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Water Quality Assessment of The Hindon River: A Geographical Study of Ghaziabad District

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ABSTRACT

This research presents a geographical assessment of the water quality of the Hindon River in the Ghaziabad district of Uttar Pradesh, a region characterized by rapid industrialization and urban growth. The study evaluates the river's ecological health by analyzing four critical parameters: Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Coliform, and Fecal Coliform across five strategic monitoring locations during the pre-monsoon and post-monsoon periods of 2021. The results indicate severe organic and microbial contamination, with the Chijarsi Bridge site consistently identified as the most polluted stretch. Alarmingly low DO levels—frequently reaching hypoxic conditions below 1 mg/L—and excessively high BOD and coliform counts demonstrate that the river's self-purification capacity is overwhelmed by untreated industrial effluents and domestic sewage. Comparative seasonal analysis shows that while monsoon dilution offers marginal improvements, the water remains categorized under the most degraded classes (Class E or below) as per UPPCB standards. The study concludes that the Hindon River in Ghaziabad is entirely unfit for human consumption and poses significant public health risks, highlighting an urgent need for robust wastewater management and strict regulatory enforcement.

Introduction

Water is the most vital natural resource, essential not only for biological survival but also for economic growth, agriculture, industry, and energy production (Kumar et al., 2017). Rivers support livelihoods through agriculture, fishing, and livestock rearing, but increasing dependence has intensified water quality degradation, especially near urban and industrial areas (Pathak & Mishra, 2020; Roy & Shamim, 2020). Rapid population growth, urbanisation, land-use change, and industrialisation have placed immense pressure on river systems, making surface water pollution a critical issue in developing countries where rivers often receive untreated urban runoff and industrial effluents (Sumok, 2001; Phiri et al., 2005). In India, disposal of wastewater into river catchments severely affects water resources, agricultural productivity, and public health, highlighting the need to study river pollution in relation to human activities, as rivers have historically been used for drinking, irrigation, and fisheries (Kaushik et al., 2009). Declining river water quality disrupts ecological balance and poses serious risks to humans and wildlife, making regular monitoring essential for domestic, agricultural, and industrial use (Kannel et al., 2007; Ravindra & Kaushik, 2003; Milovanovic, 2007). In this context, CPCB and SCPCB monitor river health using physico-chemical and biological parameters.

Ghaziabad is the fastest expanding industrial city in Uttar Pradesh, with over 300 industrial units, including 60 industrial manufacturing units along the Hindon and its two main tributaries, the Kali (West) and Krishni rivers. In this research work, the water quality of the Hindon river in Ghaziabad district been examined. The Hindon River originates in the lower Himalayas in Saharanpur district (UP, Uttar Pradesh) and runs 260 kilometres through six districts, including Muzaffarnagar, Meerut, Baghpat, Ghaziabad, and Gautambudh Nagar, before joining the Yamuna. It is a key supply of water for western Uttar Pradesh's densely populated and mostly rural population. It drains a catchment area of approximately 5,000 km of farmland while also running through a number of medium-sized cities and villages. The Hindon River is heavily used as a water resource for domestic, agricultural, and industrial purposes in densely populated and primarily rural catchments. Metal pollution in the Hindon River was previously observed in Muzaffarnagar, Meerut, Saharnpur, and Ballabhgarh, UP, India (Ajmal et al. 1987186; Jain et al. 2005187; Sharma et al. 2009188).

The different physio-chemical parameters provide information on the river water quality at different locations in the study region (Figure 5.1). The monitoring locations considered for the Hindon River in Ghaziabad are Karheda village, Raj Nagar extension road, Ghaziabad elevated road, Hindon vihar, Mohan nagar road bridge, Chijarsi bridge.

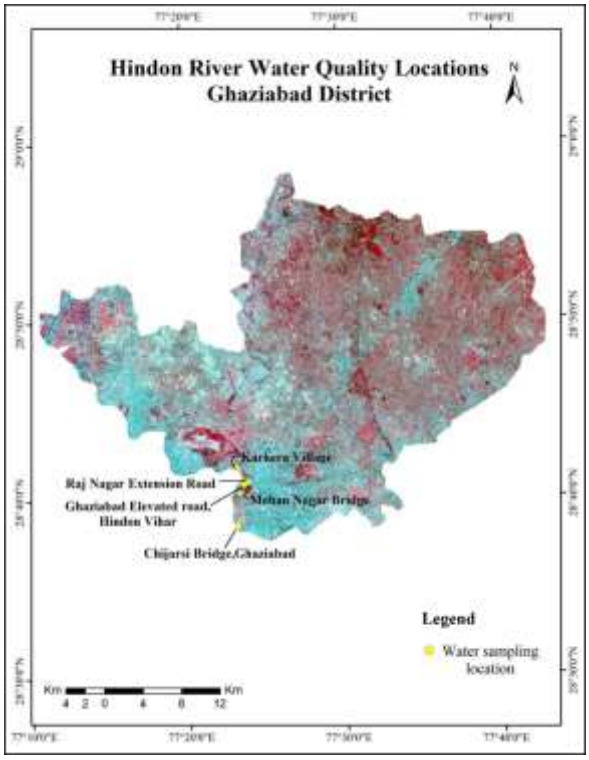

Fig 1: Water Quality Location for Monitoring the Hindon River Water Quality in Ghaziabad District

Materials and methods

Study Area

The study area, Ghaziabad district, lies in the western part of Uttar Pradesh within the National Capital Region (NCR). It measures 37 kilometres in width and 72 kilometres in length. It is situated between 77°26' and 78°10' East longitude and latitude of 28°30' to 28°59' North. It is bounded by Meerut district in the north, Bulandshahr in the east, Gautam Buddha Nagar in the south, and Delhi in the west. The district forms part of the gently sloping alluvial plain of the Ganga–Yamuna Doab and is primarily drained by the Hindon River and its tributaries, including the Kali (West) and Krishni rivers, which flow from north to south and constitute the main drainage pattern. Ghaziabad is one of the most densely populated districts of Uttar Pradesh, with a very high population density and a predominantly urban population concentrated in Ghaziabad city, Sahibabad, Loni, and adjoining industrial–residential zones, while rural population is distributed in peripheral blocks and riverine areas.

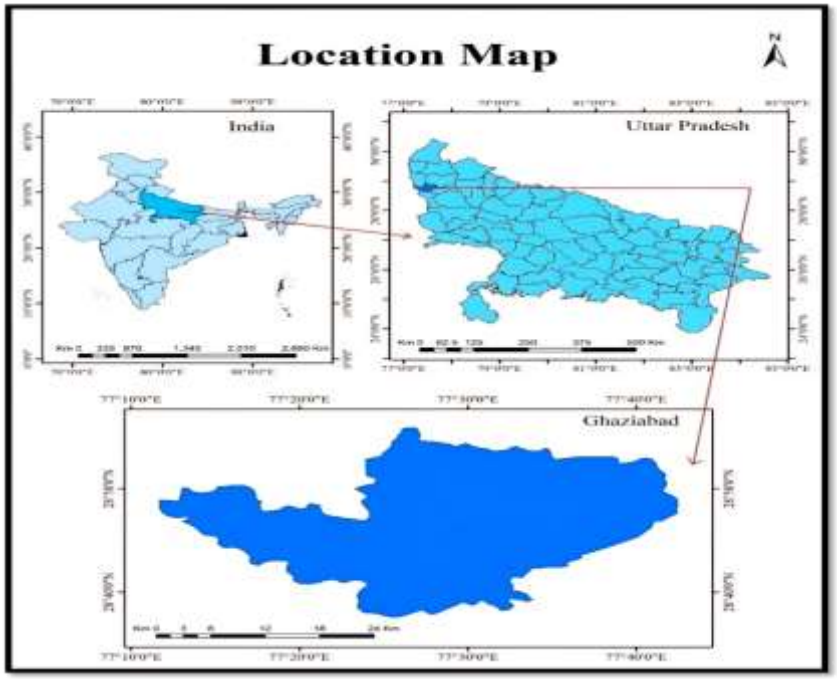

Fig 2: Location map of the study area (*Source: Survey of India)*

Objectives

The main objective of this research is to conduct a comparative assessment of the water quality of the Hindon River in Ghaziabad district based on Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Coliform, and Fecal Coliform parameters during the pre-monsoon and post-monsoon periods.

Data Source & Research Methodology

The methodology for this study utilizes a systematic geographical and scientific approach, integrating primary data collected from five strategic monitoring sites in Ghaziabad (Karheda Village, Mohan Nagar Road Bridge, Chijarsi Bridge, Raj Nagar Extension Road, and Hindon Vihar) with secondary data from UPPCB, CPCB, and Survey of India reports. The research assesses the river's health by analyzing four key parameters—DO, BOD, Total Coliform, and Fecal Coliform—to measure organic and microbial contamination. A comparative temporal analysis was performed between pre-monsoon (May 2021) and post-monsoon (October 2021) periods, with results benchmarked against UPPCB water quality standards to determine the river's suitability for drinking, irrigation, and industrial use.

Result

Biochemical Oxygen Demand (BOD) is an important indicator of organic pollution in water bodies, as it represents the amount of dissolved oxygen required by aerobic microorganisms to decompose organic matter present in water under standard conditions. It is commonly expressed in milligrams per liter and measured over a five-day incubation period at 20°C. Higher BOD values indicate a greater load of biodegradable organic matter, which can lead to depletion of dissolved oxygen and adversely affect aquatic life. Therefore, BOD is widely used to assess the level of organic contamination and overall water quality (Sawyer et al., 2003). Dissolved Oxygen (DO) refers to the amount of free oxygen available in water and is essential for the survival of aquatic organisms. Oxygen enters water bodies through atmospheric diffusion and photosynthesis by aquatic plants. DO is a key parameter for evaluating water quality, as low concentrations indicate stressed aquatic conditions. Generally, DO levels below 3 mg/L are considered harmful, while concentrations below 1 mg/L represent hypoxic conditions where most aquatic life cannot survive. Declining DO levels are often associated with high organic pollution and increased BOD.

Table1: Primary Water Quality Criteria for Designated Classes

Classification	Category	Tolerance Limit
Drinking water source without conventional treatment but after disinfection	A	1. Total Coliform Organism MPN/100 ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical oxygen demand 5 days 20 °C 2mg/l or less
Outdoor bathing (Organized)	B	1. Total Coliforms Organism MPN/100 ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C 3mg/l or less
Drinking Water source after conventional treatment and disinfections	C	1. Total Coliforms Organism MPN/100 ml shall be 5000 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 4mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C 3mg/l or less
Propagation of Wild Life and Fisheries	D	1. pH between 6.5 and 8.5 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N)1.2 mg/l or less
Irrigation Industrial Cooling, Controlled waste disposal	E	1. pH between 6.0 and 8.5 2. Electrical Conductivity at 25 °C micro mhos/cm Max. 2250 3. Sodium absorption ratio Max. 26 4. Boron Max. 2 mg/l

Source: UPPCB (http://www.uppcb.com/river_quality.htm)

Total coliform bacteria are a group of microorganisms commonly found in soil, vegetation, and the intestines of warm-blooded animals, including humans. Although most total coliforms are not harmful, their presence in water serves as an indicator of possible contamination and inadequate water quality. Detection of total coliforms suggests that pathogenic organisms may also be present, especially when contamination originates from fecal sources. However, when only total coliforms are detected, the contamination is generally considered to be of environmental origin (Doyle, 2006).

Fecal coliforms are a subgroup of total coliform bacteria and are closely associated with the intestinal tracts of warm-blooded animals. Their presence in water indicates contamination by human or animal fecal matter and signals a higher risk of waterborne diseases. Elevated fecal coliform levels often result from sewage discharge, agricultural runoff, livestock grazing near water bodies, and stormwater runoff. High concentrations of fecal coliforms suggest failures in water treatment systems and pose serious public health concerns, particularly related to gastrointestinal infections (Doyle & Erickson, 2006).

Pre-Monsoon Hindon River Water Quality

The pre-monsoon Hindon river water quality has been presented in Table 2. The data used in this analysis was from 2021. From the analysis it is found that the maximum DO is recorded in Karheda village with 2.78 (mg/l). The DO concentration in Chijarsi Bridge was not available. The maximum BOD has been recorded at Chijarsi Bridge with 39.6 (mg/l) and minimum BOD was recorded at Karheda village. DO is regarded as an important indicator of water quality because it immediately shows an aquatic resource's potential to support aquatic life. While each organism has a different DO tolerance range. From the DO analysis it was

observed that DO levels below 3mg/L are normally cause for concern, and waters below 1mg/L are termed hypoxic and usually lacking life. In the Hindon river, it was observed that BOD concentration is exceeded desirable requirement, which indicates the organic contamination in river water. The BOD value is most usually given as milligrammes of oxygen used per litre of sample incubated at 20 degrees Celsius for 5 days. It is frequently used as a measure for the level of organic contamination in water.

The maximum total coliform recorded at Chijarsi Bridge with 3100000 Total Coliform (MPN/100ml) followed by 250000 (MPN/100ml) recoded at Mohan Nagar Road Bridge. The maximum fecal coliform was recorded in Chijarsi Bridge with 2600000 (MPN/100ml), followed by Raj Nagar extension with 230000 (MPN/100ml). The coliform bacteria presence in drinking water implies that disease-causing organisms (pathogens) may be present in water supplies and have originated from human or animal faeces. Similarly, the presence of faecal coliform in aquatic habitats may indicate that the water has been contaminated with human or animal faeces. Fecal coliform bacteria can reach rivers via direct discharge from mammals and birds, agriculture, storm runoff, and human waste. Their existence, however, could be due to plant debris and pulp from paper mill wastewater.

Table 2: Pre- monsoon (May) DO, BOD and Coliform assessment of the Hindon River

Station Name	DO (mg/l)	B.O.D. (mg/l)	Total Coliform (M.P.N./100ml)	Fecal Coliform (M.P.N./100ml)
Karheda Village	2.78	12	200000	140000
Mohan Nagar Road Bridge	2.13	20	250000	210000
Chijarsi Bridge	-	39.6	3100000	2600000
Raj Nagar extension road	1.2	22	220000	230000
Hindon Vihar	1.1	19	190000	200000

Source: Water samples collected during the regional survey were analyzed.

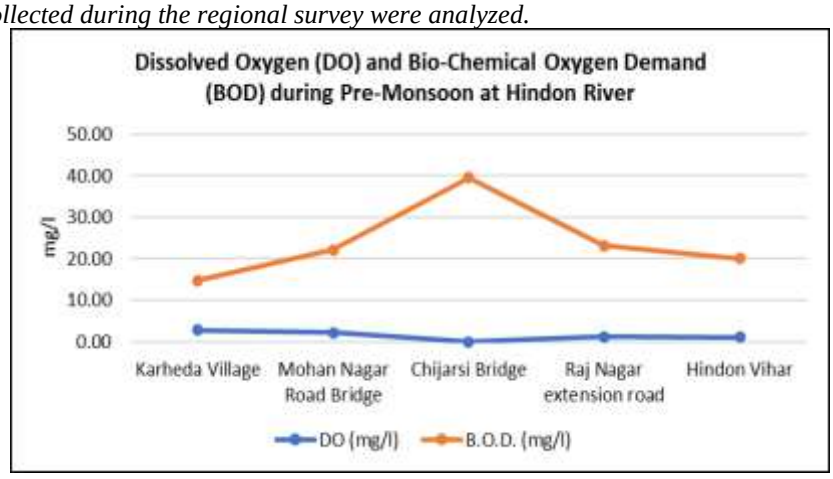

Fig 3: Hindon river Dissolved oxygen and Bio-chemical demand during pre-monsoon in Ghaziabad

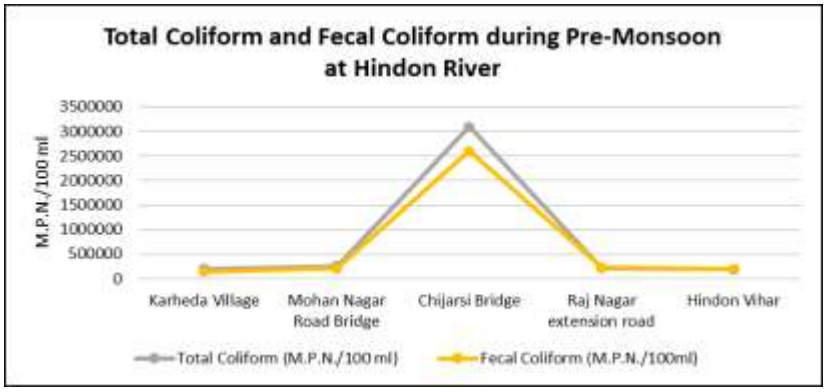

Fig 4: Hindon River Total Coliform and Fecal Coliform During Pre-Monsoon in Ghaziabad

Post-Monsoon Hindon River Water Quality

The post-monsoon Hindon river water quality has been presented in Table 3. From the analysis it is found that the maximum DO is recorded in Mohan Nagar Road bridge with 1.1 (mg/l). The maximum BOD has been recorded at Chijarsi Bridge with 21 (mg/l) and minimum BOD was recorded at Raj Nagar extension with 15 (mg/l). From the DO analysis it was observed that DO levels below 3mg/L are normally cause for concern, and waters below 1mg/L are termed hypoxic and usually lacking life. In the Hindon river, it was observed that BOD concentration is exceeded desirable requirement, which indicates the organic contamination in river water. It is measure for the level of organic contamination in water. The maximum total coliform recorded at Chijarsi Bridge with 430000, and minimum total coliform 150000 (MPN/100ml) at Raj Nagar extension. The maximum fecal coliform was recorded in Chijarsi Bridge with 220000 (MPN/100ml), followed by Hindon Vihar with 210000 (MPN/100ml). The presence of both coliforms in drinking water contaminates the water and makes it unfit for human consumption.

Table 3: Post- monsoon (October) DO, BOD and Coliform assessment of the Hindon River

Station Name	DO (mg/l)	B.O.D. (mg/l)	Total Coliform (M.P.N./100ml)	Fecal Coliform (M.P.N./100ml)
Karheda Village	0.9	18	260000	210000
Mohan Nagar Road Bridge	1.1	16	170000	140000
Chijarsi Bridge	0.2	21	430000	220000
Raj Nagar extension road	0.3	15	150000	180000
Hindon Vihar	0.8	19	180000	210000

Source: Water samples collected during the regional survey were analyzed.

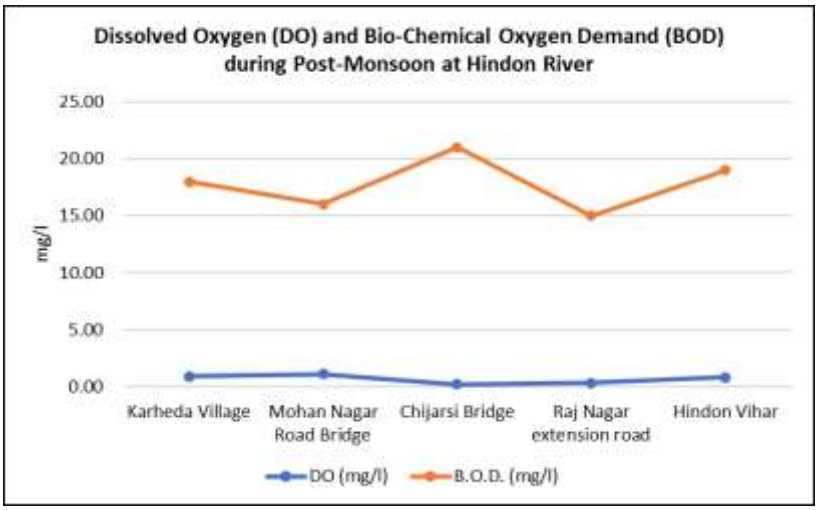

Fig 5: Hindon River Dissolved Oxygen and Bio-Chemical Demand During Pre- Monsoon in Ghaziabad

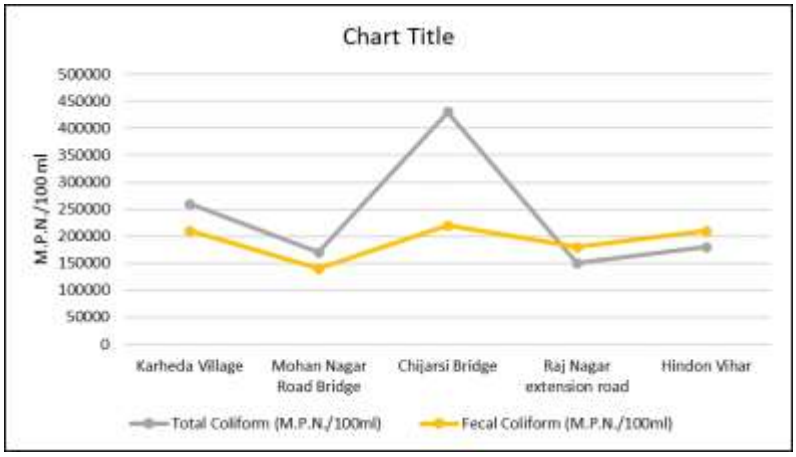

Fig 6: Hindon River Total Coliform and Fecal Coliform During Post-Monsoon in Ghaziabad

Discussion

The results of the present study clearly indicate a severe deterioration of water quality in the Hindon River within Ghaziabad district, with marked spatial and seasonal variations. Both pre-monsoon and post-monsoon analyses reveal consistently low dissolved oxygen (DO) levels and excessively high biochemical oxygen demand (BOD) values across most monitoring sites, signifying heavy organic pollution and stressed aquatic conditions. The situation is particularly critical at Chijarsi Bridge, which emerges as the most polluted stretch during both seasons, reflecting the cumulative impact of untreated domestic sewage, industrial effluents, and urban runoff entering the river downstream. Extremely high concentrations of total coliform and fecal coliform further confirm significant fecal contamination, rendering the river water unfit for drinking, bathing, and even ecological sustenance. Although post-monsoon dilution slightly reduces some pollution indicators, the overall improvement remains marginal, suggesting that seasonal rainfall alone is insufficient to offset continuous anthropogenic pressure. These findings align with earlier studies on the Hindon and other urban rivers in India, which highlight the role of rapid industrialisation, unplanned urban expansion, and inadequate wastewater treatment infrastructure in degrading river systems. The study underscores the urgent need for effective pollution control measures, strict regulation of industrial discharges, expansion of sewage treatment facilities, and continuous monitoring to restore the ecological health of the Hindon River and safeguard public health.

Conclusion

According to the pre- and post-monsoon analyses of Hindon river water quality, the Chijarsi Bridge site is the most contaminated in Hindon river for both seasons. From the physio-chemical analysis of Hindon river in Ghaizabad it is found that the river water was proven to be unfit for human consumption.

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