Pre and Post Monsoon Variation in Physico-Chemical Characteristics in Groundwater Quality of Shahjahanpur the Town of Martyrs, India: A Case Study

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Abstract

The assessment of groundwater quality is the key towards protecting and conserving the quality of groundwater. Therefore, it becomes very important to conduct a proper and detailed assessment for the maintenance of the groundwater quality, not just because it is demanded for the present but also keeping in mind the future demands for its consumption. It is a known fact that the groundwater quality is degrading day by day, which is a serious concern, as the poor quality of water poses detrimental effects on the health and hygiene of people. Since, the groundwater aquifers are the largest source of fresh water on the earth, the water quality down there is of utmost importance. Hence, the analysis of the present state of groundwater quality becomes necessary. The present study aims at the assessment of the groundwater quality of Shahjahanpur city, for the pre and post- monsoon phase, for the year 2014, by calculating the Water Quality Index. The study has been carried out by collecting samples from 10 different regions of the city and subjecting them to detailed physico-chemical analysis. The Physico-chemical parameters in terms of pH value, total dissolved solids; chlorine, calcium, magnesium, nitrate and fluorine levels were assessed to get the clear idea of the present state of groundwater of the Shahjahanpur city. The study reveals that the quality of groundwater was far better during the post-monsoon season, as compared to that of pre-monsoon season. The pollution of water occurred to a large extent because of increasing population pressure along withrapid industrialization and urbanization.

Keywords: Shahjahanpur, physico-chemical, total dissolved solids, water quality.

Introduction

One of the most abundantly available natural resources of the earth is water, which covers about 75% of its surface area[1]. It forms the prime basis for the existence of life on the earth. Groundwater is the most important water resource for domestic and agricultural use, both in rural as well as urban areas. But the quality of groundwater is deteriorating at a fast pace due to increased use of various chemicals, in the form of disinfectants, petrochemicals, cleansing chemicals, rodenticides, pesticides, insecticides, fertilizers, etc. These chemicals penetrate deep down to the aquifers and thus are responsible for groundwater pollution.

As the demands for water are increasing and the quality of water is deteriorating, the availability of quality freshwater has become one of the most critical issues of the 21st Century. Alongwith its quantity, the quality of groundwater is very important to main good health and to prevent diseases. The water intended to be used for human consumption and domestic purposes should be free from chemicals and pathogenic agents. 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[2,3].

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[4,5].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, surface impoundments, septic tanks, dumping areas, etc., can result in contamination of groundwater aquifers of immense size[6].

Shahjahanpur district is mainly agriculture based district, located in Uttar Pradesh, India, with most of its area under canal and tube well irrigation. Shahjahanpur is the municipality and town headquarters of District Shahjahanpur. The geographical location of the area is 27°35′ N latitude and 79°37′ E longitude, covering an area of about 4,575 km[2]. The significant rivers of the region are Ramganga, Garrah, Gomti, Khannaut and Suketa. Being an agricultural region there is high usage of various fertilizers, pesticides, and weedicides etc., which percolate deep

down to the aquifers and disturb the physico-chemical composition of groundwater. Therefore the groundwater in this area needs proper and timely assessment and evaluation along with effective measures to overcome any discrepancies.

Material and Methods

The area selected for study is the urban region of Shahjahanpur city. The samples of groundwater were taken from the bore wells and hand pumpsduring both, pre-monsoon and post-monsoon phases for the year 2014. These samples were acquired in clean plastic containers, so that any form of alien contamination could not enter the samples and their physical and chemical characteristics remain the same.

The present study focusses upon the analysis and interpretation in terms of the physic-chemical characteristics of groundwater acquired from 10 different locations in Shahjahanpur city. Firstly, the stations were located, established and after that sampling was done. These samples were then analysed for their physical and chemical composition using standard procedure by APHA.

Results and Discussion

The analysis of the samples of the groundwater, collected from different locations in Shahjahanpur district, for the levels of pH, TDS, calcium, chloride, nitrate and magnesium.

pH: pH is used to determine how acidic or alkaline the water is, by measuring the H_2-ion concentration in the water samples. For

the present analysis, the pH values of the samples range between 7.04 and 8.14 for the post-monsoon season and 7.14 to 8.23 for the pre-monsoon phase. Long term exposure to pH beyond the permissible limit affects the mucous membrane of cells[6].

TDS: The total dissolved solids are composed of the solid substances that dissolve in water and pose hazardous effects on human health. The following samples possess the value of the TDS ranging from 315 mg/l to 781mg/l for Pre-Monsoon and 246 mg/l to 639mg/l for Post-Monsoon phase. Therefore, for all samples the value of TDS is within the maximum permissible limit, i.e. 1500 mg/l.

Chloride (Cl): The chloride values in the present study range from 54 mg/l to 156 mg/l for Pre-Monsoon and 19.99 mg/l to 49.99 mg/l for Post-Monsoon phase. So, the values are within the maximum permissible limit prescribed by W.H.O. (i.e. 250 mg/l).

Calcium (Ca): In this study, the calcium values were recorded between 14 mg/l to 122mg/l for Pre-Monsoon and 46 mg/l to 120 mg/l. for Post-Monsoon. The values are hence, within the maximum permissible limit of 150 mg/l (prescribed by WHO).

Magnesium (Mg): The magnesium values are recorded between 16 to 75mg/l for Pre-Monsoon and 14 to 78 mg/l for Post-Monsoon. The magnesium value for all the groundwater samples is within the maximum permissible limit (150 mg/l) of WHO.

Table-1
Physico-chemical characteristics of groundwater of Shahjahanpur in Pre Monsoon Season

Sampling station No.	pH	TDS	Cl⁻	Ca⁺²	Mg⁺²	No₃⁻
S_1	8.23	315	125	14	33	11.6
S_2	8.13	781	107	42	16	49.6
S_3	8.10	582	54	60	27	21.1
S_4	7.72	422	76	122	37	7.8
S_5	7.14	503	120	54	19	35.2
S_6	8.12	338	103	88	75	9.6
S_7	7.24	438	120	64	36	23.2
S_8	7.85	433	156	89	65	12.1
S_9	7.33	498	93	72	46	18.3
S_{10}	7.96	558	127	93	75	15.7

All parameters are expressed in mg/l except pH

Nitrate (NO$_3$): The value of nitrate in all the ground water samples is found between 7.8 and 49.6 mg/l for Pre-Monsoon and 7.8 to 40.6 mg/l. The highest value (49.6 mg/l) of nitrate is recorded at station S2 for Pre-Monsoon which is slightly higher than the acceptable limit (45mg/l) of WHO. The presence of nitrate in groundwater is due to leaching of nitrate with percolating water. Toxicity of nitrates causes methaemoglobiaemia in infants and children.

Conclusion

In the present study, the quality of groundwater in Shahjahanpur city has been assessed, keeping in mind that the groundwater aquifers serve as the most important source of water for domestic and industrial uses. The water is extracted from within the ground by bore wells, hand pumps, submersible pumps, jet pumps, etc.

Table-2
Physico-chemical characteristics of groundwater of Shahjahanpur in Post Monsoon Season

Sample No.	pH	TDS	Cl$^-$	Ca^{2+}	Mg^{2+}	NO$_3^-$
S1	8.14	246	49.99	93	30	9.6
S2	7.69	639	34.99	77	14	40.6
S3	8.08	475	29.99	83	24	16.1
S4	7.23	542	19.99	58	37	7.8
S5	7.04	623	44.98	97	17	28.2
S6	7.24	265	34.98	69	78	8.4
S7	7.16	321	19.99	46	32	23.2
S$_8$	7.27	298	38.49	120	62	15.1
S$_9$	7.13	539	26	85	44	18
S$_{10}$	7.85	635	35.9	78	69	14.2

All parameters are expressed in mg/l except pH

Table-3
Classification of Groundwater based on TDS

TDS mg/l	Description	No of samples
≤ 1000	Non-saline	10
1000-3000	Slightly saline	0
3000-10000	Moderately saline	0
≥ 10000	Very saline	0

Table-4
Sampling Places or Station at Shahjahanpur city

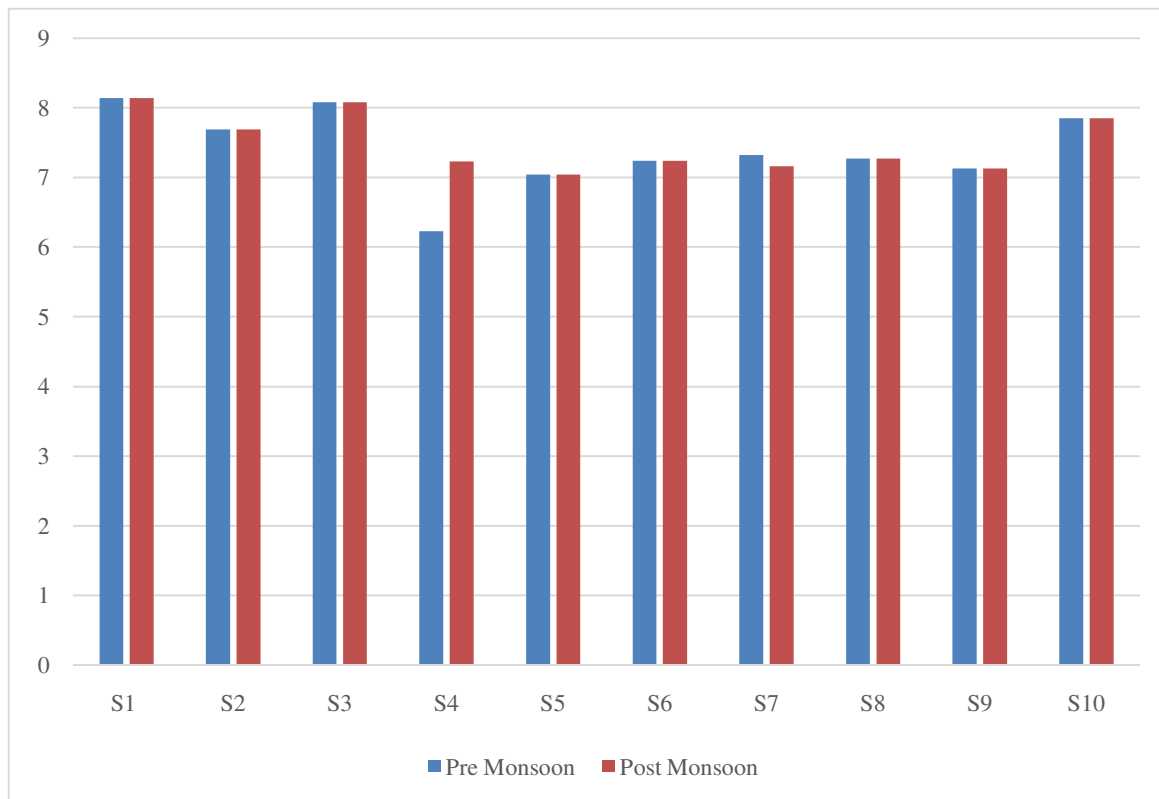| Code	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Place	Banthara	Kakra Kalan	Huddaf Chawki	Ali Zai	Clock Tower	Chowk	Hayatpura	Bijlipura	Military Cantonment	Railway Station

Figure-1
Graphical Comparison of average pH
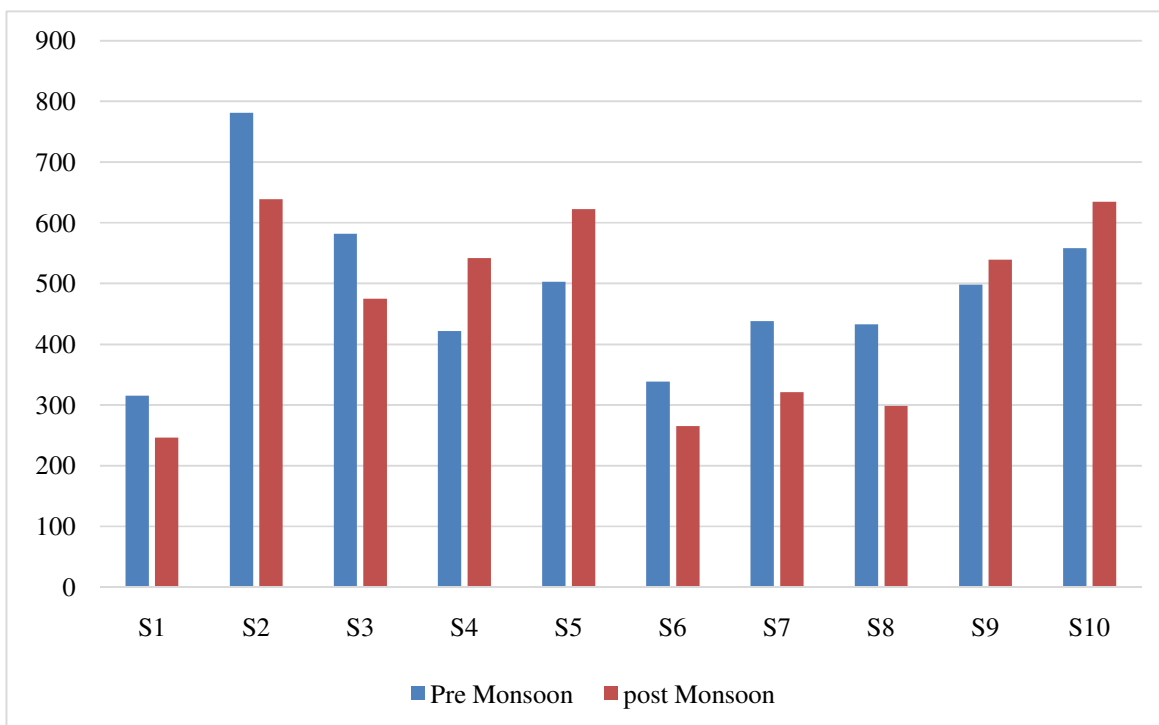

Figure-2
Graphical Comparison of average TDS mg/l
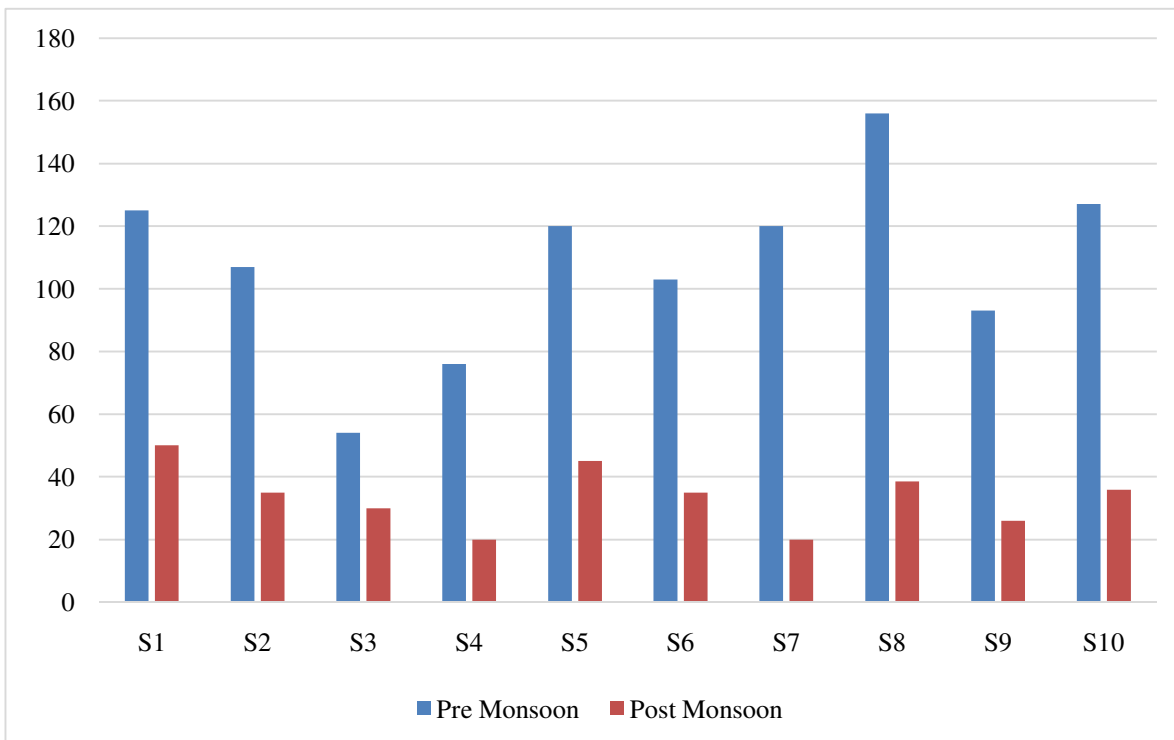
Figure 3
Graphical Comparison of average Chloride mg/l
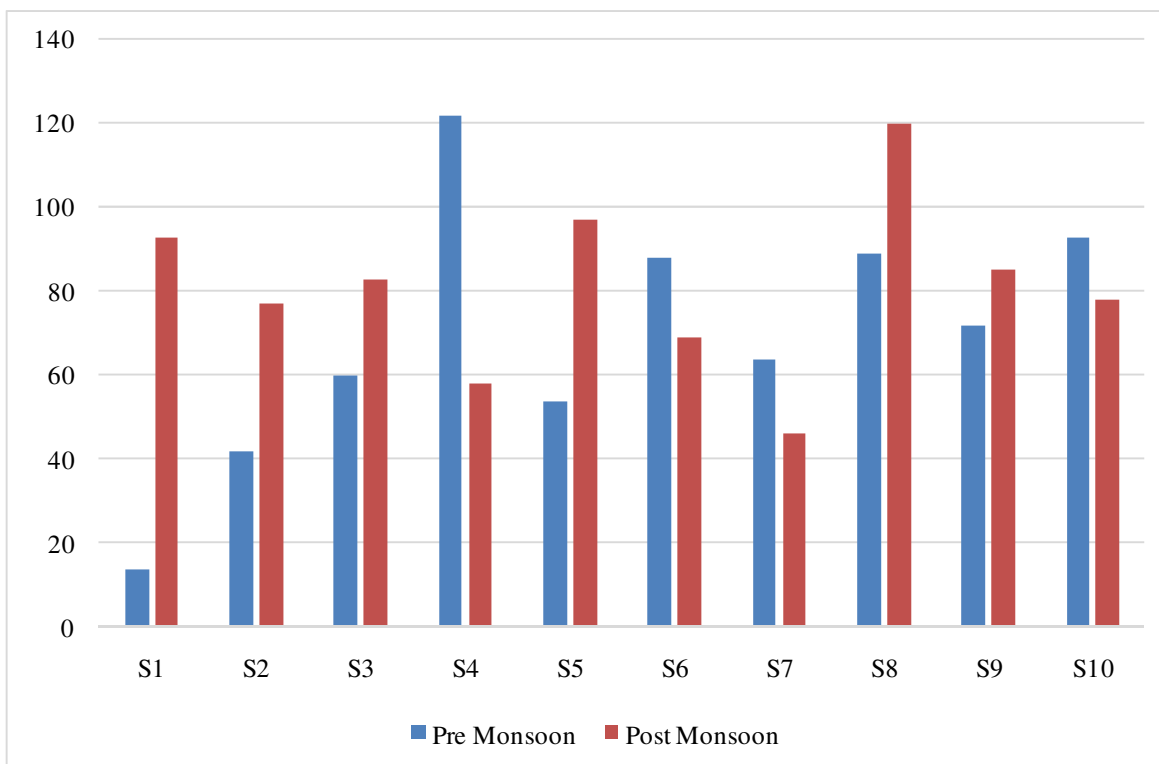

Figure 4
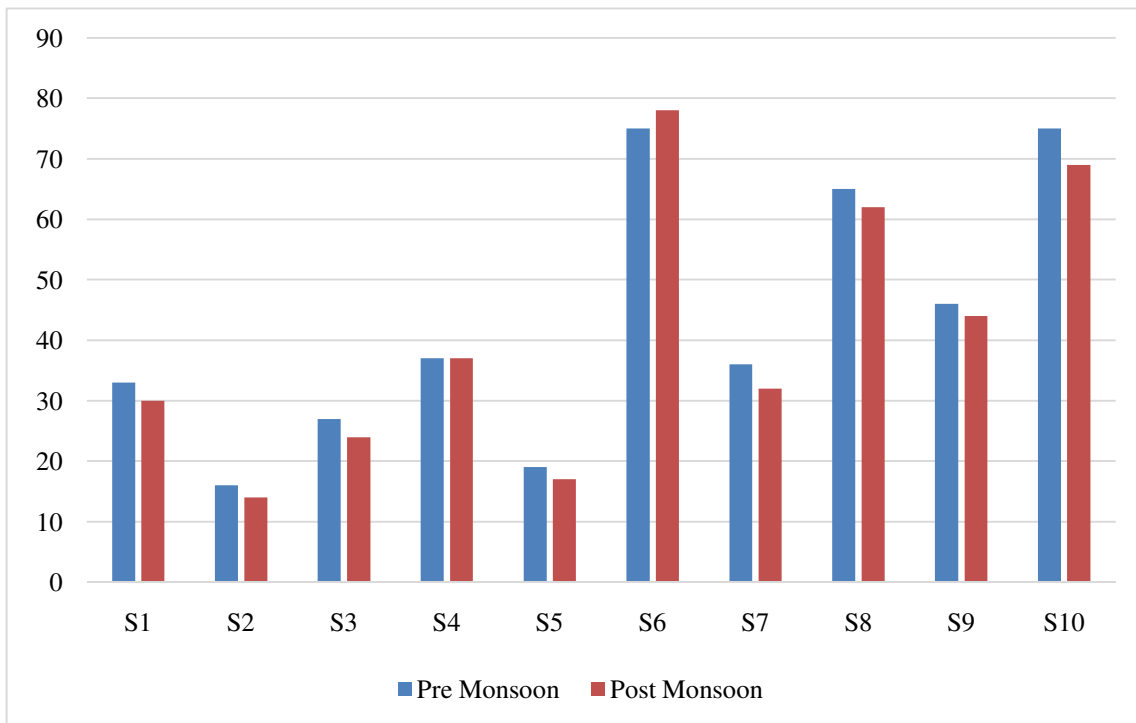**Graphical Comparison of average Calcium mg/l**

Figure 5
Graphical Comparison of average Magnesium
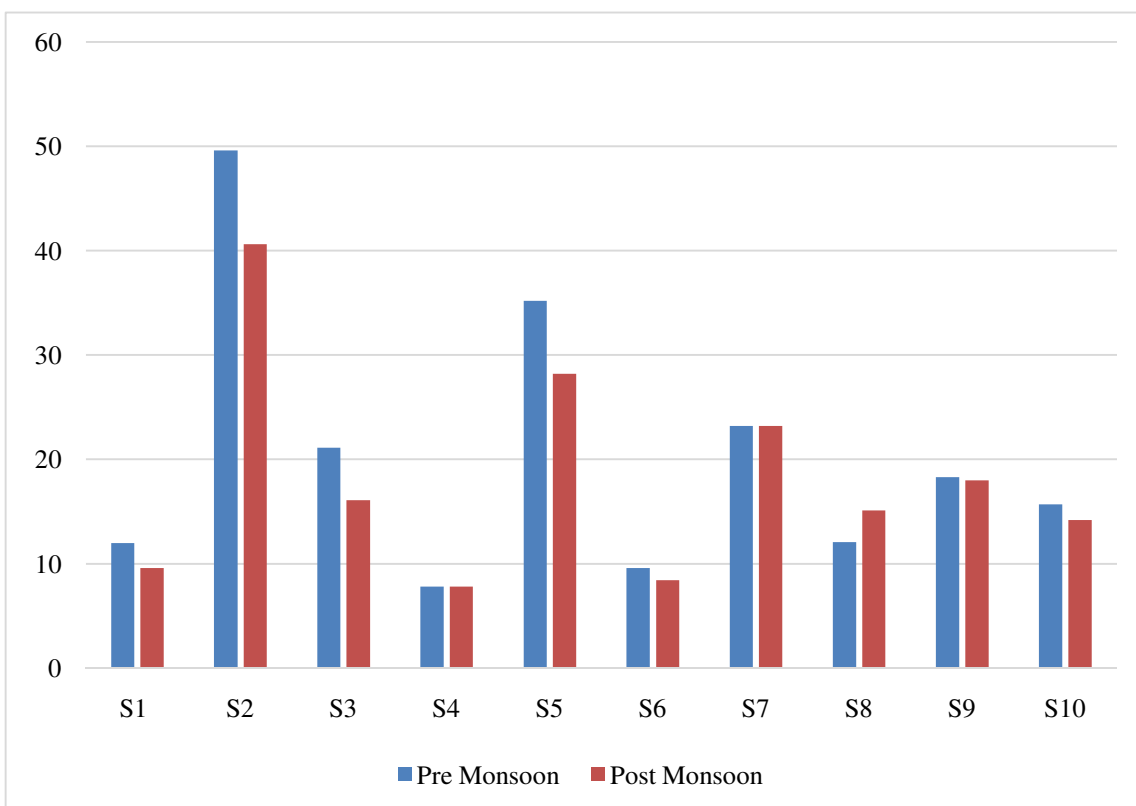

Figure 6
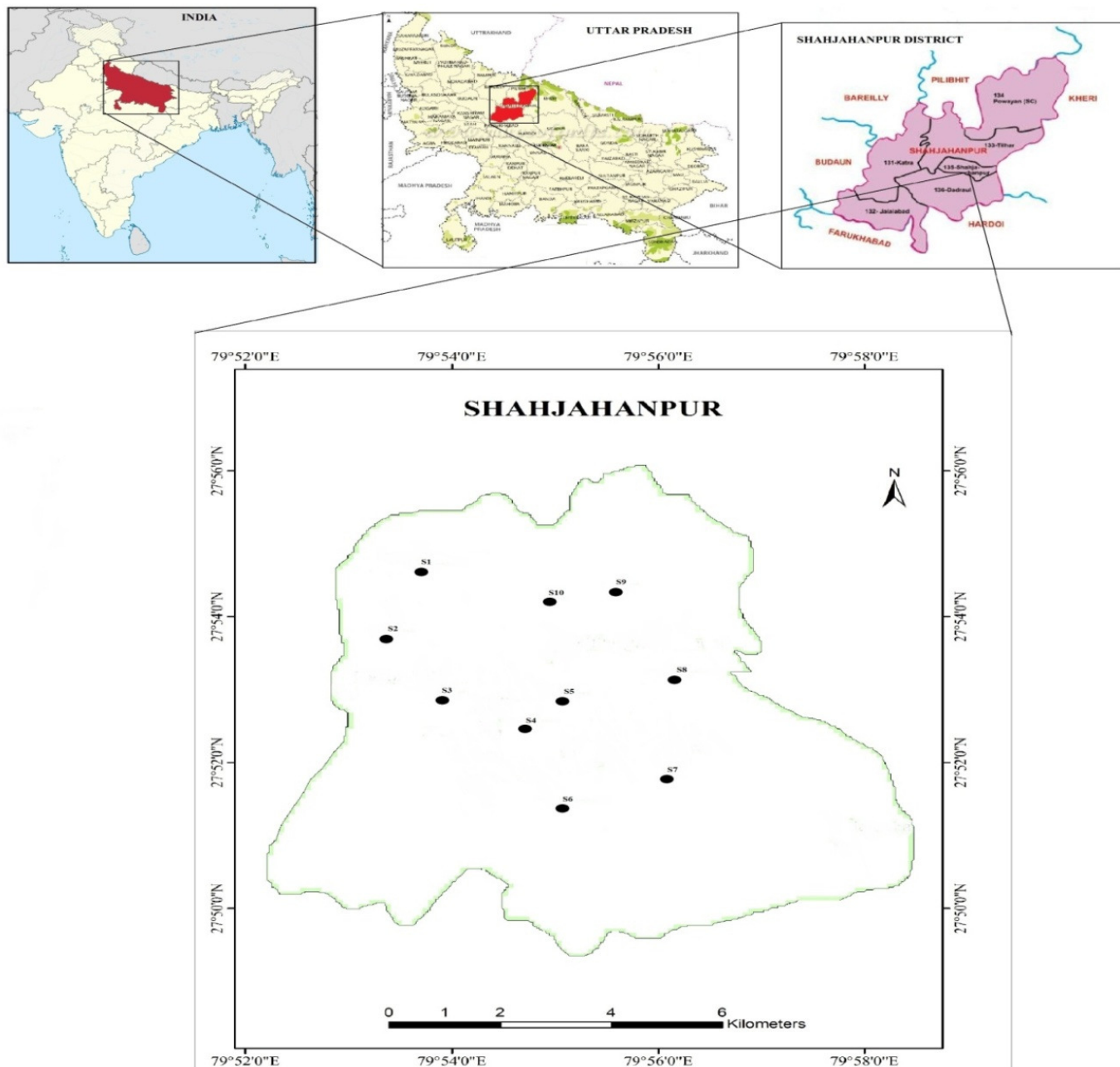**Graphical Comparison of average Nitrate**

Figure-7
Location map of Study area

The results indicate that the quality of groundwater was much better in post-monsoon phase as compared to that of the pre-monsoon phase. The reason for this might be that the groundwater aquifer are recharged with rain water during monsoon season, so, the proportion of the amount of contaminants to that of the water decreases. The pollution and contamination of the groundwater has solely been the outcome of increased anthropogenic activities, increasing population pressure, high pace of urbanization and industrialization.

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