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CORRELATION STUDY ON PHYSICO-CHEMICAL PARAMETERS AND QUALITY ASSESSMENT OF GROUND WATER OF BASSI TEHSIL OF DISTRICT JAIPUR, RAJASTHAN, INDIA

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ABSTRACT

Water is an essential natural resource for sustaining life and environment but over the last few decades the water quality is deteriorating due to it's over exploitation. Water quality is essential parameter to be studied when the overall focus is sustainable development keeping mankind at focal point. Groundwater is the major source of drinking water in rural as well as in urban areas and over 94% of the drinking water demand is met by groundwater. The study was carried out to assess the ground water quality and its suitability for drinking purpose in most rural habitations of Bassi tehsil of district Jaipur, Rajasthan, India. For this purpose, 50 water samples collected from hand pumps, open wells and bore wells of villages of study area were analysed for different physico-chemical parameters such as pH, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and total dissolved solids. pH value in the study area found from 7.0 to 8.1. EC ranges from 392-5152 µmhos/cm and total alkalinity between 190 to 980 mg/L. Total hardness ranged from 60 to 2400 mg/L and calcium hardness from 20 to 1150 mg/L. Magnesium hardness varied from 40 to 1250 mg/L and chloride from 20 to 2000 mg/L. Values of nitrate concentration varied from 2 to 380 mg/L and fluoride from 0.3 to 9.6 mg/L while value of TDS ranges from 560 to 7360 mg/L. The study reveals that almost all parameters were exceeding the permissible limits. As per the desirable and maximum permissible limit for fluoride, nitrate, total dissolved solids and chloride in drinking water, determined by WHO BIS and ICMR standards, 44%, 14%, 24% and 42% of groundwater sources are unfit for drinking purposes respectively. Due to the higher fluoride level in drinking water several cases of dental and skeletal fluorosis have appeared in this region. After evaluating the data of this study it is concluded that drinking water of Bassi tehsil is not potable and there is an instant need to take ameliorative steps in this region to prevent the population from adverse health effects.

Keywords: Groundwater quality, Physico-chemical parameters, Statistical Parameters

INTRODUCTION

"Water is life's matter and matrix, mother and medium. There is no life without water." In now days, the modern civilization, urbanization and expanded population with resulting industrial operation has intensified the old problem of polluting our life, mother and medium. At present our life, mother and medium is being polluted and even worse situation is that we encounter with scarcity of this degraded quality of water too. It has raised certain basic challenges in our environment and we are suffering both the problems of quality and quantity of water. In India groundwater is the major source of drinking water and over 94% of the drinking water demand is met by groundwater. Water quality is essential parameter to be studied when the overall focus is sustainable development keeping mankind at focal point, since it is directly linked with human welfare. (Saxena and Saxena,2013)

Statistical investigation offers more attractive options in environment science, though the result may deviate more from real situations (Nemade and Shrivastava, 1997). The correlation provides an excellent tool for the prediction of parametric values within a reasonable degree of accuracy (Venkatachalam and Jabenesan, 1998). The quality of water is described by its physical, chemical and microbial characteristics. But, if some correlations are possible among these parameters, then the more significant ones would be useful to indicate fairly the quality of water (Dhembare and Pondhe, 1997). A systematic study of correlation of the water quality parameters not only helps

to assess the overall water quality but also to quantify relative concentration of various pollutants in water and provide necessary cue for implementation of rapid water quality management programmes (Dash et al, 2006).

Rajasthan is the largest state in the country in terms of geographic spread. It has an area of 342,239 lakh Sq kms being largest state of the country having 10.41 % of the country's area and 5.5% of nation's population but has low water resources i.e. 1% of the country's resources. The state has extreme climatic and geographical condition and it suffers both the problems of quantity and quality of water.

Review on the literature showed that no studies have been undertaken in the study area with regard to physico-chemical characteristics of water yet. So the objective of this study was to investigate the quality of drinking water (underground water) in most rural habitations of Bassi Tehsil of Jaipur, Rajasthan, India.

MATERIALS AND METHODS

Study Area

Jaipur district with geographical area of 11,151 sq. km forms East-central part of the Rajasthan which is administered by 13 tehsils and 13 blocks. The district covers about 3.3% of total area of the State. Jaipur, the capital city is also popularly known as Pink city and is situated towards central part of the district. The semi-arid district receives normal annual rainfall of 527mm (1901-71) while average annual rainfall for the last 30 years (1977-2006) is 565mm. Over 90% of total annual rainfall is received during monsoon. (CGWB, 2007; JDA,2012)

Bassi Tehsil of Jaipur district is almost 29 KM far away from the main city having the area of 654.69 sq.km. It is located at $26^0$96' N latitude and $75^0$62'E longitude. In Bassi Tehsil there are 210 villages (famous for their leather footwear and Embroidery beading). There are no major surface water sources in the study area however, main sources of drinking water are open wells, hand pumps and bore wells.

Water Sampling

Ground water samples of a total of 50 villages in Bassi Tehsil of Jaipur district were collected in pre-cleaned and rinsed polythene bottles of two litre capacity with necessary precautions. (Brown et al. 1974) The samples were collected, during April 2013 to March 2014 from manually operated hand pumps, open wells and bore wells.

Physico-chemical Analysis

All the samples were analyzed for the following Physico-chemical parameters; pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Calcium hardness (Ca H), Magnesium hardness (Mg H), Chloride, Nitrate, Fluoride and Total Dissolved Solid (TDS). The analysis of water samples were out carried in accordance to standard analytical methods (APHA, 2005). All the chemicals used were of AR grade and double distilled water used for preparation of solutions. Details of the analysis methods are summarized in Table-1.

Table-1: Parameters and methods employed in the physicochemical examination of water samples

S.No.	Parameters	Unit	Method Employed
1.	pH	-	Digital pH-meter
2.	Electrical Conductivity	µmhos/cm	Digital Conductivity-meter
3.	Total Alkalinity	Mg/L	Titrimetric method (With HCl)
4.	Total Hardness (as $CaCO_3$)	Mg/L	Titrimetric method (with EDTA)
5.	Calcium Hardness (as $CaCO_3$)	Mg/L	Titrimetric method
6.	Magnesium Hardness (as $CaCO_3$)	Mg/L	Titrimetric method
7.	Chloride (as Cl^-)	Mg/L	Titrimetric method (With $AgNO_3$)
8.	Nitrate (as NO_3^-)	Mg/L	Spectrophotometric method
9.	Fluoride (as F^-)	Mg/L	Ion Selective Electrode
10.	Total Dissolved Solids	Mg/L	Digital Conductivity-meter

Statistical Analysis

In the present study Minimum, Maximum, Average, Standard Deviation and Correlation coefficient (r) has been calculated for each pair of water quality parameters by using Excel spreadsheet for the experimental data.

The standard formulae were used in the calculation for statistical parameters are as follows (S.P. Gupta, 1999):

$$Mean\ (\mu) = \frac{\sum x}{N}$$

x = Value of Observation
N = Number of Observation

$$\text{Standard Deviation } (\sigma) = \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}}$$

x = Values of Parameter
n = Number of Observations

$$\text{Karl Pearson's Coefficient of Correlation } r = \frac{n\sum xy - \sum x \sum y}{\sqrt{n\sum x^2 - \left(\sum x\right)^2}\sqrt{n\sum y^2 - \left(\sum y\right)^2}}$$

x,y = Values of array 1 and array 2 respectively.
n = Number of Observations

RESULT AND DISCUSSION

The respective values of all water quality parameters in the groundwater samples are illustrated in Table-2. All the results are compared with standard permissible limit recommended by the Bureau of Indian Standards (BIS), Indian Council of Medical Research (ICMR) and World Health Organization (WHO), depicted in Table-3. Statistical Parameters of groundwater samples of study area are summarized in Table-4.

1. **pH:** pH is measure of intensity of acidity or alkalinity of water. All chemical and biological reactions are directly dependent upon the pH of water system (Rao, 2006). In our findings pH varied between 7.0-8.1. Maximum pH was recorded at S18 in village *Ghata* and minimum pH was recorded at S12 in village *Chatarpura*, which are not within the permissible limit prescribed by BIS, ICMR and WHO. The variation of pH in ground water samples of study area is depicted in Figure – 1, which shows that most of the samples are alkaline in nature. The pH of water is very important indication of its quality and provides information in many types of geochemical equilibrium or solubility calculations (Mitharwal et al., 2009).

2. **Electrical Conductivity:** The electrical conductivity of water depends upon the concentration of ions and its nutrient status. Based on electrical conductivity values the water quality can be classified as poor, medium or good (Gulta, Sunita, & Saharan, 2009). In the present investigation maximum conductivity 5152 µmhos/cm was observed at S21 in village *Hans Mahal* and minimum 392 µmhos/cm at S11 in village *Chakrod Wali.* The maximum limit of EC in drinking water is prescribed as 1400 µmhos/cm (WHO: 2006), Samples are exceeding the permissible limit as shown in Figure- 2.

3. **Total Alkalinity:** Total Alkalinity ranges from 190 mg/L to 980 mg/L, the maximum value was recorded in village *Jhar* (S26) and minimum in village *Chakrod Wali* (S11). Variation in total alkalinity of ground water samples is represented in Figure- 3 which clearly depicts that these values are more than the permissible limits of BIS, ICMR and WHO. In ground water, most of the alkalinity is caused due to carbonates and bicarbonates.

4. **Total Hardness:** Hardness is the property of water which prevents lather formation with soap and increases the boiling point of water. Hardness of water mainly depends upon the amount of calcium or magnesium salt or both (Singh et al. 2012). It is an important criterion for determining the usability of water for domestic, drinking and many industrial supplies (Mitharwal et al., 2009). In our findings the value of hardness fluctuates from 60 mg/L to 2400 mg/L (Figure-4), which are beyond the permissible limit as prescribed by BIS, ICMR and WHO. The minimum value was found in S12 (Village- *Chatarpura*) and maximum value was found in samples S8 (village- *Benada*).

5. **Calcium Hardness:** Calcium Hardness varies from 20 mg/L to 1150 mg/L as illustrated in Figure-5. It may be due to the presence of high amounts of calcium salts in ground water samples.

Table-2: Analysis of ground water quality parameters in villages of Bassi Tehsil (Jaipur, Rajasthan, India)

S.NO.	Sampling Site	Code	pH	EC	Alk. mg/l	TH mg/l	Ca H mg/l	Mg H mg/l	Cl^- mg/l	NO_3^- mg/l	F^- mg/l	TDS mg/l
1.	Akhapura	S1	8.0	2072	710	230	100	130	680	18	3.2	2960
2.	Anantpura	S2	7.8	840	660	120	50	70	280	37	1.5	1200
3.	Ballupura	S3	7.6	448	400	190	80	110	20	19	0.4	640
4.	Banskho	S4	7.7	896	820	150	60	90	100	35	2.4	1280
5.	Bari	S5	7.7	616	470	600	250	350	300	13	3.3	880
6.	Barla	S6	7.7	487.2	390	100	40	60	130	03	2.1	696
7.	Bassi	S7	7.3	980	290	120	40	80	100	26	1.26	1400
8.	Benada	S8	7.7	3136	400	2400	1150	1250	1000	359	0.74	4480
9.	Budarpura	S9	7.7	448	440	160	70	90	40	29	1.3	640
10.	Chainpuriya	S10	7.7	448	480	80	30	50	20	05	1.8	640
11.	Chakrod Wali	S11	7.8	392	190	90	30	60	50	10	4.1	560
12.	Chatarpura	S12	7.0	896	800	60	20	40	80	12	5.9	1280
13.	Danau Kala	S13	7.8	728	700	100	40	60	60	02	1.9	1040
14.	Danau Khurd	S14	7.7	1848	400	560	200	360	480	08	0.9	2640
15.	Dholi	S15	7.4	1176	680	340	160	180	280	14	1.3	1680
16.	Garh	S16	7.7	896	490	230	100	130	220	02	1.2	1280
17.	Ghasipura	S17	7.6	448	340	140	60	80	30	06	0.3	640
18.	Ghata	S18	8.1	616	570	120	50	70	40	03	2.4	880

19.	Gumanpura	S19	7.7	560	380	200	80	120	100	08	2.0	800
20.	Gwalini	S20	7.8	406	320	200	90	110	40	10	1.3	580
21.	Hans Mahal	S21	7.8	5152	640	910	390	520	2000	54	2.9	7360
22.	Hanumanpura	S22	7.7	672	550	120	50	70	80	27	0.8	960
23.	Hathipura	S23	7.6	784	540	180	70	110	140	21	1.1	1120
24.	Jahjwar	S24	7.9	1064	720	200	80	120	220	65	1.2	1520
25.	Jeetawala	S25	7.6	1456	760	320	140	180	400	19	1.5	2080
26.	Jhar	S26	7.6	616	980	160	70	90	170	39	2.0	880
27.	Kacholiya	S27	7.7	784	800	120	60	60	90	37	2.1	1120
28.	Kanota	S28	7.5	2520	780	320	150	170	1100	38	1.8	3600
29.	Kanpuriya	S29	7.4	2464	430	670	290	380	750	16	2.1	3520
30.	Kashipura	S30	7.6	784	640	100	40	60	80	16	8.4	1120
31.	Keshopura	S31	7.7	1512	500	400	160	240	510	10	0.7	2160
32.	Kuthada	S32	7.9	784	760	240	100	140	60	31	2.7	1120
33.	Lalawala	S33	7.7	784	680	80	30	50	40	10	1.4	1120
34.	Lalgarh	S34	7.5	1064	580	320	140	180	300	02	1.5	1520
35.	Manser Khedi	S35	7.9	1176	760	300	120	180	180	43	1.0	1680
36.	Mohanpura	S36	7.7	1400	790	180	80	100	270	27	1.0	2000
37.	Mundali	S37	7.7	840	620	100	40	60	100	41	9.6	1200
38.	Nangal Karna	S38	7.7	425.6	390	110	40	70	150	2	1.9	608
39.	Nayagav	S39	7.7	560	330	180	80	100	80	28	0.3	800
40.	Parasoli	S40	7.8	492.8	580	150	60	90	50	08	2.4	704
41.	Parempura	S41	7.9	3528	510	980	460	520	570	10	1.8	5040
42.	Patalabas	S42	7.7	784	340	460	190	270	180	113	0.3	1120
43.	Patan	S43	7.8	2408	620	590	220	370	870	22	1.1	3440
44.	Peipura	S44	7.6	1400	730	260	110	150	380	51	1.3	2000
45.	Rajwas	S45	7.8	1232	660	260	110	150	260	58	1.0	1760
46.	Ratanpura	S46	7.7	1512	900	360	170	190	380	04	1.2	2160
47.	Sambhariya	S47	7.3	1064	700	70	30	40	40	24	4.2	1520
48.	Siya Ka Bas	S48	7.6	896	780	100	40	60	120	02	1.2	1280
49.	Tilpatti	S49	7.8	560	600	240	100	140	20	11	0.7	800
50.	Tunga	S50	7.8	1456	300	980	510	470	400	380	0.4	2080

6. **Magnesium Hardness**: Magnesium Hardness of groundwater is varying from 40 mg/L to 1250 mg/L as shown in Figure-6. High values of magnesium hardness can be attributed to the large amounts of magnesium salts in ground water.

7. **Chloride:** Chloride contents in fresh water are largely influenced by evaporation and precipitation. Chloride ions are generally more toxic than sulphate to most of the plants and are best indicator of pollution (Rao, 2006). Chloride found high during the study ranged from 20 mg/l to 2000 mg/l (Figure-7). Minimum value was observed at samples S3, S10 and S49 and maximum value was observed at S21 in village *Hans Mahal.* These unusual concentrations may indicate pollution by organic waste. Chloride salts in excess of 100 mg/1 give salty taste to water and when combined with calcium and magnesium, may increase the corrosive activity of water (Tatawat and Singh-Chandel, 2007).

8. **Nitrate:** During the study Nitrate fluctuated between 2.0 to 380 mg/l (Figure -8). Which are beyond the permissible limit of BIS, ICMR and WHO. In presence of high concentration of nitrate drinking water is toxic (Umavathi et al. 2007). Due to higher concentration (over

100 mg/L) of nitrate in water, infants, less than six month old, are suffering from methamoglobinemia or blue baby disease.

9. **Fluoride:** Fluoride is important in human nutrition for the normal development of bones. The required level of fluoride is 1.0 to 1.5 mg/L. Higher concentration of fluoride in ground water appears to create dental, skeletal and non-skeletal fluorosis (Saxena and Saxena, 2013). Fluoride concentration in sampling sites ranges from 0.3 to 9.6 mg/L in ground water samples, with lowest value 0.3 mg/L (S17, S39 and S42) in village *Ghasipura, Nayagav, Patalabas* and highest value 9.6 mg/L (S37) in village *Mundali.* As shown in Figure-9 and Table-2 most of the samples are having fluoride concentration more than the permissible limit and suffering from the acute fluoride problems.

10. **Total Dissolved Solids:** Total dissolved solid is an important parameter for drinking water and water to be used for other purposes beyond the prescribed limit, it imparts a peculiar taste to water and reduce its potability (Sandeep Mitharwal et al., 2009). Total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of Calcium, Magnesium, Sodium, Potassium, Manganese, organic matter salt and other particles (Siebert et al., 2010). In the present finding TDS value varied from 560 to 7360 mg/L (Figure-10), which is also not within the prescribed permissible limits. Maximum TDS recorded at S21 in village *Hans Mahal* and minimum at S11 in village *Chakrod Wali*.

Table-3: Standards for drinking water quality

S. No.	Parameter	BIS: 1999	ICMR: 1975	WHO: 2006
1.	pH	6.5-8.5	7.0-8.5	6.5-8.5
2.	EC (µmhos/cm)	-	-	1400
3.	TA	600	600	120
4.	TH	600	600	500
5.	Cl-	1000	200	200
6.	NO_3^-	100	50	45
7.	F^-	1.5	1.5	1.5
8.	TDS	2000	1500	500

Table-4: Statistical parameters of the different chemical constituents of ground water of the study area

S.No.	Parameter	Minimum	Maximum	Average	Standard Deviation
1.	pH	7.0	8.1	7.684	0.1833
2.	EC	392	5152	1170.23	912.57
3.	TA	190	980	578	182.09
4.	TH	60	2400	313	377.52
5.	Ca H	20	1150	136.6	180.51
6.	Mg H	40	1250	176.4	198.36
7.	Cl^-	20	2000	280.8	358.87
8.	NO_3^-	2	380	36.56	71.71
9.	F^-	0.3	9.6	1.97	1.80
10.	TDS	560	7360	1671.76	1303.68

Correlation of water quality parameters

In the present study the correlation coefficients (r) among various water quality parameters have been calculated and the numerical values of correlation coefficients (r) are tabulated in Table-5.Correlation coefficient (r) between any two parameters, x & y is calculated for parameter such as water pH, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and total dissolved solids of the ground water samples. The degree of line association between any two of the water quality parameters as measured by the simple correlation coefficient (r) is presented as 10 x 10 correlation matrix.

The pH has been found to show positive correlation with electrical conductivity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, and total dissolved solids and negative correlations with total alkalinity and fluoride. EC has been found to show negative correlations with fluoride while all other parameters are positively correlated with EC. Out of the 55 correlation coefficients, 6 correlation coefficients (r) between the TDS and EC, Cl^- and EC (0.9356), Ca H and TH (0.9960), Mg H and TH (0.9967), Ca H and Mg H (0.9856), Cl^- and TDS (0.9356) are found to be with highly significant levels ($0.8< r < 1.0$), and 1 correlation coefficient gives the significant ($0.5< r < 0.6$) level of r values. There are 11 value of r which belongs to the moderate significant coefficient levels ($0.6< r < 0.8$). 42 cases were calculated out positive correlation while 13 cases were calculated out negative.

Table-5: Correlation coefficient (r) among water quality parameters

Parameter	pH	EC	TA	TH	Ca H	Mg H	Cl^-	NO_3^-	F^-	TDS
pH	1.0000									
EC	0.0664	1.0000								
TA	-0.0596	0.1260	1.0000							
TH	0.1124	0.6753	-0.2128	1.0000						
Ca H	0.1080	0.6493	-0.2073	0.9960	1.0000					
Mg H	0.1156	0.6944	-0.2164	0.9967	0.9856	1.0000				
Cl^-	0.0678	0.9356	0.0861	0.6265	0.5959	0.6501	1.0000			
NO_3^-	0.0964	0.2878	-0.2039	0.7330	0.7688	0.6955	0.2825	1.0000		
F^-	-0.1871	-0.0426	0.1847	-0.2038	-0.2008	-0.2052	-0.0712	-0.1674	1.0000	
TDS	0.0664	1.0000	0.1260	0.6753	0.6493	0.6944	0.9356	0.2878	-0.0426	1.0000

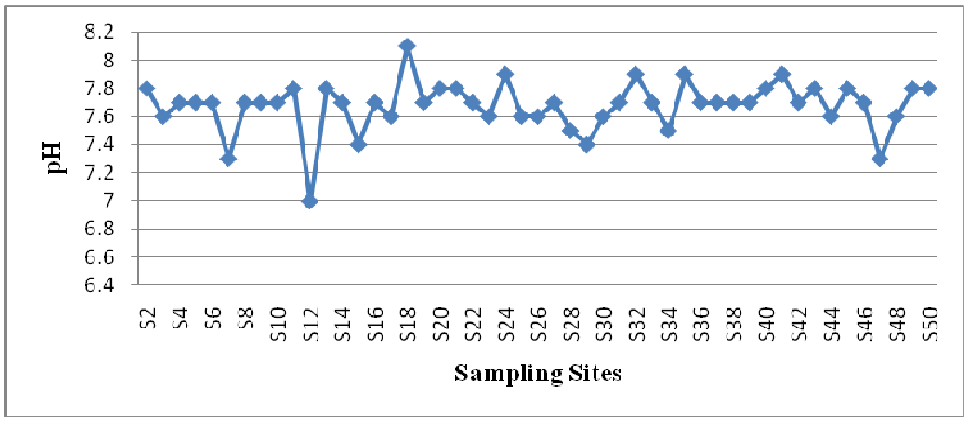

Figure 1- Variation in pH with sampling sites of Bassi Tehsil

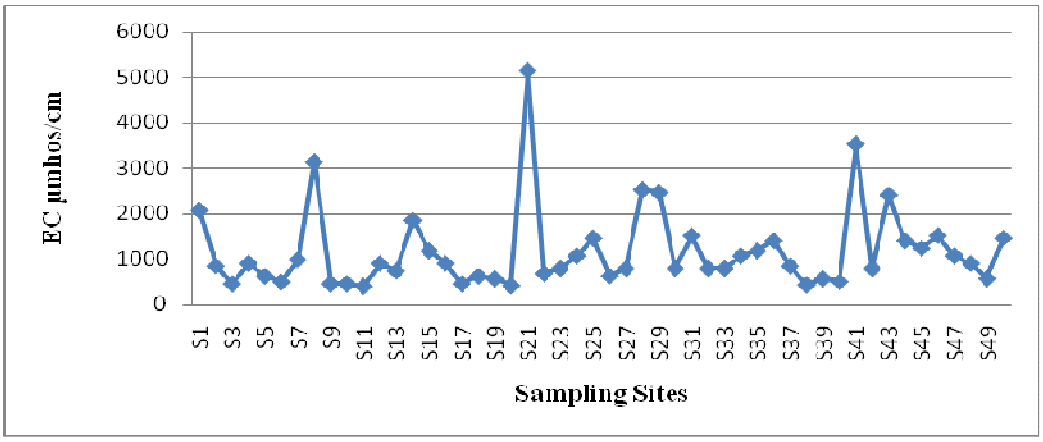

Figure 2- Variation in EC with sampling sites of Bassi Tehsil

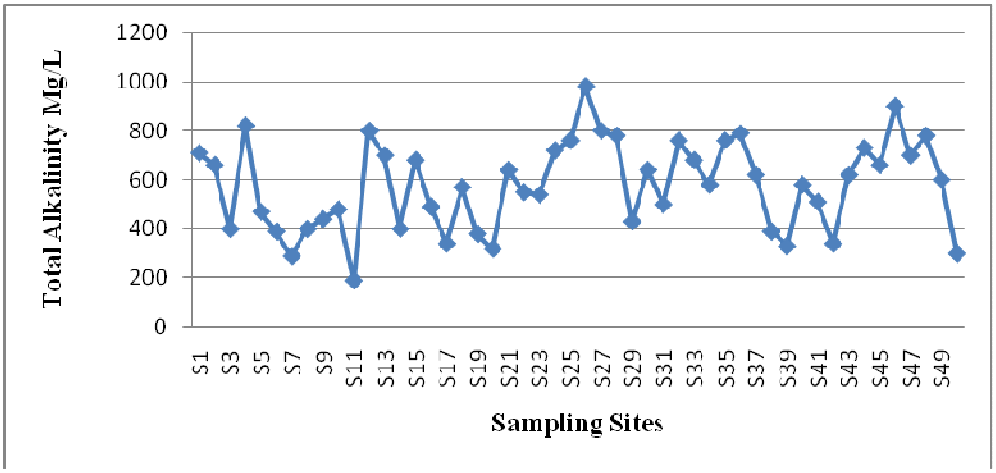

Figure 3- Variation in Total Alkalinity (mg/L) with sampling sites of Bassi Tehsil

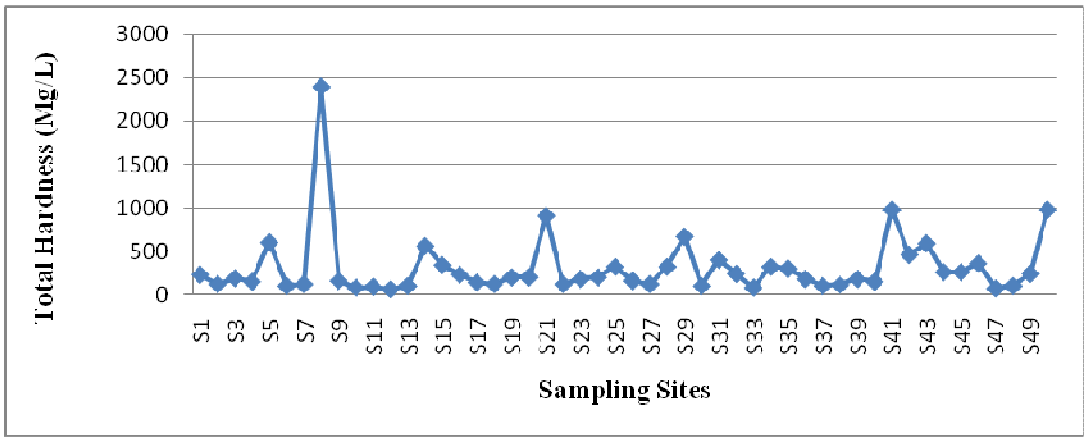

Figure 4- Variation in Total Hardness (mg/L) with sampling sites of Bassi Tehsil

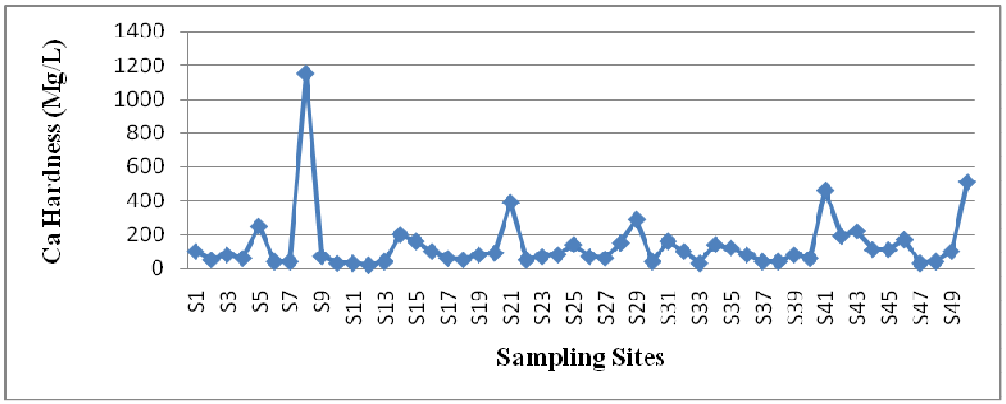

Figure 5- Variation in Ca Hardness (mg/L) with sampling sites of Bassi Tehsil

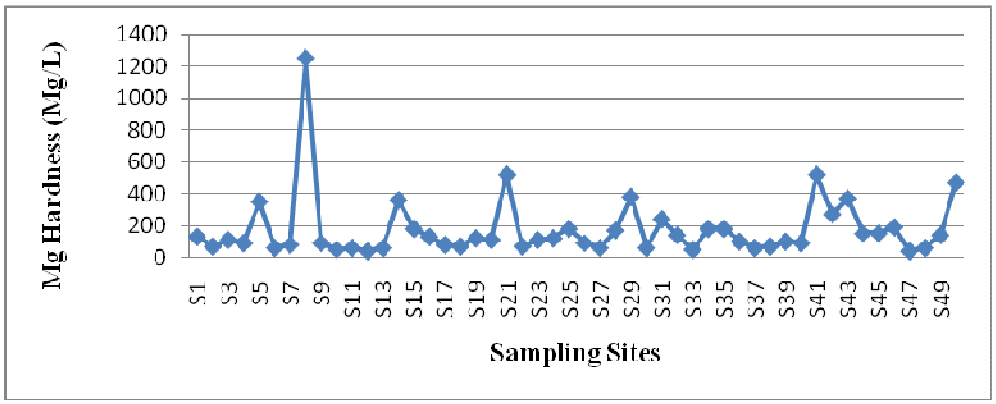

Figure 6- Variation in Mg Hardness (mg/L) with sampling sites of Bassi Tehsil

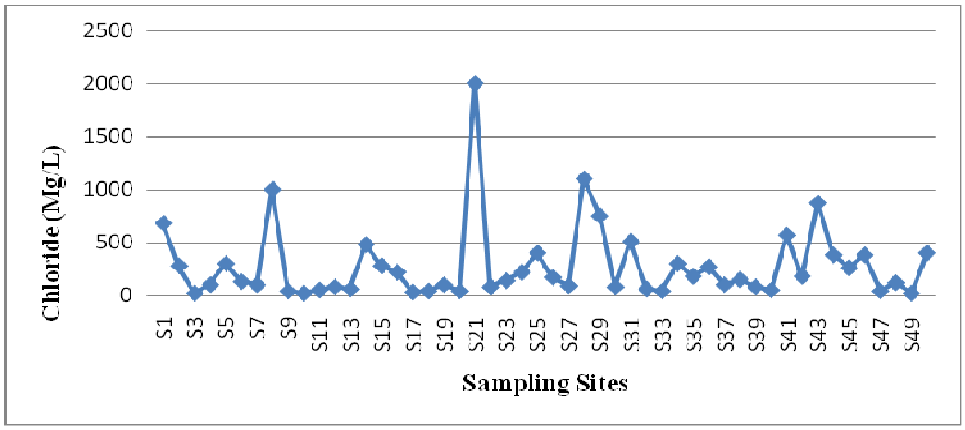

Figure 7- Variation in Chloride (mg/L) with sampling sites of Bassi Tehsil

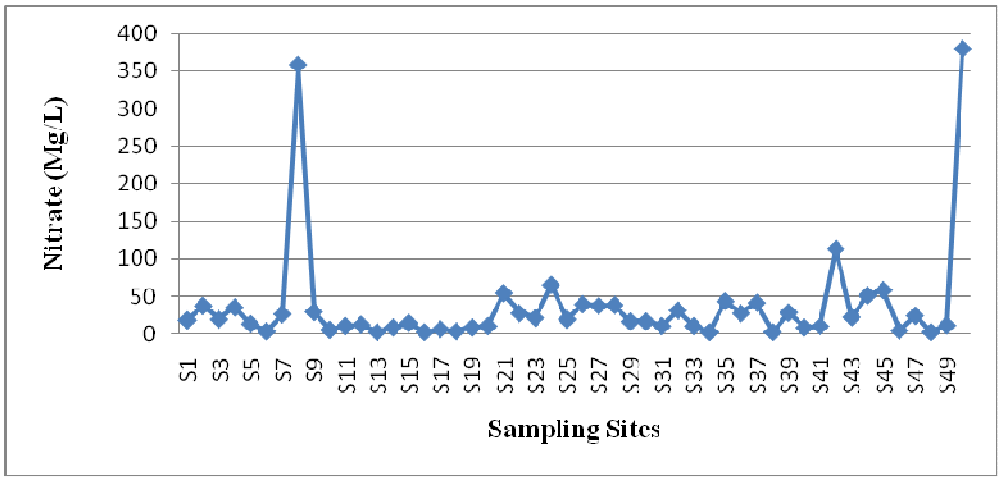

Figure 8- Variation in Nitrate (mg/L) with sampling sites of Bassi Tehsil

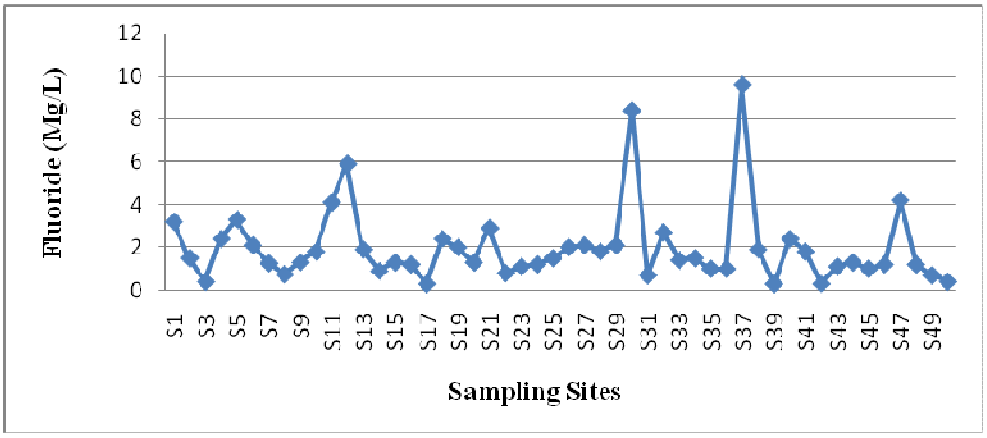

Figure 9- Variation in Chloride (mg/L) with sampling sites of Bassi Tehsil

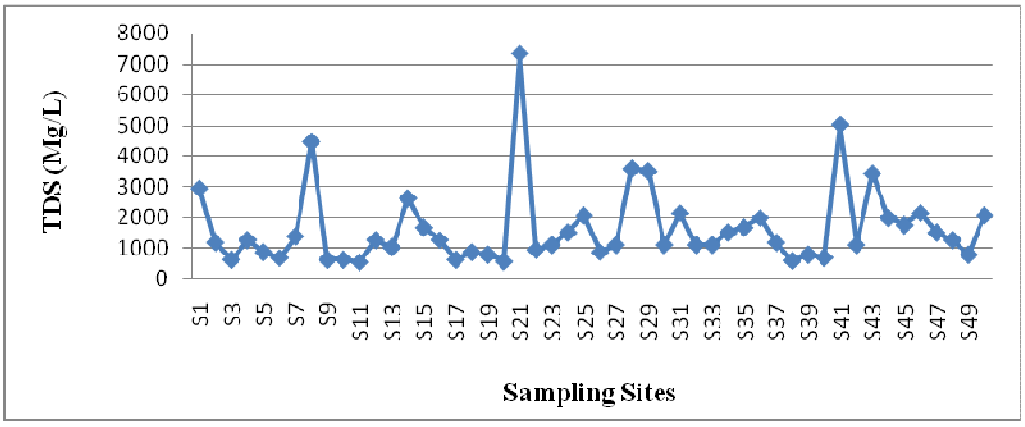

Figure 10- Variation in TDS (mg/L) with sampling sites of Bassi Tehsil

CONCLUSION

The analysis of ground water samples collected from different villages of Bassi Tehsil in District Jaipur revealed that, in samples almost all water quality parameters (pH, electrical conductivity, total alkalinity, total hardness, calcium hardness, magnesium hardness, chloride, nitrate, fluoride and TDS) are beyond the permissible limit as per BIS, ICMR and WHO standards. In comparison to all other parameters there is an acute problem of extremely high levels of Fluoride, Nitrate, Total Dissolved Solids and Chloride. As only 56% of ground water samples have fluoride content with in the permissible limit (> 1.5 mg/L, WHO) and remaining 44% of villages are having very high fluoride concentrations. The favourable factor which contributes to rise of fluoride in ground water is presence of fluoride rich rock salt system.

The nitrate ion concentration of 14% of total samples was more than 45 mg/L. Some samples contain this concentration u p to 380 mg/L. The increased nitrate level in the ground water samples may be due to the consumption of large quantity of nitrogenous fertilizers like urea, NPK and cattle-shed along with municipal wastes. 24% of ground water samples are having TDS more than 2000 mg/L (relaxed permissible limit as per BIS standards) and 42% ground water samples reported the Chloride level more than 200 mg/L.

The results of current study indicate that the drinking water, used by the people residing in villages of Bassi Tehsil, is not potable. So, the proper environment management plan must be adopted to control drinking water pollution immediately. Based on these results and analysis of water samples, it is also recommended to use water only after boiling and filtering or by Reverse Osmosis treatment for drinking purpose by the individuals to prevent adverse health effects.

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REFERENCES

1. APHA (2005). Standard Methods for the Examination of Water and Waste Water (21th ed.). Washington DC: American Public Health Association.

2. Brown, E., Skougstad, M. W., & Fishman, M. J. (1974). Method for collection and analysis of water sample for dissolved minerals for dissolved minerals and gases (Book No. 5). Washington, DC: US Department of Interior.

3. Bureau of Indian Standards, 1999. Indian Standards (IS: 10500) Drinking Water Specifiation: New Delhi.

4. Central Ground Water Board, Ministry of Water Resources, Government of India, (2007). Ground Water Scenario, Jaipur District, Rajasthan, CGWB, Jaipur.

5. Dash J.R., Dash P.C. and Patra H.K., 2006. A Correlation and Regression Study on the Ground water quality in Rural areas around Angul-Talcher Industrial Zone. Indian Journal of Environmental Protection. 26(6): 550-558.

6. Dhembare A., and Pondhe G.M., 1997. Correlation of Ground waste quality parameters of Sonai area (Maharashtra). Pollution Research. 16(3): 189-199.

7. Gajendran C. And Thamarai P., 2008.Study on Statistical Relationship between Groundwater Quality Parameters in Nambiyar River Basin, Tamil Nadu, India. Pollution Research. 27(4): 679-683.

8. Gulta D. P., Sunita & Saharan J. P. 2009. Physico chemical analysis of ground water of selected area of kaithal city (Haryana) India. Researcher, 1(2): 1-5.

9. Gupta S. P., 1999. Statistical Methods, Sultan Chand and Sons, 28th edition.

10. Jaipur Development Authority, (2012). Master Development Plan-2025, Jaipur Region (Vol. 1), JDA, Jaipur.

11. Mitharwal S., Yadav R.D., and Angasaria R.C. 2009. Water Quality analysis in Pilani of Jhunjhunu District (Rajasthan)-The place of Birla's Origin. Rasayan Journal of Chemistry. 2(4):920-923.

12. Nemade P.N., and Shrivastav V.S., 2004. Correlation and Regression analysis among the COD and BOD of industrial effluent. Pollution Research. 23(1): 187-188.

13. Rao, N. S. 2006. Seasonal variation of groundwater quality in a part of Guntur District, Andhra Pradesh, India. Environmental Geology. 49, 413-429.

14. Saxena, U., and Saxena, S., 2013. Statistical Assessment of Ground water Quality using Physico-chemical parameters in Bassi Tehsil of Jaipur District, Rajasthan, India. Global Journal of Science Frontier Research. 13(3):23-31.

15. Singh M.K., Jha D., and Jadoun J. 2012. Assessment of Physico-chemical status of Groundwater Samples of Dholpur District, Rajasthan, India. International Journal of Chemistry. 4(4): 96-104.

16. Siebert S. et al. 2010. Groundwater use for irrigation-a global inventory. Hydrology and Earth System Sciences, 14, 1863-1880. http://dx.doi.org/10.5194/hess-14-1863-2010.

17. Tatawat R.K., and Singh Chandel C.P. 2007. Quality of Groundwater of Jaipur City, Rajasthan (India) and its Suitability for Domestic and Irrigation Purpose. Applied Ecology and Environmental Research. 6(2): 79-88.

18. Thirupathaiah M., Samatha Ch., and Sammaiah C. 2012. Analysis of Water quality using physic-chemical parameters in lower manair reservoir of Karimnagar District, Andhra Pradesh. International Journal of Environmental Sciences. 3(1):172-180.

19. Umavathi, S., Longakumar K. and Subhashini. 2007. Studies on the nutrient content of Sulur pond in Coimbator, Tamil Nadu. Journal of ecology and environmental conservation, 13(5): 501-504.

20. Venkatachalam M.R. and Jebanesan. A., 1998. Correlation among water quality parameters for Groundwater in Chidambaram town. Indian Journal of Environmental Protection. 18(10): 734-738.

21. WHO, 2006. WHO Guidelines for drinking-water quality First addendum to third edition, World Health Organisation, Vol. 1.