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Assessment of Water Quality Parameters of the Yamuna River: A case study of Wazirabad Barrage

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Abstract - Untreated sewage, industrial effluents, and agricultural runoff all contribute to the serious pollution of the Yamuna River, a crucial water source in northern India. The Wazirabad Barrage is a crucial location where pollution has a major impact on river health, and this study assesses the water quality parameters there. To evaluate factors like pH, dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), total dissolved solids (TDS), electrical conductivity (EC), turbidity, and heavy metal concentrations, a number of physicochemical and biological tests were carried out. Levels of contamination were measured using standard analytical methods, such as spectrophotometry and APHA. The water is deemed extremely polluted and unfit for drinking, aquatic life, or irrigation due to the results, which show high BOD and COD, low DO, and excessive TDS. The Water Quality Index (WQI) assessment confirms a poor water quality status, highlighting the urgent need for intervention. The findings suggest that advanced wastewater treatment technologies, strict industrial discharge regulations, and sustainable water resource management are essential to improving river conditions. This study provides valuable insights for environmental agencies and policymakers, aiding in the formulation of strategies to rehabilitate the Yamuna River and restore its ecological balance.

Keywords— **Water Quality Index (WQI), Pollution Assessment**

I. INTRODUCTION

Clean water is essential for life, nature, and farming. It keeps people and animals healthy, prevents diseases, and supports daily needs like drinking and hygiene. In farming, clean water helps grow crops, improves soil, and avoids harmful chemicals that can reduce productivity. Dirty water harms human health, wildlife, and the environment. So, protecting water sources is necessary for food security, nature, and overall well-being.

The Yamuna River is heavily polluted due to industrial waste, untreated sewage, and farm chemicals. Rapid urban growth has increased pollution with harmful substances like heavy metals and chemicals, making the water unsafe. Poor waste management and illegal dumping make things worse. As a result, the Water Quality Index (WQI) of the river is very low, especially in cities like Delhi. This pollution harms the environment and public health, requiring urgent action.

Pollution in the Yamuna causes many problems. Contaminated water spreads diseases like cholera and typhoid, affecting millions who depend on the river. Toxic chemicals kill fish and other aquatic life, reducing biodiversity. Using polluted water for farming damages soil, lowers crop production, and adds harmful substances to food. The river's toxic foam and bad smell also worsen air quality, affecting people's health. Without immediate action, the damage may become irreversible.

To improve the Yamuna's water quality, researchers and the government are working on solutions. Scientists are testing advanced treatment methods like bioremediation, nanotechnology, and artificial wetlands to clean the water. Government projects such as the Namami Gange Programme and the Yamuna Action Plan aim to build more sewage treatment plants, monitor industrial waste, and improve riverbanks in cities like Delhi, Agra, and Mathura. Public awareness campaigns and stricter pollution laws are also being introduced. However, real change needs community involvement, better waste management, and strict law enforcement to prevent future pollution.

Yamuna enters **Delhi** state at Palla village, which is 15 kilometers upstream of the Wazirabad barrage. Yamuna travels 48 kilometers in Delhi out of which 22 km stretch is severely polluted. Severe level of surface pollutants is shown in Figure1. Water quality assessment involves various physicochemical and biological tests to determine contamination levels-

A. Physicochemical Tests:

- pH Test – Measures the acidity or alkalinity of water.
- Electrical Conductivity (EC) – Assesses the presence of dissolved salts.
- Total Dissolved Solids (TDS) – Indicates the concentration of dissolved substances.
- Turbidity Test – Measures the clarity of water.
- Temperature Test – Affects biological and chemical processes in water.

B. Oxygen Demand Tests:

- Dissolved Oxygen (DO) – Determines the amount of oxygen available for aquatic life.

Figure 1 Surface pollution of Yamuna River, Delhi

II. OBJECTIVES

The main objectives of this research paper are listed as:

a) To assess the water quality parameters of the Yamuna River at the Wazirabad Barrage.
b) To analyse physicochemical and biological characteristics such as pH, DO, BOD, COD, TDS, EC, turbidity, and heavy metal concentrations.
c) To evaluate the Water Quality Index (WQI) and determine the pollution status of the river.
d) To identify major sources of contamination, including industrial discharge, sewage inflow, and agricultural runoff.
e) To compare observed water quality parameters with national and international standards for suitability in drinking, irrigation, and aquatic life.

III. METHODOLOGY

This study employs a comprehensive methodology to assess the water quality of the Yamuna River at the Wazirabad Barrage, focusing on the 22-kilometer stretch that is severely polluted. The assessment includes a series of physicochemical and biological tests designed to evaluate contamination levels and determine the extent of pollution.

a. Study Area and Sampling

The Yamuna River enters Delhi at Palla village, approximately 15 kilometers upstream of the Wazirabad Barrage. Water samples were collected from multiple points along this stretch to ensure a thorough evaluation of pollution levels. The selection of sampling locations was based on proximity to major pollution sources, including industrial discharge points, sewage outfalls, and urban runoff areas.

Figure 2. Sample collection at site

b. Physicochemical Analysis

To assess the fundamental properties of water, the following physicochemical parameters were analyzed:

- pH Test: Determines the acidity or alkalinity of the water, which influences chemical reactions and biological activity.

Figure 3 Chemical testing of water

- Electrical Conductivity (EC): Measures the ability of water to conduct electricity, indicating the presence of dissolved salts and ions.
- Total Dissolved Solids (TDS): Evaluates the concentration of dissolved substances, which affects water quality and suitability for consumption and irrigation.
- Turbidity Test: Assesses water clarity by measuring the presence of suspended particles, which can impact aquatic life.
- Temperature Measurement: Monitors temperature fluctuations, which influence chemical reactions and biological processes in water bodies.

c. Oxygen Demand Tests

To determine the level of organic and chemical pollution, oxygen demand tests were conducted:

- Dissolved Oxygen (DO): Quantifies the amount of oxygen available in water, which is crucial for sustaining aquatic life. Low DO levels indicate severe pollution and poor water quality.

Figure 4. DO Sample collection

- Biochemical Oxygen Demand (BOD): Measures the amount of oxygen consumed by microorganisms in decomposing organic matter. High BOD levels signify excessive organic pollution from untreated sewage and industrial waste. The **Biochemical Oxygen Demand (BOD) test** is conducted to determine the amount of oxygen consumed by microorganisms while decomposing organic matter in a water sample over a specific period. The procedure begins with **sample collection** in a **BOD bottle (300 mL capacity)**, ensuring no air bubbles to prevent oxygen contamination. If immediate testing is not possible, the sample is stored at **4°C** in the dark. The **initial dissolved oxygen (DO)** level is then measured using a **DO meter** or **Winkler's method**, and the value is recorded as **DO_initial**.

- Chemical Oxygen Demand (COD): Determines the presence of chemically oxidizable pollutants, which include industrial and chemical waste that can severely impact aquatic ecosystems.

Figure 5. Lab testing of water

This methodological approach ensures a comprehensive evaluation of water quality parameters, providing crucial insights into the degradation of the Yamuna River at the Wazirabad Barrage. The findings help identify key pollution sources and offer a scientific basis for developing strategies to improve river health.

Table 1. Results of Testing on sample water

Sr. No	Description	Results at Palla Site	Results at Wazirabad	CPCB Criteria
1	Temperature	17.4°C	19.8°C	Below 20
2	Color	Clear	Light Brown	Clear
3	Odour	Odour Less	Foul Smell	No Smell
4	Electrical Conductivity	750 µmho/cm	1550 µmho/cm	2250 µmho/cm
5	pH Value	6.1	8.4	6.5to8.5
6	Dissolved Oxygen	5.9 mg/l	0	4 mg/l

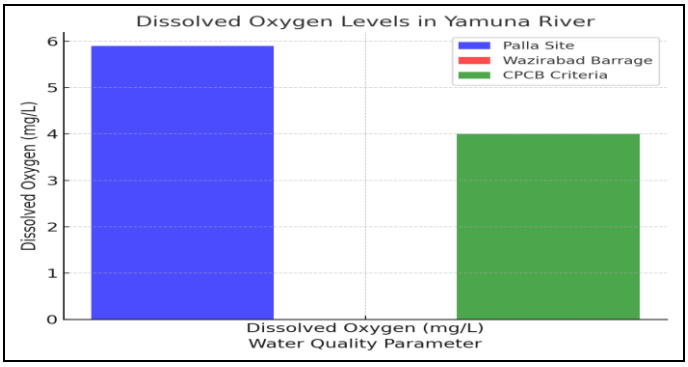

Figure 6. DO levels

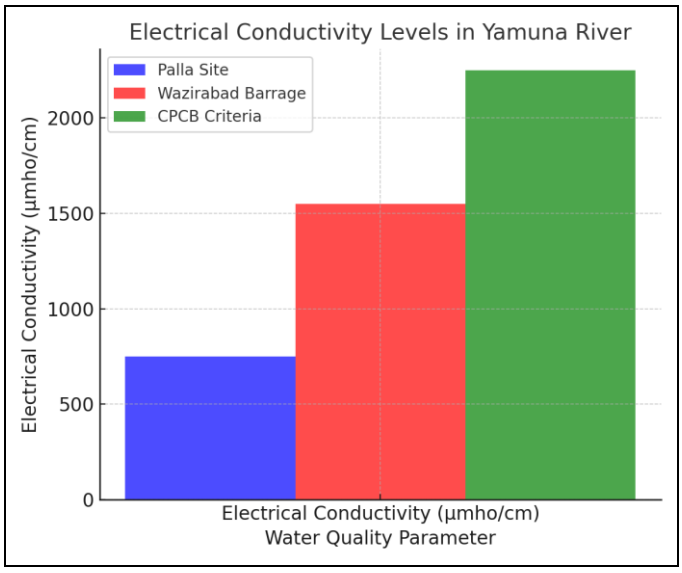

Figure 7. Electrical Conductivity

IV. CONCLUSION

In conclusion, the assessment of water quality at the Wazirabad Barrage confirms that the Yamuna River is in a severely degraded state due to excessive pollution from untreated sewage, industrial effluents, and agricultural runoff. The high levels of BOD, COD, and TDS, along with critically low DO, indicate that the river water is unfit for drinking, aquatic life, and irrigation. The Water Quality Index (WQI) further reinforces the urgent need for intervention. Addressing this crisis requires immediate action, including the implementation of advanced wastewater treatment technologies, stringent regulatory measures for industrial discharge, and effective water resource management strategies. Without proactive measures, the deteriorating water quality will continue to pose serious environmental and public health risks. This study underscores the necessity for coordinated efforts by policymakers, environmental agencies, and local communities to restore the river's ecological balance and ensure its sustainability for future generations.

a) Severe Oxygen Depletion at Wazirabad

- Dissolved Oxygen (DO) at Wazirabad is 0 mg/L, significantly lower than the CPCB standard of 4 mg/L.
- This indicates extreme pollution, making the water unfit for aquatic life and drinking purposes.

b) Increased Electrical Conductivity (EC) Signifying Pollution

- The electrical conductivity at Wazirabad (1550 µmho/cm) is more than double the value at Palla (750 µmho/cm), indicating a higher concentration of dissolved solids and pollutants.
- Although it remains within the CPCB limit (2250 µmho/cm), the increase suggests contamination from industrial and sewage discharge.

c) pH Imbalance Affecting Water Quality

- The pH at Wazirabad (8.4) is at the upper limit of the CPCB's acceptable range (6.5–8.5).
- A higher pH can lead to water toxicity, affecting aquatic organisms and human usage.

d) Deterioration in Water Aesthetics and Sensory Quality

- Water at Palla is clear and odorless, whereas at Wazirabad, it becomes light brown with a foul smell, indicating heavy organic and chemical contamination.
- This degrades the visual and olfactory quality, making it unsuitable for domestic and recreational use.

e) Rising Temperature Contributing to Pollution

- Water temperature increases from 17.4°C at Palla to 19.8°C at Wazirabad, nearing the CPCB limit of below 20°C.
- A higher temperature can accelerate biological and chemical reactions, worsening oxygen depletion and microbial activity.

f) Urgent Need for Pollution Control Measures

- The rapid degradation of water quality at Wazirabad highlights the severe impact of untreated sewage, industrial effluents, and agricultural runoff.

- Immediate intervention is required, including advanced wastewater treatment, stricter industrial regulations, and sustainable river management practices.

This analysis underscores critical pollution levels at Wazirabad and the urgent need for corrective measures to restore the Yamuna River's ecological balance.

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