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Descriptive and Correlation Analysis of Physicochemical Properties of Ground Water of Delhi and NCR Region, India

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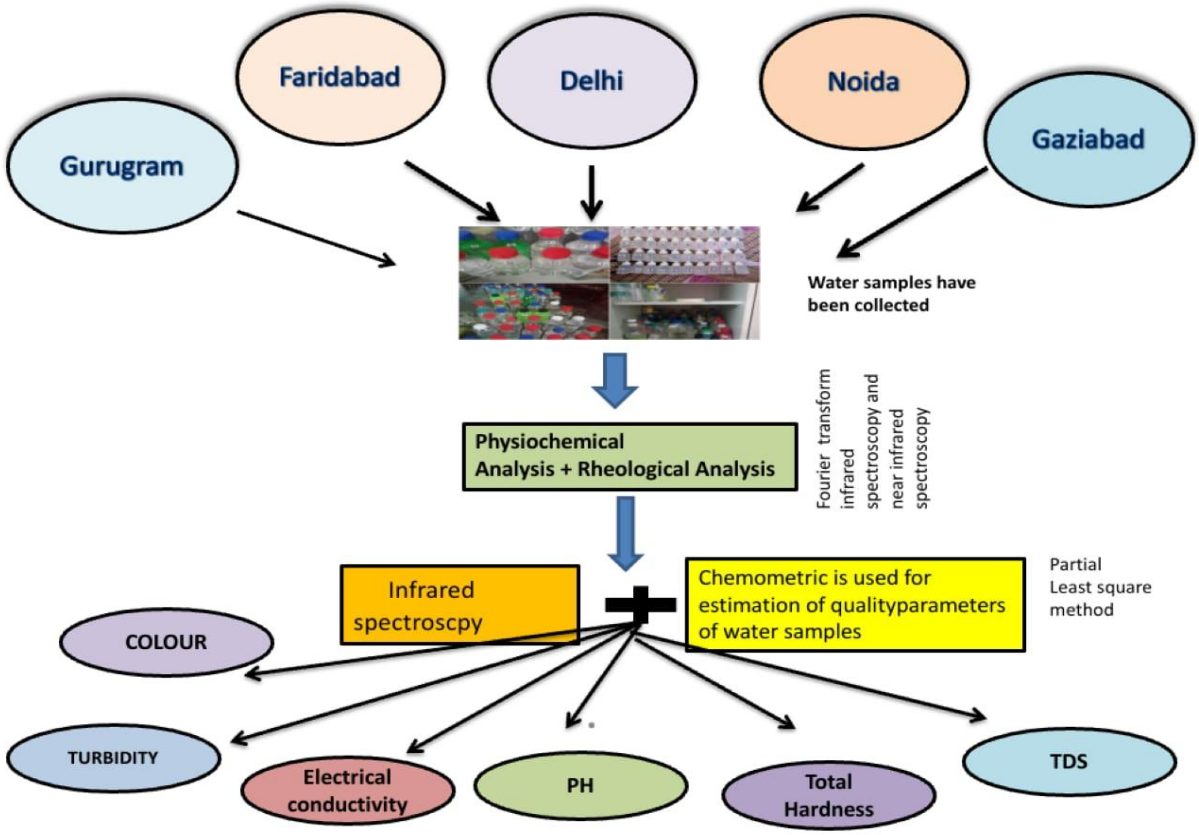
ABSTRACT

The purpose of this research was to provide a description of the physical and chemical characteristics of groundwater in the Delhi National Capital Region (NCR) in India. A total of 50 water samples were collected from various locations and analyzed for different properties, including color, turbidity, electrical conductivity (EC), pH, total hardness, and total dissolved solids (TDS). The results showed that turbidity values ranged from 0 to 15 with an average of 2.6, while conductivity ranged from 203 to 8500 µS/cm, with an average of 1933 µS/cm. pH values ranged from 7.4 to 8.9, with an average of 7.8, while total hardness values ranged from 112 to 2990 mg/L, with an average of 488.7 mg/L. TDS values ranged from 230 to 5700 mg/L, with an average of 1020 mg/L. The analysis also revealed positive correlations between color and turbidity, conductivity and hardness, as well as total hardness and TDS, with correlation coefficients of 0.82, 0.79, and 0.81, respectively. In general, the findings suggest that there is significant variability in the physicochemical properties of groundwater in the Delhi NCR region, and all the properties are interrelated to each other with coefficient of correlation greater than equal to 0.79. Thus, if one property is measured by analytical method others can be calculated using regression equations. Ongoing monitoring is necessary to ensure that the population has access to safe drinking water.

Keywords: Groundwater, Descriptive Statistics, Correlation, Regression, Phvsicochemical Parameters.

Graphical Abstract :-



INTRODUCTION

Pure, colourless, odourless water makes up the oceans, rivers, and lakes. It is a basic requirement for all life on earth. The chemical formula for water is H_2O. Water is essential for the survival of all creatures and plants, and it is also the most often used solvent. The freezing and boiling points of water are respectively 0 °C and 100 °C (212 °F).[1].The main part of the entire water cycle is ground water. Rainfall enters the land from rivers, dams, and stream flows, which are natural resources, as well as drainage of surfaces, which are artificial resources. Under the effect of gravity, water permeates the earth.The majority of the groundwater is actually moving[2]. Due to a hydraulic gradient, groundwater moves in the same way as water moves in a pipe or an open area. Yet, the movement of groundwater is significantly hampered by friction with the porous material through which it flows. This

is caused by low speeds and high head losses [3]. Water's speed can change over time and from season to season.Like a river or lake, ground water is frequently found on the earth's surface. Ground water is the term for the liquid that exists below the surface of the earth. Ground water is frequently utilized for drinking, cooking, and other purposes. Surface water can also be used for drinking and cleaning, although it is mostly used for irrigation and the production of electricity. Surface water can be evaporated, but not ground water, which cannot[4].Temperature is an additional difference. While the temperature of surface water varies, that of ground water remains constant. Surface water and subsurface water are chemically distinct from one another. For instance, surface water has less salt in it than ground water does. With depth, the salt content rises[5]. So, the quality analysis of ground is primary research, which has been studied by many researchers. A study was done to determine the existing state of physicochemical pollutants and their sources in groundwater in the granite mining region of Jhansi (Goramachia). Analyses were done on groundwater samples that were taken from mining and residential areas in 6 distinct places. In the research region, there are close to 30 crushers in operation. Goramachia is located 10 kilometres to the northeast of Jhansi City. Three samples were taken at different distances from each mining site and residential neighborhood. Analysis has been done on the chemical attributes including turbidity, TDS, , nitrate, magnesium hardness, pH, EC TDS, alkalanity, , iron, turbidity, DO, total hardness, fluorideand chloride[6].Another study's objective was to evaluate the condition of the groundwater in the city of Agra. The range of chemical attributes like pH lies between 7.2 and 7.7, EC lies between 1580 and 5200 mhos, Chloride lies between 295 and 1140 mg/l, TDS lies between 1020 and 4950 mg/l. Also, turbidity,Total hardness, Magnesium, Calcium, Potassium lies between 1.1 and 31.4 NTU, 240 and 1425 mg/l, 14.6 and 151.2 mg/l, 72 and 436 mg/l, 1.9 and 60.6 mg/l respectively in groundwater. This demonstrates the groundwater pollution found in particular water taken from 12 different Agra city monitoring sites between February and May 2011. The findings suggested that the research area's groundwater cannot generally be deemed to be of high quality [7].

The present study involves analyzing the physicochemical characteristics of ground water samples from Delhi and NCR (National Capital Region) of India. Ground water's physicochemical characteristics are evaluated by monitoring its calcium hardness, TDS,

conductivity, magnesium hardness, pH and total dissolved solids (TDS) using chemical, analytical and AOAC methods.

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MATERIALS AND METHODS

Sample Collection

In total 50 different ground water samples has been collected from the Delhi and NCR (National Capital Region) of India. The regions are Noida, Gurugram, Gaziabad, Faridabad and Delhi.

Sample Analysis

Testing was done on each and every water sample for pH, TDS, EC and turbidity. A digital pH meter (Fig.-1) was used to measure the pH of water samples. Understanding pH and TDS is crucial to understanding the water's quality. Total hardness, turbidity and TDS of all 50 samples were measured with titration method (Fig.-2), digital turbidity meter (Fig.-3) and digital TDS meter (Fig.-4) respectively. For electrical conductivity measurement conductivity meter was used.

Statistical analysis

Descriptive statistics has measured using the descriptive data analysis tool in Microsoft Excel (Version 2013). Kearl Pearson method was used for correlation analysis.

Fig.-1pH meter

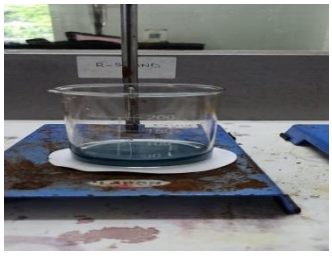

Fig.-2 Titration for total hardness

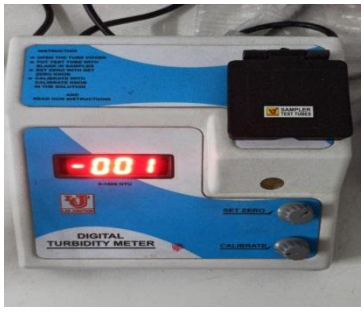

Fig.-3 Digital turbidity meter

Fig.-4 Digital TDS meter

RESULTS AND DISCUSSION

Analysis of physical and chemical parameters

Data of 50 samples of underground water have been obtained, including information on the chemical parameters TDS, Total Hardness (CaCO3), electrical conductivity, pH value, and physical parameters colour and turbidity. Analysis of descriptive statistics and correlation has been performed. The pH, TDS, EC, and Total Hardness of the ground water sample were all measured and analyzed. To determine the acidity or basicity of water samples, pH values were measured. pH primarily reveals the presence of free hydrogen or hydroxyl ions in a sample. Also, it gauges how corrosive water is. High pH values indicate corrosive nature. The hydrogen ion's negative logarithm, pH, is expressed as pH = log(H+).

Table 1 displays the findings of descriptive statistics (means and standard deviations) determined on ground water's physicochemical properties. Beyond the geographical sources of the samples, it was found that the pH values were consistent across the board. The pH data shows a mean value of 7.8 and a standard deviation of 0.20. TDS, the second parameter to be measured, assists in identifying the different solids (salts, minerals, organic debris, etc.) present in water.The samples' TDS readings ranged from 230 to 5700 mg/L. TDS averages out to be 1020 mg/L, with a standard deviation of 1011.4 mg/L. The greater dispersion in TDS levels can be explained by the fact that the samples were taken at various depths, as

Table 1 Results of descriptive analysis for Ground water samples

Parameter	**Mean**	**Standard Deviation**	**Standard Error**	**Maximum**	**Minimum**	**Range**
Colour	4.12	1.20	0.20	8.00	3.00	5.00
Turbidity	2.58	3.47	0.49	15.00	0.00	15.00
Electrical Conductivity	1933.00	1404.53	198.63	8500.00	203.00	8297.00
pH	7.76	0.23	0.03	8.85	7.35	1.50
Total Hardness	488.72	465.17	65.78	2990.00	112.00	2878.00
TDS	1020.00	1011.42	143.03	5700.00	230.00	5470.00

indicated by the large standard deviation value. The gathered samplesEC ranges from 203 S/cm to 8500 S/cm, and their total hardness content range from 2990 mg/L to 112 mg/L.

There is a wide variation in the turbidity (NTU) scale, from 0.00) to 15.00. The average turbidity level is 2.6 (NTU), with a standard deviation of 3.5 (NTU). The mean depth is 234.2 feet and the standard deviation is 125.2 feet across the sample locations, which range in depth from 60 feet to 400 feet.

Correlation and Regression Analysis

Table 2 shows the Pearson’s correlation analysis results. It is found that Turbidity and pH are negatively associated with ground water depth, while Conductivity, Total Hardness, and TDS are

positively associated with ground water depth. Turbidity is also found to be positively correlated with other physicochemical parameters. Conductivity shows the strongest correlation with Total Hardness (r = 0.79), whereas Total Hardness shows the strongest correlation with TDS (r = 0.812). No significant correlation is noticed between pH and Total hardness and between pH and Conductivity. Thus, further regression analysis was performed to explore the relation between these parameters.

Table 2 Correlational coefficients for all the parameters

	Depth	**Turbidity**	**Conductivity**	**pH**	**Total Hardness**	**TDS**
Depth	1					
Turbidity	-0.157*	1				
Conductivity	0.012**	0.268**	1			
pH	-0.543***	0.289**	-0.021	1		
Total Hardness	0.029**	0.122*	**0.787*** **	0.000	1	
TDS	0.258**	0.100*	0.592***	-0.075	**0.812*** **	1

Significant Codes: 1% '***' 5% '**' 10% '*'

Following regression equations between TDS and total hardness, conductivity and total hardness were found as a consequence of the regression analysis of quality metrics. These equations reveal how these parameters are related to one another. The line plots in Fig 5 and 6 are displayed. Consequently, it can be inferred that by using these regression equations in a non-destructive manner with good precision, the other two quality parameters of water samples can be correctly predicted after measuring one parameter using chemical methods.

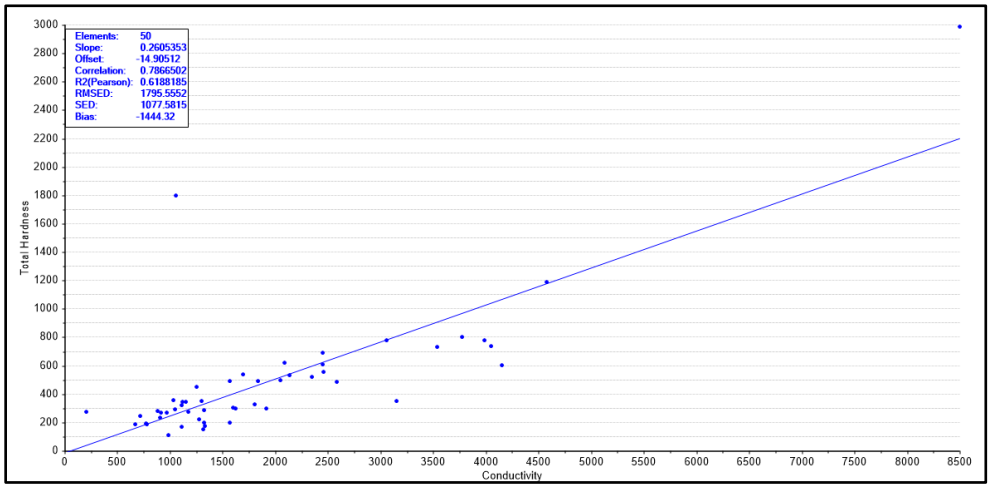

Fig.-5 Correlation plot between conductivity and total hardness

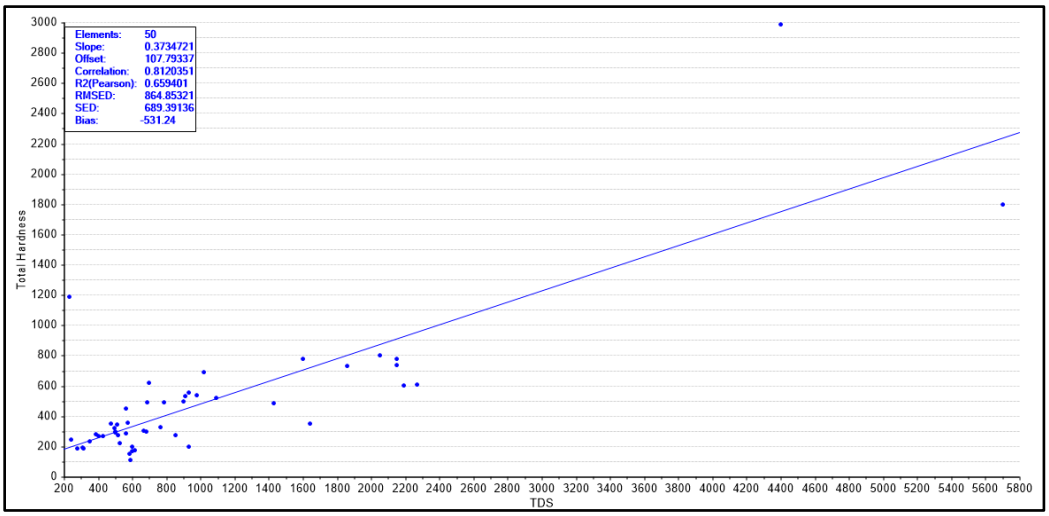

Fig.-6 Correlation plot between TDS and total hardness

Equation 1 indicates the relation between Conductivity and Total Hardness values is positive with slope of 0.2605 and the intercept value is -14.90. R-squared of the model stands at 0.6188or 61.88% indicating that Conductivity alone predicts 62% variations in Total Hardness. The results demonstrate that the Total Hardness changes by 0.2605 units for every one unit change in Conductivity.

$$\widehat{\textbf{Total Hardness}} = -14.90 + 0.2605 \times \textbf{Conductivity} \quad (1)$$

Equation 2 states the relation between TDS and Total Hardness values is positive with slope of 0.373 and the intercept value is 107.79. R-squared of the model stands at 0.6594 or 65.94% indicating that TDS alone predict 66% variations in Total Hardness. Results show that a one unit increase in TDS causes 0.373 unit change in Total Hardness.

$$\widehat{\textbf{TotalHardness}} = 107.79 + 0.3734 \times \textbf{TDS} \quad (2)$$

CONCLUSION

Aim of the research fulfilled in the present study with physicochemical results (pH, TDS, total hardness, turbidity and electrical conductivity) of all 50 samples and the statistical representation with descriptive analysis has been done. Descriptive statistics has given the statistical information (Maximum values, minimum values, standard deviation, mean, range) about all the properties. All the parameters have shown the variation in values with respect to geographic changes, except pH. The study has given a brief idea about a qualitative analysisof the ground water of Delhi NCR region briefly. Along with the descriptive analysis this research will also helped out to know the correlation among all the parameters designated with coefficient of correlation. These values are very poor for some cases, but have proved very strong in case of total hardness, total dissolved

solids and conductivity. These three parameters have correlated with each other and have developed different regression equation. Regression equations have been developed after statistical calculation. These equations have proved an efficient non-destructive approach. Overall, the present research has given an impact to check the quality of ground water of Delhi NCR region and given some statistical idea to give a quick solution to analyze one property from another without usage of any chemical.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

ETHICAL APPROVAL: NA

CONTRIBUTION OF AUTHORS

First author has performed all the experiments related to this paper. Second author has written and prepared the manuscript.All corresponding authors have given their guidance to do the research and reviewed the manuscript for final approval.

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