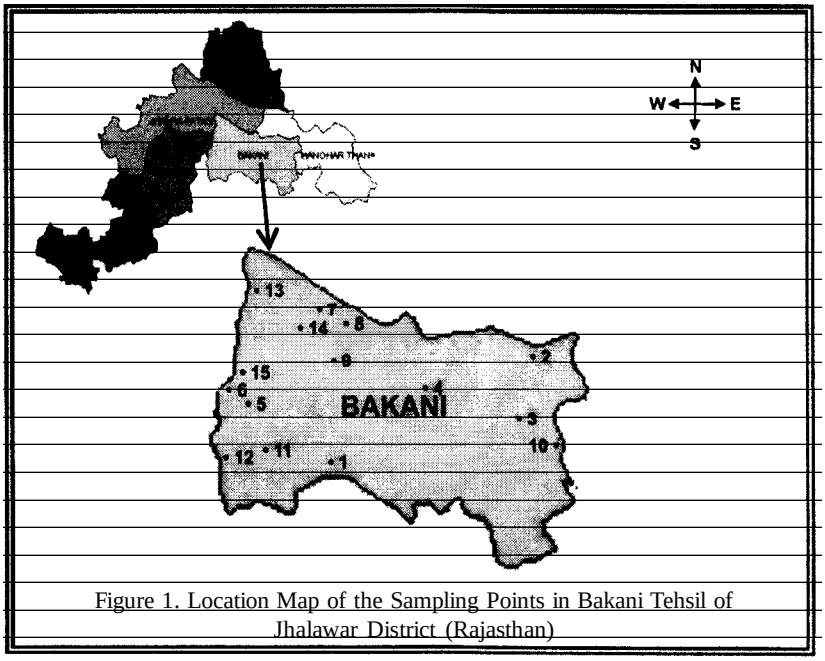

Figure 1. Location Map of the Sampling Points in Bakani Tehsil of Jhalawar District (Rajasthan)

in the south-east of Rajasthan, between the longitudes of 75°27' 35" to 76°56' 48" East and latitudes of 23°45' 20" to 24°52' 17" North, adjoining the neighbouring state of Madhya Pradesh. Bakani is 42 km away from its district headquarters, Jhalawar. Bakani is located at 24.28°N 76.23°E. It has an average elevation of 354 meters. Where groundwater is mainly found in layers of basalt, sandstone and shale, intercalated with sandstone.

Methodology: Groundwater sample were collected from the open wells of 15 grampanchayats of Jhalrapatan tehsil in 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°C 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[12]. Sodium and potassium were determined by Flame Photometric methods. Specific reagents were used for the analysis and double distilled water was used for preparation of solutions. Results are shown in the table 1.

Result and Discussions

Table 1. Concentrations of the Physico-chemical Characteristics of the Surface water Samples from Open Wells of Bakani tehsil

S. No.	Sample No.	Sample Location		Physico-Chemical Parameters (mg/L)											
				T°C	pH	EC(µS cm^{-1})	TDS	TH	Na^+	K^+	Cl^-	F^-	NO_3^-,	SO_4^{2-}
1	S_1	Agaria	Min	27.1	7.21	3100	930	485.91	34.7	22.7	190.3	0.53	48.6	16.8
			Max	29.8	7.39	3200	1010	535.06	41.8	31.9	215.8	0.58	53.8	27.6
			Average	28.2	7.32	3155.3	956.4	504.55	38.9	25.8	201.1	0.56	50.4	21.7
2	S_2	Amrti kheri	Min	26.8	7.25	3400	1060	466.93	42.5	21.8	236.1	0.52	26.6	14.8
			Max	30.6	7.46	3500	1120	514.82	49.8	31.2	266.8	0.59	36.8	26.6
			Average	28.5	7.40	3440.4	1099.2	490.66	45.8	26.7	251.5	0.55	30.5	21.3
3	S_3	Asalpur	Min	27.3	7.19	2000	620	276.17	17.3	37.9	119.5	0.29	65.8	7.2
			Max	31.7	7.31	2200	730	305.95	24.1	44.2	148.7	0.33	76.6	12.1
			Average	29.5	7.25	2102.6	673.2	290.03	20.6	41.4	131.6	0.31	70.6	11.9
4	S_4	Bairagarh	Min	27.5	6.91	3300	1040	495.09	11.4	22.4	141.8	0.40	69.6	29.8
			Max	31.6	7.12	3600	1160	524.82	16.8	32.8	169.9	0.45	81.2	38.2
			Average	29.4	7.09	3454.7	1061.2	519.07	14.2	25.9	155.7	0.43	75.5	35.4
5	S_5	Bakani	Min	26.9	6.76	3100	920	499.83	33.5	17.4	124.6	0.41	71.2	12.7
			Max	30.9	7.27	3400	1090	534.27	38.9	24.8	153.2	0.49	86.8	19.1
			Average	27.6	6.84	3210.5	1034.2	513.98	36.7	21.8	142.1	0.45	79.4	13.8

6	S_6	Deonagar	Min	27.5	7.02	6000	1780	732.11	42.4	31.1	641.5	1.01	59.1	40.2
			Max	31.7	7.32	6300	1890	758.67	49.8	40.6	666.7	1.72	69.8	45.8
			Average	28.7	7.21	6195.3	1854.2	751.62	45.9	34.8	658.5	1.61	65.7	42.3
7	S_7	Devri	Min	26.6	8.48	2700	890	231.12	19.4	44.2	215.6	0.91	36.6	16.2
			Max	30.9	8.66	3200	1020	250.62	25.7	47.3	248.9	1.02	48.7	26.3
			Average	28.5	8.59	3112.6	992.4	240.19	22.9	45.8	234.5	0.99	41.5	19.7
8	S_8	Jheejha-niya	Min	26.8	7.45	2100	680	200.12	16.7	31.9	121.3	0.97	39.2	38.2
			Max	31.4	7.58	2400	760	225.29	21.4	40.4	136.8	1.09	53.7	43.5
			Average	28.9	7.51	2280.1	738.4	220.78	18.7	34.8	129.5	1.01	47.5	40.8
9	S_9	Kheriya	Min	27.1	7.76	2600	820	445.12	34.7	46.8	119.8	0.89	59.2	28.7
			Max	31.3	7.92	3000	910	459.93	39.6	54.3	136.3	0.99	69.8	30.6
			Average	29.2	7.83	2892.4	886.7	452.77	36.3	50.1	127.8	0.95	65.7	29.8
10	S_{10}	Kohrijhar	Min	27.2	8.89	3700	1170	581.29	51.9	*Til*	300.6	0.94	61.3	40.8
			Max	31.5	9.14	4400	1250	599.62	56.8	29.1	329.8	1.02	70.8	54.9
			Average	28.7	9.09	3868.2	1219.4	590.88	53.8	25.6	318.5	0.98	67.8	49.5
11	S_{11}	Mori	Min	26.8	7.99	1300	310	81.21	31.8	10.6	19.8	0.97	88.6	11.8
		Max		30.8	8.21	1400	380	97.32	37.6	15.9	29.6	1.09	99.3	22.6	
		Average		28.3	8.12	1348.3	348.5	89.63	33.8	12.6	21.3	1.01	95.7	18.9	
12	S_{12}	Nanor	Min	27.3	8.52	1500	450	168.31	9.2	24.5	70.8	0.52	61.6	28.8
			Max	31.6	8.66	1600	490	182.23	14.8	31.9	83.2	0.57	80.8	37.6
			Average	28.8	8.60	1567.8	470.7	178.22	12.5	26.6	78.1	0.55	75.5	32.5
13	S_{13}	Nasirabad	Min	26.7	7.39	1300	410	99.82	10.5	18.9	62.1	0.54	75.8	51.8
			Max	30.8	7.52	1600	480	111.21	18.6	27.1	79.2	0.61	84.3	69.3
			Average	28.7	7.45	1544.5	456.8	103.23	13.9	22.9	70.6	0.58	80.7	60.2
14	S_{14}	Ratlai	Min	27.3	7.98	2500	790	300.11	61.4	31.7	42.6	1.01	69.5	56.4
			Max	31.7	8.11	2700	860	322.19	69.2	38.8	62.3	1.19	83.3	69.5
			Average	29.2	8.08	2640.6	838.8	318.85	63.8	34.9	56.8	1.14	77.7	63.8
15	S_{15}	Salawad	Min	26.9	7.98	2300	740	241.32	12.8	64.8	265.6	0.27	25.6	15.3
			Max	31.4	8.12	2500	800	260.92	17.7	71.2	280.8	0.35	39.7	27.9
			Average	28.5	8.08	2452.1	786.4	253.56	15.6	68.3	276.9	0.31	32.1	21.4
16		WHO		-	7.0-8.5 8.5	1400	1000	500	200	-	250	1.5	50	200
17		ISI		-	6.5 8.5	-	500	300	200	-	250	1.0	45	200

The physico-chemical characteristics are given in Table 1.

Temperature (T): Temperature is basically important for its affects on certain chemical and biological activities in the organism attributing in aquatic media[13]. The temperature ranged between 26.6°C to 31.7°C. During the present investigation, there was no great difference between the temperature of the open wells, which can be explained on the basis of depth of water.

pH: pH is an important parameter that determines the suitability of water for various purposes. pH of water is important for the biotic communities because most of the plant and animal species can survive in a narrow range of pH from slightly acidic to slightly alkaline condition[14]. During the study period the high pH value 9.14 at station s_{10} and low pH value 6.76 at station s_5 was recorded. It was notice that s_7, s_{10} and s_{12} water sample have more pH as compare to WHO permissible limits.

Electrical Conductivity (EC): In present observation the EC varies from 1300 to 6300 µs/cm. High EC indicates a large quantity of dissolved minerals, salt thereby making it sour and unsuitable for drinking.

Total Dissolved Solids (TDS): The total dissolved solids of open well water ranged from a minimum of 310 mg/l to a maximum of 1890 mg/l. In water, TDS are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles. The sampling points s_1 s_2, s_4, s_5, s_6, s_7 and s_{10} showed higher range of TDS than desirable limits of 1000 mg/l (WHO).

Total Hardness (TH): In most of the fresh water TH is imparted mainly by the Calcium and magnesium ions, which apart from sulphate, chloride and nitrates are found in combination with carbonates and bicarbonates. In the present study of TH were found to be 81.21 to 758.67 mg/l. The values for sample from point s_1, s_2, s_4, s_5, s_6 and s_{10} were higher than the (WHO) prescribed limit.

Sodium (Na^+): Na^+ concentrations were found in between 9.2 to 69.2 mg/l which were found within WHO limit.

Potassium (K^+): Potassium is one of the macronutrient found in cationic form. In the present investigation potassium ranges from 10.6 mg/l to 71.2 mg/l. The major source of K^+ in natural fresh water is weathering of rocks but the quantities increase in the polluted water due to disposal of waste water[15].

Chloride (Cl^-): Chlorides are found in practically all natural waters. This is the most common inorganic anion present in water man and animals excrete high quantities of chlorides therefore it indicates sewage contamination. Variation observed is usually associated with the hydrology of the basin[13]. In the present analysis, chloride concentration was found in the range of 19.8 mg/l to 666.7 mg/l. The values are within the limit except water samples collected from sites s_2, s_6, s_{10}, 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 containg

rocks. Intake of excess fluoride causes skeletal and dental fluorosis. The non skeletal fluorosis due to continuous intake of fluoride containg water, air and agricultural produce[16]. Fluoride content of the study area in the present investigation is ranged from 0.27 to 1.72 mg/l and found below permissible limit of WHO, except samples from samples from sampling point s_6.

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. In the present study the nitrate has found to be between 25.6 -99.3 mg/l. The values for sample from point s_1, s_3, s_4, s_5, s_6, s_8, s_9, s_{10}, s_{11}, s_{12}, s_{13} and s_{14} were higher than the WHO prescribed limit.

Sulphate (SO_4^{-2}): Sulphate occurs naturally in all kinds of water. It is dissolved from rocks and soils containg gypsum, iron sulfides, and other sulfur compounds[17]. In the study area it ranged between 7.2 to 69.5 mg/l. All the samples showed the sulphate content within the prescribed limit of 200 mg/l.

Table 2. Correlation Matrix

Para-meter	Temp.	pH	EC	TDS	TH	Na^+	K^+	Cl^-	F^-	$N0_3^-$	SO_4^{-2}
Temp.	1.000										
pH	-0.147	1.000									
EC	0.020	-0.207	1.000								
IDS	0.003	-0.202	0.995*	1.000							
TH	0.153	-0.289	0.910*	0.914*	1.000						
Na^+	0.039	0.121	0.482	0.485	0.537	1.000					
K^+	0.029	0.152	0.080	0.115	-0.029	-0.195	1.000				
Cl^-	-0.048	-0.072	0.900*	0.889*	0.723*	0.279	0.243	1.000			
F^-	-0.112	0.244	0.497	0.461	0.262	0.535	-0.081	0.450	1.000		
NO_3^-	-0.124	-0.042	-0.242	-0.291	-0.153	0.060	-0.592	-0.379	0.137	1.000	
SO_4^{-2}	0.018	0.289	0.149	0.138	0.001	0.319	-0.020	0.122	0.586	0.202	1.000

Significant at 5% level, r > 0.649

Statistical Analysis :

In statistics, correlation is a broad class of statistical relationship between two of more variables. Hence, it can be considered as a normalized measurement of covariance. The correlation study is useful to find a predictable relationship which 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 coefficient are listed in Table 2. The negative correlations were found in 18 cases between Temp. & pH, Temp. & Cl^-, Temp. & F^-, Temp. & NO_3^-, pH & EC, pH & TDS, pH & TH, pH & Cl^-, pH & NO_3^-, EC & NO_3^-, TDS & NO_3^-, TH & K^+, TH & NO_3^-, Na^+ & K^+, K^+ & F^-, K^+ & NO_3^-, K^+ & SO_4^{-2}, Cl^- & NO_3^- . Some of the highly significant correlations were discernible between EC & TDS, EC & TH, EC & C^-, TDS & TH, TDS & C^-, TH & C^-. Poor positive correlation was found between Temp. & TH, pH & Na^+, pH & K^+, pH & F^-, pH & SO_4^{-2}, EC & Na^+, EC & F^-, EC & SO_4^{-2}, TDS & Na^+, TDS & K^+, TDS & F^-, TDS & SO_4^{-2}, TH & Na^+, TH & F^-, Na^+ & Cl^-, Na^+ & F^-, Na^+ & SO_4^{-2}, K^+ & Cl^-, C^- & F^-, C^- & SO_4^{-2}, F^- & NO_3^- & F^- SO_4^{-2}, NO_3^- & SO_4^{-2}. Very negligible positive correlation was observed between Temp. and EC, Temp. and TDS, Temp. and Na^+, Temp. and K^+, Temp. and SO_4^{-2}, EC & K^+, Na^+ and NO_3^-.

Conclusion

The values of parameters such as pH, EC, TDS, TH, Cl^-, F^-, NO_3^-, are higher than ISI and WHO standards are major threats to the groundwater quality in the study area drinking these well waters is dangerous to human health, although, WHO has no standards for some of the measured parameters.

This shows that the ground water of this area is very much affected by various pollutants. The major source of these pollutants may be the effluent flowing from the agricultural wastes, and domestic sewage disposals. All these are disposed to pollute the ground water resource of this area in their own way. Dissolution of rock minerals with the ground water is another reason for pollution.

The values of correlation coefficients and their significance levels will help in selecting the proper treatments to minimize the contaminations of well water of Bakani tehsil. There is an increasing awareness among the people to maintain the well water at their highest quality and purity levels and the present study may prove to be useful in achieving the same.

Acknowledgements

The authors are thankful to the Principal, Govt. College, Kota for providing necessary research facilities.

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