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Physico-Chemical Characteristics of Groundwater and Soil of Ajmer

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ABSTRACT: Water, the universal solvent, takes the first priority of life on our planet Earth which serves as a unavoidable medium for the livelihood of the human beings. A little more than 65% of the Indian population now utilizes ground water for its daily needs. The diverse uses of water are for the purpose of drinking, cooking, washing, bathing, gardening, irrigation, industry and a lot of other purposes. The requirement for quality of water varies widely with respect to its various uses. Drinking water quality is a matter of concern as it is related to human health, and ground water resources have been contaminated by pollutants from various resources. Additional impurities are added as the liquid water travel through the soil and came in contact with material on and beneath surface of earth. This paper deals with the present qualitative environmental scenario of Ajmer, a centrally located, fourth largest city of Rajasthan, suffering from pressures of multiple forces like industrialization, urbanization along with increasing trend of population. It lies between 26°20′ N to 26°33′ N Latitude and 74°35′ E to 74°43′ E Longitude, covers an area of 241.50 sq. km. and has a population of 485575 according to 2001 census. Sixteen ground water samples from the most preferred drinking water sources were collected from and were analyzed for pH, electrical conductivity, TDS, total hardness, calcium hardness, magnesium hardness, total alkalinity, sodium, potassium and nitrate. It was observed from the study that most of the water samples exceed the limit permissible for potable water with respect to almost every parameter considered. Also soil samples from similar sixteen sites were analyzed for pH, electrical conductivity, calcium, magnesium, total alkalinity, sodium, potassium, nitrate, zinc, cupper and iron. The result revealed that concentration of nearly all parameters are very high. Thus arising a possibility of further deterioration in ground water quality because of percolation of water through soil thereby addition of these elements and minerals by process of leaching. It may have adverse effect on health of people residing in the study area, thus suggesting an urgent need for proper remedial measures.

INTRODUCTION

Water, the universal solvent, takes the first priority of life on our planet earth which serves as an unavoidable medium for livelihood of the human beings. A little more than a 65% of Indian population now utilizes ground water for its daily needs in diversified tasks. Ground water is not only the major source of drinking water in both urban and rural India but also, is important source of water for agriculture and industrial sector. The requirement for quality of water varies widely with respect to its various uses.

Though, ground water is an integral part of the environment, and hence cannot be looked upon in isolation. The pollution of air water and soil has an effect on the pollution and contamination of ground water, a major problem of present environmental scenario.

The solid, liquid and gaseous waste that is generated, if not treated properly, results in pollution of environment; this affects ground water too due to hydraulic connectivity in the hydrological cycle. Thus, additional impurities are added to ground water already been contaminated by pollutants from various sources, as the liquid water travel through the soil and came in contact with material on and beneath the Earth.

The quality of water is getting vastly deteriorated, this led to scarcity of potable water, also affecting the human health. It is therefore essential to monitor water supply and quality of water (Devidas Kamath *et al.*, 2006).

STUDY AREA

Ajmer, fourth largest city in Rajasthan, lies between 26°20' N to 26°33' N latitude and 74°35' E to 74°43' E longitude covering an area of 241.50 Sq. km. It has a population of 485575 according to 2001 causes. It is at a distance of about 132 Km to south west of Jaipur city and is situated in a beautiful valley. The prominent feature of the city is the NW-SW trending Aravalli hill ranges influenced by the Thar Desert to the west part. The general climate is semi arid type. Monthly mean temperature is about 43°C (June) with annual temperature of about 24.2°C.

Ajmer is one of the developing cities known as 'Heart of Rajasthan'. From ancient time it has been

known as a political center and British also made this as a political head quarter. Beside being the main education center, it is an important tourist destination from historic and pilgrimage aspect due to famous Durgah Sharif and Pushkar.

MATERIAL AND METHODS

The physico-chemical test for soil and ground water samples of Ajmer city and its neighbouring areas were calculated in the month of April 2006. A total number of 16 sites were selected from the four zones i.e. residential, commercial, agricultural and industrial for collection of soil and ground water samples. Soil samples were collected with help of an auger and ground water samples were collected in pre cleaned polyethylene bottles with necessary precautions.

About one kg of soil ample and one liter of ground water samples were collected from different locations and taken to the laboratory for analyses. Soil samples were prepared for analysis through series of processes i.e. drying, sieving, grinding and storing. Than a soil suspensions are prepared according to parameter to be analyzed.

TDS, EC and pH of all ground water samples were analyzed using conductivity meter and pH meter. Alkalinity, Calcium, Magnesium and chloride were determined by titrations using standard methods. Sodium and Potassium were determined on flame photometer and nitrate was analyzed through UV spectrometer.

Soil sample's suspensions were analyzed for Electrical Conductivity and pH through pH meter and conductivity meter. Chloride, Calcium and Magnesium were determined using standard titration methods. Nitrogen and Phosphate were analyzed through Subbiah and Asiji, 1956 and Olsen *et al.*, 1954 methods. Sodium and Potassium were analyzed using flame-photometeric method and DTPA extractant method is used to analyze Zinc, Copper, Iron and Manganese using Atomic Absorption Spectrophotometer.

RESULT AND DISSCUTION

There is no such thing as naturally pure water. In nature all water contains some impurities. As water flows in streams, silts in lakes and filters through layers of soil and rock in the ground, it dissolves or absorbs the substances it touches. Some of these substances are harmless. At certain levels, these substances act as contaminants that can make water unpalatable or even unsafe.

Thus, while taking about ground water quality of a place, the soil present above and beneath, must also be taken in consideration.

In this study, the ground water quality of different sites covering the study area was assessed along with the soil quality.

Water Quality

The physico-chemical characteristics of various sample stations are tabulated in Table 3. The pH of Ajmer city varies between 5.8 to 8.25 The lowest value of pH was observed in Adarsh Nagar, while maximum pH 8.25 was observed in Gangwana The pH of the samples showed that the water of city is mild acidic to mild alkaline and is potable according to pH view.

Conductivity is found between the 1.0 microsiemns/cm to 3.8 microsiemns/cm. Minimum value recorded from Shashtri Nagar, on the other hand Tabijii showed the maximum value. The Total Dissolved Solids measure of the samples ranged between 710 mg/L (observed in Makhupura) to 2600 mg/L (observed in Kesargunj) TDS concentration beyond 500 mg/L decreases palatability and may cause gastrointestinal irritation. The result shows that nearly all samples, are non palatable with view of human health.

Alkalinity in ground water of Ajmer city ranges from 67 mg/L to 700 mg/L. The minimum value 67 mg/L is of Makhupura while maximum 700 mg/L of Keisergunj. Though, Alkalinity in itself is not harmful to human beings, still the water supplies with less than 100 mg/L are desirable for domestic use. The data revealed that from this point of view, out of 16 samples analyzed, 11 are not fit for the purpose.

The Total Hardness of the samples varied between 41 mg/lit. to 736 mg/lit. The minimum value is recorded from Kajipura ground water sample and the maximum was from ground water sample of Tabijii. Calcium hardness is minimum in Kajipura i.e. 20 mg/L and maximum 324 mg/L is observed from Naya Baazar Area. Similarly, Magnesium Hardness is lowest in Makhupura, only 21 mg/L whereas 456 mg/L is reported from Tabijii area. The study of total hardness, calcium and magnesium concentration in the samples showed concentration slightly near the permissible limit, in some samples it is even much above the permissible limit, rendering the water not much suitable for drinking purpose as magnesium salts have a laxative and diuretic effects.

Table 1: Physico-Chemical Characteristics of Ground Water Samples of Ajmer

Sl. No.	Location	pH	EC	TDS	Ca^{++}	Mg^{++}	T.H.	Alka.	Cl^{-1}	NO_3	Na^{+}	K^{+}
1.	Shashtri Nagar	7.11	1.00	820	33.6	58.4	92	112	35.5	55	47	3
2.	Gangwana	8.25	2.90	1680	140.0	78	218	214	794	96	370	78
3.	Ghoogra	6.97	2.00	1570	136.5	67.5	204	100	153.36	60	68	19
4.	JLN	6.37	3.30	1990	319.2	70.8	380	117	511.2	40	270	28
5.	Naya Baazaar	6.00	2.90	2100	324.0	238	562	300	400	20	65	22
6.	Madargate	6.50	2.51	1505	152.0	24	176	350	40	20	55	15
7.	Kesargunj	7.60	2.00	2600	80.0	290	370	700	720	90	4	11.6
8.	Makhupura	6.54	1.10	710	161.7	124	286	67	134.9	90	220	100
9.	Kajipura	7.86	2.60	1470	20.0	21	41	158	43	9	18.3	55
10.	Tabijii	7.86	3.80	2500	280.0	456	736	415	439	10	1000	37
11.	Adarsh nagar	5.80	2.16	1500	184.0	48	234	300	600	10	68	29
12.	Parbatpura	6.31	2.00	1270	128.1	277.9	346	98	383	120	310	26
13.	Kotra	7.80	1.60	1650	210.0	220	430	320	220	40	66	36
14.	Vaishali Nagar	6.94	2.10	1490	184.0	49.1	233.1	94	115.02	15	91	56
15.	Chaursiyawas	7.30	2.00	1430	98.0	112	210	130	86.62	500	137	47
16.	Christiangunj	6.55	1.50	1080	224.7	295.3	520	70	205.9	40	220	15

All the values are in mg/lit. Accept pH and Conductivity (microsiemns cm^{-1})

Table 2: Correlation Co-Efficient Among Different Ground Water Quality Parameters

	pH	EC	TDS	Ca^{++}	Mg^{++}	T.H.	Alka.	Cl^{-1}	NO_3	Na^{+}	K^{+}
Ph	1										
EC	0.1523	1									
TDS	0.2716	0.7346	1								
Ca^{++}	–0.3812	0.5047	0.3891	1							
Mg^{++}	0.1384	0.2071	0.4627	0.3906	1						
T.H.	–0.0696	0.3976	0.5298	0.7756	0.879	1					
Alka.	0.2630	0.3034	0.7670	0.0400	0.4154	0.3314	1				
Cl^{-1}	0.0817	0.4475	0.6025	0.2978	0.3164	0.3619	0.5142	1			
NO_4	0.1412	–0.1795	–0.1337	–0.2899	–0.0375	–0.1779	–0.1572	–0.1313	1		
Na^{+}	0.2679	0.5651	0.3261	0.4171	0.6188	0.6310	0.0708	0.2938	–0.0547	1	
K^{+}	0.2768	0.0126	–0.2504	–0.0451	–0.1985	–0.1525	–0.3016	0.0183	0.1633	0.1992	1

The nitrate concentration of the samples showed a range between 9 mg/lit. to 500 mg/lit. Minimum value is recorded from Kajipura and maximum from Chaursiyawas site. Seven samples showed the values of nitrate much above the maximum permissible limit thus the persons residing in these areas may suffer various health hazards most important being methe-hemoglobinemia i.e. blue baby disease in infants.

The sodium, Potassium and chloride concentration in ground water of Ajmer city ranges between 4.0 to 1000 mg/L, 3 to 100 mg/L and 35.5 mg/L to 794 mg/L respectively.

Soil Quality

The dynamic interaction between various physical, chemical and biological soil properties which vary in space, time and intensity makes soil quality difficult to define measure and explain. Each soil is unique because these dynamic properties are influenced by many external factors such as land use, land management, environmental interaction and socio-economic properties. Soil quality is relative to its intended use and therefore the perception of "good" soil depends on the function a soil is required to perform. As a result, the quality of a soil can be defined as its ability to perform a vide range of functions.

Table 3: Physico-Chemical Characteristics of Soil Samples of Ajmer

Sl. No.	Location	N%	pH	EC	Cl^{-1}	PO_4	K^+	Na^+	Ca^{++}	Mg^{++}	Zinc	Iron	Copper	Mn
1.	Shashtri Nagar	0.0155	7.7	102.5	152.65	23	300	412	91	51.03	2.92	5.92	0.24	3.74
2.	Gangwana	0.0172	8.2	5	14.2	28	270	63	19	0	3.42	6.02	0.36	4.22
3.	Ghoogra	0.0198	8.2	7.6	10.65	36	290	84	13	1.215	3.26	5.14	0.42	2.96
4.	JLN	0.0129	9.4	25.9	22.72	44	180	94	14	15.795	3.2	8.04	0.38	4.18
5.	Naya Baazaar	0.0207	8.7	9.3	13.49	32	260	134	19	3.645	2.16	8.2	0.46	2.76
6.	Madargate	0.0224	8.5	14.3	21.3	29	210	156	14	3.645	3.26	8.54	0.54	2.98
7.	Kesargunj	0.0172	8.8	7.2	12.78	36	190	110	11	0.6075	3.3	6.52	0.44	4.22
8.	Makhupura	0.0189	8.4	8	9.23	40	270	71	11	4.2525	2.04	7.12	0.2	2.72
9.	Kajipura	0.0224	8.5	4.1	8.25	38	240	57	190	30.375	3.24	8.24	0.28	4.46
10.	Tabijii	0.0189	8.5	2.4	10.65	30	220	61	8	4.2525	3.2	5.92	0.36	2.78
11.	Adarsh nagar	0.0129	7.8	3.8	11.36	26	310	47	24	7.29	2.58	6.14	0.44	4.46
12.	Parbatpura	0.0155	9.1	92.5	62.48	34	270	300	245	63.7875	6.54	7.24	0.4	2.42
13.	Kotra	0.0164	8.5	82.5	111.47	44	240	560	170	36.45	2.85	5.28	0.22	3.78
14.	Vaishali Nagar	0.0189	8.6	6.2	10.65	35	220	61	12	1.8225	1.24	6.18	0.19	4.72
15.	Chaursiyawas	0.0207	9.2	4.6	12.07	38	170	154	17	13.365	2.24	6.28	0.38	2.98
16.	Christiangunj	0.0224	8.6	3.6	11.36	30	210	50	11	1.8225	1.38	7.12	0.46	4.22

All the values are in mg/lit. Accept Ph, EC (microsiemns cm^{-1}), Phosphate and Potash (Kg/hectare)

Table 4: Correlation Co-Efficient Among Different Soil Quality Parameters

	N%	pH	EC	Cl^{-1}	PO_4	K^+	Na^+	Ca^{++}	Mg^{++}	Zinc	Iron	Copper	Mn
N%	1												
pH	0.0756	1											
EC	–0.4492	–0.0793	1										
Cl^{-1}	–0.3865	–0.2954	0.9302	1									
PO_4	–0.0193	0.6425	–0.0238	–0.1319	1								
K^+	–0.2896	–0.7695	0.3108	0.3225	–0.4599	1							
Na^+	–0.2874	–0.0754	0.8949	0.9106	0.1206	0.1665	1						
Ca^{++}	–0.1365	0.0812	0.6873	0.5164	0.1926	0.2449	0.5965	1					
Mg^{++}	–0.3444	0.0439	0.8940	0.7613	0.0407	0.2659	0.7297	0.8795	1				
Zinc	–0.3352	0.2048	0.5072	0.2449	–0.0025	0.1974	0.2974	0.6410	0.6234	1			
Iron	0.3071	0.4212	–0.1842	–0.3055	0.0876	–0.3028	–0.2818	0.0713	–0.0028	0.0825	1		
Copper	0.1755	0.1820	–0.3141	–0.3918	–0.3227	–0.1741	–0.3198	–0.2860	–0.3117	0.2147	0.3538	1	
Mn	–0.2173	–0.1984	–0.1851	–0.0454	–0.0310	–0.1038	–0.1841	–0.0833	–0.1653	–0.3811	–0.0888	–0.2143	1

One popular definition of soil quality is the "Capacity of a specific soil to function: within natural or managed ecosystem boundaries, to sustain plant or animal productivity, maintain or enhance water and air quality, and support human health and habitation" (Karlen *et al.*, 1997).

The physico-chemical characteristics of various sample stations are tabulated in Table 3. The pH of Ajmer city varies from 7.7 to 9.4. The lowest value of pH was observed in Shashtri Nagar, while maximum pH 9.4 was observed in JLN area. The pH of the samples showed that the soil of city is mild alkaline to high alkaline. Conductivity is found between the 2.4 microsiemns/cm to 102.5 microsiemns/cm. Minimum value recorded from Tabijii; on the other hand Shashtri Nagar showed the maximum value.

Calcium hardness is minimum in Tabijii i.e. 8mg/L and maximum 285 mg/L is observed from Parbatpura. Similarly, Magnesium Hardness is lowest in Gangwana i.e. Nil, whereas 63.78 mg/L is reported from Parbatpura area. The nitrate concentration of the samples showed a range from 0.0155% to 0.0224%. The sodium and

chloride concentration in sample solutions of soil of Ajmer city ranges between 47.0 to 560 mg/L and 10.65 mg/L to 152.65 mg/L respectively.

Heavy metals like Zinc, Iron, Copper and Manganese concentration in soil sample solutions comes to be 1.24 mg/L to 3.42 mg/L, 5.28 mg/LK to 8.54 mg/L, 0.19 mg/L to 0.54 mg/L and 2.42 to 4.72 mg/L respectively.

Correlation Study

Ground Water Sample Study

The correlation coefficient 'r' for various physico-chemical parameters of ground water (Table 2) reveals that Electrical Conductivity (EC) of ground water sample shows significant positive correlation with parameters TDS (0.74), Calsium (0.50), Chloride (0.44) and Sodium (0.56) The TDS had positive significant correlation with magnesium (0.42), Total Hardness (0.52), Alkalinity (0.76) and chloride (0.62). Magnesium had shown significant positive correlation with Total Hardness (0.87) but is negatively correlated with potassium. Sodium is positively correlated to total hardness (0.63). Nitrate had negative correlation with all parameters under study accept pH and Potassium but that is of insignificant type.

Soil Sample Study

The correlation coefficient 'r' for various physico-chemical parameters of different soil samples reveals that Electrical Conductivity (EC) of soil solution had significant positive correlation with Sodium (0.89), calcium (0.68), magnesium (0.89) and zinc (0.50). Chloride had significant positive correlation with Sodium (0.91), calcium (0.51) and magnesium (0.76) and negative correlation with heavy metals Iron, Copper and manganese. Sodium had significant correlation with Calsium (0.59) and magnesium (0.72). Calsium had shown positive correlation with magnesium (0.87) and zinc (0.64). Magnesium had negative correlation with all parameters under study.

CONCLUSION

Thus overall picture that arises from the present study is that ground water quality of Ajmer city varies a lot, at same places is suitable for drinking purpose but is not much fit for use in drinking purpose in some areas at other hand. High pH and EC in Soil Sample solutions reveals possibility of presence of salts in higher amounts. Presence of heavy metals arises possibility of their leaching or percolation in ground water.

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