



## Physico-Chemical Study of Groundwater at Shahjahanpur city, Uttar Pradesh, India

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### Abstract

Today, it is a known fact that the groundwater quality is degrading day by day which is a serious concern nowadays, as water with poor quality pose threats to human health and hygiene. Good quality of water is of utmost importance for survival of man and animals, and as we know because the groundwater aquifers are the largest source of fresh water, their contamination will prove to be havoc. In the light of aforesaid facts it becomes necessary to assess the current groundwater quality of Shahjahanpur city, in terms of pH value, total dissolved solids, Chlorine, Calcium, Magnesium, Fluorine and Nitrate levels, by taking samples from bore wells. In terms of Ph value, TDS, Cl, Ca, and Mg, the values were within the acceptable limits as prescribed by W.H.O, while the levels of F and NO<sub>3</sub> were detected to be exceeding their permissible limits. Thus, the study reveals the need for proper and timely evaluation of groundwater quality and simultaneously highlights the urgency of the necessary steps to be taken for the preservation and up gradation of water quality to manage the present water resources.

**Keywords:** Groundwater, Shahjahanpur, physicochemical, total dissolved solids, water quality.

### Introduction

About 75% of the earth's surface is covered with water, which is an abundantly available natural resource. Not only the life processes of animals and plants depend upon water but it also has a significant role in industrial processes<sup>1</sup>.

Quality of water is a measure of its physical and chemical properties along with the biological and aesthetic characteristics. It refers to the efficiency of water to meet the basic requirements for the progressive survival of human beings as well as several other species. There are a certain set of standards which are referred to as a reference for the assessment of water quality.

Since last few years, continuously growing population, fast pace of industrialization and the simultaneous techniques of waste disposal have been responsible for the discharge of pollutants into the water bodies, resulting in rapid contamination of water. Moreover, the rate of contamination of water is much faster than the processes of its purification<sup>2</sup>. The analysis of the physico-chemical properties of water, assist in analyzing the structure and functions of water bodies<sup>3</sup>. The physical, chemical and biological characteristics of water are the decisive factor for defining the suitability or non-suitability of water for consumption, irrigation or industrial uses<sup>4,5</sup>. Considerable number of researches have been made in this direction, which focus on how anthropogenic activities, mainly agricultural and industrial processes, result into the contamination of groundwater<sup>6,7</sup>. The industrial effluents and disposed sewage water are the main causes of groundwater contamination.

Degradation of groundwater quality initiates from a diffuse source and later on covers a larger area. For instance, the percolation of various chemicals from the agricultural fields, septic tanks, dumping areas, etc., can result in contamination of groundwater aquifers of immense size.

Shahjahanpur is the municipality, town and Headquarters of district Shahjahanpur. It is located in Uttar Pradesh state of India and is mainly agricultural, where most of the areas are under canal and tube well irrigation. Its geographical location is 27°35' N Latitude and 79°37' E Longitude and covers an area of about 4,575 km<sup>2</sup>.

The average annual rainfall is about 807 mm. Ramganga, Garrah, Gomti are the significant rivers of the area along with Khannaut, Suketa and Kai flowing into the Garrah, while, Kathana, Jhukma and Mensi rivers feed the Gomti.

Experimental area having groundwater potential, net groundwater availability is 140974.03 hectare meter (Ham), and groundwater draft (all uses) is 83111.52 hectare meter, hence the level of development of groundwater is 58.96%.

Being an agriculture based district, the use of fertilizers, insecticides, pesticides, weedicides, rodenticides, etc is vigorous due to which the groundwater is constantly being contaminated.

Hence the present assessment of groundwater quality helps in determining the physical and chemical characteristics of groundwater in parts of Shahjahanpur district.

## Material and Methods

The sampling places are referred as stations (S1-S10). The stations are represented as Banthara (S1), Kakra Kalan (S2), Huddaf Chawki (S3), Ali Zai (S4), Ghantaghar (S5), Chowk (S6), Hayatpura (S7), Bijlipura (S8), Military Cantonment (S9) and Railway Station (10).

The water samples were collected from various bore wells located in Shahjahanpur district, in plastic bottles having capacity of 1 liter. Necessary precautions were taken while sampling and then the samples were carefully sealed, labeled and taken for analysis of physico-chemical parameters such as pH, TDS, Cl, Ca, Mg, F, and  $\text{NO}_3$ . The groundwater samples were subjected to physico-chemical analysis using standard procedure by APHA<sup>8</sup>.

## Results and Discussion

The groundwater samples were collected in Shahjahanpur city. The obtained results are shown in table-1. The experimental results are then analyzed and compared with the limits prescribed by WHO<sup>9</sup> and then discussed.

**pH:** pH is used to determine the acidity or alkalinity of water and the concentration of hydrogen ions in the water. The pH value of all groundwater samples is found to be in the range of 6.23 to 8.14. The highest value of 8.14 is observed at station S1 whereas the lowest value of 6.23 is observed at station S4. In terms of pH value, the groundwater samples are well within the acceptable limit of WHO. There is no anomalous change in the groundwater samples. Long term exposure to pH beyond the permissible limit affects the mucous membrane of cells<sup>10</sup>.

**TDS:** The total dissolved solids are composed mainly of calcium, potassium, sodium, manganese, magnesium, carbonate and bicarbonate and other particulate matter. In present assessment the groundwater samples show variation between 315 and 781 mg/l, in terms of TDS. For domestic uses, the maximum permissible limit of total dissolved solids is 1500 mg/l (prescribed by WHO). The maximum value of 781 mg/l is recorded at station S2 and minimum value of 315 mg/l is recorded at station S1. Hence all the groundwater samples are not saline. In the present assessment, the total dissolved solids are found to be in the permissible limit of 1500mg/l.

**Chloride (Cl):** The chloride values for samples were found to be within the range of 54 – 156 mg/l. The maximum value of 156 mg/l is recorded at station S8 and the minimum value of 54 mg/l is recorded at station S3. All of the groundwater samples show chloride values within the acceptable limit (250 mg/l) of WHO.

**Calcium (Ca):** In this study, the calcium values are recorded between 46 and 120 mg/l. the maximum value of 120 mg/lis

recorded at station S8 while the minimum value of 46 mg/l is recorded at station S7. For all the samples the values of calcium were found within the maximum permissible limit (200mg/l).

**Magnesium (Mg):** The magnesium values are recorded between 14 and 78 mg/l. The highest value of 78 mg/l is observed at station S6 and the lowest value of 14 mg/l is observed at station S2. All samples recorded the magnesium values within the permissible limit of 150 mg/l (prescribed by W.H.O).

**Fluoride (F):** The fluoride values for the samples taken is recorded between 0.68 and 2.87 mg/l. the maximum value of 2.87 mg/l is recorded at station S3 and minimum value of 0.68 mg/l is recorded at station S9. The maximum permissible limit of fluoride according to WHO is 1.0 value of fluoride at most of stations is higher than the permissible value (1 mg/l) of W.H.O. Long term exposures to the drinking water with high value of fluoride can cause skeletal fluorosis<sup>11</sup>.

**Nitrate ( $\text{NO}_3$ ):** The value of nitrate in all the ground water samples is found between 7.8 and 49.6 mg/l. The highest value of 49.6 mg/l is recorded at station S2 and the lowest value of 7.8 mg/l is recorded at station S6. The nitrate value of 49.6 mg/l at station S2 is slightly higher than the acceptable limit (45mg/l) of W.H.O. The presence of nitrate in groundwater is due to its percolation with water. Toxicity of nitrates causes methaemoglobinemia in infants and children<sup>11</sup>.

**Table- 1**  
Physicochemical characteristics of groundwater of Shahjahanpur city

Sample No.	pH	TDS	Cl <sup>-</sup>	Ca <sup>+2</sup>	Mg <sup>+2</sup>	F <sup>-</sup>	NO <sub>3</sub> <sup>-</sup>
S <sub>1</sub>	8.14	315	125	93	30	1.2	11.6
S <sub>2</sub>	7.69	781	107	77	14	1.1	49.6
S <sub>3</sub>	8.08	582	54	83	24	2.87	21.1
S <sub>4</sub>	6.23	422	76	58	37	1.6	7.8
S <sub>5</sub>	7.04	503	120	97	17	1.0	35.2
S <sub>6</sub>	7.24	338	103	69	78	1.3	9.6
S <sub>7</sub>	7.32	438	120	46	32	0.72	23.2
S <sub>8</sub>	7.27	433	156	120	62	1.3	12.1
S <sub>9</sub>	7.13	498	93	85	44	0.68	18.3
S <sub>10</sub>	7.85	558	127	78	69	0.70	15.7

All parameters are stated in mg/l except pH

## Conclusion

This research examined physico- chemical characterization of groundwater samples taken from Shahjahanpur city. Total 10 samples were collected from different parts of Shahjahanpur city and were analyzed for pH, TDS, Cl, Ca, Mg, F and  $\text{NO}_3$  using standardized procedure. Then a comparison was made between the values arrived from the samples and the standard permissible values recommended by WHO. The results

derived from the study shows that the water from all the sampling sites is suitable for both agricultural and domestic purposes. Nitrate and fluoride are slightly exceeding the permissible limit in some groundwater samples, so, it may be concluded that a proper check and periodical assessment of groundwater in this area is necessary to put a bar on the exceeding values of fluoride and nitrate.

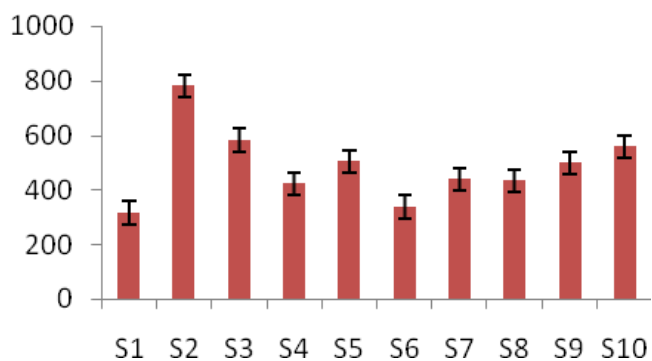
**Table- 2**  
**Classification of Groundwater based on TDS**

TDS mg/l	Class	Number of samples
Less than 1000	Non-saline	10
1000-3000	Slightly saline	0
3000-10000	Moderately saline	0
More than 10000	Very saline	0

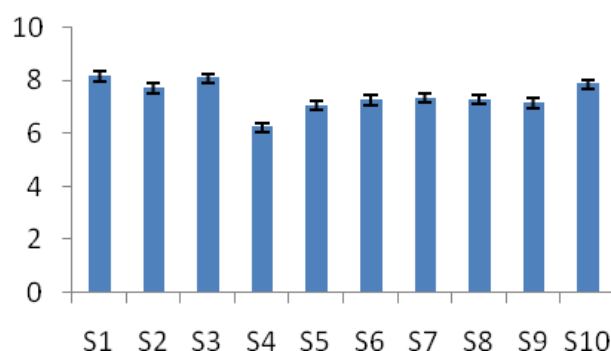
**Table- 3**  
**Statistical evolutions of groundwater samples collected in Shahjahanpur city**

Parameters	Minimum	Maximum	Mean	Median	SD	WHO (1992)	
						Acceptable	Allowable
pH	6.23	8.14	7.39	7.29	0.54	7.0 – 8.5	6.5 – 9.2
TDS	315	781	486.8	468	127.35	500	1500
Cl	54	156	108.1	113.5	27.26	250	1000
Ca	46	120	80.6	80.5	19.65	75	200
Mg	14	78	40.7	34.5	21.00	50	150
F	0.68	2.87	1.24	1.15	0.61	-	1.0
No <sub>3</sub>	7.8	49.6	20.42	17	12.36	45	100

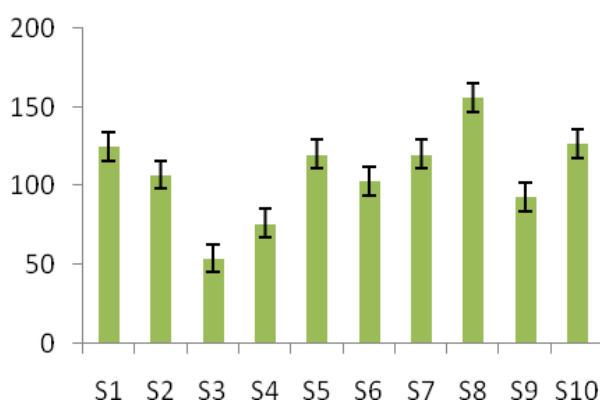
All parameters are stated in mg/l except pH.



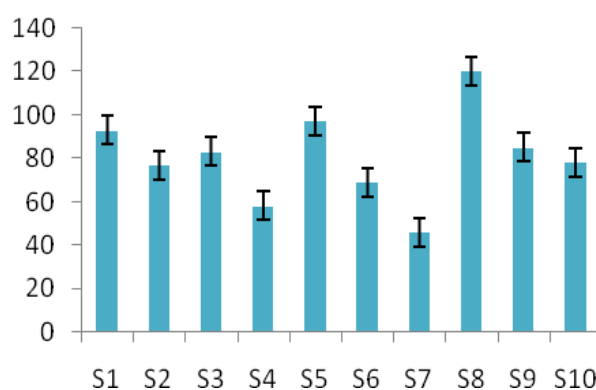
Average pH



Total TDS mg/l



Average Chloride mg/l



Average Calcium mg/l

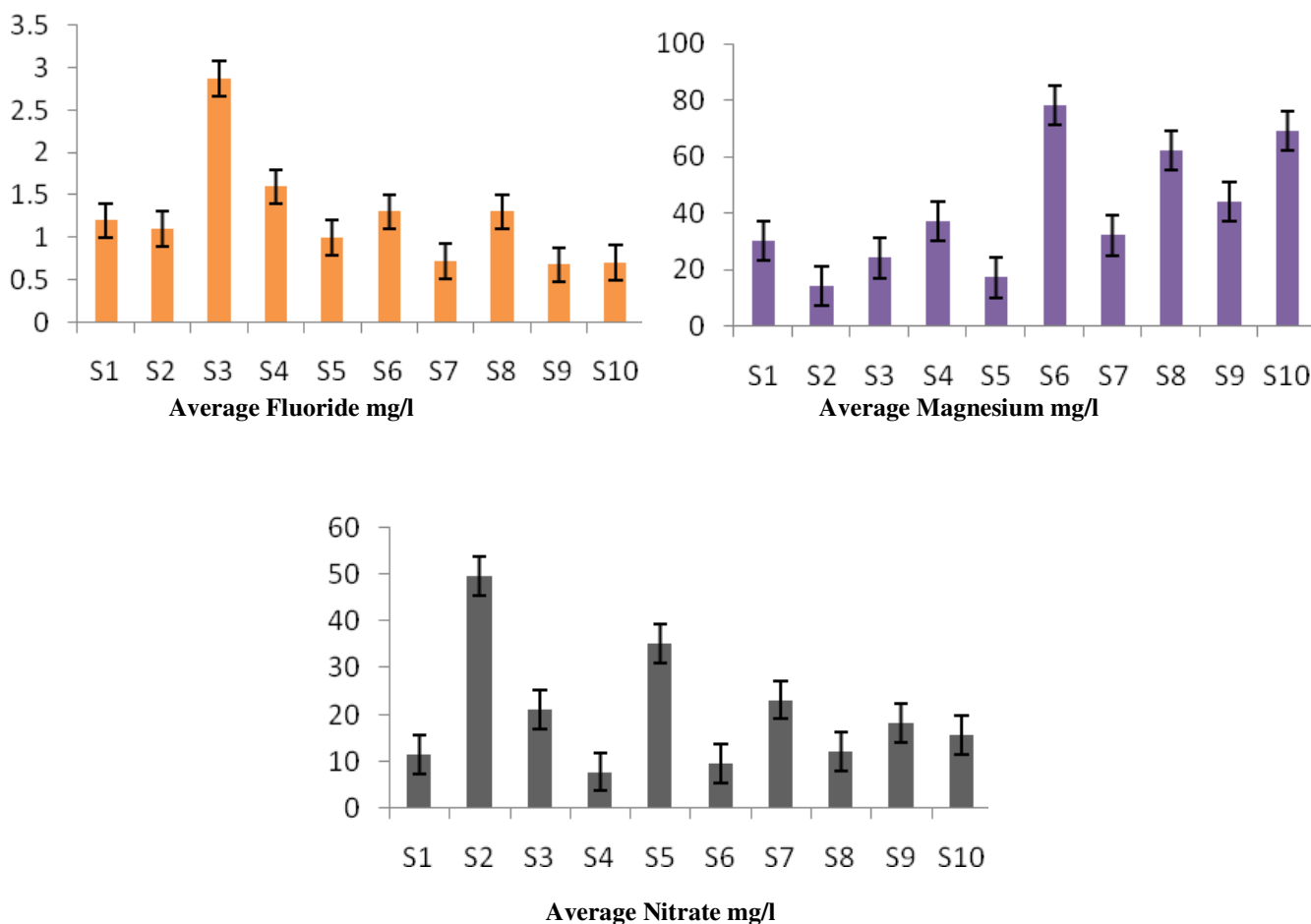


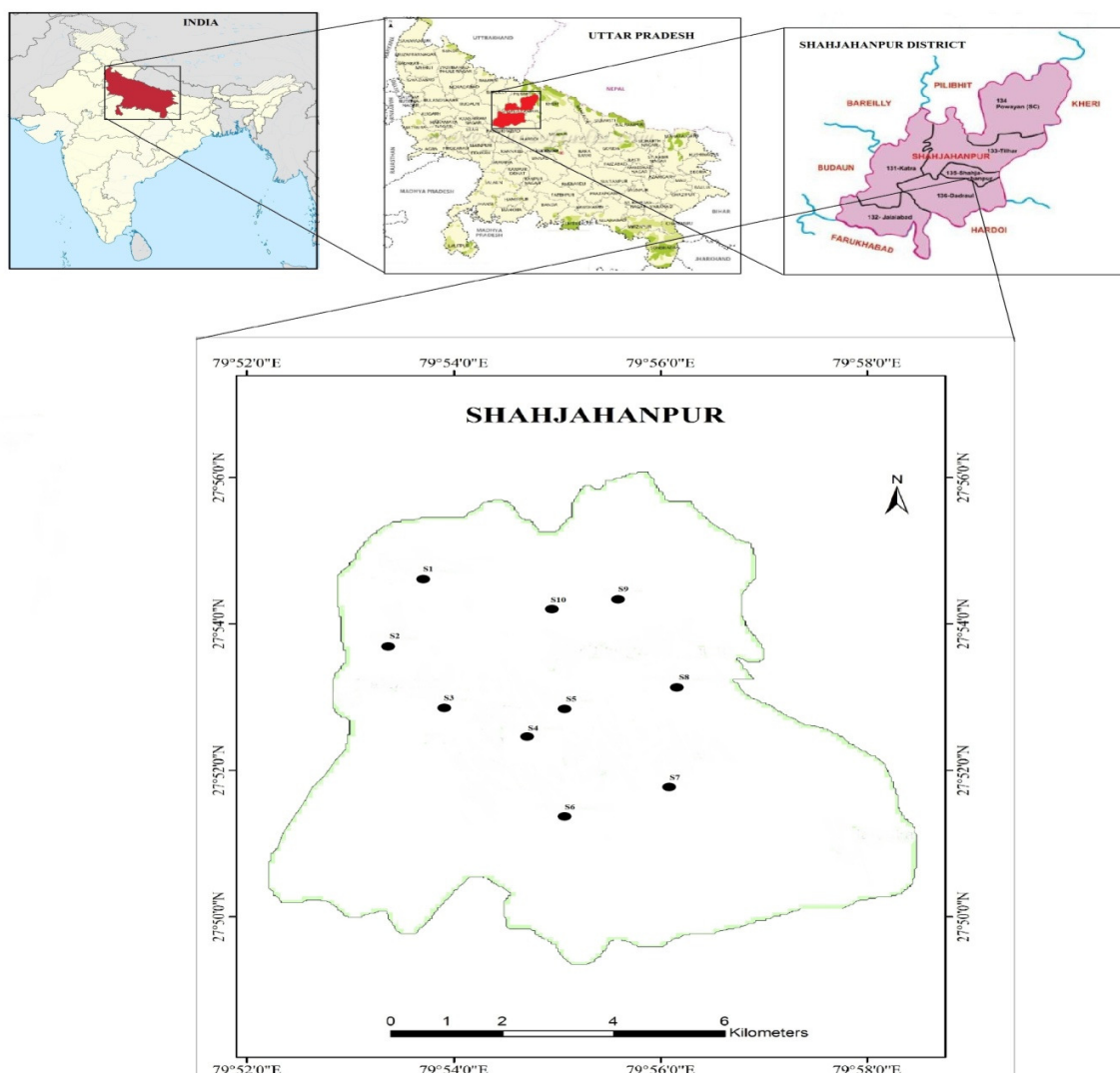
Figure-1  
Graphical representation of Physico-chemical Parameters' analysis of Groundwater

Table-4  
Sampling Places or Station at Shahjahanpur city

Code	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Place	Banthara	Kakra Kalan	Huddaf Chawki	Ali Zai	Clock Tower	Chowk	Hayatpura	Bijlipura	Military Cantonment	Railway Station

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**Figure-2**  
**Location map of the Study Area**

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