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Analysis of Physico-Chemical properties of Ajmer's Groundwater and Soil

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ABSTRACT

The physico-chemical analysis of ground water quality of Ajmer city in Rajasthan is presented in this paper. It is important from this point of view to observe the suitability of water for safe drinking and irrigation. The different parameters measured are calcium hardness, magnesium hardness, total hardness, As^{3+}, Cd^{2+}, Pb^{2+}, Hg^{2+} , TDS, F- , Cl–, NO_3–, SO_4 – alkalinity, carbonate hardness, pH and conductivity. From the observed data it is found that parameters like conductivity, TDS, F–, NO_3 – and hardness are higher in concentration from prescribed values. From the analysis of ground water quality, it is observed that some of the sites are not suitable for drinking purpose as well as domestic purpose.

Key words: Ground water quality, Different parameters

I. INTRODUCTION

Water is one of the foremost essential components and it is essentially required by all living organisms. Availability of good quality water for drinking purpose is very essential for healthy human society. About 80% of the earth's surface is covered by water. Out of the estimated 1,011 million Km3 of the total water present on earth, only 33, 400 Km of the total water is available for drinking, domestic and industrial consumption. The rest of the water is locked up in oceans as salt water, polar ice caps, glaciers and underground. Ground water is also one of the earth's renewable resources, which occur as a part of hydrological cycle. The quality of ground water is the resultant of all the processes and reactions that act on the water from the moment; it condenses in the atmosphere to the time it is discharged by well. Therefore, determining ground water quality is important to observe the suitability of water for particular purpose through anthropogenic and other sources like different land conditions, rain conditions, and use of different chemical pesticides and different depths of bore wells. Continued economic growth, green revolution, urbanisation and increase in health consciousness are posing enormous stress and threat to the limited fresh water resources. The 26th December, 2004 Tsunami has major impact on the quality of ground water6 along the south east coast of India. The Tsunami flooded large coastal areas, destroyed vegetation and greatly affected ground water supply. Water quality monitoring involves the sampling and testing of water sources of the public at specific intervals and at different locations. Constant, regular and effective monitoring of water sources can ensure and help in effective water quality management. Natural ground water bodies are subjected to pollution comprising of organic and inorganic constituents. Among the inorganic constituents, metals have been recognized as the most harmful pollutants because they are not biodegradable and often have long term toxic effects. A number of metals are present at trace levels in residential and industrial waste water. These trace metals, significantly As, Cd, Pb, and Hg are considered to be highly toxic while Cu, Zn and Fe etc. can also be considered so, at appropriate levels8, 9. The present report discusses the results of physico-chemical analysis of ground water from different points of Ajmer city and surrounding area with reference to its suitability for various uses.

II. AREA OF STUDY

Ajmer, Rajasthan's fourth biggest city, is located between 26°20' N and 260 33' N latitude and 74°35' E and 74°43' E longitude, with a total area of 241.50 square kilometres. According to 2001 causes, it has a population of 485575 people. It is located around 132 kilometres south of Jaipur city and is nestled in a lovely valley. The city's most notable feature is the NW-SW trending Aravalli hill ranges, which are affected by the Thar Desert to the west. The climate is semi-arid in general. The average monthly temperature in June is around 43°C, with an annual temperature of around 24.2°C.

Ajmer, often known as the 'Heart of Rajasthan,' is a growing city. It has been renowned as a political hub from ancient times, and the British used it as a political headquarters. Aside from being the primary educational hub, it is a significant historic and pilgrimage site because of the famed Durgah Sharif and Pushkar.

RESEARCH

MATERIALS AND METHODS

The water samples have been collected from 22 hand pumps of Ajmer city. Geographically, Ajmer is situated in 26o 27’ N latitude and 74o 44’ E longitudes on the lower slopes of Taragarh hill, in the Aravalli range. The annual rainfall is below 500 mm. showing a semi-arid climate. The North-Western part is covered with sand dunes and rest of the area is generally flat. Hydro geologically the major part of the region is occupied by crystalline rocks comprising of calc-schist, amphibolite /Calc-gneiss and biotite schist and alluvium of younger age are other important formations. A small occurrence of fluorspar in

Ajmer, has also been reported. The study has been initiated from July 2006 to December 2009 in different seasons premonsoon, monsoon and post monsoon period to check the various physico-chemical parameters. Samples have been collected in clean and sterilised polyethylene bottles of 2 L capacity. Standard methods with precise instruments are used to test the samples as per the literature method (APHA and AWWA). All the chemicals and solvents are of AR grade.

RESULT AND EXAMINATION

The results of water analysis of the samples collected are summarized in Table 1 and the observed results for different parameters for three seasons for twenty two hand pumps in order to visualize the quality and their trends in deterioration over different seasons. The physio-chemical investigation of the water samples for the following features of the ground water viz; calcium hardness, magnesium hardness, total hardness, As, Cd, Pb, Hg, TDS, fluoride, chloride, nitrate, sulphate, alkalinity, carbonate hardness, pH and conductivity etc. have been analysed by standard methods and compared with standards of the World Health Organization (WHO) and Bureau of Indian Standards (BIS). The findings of these major chemical parameters have been summarized.

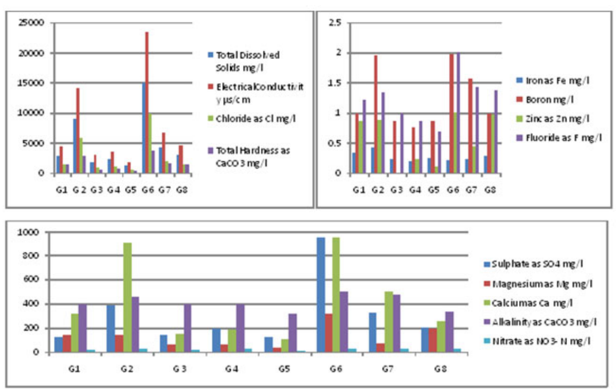


Fig.2: Comparative values of groundwater parameters of different sites.

Quality of Water

Hardness is defined as the sum of polyvalent cation present in the water, notably calcium and magnesium. Calcium and magnesium are the two major scale forming constituents in most raw water supplies. The presence of calcium and magnesium in ground water is mainly due to its passage through or over deposits of limestone, dolomite, gypsum and other gypseous materials. Calcium content in all experimental water samples is varying from 20 to 600 ppm. Calcium salts are non-toxic except at very high doses (100 mL for 20 days) in human body, hyper calcaemic causes comma and death, if in serum; calcium level rises to

160 ppm. The suggested limit of calcium is 75 ppm. Magnesium in too high concentration causes nausea, muscular weakness and paralysis in human body, when it reaches up to the level of about 400 ppm. The suggested limit of magnesium is 80 ppm (WHO), in this area magnesium concentration has been observed from 10 to 930 ppm. The permissible limit of hardness in drinking water according to WHO is 600 ppm. Total hardness at some stations has been found much higher than the said limit. The total hardness ($Ca2+$, $Mg2+$, $Cl–$, $SO4\ 2–$) of all water samples has been found to be above the permissible limits, varying from 60 to 990 ppm. This is mainly attributed to natural action i.e. rock, weathering rather than man made pollution, which has been affecting the soil nature like aeration and permissibility of earth surface. The environmental presence of arsenic derives from both; natural and anthropogenic sources. It occurs naturally when aquifers pass through bedrock containing arsenic. Significant amounts of arsenic are also introduced into the environment from anthropogenic sources, metal mining and smelting being the most important. Arsenic is a carcinogen and a potential health hazard11 known to produce skin, bladder & lung cancers and diarrheal diseases. According to some current estimates, approximately 1.8 million people still die every year from diarrheal diseases12 mostly in developing countries (WHO, 2008). The WHO and U.S. Environmental Protection Agency (EPA) recommended limit for arsenic in drinking water is currently 10 μg/L.

Cadmium is extensively used in the manufacture of batteries, paints, plastics etc. It is also used in plating iron products such as nuts and bolts for corrosion protection. At extreme levels13, it causes an illness called itabirite disease characterised by brittle bones and intense pain.

Exposure for prolonged periods at low levels causes high blood pressure, sterility among males, kidney damage and flue like disorders. The maximum and minimum concentration of cadmium has been registered to be 0.09 and nil ppm. Lead (II) is the abundant of the natural heavy metal. The primary form of lead in nature is galena (Pb), a relatively insoluble ore. Lead also occurs as plattnerite ($PbO2$), cerussite ($PbCO3$) and anglesite ($PbSO4$). From the observation, lead content in water.

Quality of the Soil

The natural abundance of fluoride in soils of the Ajmer district, Rajasthan was examined. From undisturbed soil, the top 15 cm of the profile was examined and the soil split into fractions based on sand, silt and clay particle size. Clay contained a high amount of fluoride, whereas sand and silts are enriched with much less fluoride. The relation between the soil fractions in observed clay fraction fluoride content matched groundwater fluoride variation. However, the enrichment of fluoride material extracted from the largest soil fraction had considerably lower amounts of clay relative to that from the smaller fractions

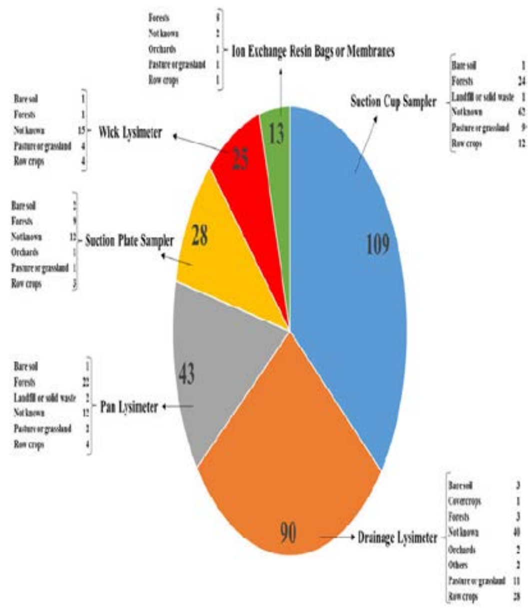
Table 3: Physio-Chemical Properties of Ajmer Soil Samples

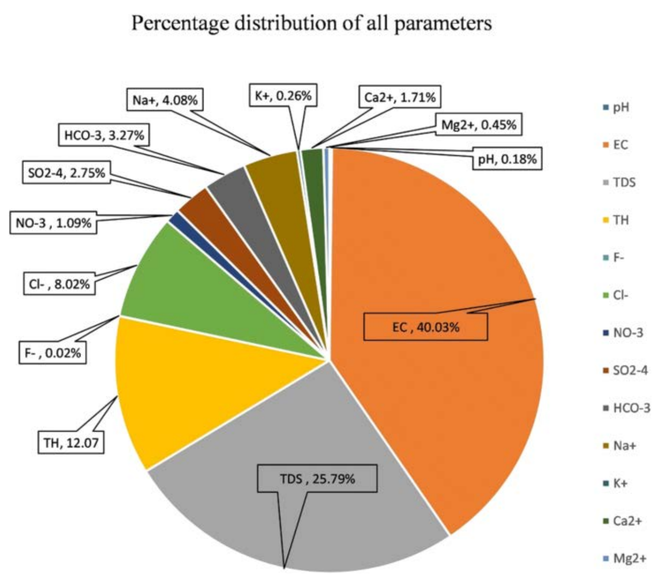
SI. No	*Location*	N%	*pH*	*EC*	*CF'*	*PO*	*K'*	*Na'*	*Ca"*	*Mg"*	*Zinc*	*Iron*	*Coppar*	*Mn*
1.	Shashtri Nagar	0.0 155	7.7	102.5	152.65	23	300	41 2	91	51.03	2.92	5.92	0.24	3.74
2.	Gangwana	0.0172	8.2	5	14.2	28	270	63	19	0	3.42	6.02	0.36	4.22
3.	Ghoogra	0.0198	8.2	7.6	10.65	36	290	84	13	1.215	3.26	5.14	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.	Nay a 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	6.8	7.2	12.76	36	190	110	1 1	0.6075	3.3	6.52	0.44	4.22
6.	Makhupura	0.0189	8.4	8	9 23	40	270	71	1 1	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	6.24	0.28	4.46
10.	Tabij ii	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	2.5B	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	1 11.47	44	240	560	170	36.45	Z.85	5.28	0.22	3.78
14.	Vaishali Nagar	0.0189	8.6	6.2	10.65	35	220	61	1 2	1.8225	1.24	6.18	0.18	4.72
15.	Chaursiyawas	0.0207	9.2	4.6	12.07	3B	170	1 54	17	13.365	2.24	6.28	0.38	2.98
16.	Christiangunj	0.0224	B.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 (microsomes cm^{-1}, Phosphate and Potash (Kg/hectare)

"Capacity of a specific soil to function: within natural or controlled ecosystem limits, to sustain plant or animal productivity, maintain or enhance water and air quality, and support human health and habitation," according to one prominent definition of soil quality.

Table lists the physio-chemical properties of several sample sites. Ajmer's pH ranges from 7.7 to 9.4. The lowest pH value was found in Shastri Nagar, while the highest pl-1 9.4 was found in the JLN region. The pH of the tests revealed that the city's soil is mildly alkaline to very alkaline. The conductivity ranges from 2.4 micro siemens/cm to 102.5 micro siemens/cm. Taiji provided the lowest value, while Shastri Nagar provided the highest value.





AND WATER QAULITY INDEX AND GIS BASES TECHNIQUE

Co-Efficient of Correlation Among Soil Quality Parameters

Calcium hardness is lowest in Tyabji, at 8 mg/L, and highest, at 285 mg/L. Similarly, Magnesium Hardness is lowest in Gangwon, at Nil, while it is highest in Parbatpura, at 63.78 mg/L. The concentrations of nitrate in the samples ranged from 0.0155 percent to 0.0224 percent.

The concentrations of sodium and chloride in soil samples from Ajmer city vary from 47.0 to 560 mg/L and 10.65 mg/L to 152.65 mg/L, respectively. Heavy metal concentrations in soil sample solutions range from 1.24 mg/L to 3.42 mg/L, 5.38 mg/LK to 8.54 mg/L, 0.19 mg/L to 0.54 mg/L, and 2.42 to 4.72 mg/L.

Study of Groundwater Samples

Most parts of the study area show F– concentrations above the maximum permissible limit (i.e. 1.5 mg/l) with high fluoride groundwater noticed in the discharge areas as compared to recharge areas. Presence of fluoride bearing minerals in the host rocks and their interaction with water is considered to be the main cause for fluoride enrichment in groundwater. Decomposition, dissociation and dissolution are the main chemical processes responsible for mobility and transport of fluoride into groundwater. Chemical weathering under arid to semiarid conditions with relatively high alkalinity and long residence time of interaction seem to have favoured high concentration of fluoride in groundwater. Geochemical behaviour of groundwater from the study area suggests that high fluoride groundwater contain low levels of Ca and high alkalinity. High pH and HCO3 /Ca ratio between 0.9 and 3.5 suggest favourable chemical conditions for fluoride dissolution process. Regular intake of fluoride rich waters seems to be the main cause for high incidence of fluorosis in the region. Dilution by blending, artificial recharge, efficient irrigation practices and well construction are some common cost effective fluoride control measures which can be adopted to improve the health status of the community.

Investigation of a Soil Sample

The fractionated soil samples of Ajmer district contain an average of 85% sand, 10% silt and 5% clay. The fractionated soil contains 13 mg g21 fluoride (9–18 mg g21 F) for sand, 30 mg g21 fluoride (19–45 mg g21 F) for silt and 55 mg g21 fluoride (27–129 mg g21 F) for clay. The plotted fractionated fluoride values in a trilinear diagram clearly show fluoride predomination in the clay fraction. In bulk soil an average of 26 mg g21 fluoride (18–39 mg g21 F) was found. The value of coefficient of variation (CV) was less for the sand fraction (8%) and higher for silt and clay fractions (y50%), showing heterogeneity with bulk soil. This was the same with the extraction of fluoride from the fractionated soil samples. Groundwater fluoride concentrations from the soil sampled region show high variation, 0.3–5.4 ppm and the multiple regression results indicate that the fluoride concentration present in the fractionated bulk soil sample does not correlate well with groundwater fluoride. A moderate correlation was obtained for the amount of clay present in bulk soil versus groundwater fluoride (r ~ 0.403)

CONCLUSION

In Ajmer district soil, fluoride was found predominately in the clay fraction. A moderate relationship was established between groundwater fluoride and the amount of clay in bulk soil. If the amount of clay decreases the value of fluoride present in groundwater also decreases. To distinguish the influence of soil at different sampling sites on the overall fluoride concentration levels, an extensive investigation using GIS data evaluation has still to be carried out..

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