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Ground Water Quality in Jodhpur Western Rajasthan

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Abstract : Water is source of living world. Aridity in the State of Rajasthan including Jodhpur district has caused not only scarcity of water resources but also adversely affected quality of precious groundwater assets. In view of acute water crisis, water resources studies (especially hydro-geochemical investigations causing health hazards) were carried out in different block of Jodhpur district for identifying various water related issues and to explore management options thereof. A total of 30 wells were identified as monitoring stations and water samples were collected and analysed for pH, electrical conductivity, total dissolved solids (TDS), total hardness, total alkalinity, fluoride (F^-), chlorides (Cl^-), and nitrates (NO_3^-). In present study we found that groundwater of this district contains high concentrations of anions in surface and groundwater collected from these villages.

Key-Words: Chemical parameters, Electrical conductivity, Fluoride, Groundwater, Nitrate, Total Dissolved Salts

1 INTRODUCTION

Water, the blue gold has become much more precious than yellow gold, globally. It is one of the essential components for the sustenance of life on earth and is the foundation for health, hygiene, progress and prosperity. Therefore efficient water management is essential to civic society for betterment of quality of life. Water has some curious and unusual properties, thus "No life without water" is a common saying. It is a master solvent, and all metabolic reactions of living organisms depend on the presence of water. Water is lost from the earth by the way of evaporation, transpirationand exhalation, and is returned to the earth by the way of precipitation.

Fluorine is the 13th most abundant element on earth. It cannot exist outside a controlled environment without combing with other substances to become fluorides. Three main anthropogenic sources were identified as fertilizers, combusted coal and industrial waste with phosphate fertilizer being the most significance source of fluoride. There are ionisable and non-ionisable, organic and inorganic fluorides. Fluorine is probably an essential element for animals and humans. Low concentrations provide protection against dental caries, especially in children. Minimum concentration of fluoride in potable water required to produce protective effects is approximately 0.5mg/L. Soluble organic fluorides ingested through water and foods almost completely absorbed from the gastrointestinal (GI) tract by a process of simple diffusion. When ionic fluoride enters the acidic environment of stomach lumen, it's largely converted into hydrogen fluoride. It's rapidly distributed by the systemic circulation to the intercellular and extracellular sites of tissues.

Rajasthan suffers both the problems of quantity and quality of water. In most part of the state groundwater is either saline or having high nitrates and fluoride content. Obviously, groundwater is the major source of drinking water and over 94% of the drinking water demand is met by groundwater. Excess fluoride concentration in drinking water has deleterious effects on human health. All the districts in Rajasthan are engulfed by the clutches of fluorosis, to a varying degree. There being no perennial surface source for drinking water, the state is dependent chiefly on groundwater and its level is deeper year-by-year due to over exploitation.

1.1 Hydro Geography of Study Area

Jodhpur district is situated between 250 51'08" & 270 37'09" North latitude and 710 48'09" & 730 52'06" East longitude covering geographical area of 22,850 sq km. This district comes under arid zone of the Rajasthan State. Jodhpur district is part of Jodhpur Division. The district is divided into 5 sub-divisions namely Jodhpur, Shergarh, Pipar City, Osian & Phalodi and comprises of 07 tehsils & 09 blocks. Total number of villages in the district is 1157. Jodhpur district is bounded by Nagaur in the East, Jaisalmer in the West, Bikaner in the North and Barmer as well as Pali in the South. Population of the district is 3687165 including rural and urban populace of 2422551 and 1264614 respectively. Decadal population growth rate of the district is 27.69% since 2001.

1.2 Rainfall & Climate

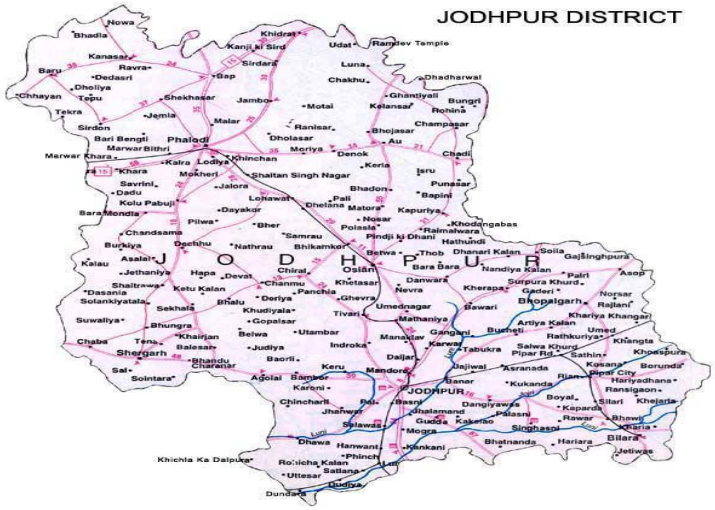
The district experiences arid to semi-arid type of climate. Mean annual rainfall (1971-2012) of the district is 374 mm whereas normal rainfall (1901-1970) is lower than average rainfall and is placed at 314 mm. Rainy days are limited to maximum 15 in a year. Almost 80% of the total annual rainfall is received during the southwest monsoon, which enters the district in the first week of July and withdraws in the mid of September. Probability of annual rainfall exceeding 650 mm is only 10%. However, there is

90% probability that the annual rainfall will be more than 190 mm. The probability of occurrence of mean annual rainfall is 45%. Drought analysis based on agriculture criteria indicates that the district is prone to mild and normal type of droughts. Occurrence of severe and very severe type of drought is very rare. As the district lies in the desert area, extremes of heat in summer and cold in winter are the characteristic of the desert. Both day and night temperatures increase gradually and reach their maximum in May and June respectively. The temperature varies from 49oC in summer to 1oC in winter. Atmosphere is generally dry except during the monsoon period. Humidity is the highest in August with mean daily relative humidity at 81%. The annual maximum potential evapotranspiration in the district is quite high and is highest (264.7 mm) in the month of May and lowest (76.5 mm) in the month of December.

1.3 Geomorphology & Drainage

Jodhpur district forms part of Great Thar Desert of Rajasthan. In this arid region, there are sand dunes, alluvial areas dotted with few hillocks and hill chains scattered in the area. In the eastern part of the district, the area between Bilara and Jodhpur is covered by alluvium deposited due to fluvial action of Luni river system. The eastern part of the district exhibits gentle undulating topography interrupted by small ridges of hard rocks. The general elevation of plains varies from 300 m amsl in north to 150 m amsl in south. Regional slope is from north-east towards south-west direction. Orientation of alluvial plain area follows the Luni River and its tributaries. Sand dunes occupy a major part of the district north of Vindhyan escarpment in northern and northwestern part of the district. The sand dunes are transverse and longitudinal types formed due to aeolian action and overlie the denuded consolidated formations. Ridges and hillocks are common features in Bilara and Osian tehsils. A chain of escarpments and ridges composed of comparatively resistive rocks like granite, rhyolite and Jodhpur sandstone are found extending from Shergarh in the west to Bilara in the east. The alluvial and sand filled valleys are separated by the ridges whose crest elevation ranges from 325 to 460 m amsl. In the northern part of the district, highest peak of the hill is 284 m amsl. Presence of boulder beds exhibits striking plain topography around Bap and low lying outcrops of limestone, shale and sandstone layers are observed in northern part of the district near Phalodi. Distribution of various geomorphic units in the district is shown in Table 3. Table 3: Distribution of various geomorphic units in Jodhpur district Origin Landform Unit Occurrence Sand dunes North and northwestern part of the district. Aeolian Sandy Plains North and northwestern part of the district. Alluvial Plains Eastern part of the district along rivers- Luni, Mithri etc. Fluvial Interdunal Plains Scattered in entire district, mainly in north and western part of the district. Denudational Pediments Scattered in district, mainly in east & west. 4 Linear Ridges Occur in Bilara and Osian Blocks. Extend from Shergarh in the west to Bilara in the east. Hills Structural Hills In northwestern & eastern parts of the district and Jodhpur town. Jodhpur district falls in the Luni & Barmer Basins. Major River of the district is Luni, which flows in ENE – WSW direction. It enters Jodhpur district near village Jhak in Bilara tehsil and leaves the district near village Dhundhara. Total length of the Luni River in Jodhpur district is 125 km. Channel pattern of Luni is dendritic to sub-parallel. However, in major part of the district, the drainage is essentially ephemeral and internal. Important tributaries to the Luni river are Mithri and Bandi. Other streams in the district are Jojri, Golasmi, Guniamata and Bastua, which are all ephemeral. 4.0 Soil, Land Use & Irrigation Practices Soils of the district have been classified as follows: Red desertic soils: This type of soils are predominant in central, eastern and southern parts of the district. These are pale brown to reddish brown soils, loose and well drained and texture varies from sandy loam to sandy clay loam. Desert soils: Desert soils occupy a considerable area covering northern and western parts of the district. These are mainly wind blown sand and soils of interdunal depressions. Sand dunes: Sand dunes occupy a small part in northern and north-western margin of the district. These are sandy to loamy sand, loose, structure less and well drained. Lithosols and regosols of hills: These types of soils are found in hills and hill slopes of central and western parts of the district. These are shallow, light textured, fairly drained and reddish brown to grayish brown in colour.

Fig 1- Map of Jodhpur District, Rajasthan (India)



2 METHODS AND MATERIALS

All the samples were analyzed for various physico-chemical parameters eg. pH, Total Dissolved Solids (TDS), Electrical Conductance (EC), Total Alkalinity (TA), Total Hardness (TH), Chloride (Cl), Nitrate (NO_3^-), Fluoride (F^-), Sodium (Na^+), Potassium (K^+), Sulphate (SO_4^{2-}) etc following standard methods. Analysis of water samples for determination water quality is not only cumbersome but time consuming also. However the task of periodic monitoring of the quality of water may be greatly facilitated if we can find some correlations among the numerous water quality parameters. This becomes possible from the fact that, when such correlations do exist, the determination of a few important parameters would suffice to give a rough idea of the overall quality of water since the other parameters can be predicted from the relations derived by using correlations.

2.1 Sampling methods:-Thirty water samples from different sites were collected from different areas of Nagaur region. The water samples were extensively used for drinking and other domestic purpose. . The samples were collected in high grade plastic bottles of one liter capacity after rinsing with Distilled water. The techniques and methods followed for collection, preservation, analysis and interpretation.

2.2 Analysis Methods:-The physicochemical characteristics of the ground water samples were determined by standard methods .The pH and Electrical conductivity were measured by using portable meters. The concentrations of Magnesium, Calcium hardness, total hardness, nitrate, were estimated by volumetric methods and the results are compare with Water standards.

Table 1: Permissible limits of various parameters by Institutes

S.N.	Parameters	WHO	UNICEF	BIS
1.	pH	6.5-8.0	6.5-8.5	6.5-8.5
2.	TDS	500	500	500-2000
3.	Alkalinity	200	200	200-600
4.	TH	350	300	300-600
5.	Fluoride	1.5	1.5	0.5-1.5
6.	Chloride	200	200	250-1000
7.	Nitrate	50	45	45-100
8.	Calcium	100	100	75-200
9.	Magnesium	40	30	30-150

2.3 Location of sampling stations: The samples were collected from villages of different regions namely Mandore(1), Bhawad(2), Baori(3), Banar(4), Banwarala(5), Bisalpur(6), Jajiwal(7), keru(8), Beru(9), Chokha(10), Daikara(11),Dangiyawas(12)Indroka(13)Jaleli Fouzdara(14), Joliyali(15), Karwar(16), Khatiyasany(17), Lordi daijagara(18), Narwa Khichiyan(19), Peethawas (20), Popawas(21), Rohilla Kallan(22), Salwan kallan(23), Soorpura(24), Manaklao(25), Mathaniya(26)Daijer(27) Rampura(28), Manai(29),Binjwadiya(30).

Table 2:- Physicochemical characteristics of water during the Post-monsoon season

Sample* No.	Source	pH	EC mhos/cm	TDS mg/l	Alk mg/l	TH mg/l	Ca mg/l	Mg mg/l	SO_4^- mg/l	Cl mg/l	F mg/l	NO_3 mg/l
1	T.W.	7.6	5300	4200	680	725	140	92	262	1300	2.5	13
2	POND	7.5	3381	2254	240	720	132	108	198	780	0.34	13
3	T.W	7.4	2722	1148	310	410	87	56	28	190	0.65	62
4	H.P	7.7	3700	3136	610	310	52	46	176	840	5.2	13
5	O.W	7.2	1152	721	380	60	15	16	80	70	3.8	4
6	H.P	7.8	4200	280	190	110	23	16	16	28	0.32	4
7	O.W	7.6	3358	2905	660	280	60	48	58	740	4.2	35
8	H.P	7.8	2284	2856	670	290	68	42	88	720	4.2	32

9	H.P	7.3	4027	4018	310	730	158	98	146	1400	0.72	24
10	H.P	7.5	2273	315	150	140	28	22	182	30	0.34	4
11	H.P	7.9	4521	4347	410	510	114	68	588	1250	3.6	8
12	T.W	7.1	3121	1414	570	290	58	34	47	260	1.3	7
13	POND	7.5	3326	2884	630	410	80	58	28	720	2	10
14	H.P	7.6	4190	3346	910	280	61	34	58	800	6.8	10
15	H.P	7.4	3480	3661	420	510	119	68	88	1750	3.7	13
16	H.P	7.4	2209	1806	810	250	52	36	96	360	1.9	7
17	H.P	7.7	2654	2436	240	340	72	48	126	800	2.3	3
18	H.P	7.8	2540	1960	210	280	68	46	148	640	1.9	4
19	H.P	8.1	2489	2326	250	290	62	44	58	780	2.3	7
20	H.P	7.4	7539	5159	410	610	122	78	86	1800	3.8	13
21	T.W	7.5	3200	4600	610	660	216	74	240	1250	2.3	23
22	O.W	7.8	3050	2260	215	735	148	98	196	780	1.4	20
23	H.P	7.2	1460	1170	325	415	98	54	28	190	0.9	50
24	H.P	7.6	3590	3210	650	385	72	48	164	840	5.5	10
25	H.P	8.0	2120	790	360	150	22	14	96	70	4.3	5
26	T.W	8.3	3620	340	140	110	24	16	22	30	0.8	8
27	H.P	7.9	3410	3180	660	310	68	46	58	740	4.9	33
28	T.W	6.9	1320	2930	710	370	78	44	88	720	4.5	38
29	T.W	8.2	2150	4045	390	760	182	98	158	1400	0.6	23
30	T.W	7.6	1660	395	180	150	46	26	176	30	0.3	4

3 Results and Conclusion

3.1 pH: The data revealed that pH ranged from 7.1 to 8.6. The minimum pH was observed in village Rampura and maximum pH was detected in Mathaniya village. pH is the negative exponent of H+ concentration. According to BIS standards, best and ideal pH value for human consumption is 7.0, but it may vary from 6.9-8.5 Thus, all the samples tested were slightly alkaline; the pH of all samples was within limit. (Table 2.)

3.2 Chloride: The concentration of chloride varied between 100 to 1800 mg/l. The minimum value was observed in Bisalpur village and maximum concentration in Peethawas village. However, according to BIS the permissible limit for chloride is 25-1800 mg/l, which indicate that drinking water of locations contained chloride concentration within permissible limit except for Peethawas village wherein the chloride concentration is higher than the permissible limit**.** (Table 2.)

3.3 Electric conductivity: EC is the capacity of water to carry ions, so it depends on the presence of ions and their concentration. Maximum and minimum values of EC were recorded in Peethawas i.e. 7539 mhos/cm. and Banwarla village i.e. 1152 mhos/cm. respectively. Thus variation in EC was observed in all the samples. EC signifies the amount of total dissolved salts, which indicates inorganic pollution of water (Table 2.)

3.4 TDS: According to BIS, the maximum acceptable limit of TDS in ground water for domestic purpose is 200 mg/l. Here TDS found to be varied minimum 280 mg/l from Bisalpur village and maximum 5159 from Peethawas village means maximum samples are beyond the Excessive limit. (Table 2).

3.5 Hardness: In ground water hardness is mainly due to carbonates, bicarbonates, sulphates, chloride of Ca and Mg. Data revealed that the values of hardness ranged between 60 to 735 mg/l from Banwarla & Rohilla Kallan village respectively, while the permissible limit of total hardness is 300-600 mg/l (Table 2).

3.6 Fluoride: The fluoride content in water sources of present study area ranged from 0.3 mg/l to 5.5 mg/l at Binjwadiya and Soorpura village respectively. However, the permissible limit of fluoride in drinking water is 1 mg/l, but it may extend to 1.5 mg/l in tropical areas where water is in less quantity. All the samples have fluoride more than the permissible limit, which leads to various health hazards like- dental and skeletal fluorosis. The people of study area also complained for joint and abdominal pain. (Table 2).

3.7 Nitrate: The Nitrate content in water sources of present study area ranged from 3 mg/l to 62 mg/l at Khatiyasani and Baori

village respectively. The origin of nitrate in ground water is primarily from fertilizers, septic systems and manure storage or spreading operations. Nitrate is one of the most frequent ground water pollutants in rural areas it needs to be regulated in drinking water basically because excess level can cause Methamoglobinaemia or Blue baby Disease. It is a disease, which reduces capacity of blood to carry oxygen for proper functioning of human body. Stomach Cancer is another disease caused by nirite produced by nitrate.(Table 2).

4 CONCLUSIONS

The analysis of ground water shows higher values of fluoride and nitrate in the drinking water samples of almost all locations, some places have higher values of alkalinity and chloride while remaining parameters are within the permissible limits. In these areas, the treatment technologies must be implemented to ensure good health of the community.

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