Seasonal Variation of Groundwater Quality in Rural Areas of Jaipur District, Rajasthan

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Abstract

Background: Water plays an important role for healthy well-being of all living beings. During last decade, due to human interference ground water get polluted drastically and resulted into many health hazards. **Objective:** This study is done to understand the seasonal variations in the physiochemical parameters of the groundwater of three sites of Amber Tehsil of Jaipur district, Rajasthan using statistical tools. **Methodology:** To carry out the research, ground water samples were collected once a month throughout a year. Three samples were collected from each site and chemical analysis was conducted. With the help of one-way ANOVA test the difference between the three sites based on the parameters was calculated. **Findings:** This paper reveals that groundwater of these three sites shows seasonal variations in all twelve parameters using statistical methods like paired t-test and Analysis of Variance (ANOVA) tests. The groundwater of all the sites is not suitable for drinking & industrial purposes which will help the local government to take necessary action.

Keywords: Anova, Bureau of Indian Standard, Seasonal Variation, Water Quality Assessment

1. Introduction

Water is necessary for healthy development of man, animals and plants. Groundwater is extensively used as a source of drinking for millions of rural and urban families. The groundwater is found to be clean and pollution free than surface water[1]. But because of human interference[2] such as industrialization, urbanization and modern agriculture practices lead to mixing of external undesirable substances in this precious resource and make it unfit for drinking and other purposes. Many states in our country have been identified with water borne diseases[3] and morphological abnormalities[4]. Nitrate and fluoride are the most common ground water pollutants in rural areas of Rajasthan[4]. Rural areas of Rajasthan state was found to have very high concentration of fluoride (up to 16ppm) in groundwater which lead to health hazards as crippling fluorosis[5-14] and blue baby disease[4]. Therefore, there is always a need for the protection and management of groundwater quality.

Thus, it was, thought to study ground water quality of rural areas of Amber Tehsil, Jaipur district, Rajasthan, India. Various samples of ground water were collected from three villages of Amber district every month throughout a year and were analyzed for various physicochemical parameters to understand impact of seasonal variation on concentration of pollutant. Statistical methods were also employed to establish the relation between these parameters with seasonal variation.

2. Materials and Methods

2.1 Study Area

Study area comprises of Amber Tehsil of Jaipur district, Rajasthan, India. Jaipur district, covering geographical area of 11,061.44 sq. km and extending between north latitudes 26º25' and 27º51' and east longitudes 74º55' and 76º15' forms east-central part of the Rajasthan State. For administrative convenience, the district is divided

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into 13 tehsils and 13 blocks. Amber Tehsil is situated at north east part of Jaipur district and includes 192 villages according to 2011 census. In present communication various parameters of different villages, Bhanpur Kala, Achrol and Kant Kalwar, are analyzed chemically and statistically to predict seasonal impact on concentration of various parameters.

2.2 Collection of Samples

Groundwater samples were collected once a month throughout a year from the community borehole as per APHA-Standard Methods for Examination of Water and Samples. Three samples were collected from each site and analyses were conducted in triplicate and the mean value calculated. The mean values from each sampling site were recorded as the concentration/value for that particular month. The twelve sampling periods were used to analyze impact of variation of season on all twelve parameters.

3. Results and Discussion

3.1 Kant Kalwar

Table 1 gives values obtained in the experiments done for water samples in different seasons and its comparison with BIS standards. It is evident from Table 1, that in pre-monsoon season, experimental values of all physicochemical parameters under study were found to be within the permissible limits. In the post monsoon season all parameters except pH, nitrate and fluoride concentration are within the permissible limits. Values of parameters analyzed in post monsoon are found to be slightly higher than pre-monsoon season.

Table 1. Experimental values of physico-chemical parameters of kant-kalwar area

S. No	Parameters	Pre monsoon	Post monsoon	Permissible limit as per BIS standards
1	pH	6.7-7.5	7.1-8.1	No Relaxation
2	Total Hardness	312-398	334-455	600
3	Conductivity	1.8-2.5	2.6-3.6	-
4	TDS	732-795	734-807	2000
5	Fluoride	1.48-1.6	2.73-3	1.5
6	Nitrate	78.3-91.2	99.8-113.5	100
7	Sulphate	356-389	342-363	400
8	Calcium	114-131	121-130	200
9	Dissolved Oxygen	22-28	24-30	-
10	Alkalinity	429-451	449-462	600
11	Magnesium	50-59	52-61	100
12	Chloride	39-57	49-54	1000

All the values are in mg/l except for pH

To test whether there is any significant difference in the pre monsoon and post monsoon values, the following null hypothesis was framed:

H_0: There is no significant difference in the pre monsoon and post monsoon values. To test the stated hypothesis paired t- test was applied. The results of the test are given in Table 2.

Table 2. Paired t-test results for difference in the physiochemical parameters of pre monsoon and post monsoon of kant kalwar area

S.No	Physico-chemical Parameters	Calculated value of t	Level of Significance
1	pH	1.37	2.57
2	Total Hardness	1.21	0.28
3	Conductivity	5.32	0.00
4	TDS	2.67	0.04
5	Flouride	28.4	0.00
6	Nitrate	4.46	0.006
7	Sulphate	3.57	0.02
8	Calcium	1.29	0.25
9	Dissolved Oxygen	1.18	0.29
10	Alkalinity	5.01	0.00
11	Magnesium	1.32	0.25
12	Chloride	1.29	0.21

*Significant at 5% level

From the table we can clearly see that the calculated values of paired t-test for conductivity, TDS, fluoride, nitrate, sulphate and alkalinity are significantly higher than the tabulated value (2.57) at 5% level of significance. This implies that null hypothesis is rejected i.e. there is a significant difference in the pre monsoon and post monsoon values of groundwater parameters. Also it is evident

from the table that the calculated values of paired t-test for pH, total hardness, DO, calcium and magnesium are less than the tabulated value (2.57) at 5% level of significance. This result in the acceptance of null hypothesis i.e. there is no significant changes in *pH*, total hardness, DO, calcium and magnesium values before and after monsoon.

Table 3. Experimental values of physico-chemical parameters of achrol area

S. No	Parameters	Pre monsoon	Post monsoon	Permissible limit body as per BIS Standard
1	pH	6.7-7.5	6.9-8.1	No Relaxation
2	Total Hardness	189-200	189-211	600
3	Conductivity	1.9-2.7	2.6-3.6	-
4	TDS	336-355	391-407	2000
5	Fluoride	1.31-1.37	1.43-1.87	1.5
6	Nitrate	72-86	89-123	100
7	Sulphate	220-251	258-277	400
8	Calcium	114-131	113-131	200
9	Dissolved Oxygen	27-32	27.3-31	-
10	Alkalinity	310-339	312-348	600
11	Magnesium	60-65	60-68	100
12	Chloride	81-92	86-101	1000

All the values are in mg/l except for pH

3.2 Achrol

Table 3 indicates experimental values of various physico-chemical parameters of water samples of Achrol area in different seasons. From Table 3, it is observed that values of these twelve parameters are higher in post-monsoon season than pre-monsoon season. All the parameters are in permissible limit except *pH*, nitrate and fluoride content.

In order to test whether there is any significant difference in the parameters of the water samples before and after monsoon, the following null hypothesis was framed:

H_0: There is no significant difference in the pre monsoon and post monsoon values.

To test the hypothesis paired t- test was applied. The results of the test are given in Table 4.

From the table we can clearly see that the calculated values of Student's t-test conductivity, TDS, fluoride, sul-

phate, nitrate and chloride are significantly higher than the tabulated value (2.57) at 5% level of significance. This implies that null hypothesis is rejected i.e. there is a significant difference in the water parameters before and after monsoon. Also it is evident from the table that the calculated values of paired t-test for *pH*, total hardness, calcium, DO, alkalinity and magnesium are less than the tabulated value (2.57) at 5% level of significance. This results in the acceptance of null hypothesis i.e. there is no significant changes in *pH*, total hardness, calcium, DO, alkalinity and magnesium.

Table 4. Paired t-test results for difference in the physico-chemical and parameters of pre monsoon and post monsoon of Achrol area

S.No	Physio-chemical Parameters	Calculated value of t	Level of Significance
1	*pH*	1.34	0.12
2	Total Hardness	0.83	0.45
3	Conductivity	3.72	0.01
4	TDS	9.75	0.00
5	Flouride	4.05	0.01
6	Nitrate	3.49	0.017
7	Sulphate	4.21	0.01
8	Calcium	0.98	0.37
9	Dissolved Oxygen	0.85	0.44
10	Chloride	2.60	0.05
11	Alkalinity	1.62	0.17
12	Magnesium	0.80	0.46

3.3 Bhanpur Kala

Table 5 gives experimental values of twelve physico-chemical parameters obtained from water samples of Bhanpur Kala. From Table 5, it is observed that all the parameters in pre-monsoon season were found to be within acceptable limits. Also except *pH* and nitrate, values of all other parameters for post monsoon season were found to be in permitted limits. Concentration of all the parameters is slightly greater in post-monsoon season.

To test whether there is any significant difference in the parameters of the water samples before and after monsoon, the following null hypothesis was framed:

H_0: There is no significant difference in the pre monsoon and post monsoon values.

To test the hypothesis paired t- test was applied. The results of the test are given in Table 6.

Table 5. Experimental values of physico- chemical parameters of Bhanpur kala area

S. No	Parameters	Pre monsoon	Post monsoon	Permissible limit body as per BIS Standard
1	*pH*	7.19-7.52	7.4-8.1	No Relaxation
2	Total Hardness	406-420	428-438	600
3	Conductivity	1.42-2.2	1.69-2.2	-
4	TDS	398-412	426-448	2000
5	Flouride	0.7-1.3	0.98-1.37	1.5
6	Nitrate	74.7-80.2	95.7-102	100
7	Sulphate	109-130	125-152	400
8	Calcium	92-101	103-125	200
9	Dissolved Oxygen	24-42	29-41.1	-
10	Alkalinity	449-471	462-482	600
11	Magnesium	55-72	59-78	100
12	Chloride	65-86	78-93	1000

All the values are in mg/l except for pH

Table 6. Paired t-test results for difference in the physico-chemical parameters of pre monsoon and post monsoon of Bhanpur kala area

S.No	Physio-chemical Parameters	Calculated value of t	Level of Significance
1	*pH*	0.86	0.43
2	Total Hardness	3.19	0.02
3	Conductivity	2.26	0.07
4	TDS	10.14	0.00
5	Fluoride	3.39	0.019
6	Nitrate	7.79	0.00
7	Sulphate	2.90	0.03
8	Calcium	4.27	0.01
9	Dissolved Oxygen	0.14	0.90
10	Chloride	1.84	0.05
11	Alkalinity	3.20	0.02
12	Magnesium	1.21	0.28

From the table we can clearly see that the calculated values of Student's t-test for total hardness, conductivity, TDS, fluoride, nitrate, sulphate and chloride are significantly higher than the tabulated value (2.57) at 5% level of significance. This implies that null hypothesis is rejected i.e. there is a significant difference in the parameters of water after monsoon. Also it is evident from the table that the calculated values of paired t-test for *pH*,DO, chloride and magnesium are less than the tabulated value (2.57) at 5% level of significance. This result in the acceptance of null hypothesis i.e. there is no significant changes in for *pH*, DO, chloride and magnesium.

We test whether there is a significant difference in the three sites using ANOVA model. In order to test the three sites, the following null hypothesis is framed:

H_0: There is no significant difference in the three sites based on the concentration of all twelve parameters.

To test the hypothesis one way ANOVA was applied. The results of the test are:

From Table 7, we can conclude that there is a significant difference in the concentration of the water parameters in all the three sites as the calculated value of F test is more than the tabulated value ($F_{tab (2,213)} = 3.04$) which implies that the null hypothesis is rejected i.e. there is a significant difference in the three sites based on concentration of all the water parameters considered in the study.

Table 7. Anova tests results

Source of Variation	SS	df	MS	F	P-value	F-critical
Between Groups	609073.7	2	304536.9	7.425	0.0007	3.04
Within Groups	8735680	213	41012.58			
Total	9344754	215				

*Significant at 5% level.

4. Conclusion

The study reveals that groundwater of all the sites is not suitable for drinking & industrial purposes. Technical suitability has been checked by comparing values with BIS Standards. Statistical suitability has been verified using statistical methods like paired t-test methods and ANOVA method. The t-test used for all parameters showed that the calculated t-values of many parameters especially TDS, nitrate and fluoride are more than the tabulated values resulting in rejection of null hypothesis which indicated that there is a significant difference between pre monsoon and post monsoon values. High concentration of fluoride and nitrate in all water samples is due to mixing of various types of salts in post monsoon groundwater samples through infiltration which leads to poor water quality. Moreover, ANOVA method showed that there is a significant difference in the concentration of all twelve parameters in all the three sites under consideration. Hence the results and discussions carried out confirm the chemical and statistical suitability of groundwater of all the three sites.

5. References

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