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# CORRELATION ANALYSIS OF GROUND WATER QUALITY IN AND AROUND SHAHZAD NAGAR BLOCK OF RAMPUR DISTRICT, UTTAR PRADESH, INDIA

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## ABSTRACT

Water is most important commodities and mainly most misused one. The present study is to bring an acute awareness among the people about the quality of ground water by taking water samples from specific locations for analysis. The experiment analyses its various physico-chemical parameters such as pH, electrical conductivity, TDS, TH, TA, $Ca^{2+}$, $Mg^{2+}$, $Cl^{-}$, $SO_4^{2-}$, $Na^{+}$, $K^{+}$, $CO_3^{2-}$, $HCO_3^{-}$ and $F^{-}$ content in ground water. Results of Shahzad Nagar block of Rampur District, Uttar Pradesh, India were compared with WHO, USPH, ICMR and European standards. A systematic correlation matrix study showed significant relationship among different pairs of water quality parameters.

**Key words**: Water quality, Physico-chemical parameters, Correlation, Shahzad Nagar, Rampur (U.P.).

## INTRODUCTION

Water is one of the most indispensable resources and is the elixir of life. Water constitutes about 70% of the body weight of almost all living organisms. Life is not possible on this planet without water. It exists in three states namely solid, liquid and gas. It acts as a media for both ; chemical and biochemical reactions and also as internal and external medium for several organisms. About 97.2% of water on Earth is salty and only 2.8% is present as fresh water from which about 20% constitutes ground water. Ground water is highly valued because of certain properties not possessed by surfaces water[1]. The rapid growth of urban areas, domestic and irrigation uses have further affected the ground water quality due to over exploitation of resources and improper waste disposal practices. The ground water quality of Shahzad Nagar block, which is located 13 km from Rampur, has been altered due to many anthropogenic activities. Therefore, it is essential to protective and manage the ground water quality. Consequently, number of cases due to water pollution,

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water borne diseases have been seen, which cause health hazards[2-4]. It is a matter of history that facial pollution of drinking water caused diseases, which wiped out the entire population of the studied area[5]. The present work is an attempt to measure the water quality of Shahzad Nagar, Rampur District, Uttar Pradesh, India.

## EXPERIMENTAL

### Study area

The area under study Shahzad Nagar block lies in Rampur District and this district is located between longitudes $78^0 54^{''}$ to $69^0 28^{''}$ E and latitude $28^0 25^{''}$ to $29^0 10^{''}$ N. It covers 2,367 $km^2$ areas. Shahzad Nagar is 13 km distance from Rampur city and located on Rampur to Bareilly National Highway (NH-24). It has an average elevation of 288 m (968 ft.) (Fig. 1).

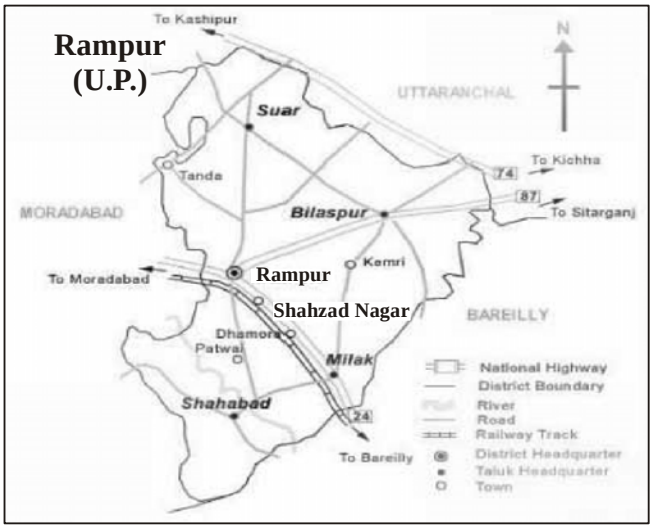


**Fig. 1: Location of site**

The people of Shahzad Nagar mainly work in agricultural activities. The main sources of water supply in the area is hand pumps, bore holes, manually operated hand pumps, dug wells. The precipitation, which is the sole source of ground water recharges in the study area, is very low due to average rain fall.

### Water sampling

In present investigation, one hundred ground water samples (bore wells) are collected from twenty five locations (four from each location) of Shahzad Nagar of Rampur District. The water samples were collected in polythene bottles, which were cleaned with

acid water, followed by rinsing twice with distilled water. The water samples are chemically analyzed[6]. The analysis of water was done using standard methods.

**Methodology**

The pH and EC were measured by using Eutech-Cybernetics pH meter and EC scan meter[7]. Total hardness, calcium, magnesium were measured by EDTA titration methods[8]. Total alkalinity was determined volumetrically by silver nitrate titrametric methods using potassium chromate as indicator[9]. Sodium and potassium were analyzed using flame photometer. Sulphate was determined nepthalometrically using ELICO-52 Nepthalometer[10]. For bicarbonate, a titration with 0.01N sulphuric acid is used. Fluoride content in water was measured by ELICO-52 Spectrophotometer. The physico-chemical analysis was carried out according to standards meethods[11-13].

**Correlation coefficient and linear regression**

It is calculated as follows[14]-

Let X and Y are two variables and then the correlation coefficient [PEARSON] (r) between the variable X and Y is given by -

$$R = \frac{\Sigma (X - \overline{X})(Y - \overline{Y})}{\sqrt{\Sigma (X - \overline{X})^2 \Sigma (Y - \overline{Y})}} \quad \ldots(1)$$

If the values of correlation coefficient ‘r’ between two variables X and Y are fairly large, it implies that these two variables are highly correlated.

## RESULTS AND DISCUSSION

The ground water from the study area of Shahzad Nagar block has no colour, odour and turbidity. Taste of the water of the water sample in most of the locations showed brackish water. The results of the chemical analysis of ground water in the present study are given in Table 1. It was thought necessary to a make a comparison of ground water given by WHO, USPH, EUROPEAN and ICMR standards. Theses parameters are shown in Table 2. The data of chemical parameters show considerable variations, which reflect the chemical composition. The pH of ground water ranges from 7.3-8.4. It indicates that they are in range of ground water quality parameter permissible limits i.e., 6.5-9.2[15]. The EC of water samples shows wide variation in Shahzad Nagar block. Ground water of studied block is found hard in maximum locations. The $Ca^{2+}$ and TA content were beyond the accepted limits. Carbonate

was either present or absent in the study block. Chloride content in water ranged from 202-452 mg/L, Lower concentration of calcium compared to sodium indicates the absence of rapidly soluble calcium minerals or the action of base exchanged by sodium[16]. The fluoride content in water in few locations is in higher ranges. Also due to high fluoride ranges, peoples are suffering from water borne diseases i.e., dental and skeltal fluorosis[17]. The statistical analysis given in Table 3 showed that the EC has positive and significant correlation with TDS, TH, $Ca^{2+}$, $Na^{+}$, $SO_4^{2-}$, $Mg^{2+}$ and TA was positively and significantly correlated with $Ca^{2+}$, $Mg^{2+}$, $SO_4^{2-}$, $Cl^{-}$ and $F^{-}$.

**Table 1: Physio-chemical parameters of ground water samples at Shahzad Nagar block**

| Location No. | pH | EC | TDS | TA | $Ca^{2+}$ | $Mg^{2+}$ | $Na^{+}$ | $K^{+}$ | $CO_3^{2-}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{2-}$ | $F^{-}$ | TH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 7.3 | 2.6 | 789 | 834 | 54 | 45 | 156 | 34 | 34 | 234 | 345 | 57 | 0.9 | 540 |
| **2** | 7.5 | 3.7 | 987 | 176 | 57 | 67 | 234 | 7 | 67 | 345 | 67 | 890 | 0.9 | 213 |
| **3** | 7.8 | 7.8 | 1234 | 616 | 90 | 89 | 256 | 34 | 89 | 245 | 89 | 754 | 0.8 | 145 |
| **4** | 7.3 | 13.7 | 798 | 185 | 89 | 56 | 167 | 23 | 56 | 354 | 412 | 345 | 1.7 | 564 |
| **5** | 7.9 | 4.8 | 1345 | 256 | 79 | 44 | 189 | 14 | 43 | 337 | 432 | 567 | 0.8 | 443 |
| **6** | 8.1 | 6.8 | 807 | 389 | 112 | 69 | 278 | 25 | 23 | 213 | 347 | 234 | 2.2 | 221 |
| **7** | 7.9 | 7.9 | 879 | 512 | 59 | 80 | 276 | 45 | 78 | 231 | 222 | 678 | 1 | 123 |
| **8** | 8.3 | 5.6 | 987 | 362 | 79 | 78 | 179 | 24 | 90 | 299 | 45 | 870 | 0.9 | 321 |
| **9** | 7.8 | 11.8 | 1123 | 730 | 98 | 98 | 196 | 15 | 70 | 278 | 156 | 56 | 0.8 | 256 |
| **10** | 7.5 | 4.9 | 1456 | 512 | 109 | 87 | 213 | 8 | 59 | 387 | 218 | 541 | 1 | 231 |
| **11** | 7.3 | 7.9 | 867 | 206 | 67 | 65 | 267 | 35 | 33 | 422 | 56 | 321 | 0.9 | 443 |
| **12** | 7.6 | 7.5 | 875 | 120 | 75 | 55 | 299 | 9 | 61 | 344 | 80 | 116 | 0.8 | 507 |
| **13** | 7.8 | 4.5 | 908 | 218 | 95 | 53 | 238 | 13 | 89 | 321 | 78 | 178 | 0.8 | 443 |
| **14** | 8.2 | 12.9 | 824 | 328 | 78 | 42 | 289 | 11 | 26 | 323 | 359 | 245 | 2.1 | 228 |
| **15** | 8.4 | 3.8 | 1256 | 432 | 86 | 52 | 222 | 23 | 58 | 432 | 456 | 679 | 0.9 | 211 |
| **16** | 8.2 | 2.5 | 946 | 169 | 59 | 63 | 260 | 32 | 99 | 452 | 489 | 556 | 0.9 | 543 |
| **17** | 7.9 | 9.5 | 1089 | 154 | 62 | 77 | 231 | 4 | 93 | 377 | 234 | 478 | 1.8 | 227 |
| **18** | 7.6 | 1.8 | 923 | 245 | 66 | 85 | 155 | 37 | 35 | 256 | 217 | 432 | 0.8 | 332 |

Cont…

| Location No. | pH | EC | TDS | TA | $Ca^{2+}$ | $Mg^{2+}$ | $Na^{+}$ | $K^{+}$ | $CO_3^{2-}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{2-}$ | $F^{-}$ | TH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **19** | 7.5 | 3.9 | 967 | 622 | 72 | 93 | 187 | 43 | 65 | 218 | 149 | 754 | 1.5 | 118 |
| **20** | 7.3 | 7.2 | 890 | 516 | 74 | 91 | 241 | 41 | 47 | 378 | 387 | 834 | 0.8 | 328 |
| **21** | 7.9 | 9.8 | 1145 | 222 | 80 | 83 | 298 | 47 | 39 | 350 | 480 | 654 | 0.9 | 443 |
| **22** | 8.3 | 5.9 | 873 | 148 | 60 | 61 | 262 | 22 | 21 | 260 | 179 | 590 | 0.9 | 220 |
| **23** | 7.9 | 4.8 | 1378 | 306 | 82 | 46 | 186 | 19 | 22 | 287 | 34 | 271 | 0.8 | 432 |
| **24** | 7.3 | 4.3 | 756 | 312 | 84 | 49 | 240 | 6 | 29 | 202 | 59 | 167 | 1 | 439 |
| **25** | 7.6 | 14.8 | 915 | 432 | 117 | 97 | 165 | 39 | 79 | 439 | 267 | 965 | 0.8 | 332 |

**Table 2: Comparison of ground water samples with drinking water quality standards**

| Parameter | Value from water samples | | | WHO | European | ICMR | USPH |
|---|---|---|---|---|---|---|---|
| | Min. | Max. | Mean | | | | |
| **pH** | 7.3 | 8.4 | 7.7 | 6.5-9.2 | 6.5-8.5 | 6.5-8.5 | 6.0-8.5 |
| **EC** | 1.8 | 14.8 | 6.8 | 300 | 400 | 400 | 300 |
| **TDS** | 789 | 1456 | 1000.6 | 300 | 500 | 500-1500 | 500 |
| **TH** | 118 | 564 | 332 | 500 | 500 | 300 | 500 |
| **TA** | 120 | 834 | 360.8 | | | | |
| **$Ca^{2+}$** | 54 | 117 | 79.32 | 75 | 100 | 75 | 100 |
| **$Mg^{2+}$** | 42 | 97 | 69 | 50 | | 50 | 30 |
| **$Na^{+}$** | 155 | 299 | 227.36 | 200 | 300 | 200 | 300 |
| **$K^{+}$** | 4 | 47 | 24.4 | 200 | 300 | 200 | 300 |
| **$CO_3^{2-}$** | 21 | 99 | 56.2 | 200 | 200 | 200 | 200 |
| **$HCO_3^{2-}$** | 202 | 452 | 319.36 | | | | |
| **$Cl^{-}$** | 34 | 489 | 234.28 | 200 | 250 | 250 | 250 |
| **$SO_4^{2-}$** | 56 | 965 | 489.28 | 200 | | 200 | 250 |
| **$F^{-}$** | 0.76 | 2.2 | 1.06 | 0.5-1.5 | 0.5-1.5 | 0.5-1.5 | 0.5-1.5 |

**Table 3: Correlation matrix for different water quality parameters**

| | pH | EC | TDS | TA | $Ca^{2+}$ | $Mg^{2+}$ | $Na^{+}$ | $K^{+}$ | $CO_3^{2-}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{2-}$ | $F^{-}$ | TH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **pH** | 1 | -0.0295 | 0.00393 | -0.00355 | 0.00312 | -0.0296 | 0.02029 | -0.057 | 0.0126 | 0.0018 | 0.0032 | 0.0018 | 0.9328 | 0.0065 |
| **EC** | | 1 | 0.00031 | 0.00235 | 0.00438 | 0.00266 | 0.00054 | 0.0007 | 0.0011 | 0.0007 | 0.0003 | 0.0542 | 0.1709 | 0.0001 |
| **TDS** | | | 1 | -0.0608 | 0.2488 | 0.0351 | -0.0096 | 0.1759 | 0.0151 | 0.0071 | 0.9503 | 0.0856 | 0.6601 | 0.2626 |
| **TA** | | | | 1 | 0.2588 | 0.4213 | 0.2472 | 0.0319 | 0.2222 | 0.3042 | 0.1601 | 0.0372 | 0.0466 | 0.0592 |
| **$Ca^{2+}$** | | | | | 1 | 0.7273 | 0.8689 | 0.2155 | 0.4068 | 0.1601 | 0.3042 | 0.1601 | 0.2384 | 0.0372 |
| **$Mg^{2+}$** | | | | | | 1 | 0.3569 | 0.1548 | 0.4758 | 0.5691 | 0.4286 | 0.0254 | 0.0325 | 0.0235 |
| **$Na^{+}$** | | | | | | | 1 | 0.0256 | 0.1313 | 0.0521 | 0.0569 | 0.0864 | 0.0156 | 0.0465 |
| **$K^{+}$** | | | | | | | | 1 | 0.2526 | 0.0246 | 0.0789 | 0.0456 | 0.0156 | 0.0457 |
| **$CO_3^{2-}$** | | | | | | | | | 1 | 0.1256 | 0.0221 | 0.2612 | 0.0891 | 0.0894 |
| **$HCO_3^{-}$** | | | | | | | | | | 1 | 0.0568 | 0.0458 | 0.0785 | 0.2541 |
| **$Cl^{-}$** | | | | | | | | | | | 1 | 0.0659 | 0.0987 | 0.0895 |
| **$SO_4^{2-}$** | | | | | | | | | | | | 1 | -0.002 | 0.0003 |
| **$F^{-}$** | | | | | | | | | | | | | 1 | -0.0044 |
| **TH** | | | | | | | | | | | | | | 1 |

## CONCLUSION

Ground water is the only source for the people in the Shahzad Nagar and the results of the chemical analyses of ground water indicate considerable variations. Most of the locations do not comply with WHO, USPH, ICMR and European standards. In maximum locations, it is contaminated. It must be noted that a regular chemical analysis must be done to ensure that the quality of water in Shahzad Nagar is not further contaminated.

## REFERENCES

1. P. K. Goel, Water Pollution-Cause, Effects and Control, New Age Inter (P) Ltd., New Delhi (2000).
2. P. V. Desai, Poll. Res., **4**, 377 (1995).
3. K. M. Elizabeth and L Naik Premnath, Poll. Res., **24(2)**, 337 (2005).
4. E. E. Muller and M. M. E. Grasam, Water Res., **35**, 3085 (2001).
5. S. S. Yadav and Rajesh Kumar, Rasayan J. Chem., **3(3)**, 589-596 (2010).
6. Rajesh Kumar and S. S. Yadav, IJABPT, 2-1 (2011).
7. S. S. Yadav and Rajesh Kumar, Ultra Chem., **6(2)**, 181-186 (2010).
8. B. K. Handa, Hydrochemical Zones of India, Proc. Seminar on Ground Water Development, Roorkee, (1986) pp. 339-450.
9. N. Manivasagam, Physico-Chemical Examination of Water, Pragati Publication, Meerut (1984).
10. Rajesh Kumar and S. S. Yadav, Shodh Samiksha Aur Mulyakan, **2(22)**, 19-20 (2010).
11. APHA, 19th Edition, American Public Health Association, Washington, D.C. (1995).
12. Mayur C. Shah, Poll. Res., **25(3)**, 549 (2006).
13. B. Kotaiah and N. Kumaraswamy, Environmental Engg. Lab. Mannual, 5th Edition, Charotar Publishing House, India (1994).
14. K. Jothivenkatachalam, A. Nithiya and S. Chadramohan, Rasayan J. Chem., **3(4)**, 649-654 (2010).

15. WHO, Guidelines for Drinking Water Quality, Recommendation, 2nd Edition, Geneva (1993).

16. D. R. R. Sharma and S. L. N. Rao, Bull. Environ. Conta. Toxicol., **58**, 241 (1997).

17. S. S. Yadav and Rajesh Kumar, J. Chem. Pharm. Res., **2(4)**, 564-568 (2010).

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