GEOGRAPHICAL ANALYSIS

RESEARCH ARTICLE

Check for updates

OPEN ACCESS

Received: 21.02.2024

Accepted: 27.02.2024

Published: 18.03.2024

Citation: Dubey A. (2024). A Comparative Assessment and Evaluation of Water Quality Parameters of Alluvial Ganga Plains and Vindhyan Plateau. Geographical Analysis. 13(1): 12-17. https://doi.org/10.53989/bu.ga.v13i1.7

* **Corresponding author**.

geo5aashi@gmail.com

Funding: Nil

Competing Interests: Nil

Published By Bangalore University, Bengaluru, Karnataka

ISSN
Print: 2319-5371
Electronic: XXXX-XXXX

A Comparative Assessment and Evaluation of Water Quality Parameters of Alluvial Ganga Plains and Vindhyan Plateau

Anupama Dubey[1,2]*

1 *PhD, Department of Geography, Delhi University, ICSSR, New Delhi, India*
2 *Assistant Professor, Institute of Public Enterprise, Hyderabad*

Abstract

This study evaluated the condition of ground and surface water contamination. Analyzed the spatial-temporal variability and influential elements impacting water quality in Mirzapur district's physiographic regions/villages to present a way forward for future management plans. A preliminary survey was undertaken to find appropriate sampling sites. Seven villages were chosen for sampling, three from the Alluvial Ganga plain and four from the Vindhyan plateau to ensure comprehensive coverage of the entire area. Three samples, one from surface water and two from ground water, were obtained from each town. A total of 21 sampling sites were chosen based on the survey, taking into account both ground water and surface water sources for thorough study. The hydro-geochemical composition of the ground waters collected in the study region varied during the rainy (2012), summer (2013), and winter (2013) seasons. This research aims to analyze water quality variations in water samples and estimate the water's uses in selected region on the basis of water quality assessment.

Keywords: water quality; regional variation; Water quality; Regional variation; Temporal variation

1 Introduction

Water is essential for the survival of plants and animals. Water security has been gradually degrading. Forest coverage has been rapidly declining during the previous few decades. Wetlands have been reclaimed and repurposed for activities such as agriculture, industry, or urban development. The escalating reliance on water supplies, coupled with reduced protection, has led to several serious issues. Water resource contamination poses a significant threat to human security globally, especially in underdeveloped countries[(1)]. It is not surprising that the demand for access to clean drinking water has united scholars, activists, and policymakers. The fight for this right has become a central focus for political movements worldwide. Water was abundant and hence seen as a freely available resource for many centuries. The increasing demand for water and depletion of natural water sources are raising concerns about ensuring a reliable supply of high-quality water. Due to uneven distribution of water resources, some countries have excess water while others are experiencing water scarcity.

There is uneven population increase throughout continents, leading to a significant disparity between population size and water resources. Population growth exacerbates the demands on natural ecosystems. Bacteria and microbes are present in several drinking water sources, whereas chemical contaminants have been identified in various streams and rivers. They pose a threat to humans, plant life, and animal species [2].

The rising pollution of groundwater is mostly caused by the increasing scarcity resulting from the overexploitation of resources. The quantitative and qualitative characteristics of water are directly proportionate to each other.

Accessing drinking water remains a persistent issue, but ensuring its safety presents a separate barrier. Water quality issues arise from pollution and over exploitation. Human and natural activities can alter the physical, chemical, and biological properties of water, impacting human health and ecosystems. Water quality can be influenced by various factors such as nutrients, sedimentation, temperature, pH, heavy metals, non-metallic toxins, persistent organics, pesticides, and biological elements [3]. Continual introduction of pollutants will surpass an ecosystem's ability to recover, resulting in significant, abrupt alterations that could be irreversible [4].

2 Study Area

Mirzapur is situated at a geographically and culturally advantageous juncture. Mirzapur district, located on the Vindhyan range, is recognized as the cultural dividing line between north and south India. The region is bordered by Bundelkhand to the southwest, Baghelkhand to the east and southeast, Awadh to the north and northeast, and the (lower) Doab to the west, of which it is a part. The research area has been divided into four Tahsils and twelve community development blocks: Chhionway, Kon, Majhwa, Nagar, Pahari, Lalganj, Haliya, Rajgarh, Sikhar, Narainpur, and Jamalpur. The district has two primary relief features: plains in the north and an upward slope towards the south, physiographically. The drainage system consists of the Ganga and Belan rivers as the principal river system, along with various lesser rivers.

Tributaries merge with these rivers. Mirzapur district is more complex than any other plain district. The highest temperature in June reaches 45°C, while the lowest temperature in January drops to 5°C. Rainfall varies from 100 to over 250 mm over different seasons. The Southern Vindhyan plateau primarily relies on surface water resources for irrigation, whereas the northern region is mainly dependent on groundwater supplies. According to the 2011 Census of India, the total population of Mirzapur district is 24,94,533. The population has significantly increased since 1931.80% of the population is still predominantly rural. The literacy rate in the district has likewise experienced a remarkable growth. The majority of the population is engaged in elementary and secondary activities.

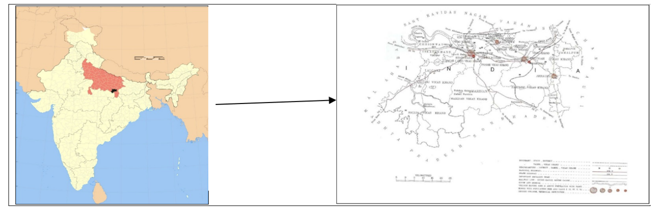

Fig. 1. Study Map of Mirzapur, District, 2011 Source: Census of India, 2011

3 Methodology

This study also assessed the state of ground and surface water pollutions. The spatial temporal variations and the influential factors affecting the water quality along physiographic region/village in Mirzapur district was analysed in order to provide the basis for future management strategies. In order to select suitable sampling site, a preliminary survey was conducted to determine the suitable sites. Seven sample villages were selected, three from Alluvial Ganga plain four from Vindhyan plateau to cover the whole area. Three samples, one of surface water and two of ground water were collected from each village, thus on the basis of survey 21 sampling sites were selected considering ground water and surface water source for detailed analysis.

Field investigations were performed in the Mirzapur district of Uttar Pradesh between July-August 2012, December-January 2013, and May-June 2013. After investigations of the study areas water samples were collected from tube wells from the study area simultaneously. The water samples were collected from seven villages, three (Semara, Bainsa and Kelawela) from Alluvial Ganga Plains and four (Lalapur, Sikta, Baruha and Salaiya) from Vindhyan Plateau. From each villages three samples, one surface water (Pond/Check Dam) and two from Ground water (Well/Tube Well/Hand Pump) samples were collected.

To find out appropriate site for drilling 20 water samples were collected randomly around the study area. Before the collection of the samples, each tube wells was purges for an average 10-12 minute in order to expel the existing water inside the well casing. Purging was carried out to collect the representative water from aquifer itself. Field parameter like temperature, oxidation reduction potential (ORP), pH value and electrical conductivity were measured using HANNA portable metres. Water was pumped continuously in customized plastic container with provision for insertion of electrode in air-sealed manner.

Table 1. Count of Data Region-wise, Season-wise and Source-wise

		Region					
		Alluvial Ganga Plain			Vindhayan Plateau		
		Seasons			Seasons		
		Rainy	Winter	Summer	Rainy	Winter	Summer
Sources	Pond	3	3	3	1	1	1
	Hand Pump	3	3	3	4	4	4
	Tube Well	2	2	2	3	3	3
	Well	1	1	1	1	1	1
	Check Dam	0	0	0	3	3	3

Source: Calculated by author based on primary water sample test analysis

Table 2. Mean of the observed pH values- Region-wise, Season-wise and Source-wise

		Region					
		Alluvial Ganga Plain			Vindhayan Plateau		
		Seasons			Seasons		
		Winter	Summer	Rainy	Winter	Summer	Rainy
Source	Ground Water	7.00	7.65	7.26	7.04	7.48	7.53
	Surface Water	7.47	7.81	7.52	7.32	8.22	7.49

Source: Calculated by author based on primary water sample test analysis

4 Results

4.1 Analysis Through One Way ANNOVA

4.1.1 pH

By definition pH is the negative logarithm of the hydrogen ion concentration of a solution and it is thus a measure of whether the liquid is acid or alkaline. The pH scale (derived from the ionisation constant of water) ranges from 0 (very acid) to 14 (very alkaline). The range of natural pH in fresh waters extends from around 4.5, for acid, peaty upland waters, to over 10.0 in waters where there is intense photosynthetic activity by algae. However, the most frequently encountered range is 6.5-8.0. pH level above 8.0, there is progressive decrease in the efficiency of the chlorine disinfection process. The pH of different aquatic ecosystems determines the health and biological characteristics of those systems. Thus, the increasing or decreasing range of pH creates bad impact on health due to increasing saline or basic effect of pH value. One of the main objectives in controlling the pH is to minimize corrosion and incrustation in the distribution system, which results from the complex relationship between pH and other constituents or characteristics, such as lead, may results from the corrosion of specific types of pipe, and the rate of corrosion increases with decrease in the efficiency of the chlorine disinfection process. There is a non-significant main effect of region on the pH values of the water samples collected. It indicates that pH value of water is not significantly different in both the regions.Figure 2 also depicts that pH of Vindhyan plateau is higher than Alluvial Ganga plains, showing high level of salinity. Results indicate that this difference is only due to region wise change. There is a significant difference in the main effects on the pH values of water samples collected from different sources and various seasons wise. Previous it is being discussed that change in ground and surface water is due to other anthropogenic factors. No doubt pH value of summer season is high among all seasons as there is less percolation of fresh water Figure 2.

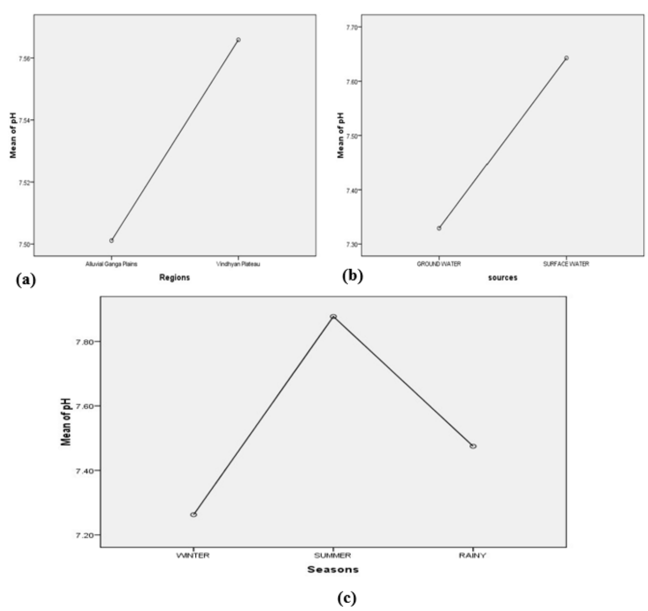

Fig. 2. Calculated Marginal Means of pH (a) Region-wise (b) Source-wise and (c) Season-wise

4.1.2 EC (ELECTRICAL CONDUCTIVITY)

Cool water is generally more palatable. Low water temperature tends to decrease the efficiency of treatment processes, including disinfection, and may thus have a deleterious effect on drinking water quality. However, high water temperature enhances the growth of micro organisms, and taste, odour, colour and corrosion problem may be increased. There is a non-significant main effect of region as well as seasons on the EC values of the water samples collected. It indicates that EC value of water is not significantly different in both the regions wise as well as different source wise. Results indicate that again change in region is the dominant cause of variation-Figure 3. Besides that EC value of surface water is very high because as intermixing of fresh water is more incomparison to ground water. Although EC value of summer season of Alluvial Ganga plain is much higher in comparison to samples of Vindhyan plateau Table 3. But there is a significant difference in the main effects on the EC values of water samples collected from different seasons.

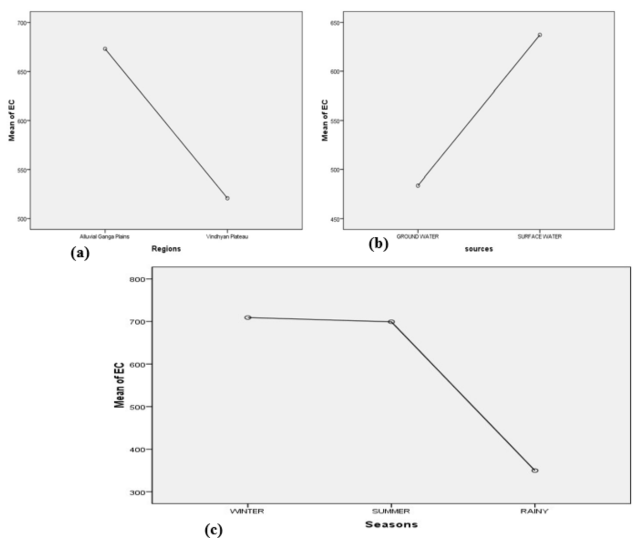

Fig. 3. Calculated Marginal Means of EC (a) Region-wise (b) Source-wise and (c) Season- wise

TDS (Total Dissolved Solids)

Total dissolved solids consist mainly of inorganic substances. The principal constituents of TDS are calcium, magnesium, sodium, bicarbonate, chlorides, and sulphates. An important aspect of TDS, with respect to drinking water quality, is the effect on taste. The palatability of water with TDS level of less than 500 mg/litre is generally considered to be good (Table 4). Thus, the TDS value of Mirzapur District is crossing the permissible limit, which is alarming in nature. TDS value of water is not significantly different in both the regions. But results indicates that there is a significant difference in the main effects on the TDS values of water samples collected from different sources and as per the various seasons wise. Results indicates that TDS value of surface water is very high which is due to anthropogenic changes of water Figure 4 and Table 4.

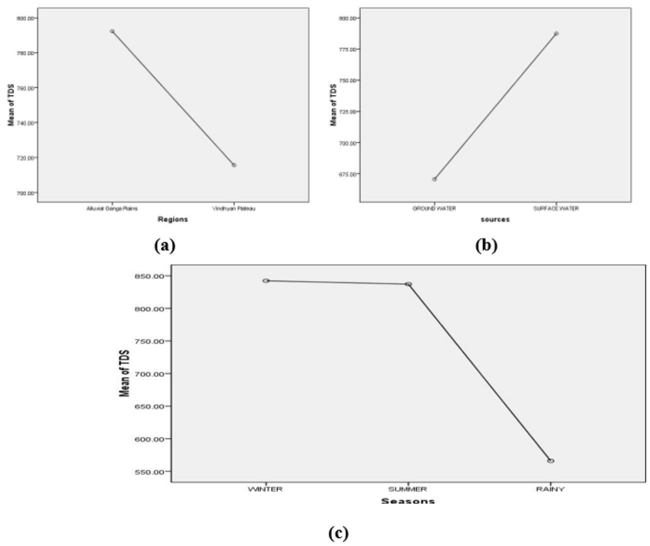

Fig. 4. Calculated Marginal Means of TDS (a) Region-wise (b) Source-wise and (c) Season- wise

5 Discussion

The increasing or decreasing range of pH creates bad impact on health due to increasing saline or basic effect of pH value. One of the main objectives in controlling the pH is to minimize corrosion and accumulation in the distribution system, which results from the complex relationship between pH and other constituents or characteristics, such as lead, may results from the corrosion of specific types of pipe, and the rate of corrosion increases with decrease in the efficiency of the chlorine disinfection process. pH of Vindhyan plateau is higher than Alluvial Ganga plains, showing high level of salinity. Low water temperature tends to decrease the efficiency of treatment processes, including disinfection, and may thus have a deleterious effect on drinking water quality and pH value of Mirzapur district is very alkaline by nature. In the same way, total dissolved solids consist mainly of inorganic substances. The TDS value of Mirzapur District is crossing the permissible limit, which is alarming by nature. Results indicate that TDS value of surface water is very high which is due to anthropogenic changes of water.

The Hydrogeochemical composition ranges of collected ground waters of the study area in the August 2012, January 2013 and June 2013, and it's shown in the Table 5.

In general, pH of the waters is alkaline in nature. The pH is controlled by total alkalinity of the ground water and partially of sea water. pH of water sample in during the year 2013 in

Table 3. Mean of the Observed EC Values- Region-wise, Season-wise and Source-wise

		Region					
		Alluvial Ganga Plain			**Vindhayan Plateau**		
		Seasons			**Seasons**		
		Winter	**Summer**	**Rainy**	**Winter**	**Summer**	**Rainy**
Source	Ground Water	773	792	327	364	376	381
	Surface Water	870	830	384	737	728	317

Source: Calculated by author based on primary water sample test analysis

Table 4. Mean of the Observed TDS Values- Region-wise, Season-wise and Source-wise

		Region					
		Alluvial Ganga Plain			**Vindhayan Plateau**		
		Seasons			**Seasons**		
		Winter	**Summer**	**Rainy**	**Winter**	**Summer**	**Rainy**
Source	Ground Water	876.91	807.09	493.21	734.05	546.59	607.14
	Surface Water	892.25	1018.07	566.68	846.09	858.11	572.12

Source: Calculated by author based on primary water sample test analysis

Table 5. Minimum, Maximum and Average data on water chemistry for 2012 and 2013 (All values in ppm except pH and EC)

	Jun-12			**August 2012**			**Jan-13**		
	Minimum	**Maximum**	**Average**	**Minimum**	**Maximum**	**Average**	**Minimum**	**Maximum**	**Average**
pH	7.23	8.64	7.88	7.03	7.7	7.47	6.63	8.07	7.27
EC	205	1730	722.57	133.39	566.84	349.82	191	1817	734.78
TDS	392.82	1592.03	850.69	416.5	872.5	572.79	413.7	1307.32	843.92

Source: Calculated by author based on primary water sample test analysis

summer varies from 7.23 to 8.64 with an average of 7.88, while during monsoon samples varies from 7.03 to 7.70 with an average of 7.47, and in the winter 2013 it varies from 6.63 to 8.07 with an average of 7.27. pH is dominating in the study area during summer 2013 (June) and winter 2013 (January) seasons. The high pH in certain location might be due to the natural salinity presents and it mixing with fresh water.

The measure of conductivity is directly proportional to the strength of the water. Higher values of EC and TDS are represented in the summer 2013 and winter 2013. They indicate that dissolution of infiltrating rain water and over exploration of ground water for domestic and agriculture purposes. In the study area, EC of water samples during the year of 2013 in summer it varies from 205 μs/cm to 1730 μs/cm with an average of 722 μs/cm, while in the monsoon samples it ranges between 133 μs/cm to 566 μs/cm with an average of 349 μs/cm, and in the winter 2013 samples it ranges from 191 μs/cm to 1817 μs/cm with an average of 734 μs/cm. In the present study, higher EC values are observed in winter and summer during 2013 it indicate the more industrial influence to contaminate the ground water potential in this area. The TDS of water samples during the year of 2012 and 2013, 416 mg/l to 872 mg/l in August 2012 and 392 mg/l to 1592 in June 2013. In January 2013 varies from 413 mg/L to 1307 mg/L. The TDS values are relatively higher during January 2013 and followed by June 2013.

6 Statistical Analysis

Tables 5, 6 and 7 shows the correlation matrix and its significance levels for all the observed data. Because all the sampling stations were combined in order to calculate the matrix, the correlation coefficients should be interpreted with caution as they are affected simultaneously by spatial and temporal variations. Nevertheless, some physio-chemical relationships can be inferred. The chemistry of water is influenced by the input of materials their solubility and the chemical equilibrium prevailing in the aqueous solution. For the effective management of water quality through appropriate control measures one needed continuous monitoring of water quality about different physio-chemical parameters of water. January 2013 shows absence of correlation among Ph-TDS and EC. In year August 2012,shows good correlation with TDS-EC, EC-TDS. June 2013, shows good correlation with EC-pH, TDS-pH, TDS-EC (Table 8).

pH stands for "potential of hydrogen" referring to the amount of hydrogen found in a substance (in this case, water). pH is measured on a scale that runs from 0 to 14. Seven is neutral, meaning there is a balance between acid and alkalinity. Water with a low pH can be acidic, naturally soft

Table 6. Correlation Co-efficient Matrix of Hydro-chemical Data of Ground and Surface Water in the Month of August, 2012 in Sample Villages of Mirzapur District

Elements	pH	EC	TDS
pH	1.000		
EC	-.056	1.000	
TDS	-.045	**.767**	1.000

Source: Calculated by author based on primary water sample test analysis, 2012

Table 7. Correlation Co-efficient Matrix of Hydro-chemical Data of Ground and Surface Water in the Month of January 2013 in Sample Villages of Mirzapur District

Elements	pH	EC	TDS
pH	1.000		
EC	.577	1.000	
TDS	-.114	.156	1.000

Source: Calculated by author based on primary water sample test analysis, 2013

Table 8. Correlation Co-efficient Matrix of Hydro-chemical Data of Ground and Surface Water in the Month of June, 2013 in Sample Villages of Mirzapur District

Elements	pH	EC	TDS
Ph	1.000		
EC	**.744**	1.000	
TDS	**.796**	**.953**	1.000

Source: Calculated by author based on primary water sample test analysis, 2013

and corrosive. Acidic water can leach metals from pipes and fixtures, such as copper, lead and zinc. It can also damage metal pipes and cause aesthetic problems, such as a metallic or sour taste, laundry staining or blue-green stains in sinks and drains. Water with a low pH may contain metals in addition to the before-mentioned copper, lead and zinc. Drinking water with a pH level above 8.5 indicates that a high level of alkalinity minerals are present. High alkalinity does not pose a health risk, but can cause aesthetic problems, such as an alkali taste to the water that makes coffee taste bitter; scale build-up in plumbing; and lowered efficiency of electric water heaters [5].

7 Total Dissolved Water

TDS in water supplies originate from natural sources, sewage, urban and agricultural run-off, and industrial wastewater. Salts used for road de-icing can also contribute to the TDS loading of water supplies. No recent data on health effects associated with the ingestion of TDS in drinking-water appear to exist; however, associations between various health effects and hardness, rather than TDS content, have been investigated in many studies.

8 Suggestions

As per the analysis pH of Vindhyan plateau is higher than Alluvial plains. Wells are the basic source of drinking water resource since long time. But deteriorating water level is the major problem. As per the primary survey now district administration is providing water through piped water supply by accumulating water in tanks. But in most of the remote villages of Blocks of Vindhyan plateau such as Hallia, Lalganj and Rajgarh blocks these facilities are still needed. Thus, by developing piped water system dependency on surface water will also decline and ground water sustainability will remain under limits.

9 Conclusion

There is variation in the hydro-geochemical composition of the collected ground waters of the study area during rainy (2012), summer (2013) and winter (2013) season. So far as geo composition of ground water is considered, in general pH of the waters is alkaline in nature. The high pH in certain location might be due to the natural salinity presents and it mixing with fresh water. Higher EC values during summer (2013) and winter (2013) indicate the more industrial influence to contaminate the ground water potential in this area.

References

1) Kauzuo T. In Search of a Comprehensive Approach to Sustainable Management of Water Resources in the World Community. In: Water Management in 2020 and Beyond . Berlin, Heidelberg. Springer. 2009;p. 115–124. Available from: https://doi.org/10.1007/978-3-540-89346-2_5.
2) United States Geological Survey (USGS). 2005. Available from: https://www.usgs.gov/special-topics/water-science-school/science/water-quality.
3) Carr GM, Neary JP. Water Quality for Ecosystem and Human Health. In: United Nations Environment Programme Global Environment Monitoring System. Ross, Nancy; Kenya. UNON, Publishing Services Section. 2010. Available from: https://www.cbd.int/doc/health/health-waterquality-en.pdf.
4) Assessment ME. Ecosystems and Human Well-Being: Wetlands And Water Synthesis. 2010. Available from: https://www.millenniumassessment.org/documents/document.358.aspx.pdf.
5) Bond P. Macro Dynamics of Globalization, Uneven Urban Development and The Commodification of Water. 2008. Available from: https://go.gale.com/ps/i.do?id=GALE%7CA187844299&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=14670437&p=AONE&sw=w&userGroupName=anon%7Ef5f7aba0&aty=open-web-entry.