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# Qualitative Analysis of the Water Quality of the Ganga River in Kanpur

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## Abstract

This study compares the water quality of the Ganga River at two important locations in Kanpur; Jajmau Ghat and Parmat Ghat. The aim was to find out how much the water at these two ghats is polluted by testing for three main indicators: Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Coliform bacteria. Water samples were collected from both ghats and tested using basic lab methods. The results showed that the BOD, COD, and Coliform levels were higher than the safe limits at both sites but Jajmau Ghat was more polluted than Parmat Ghat.

This study highlights the need for better water treatment, proper sewage management and more awareness about keeping the river clean. Regular monitoring and community participation are also important steps to improve the condition of the Ganga River in Kanpur.

## Keywords

Ganga River, BOD, COD, Coliform, Pollution

## 1. Introduction

The Ganga River is one of the most important and holy rivers in India. It is worshipped by millions of people and is considered sacred in Hinduism. The river originates from the Gangotri Glacier in Uttarakhand, where it is first called the Bhagirathi. It becomes the Ganga after meeting the Alaknanda at Devprayag. The Ganga flows through several states- Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal. Then it finally enters and drains into the Bay of Bengal. Despite its religious importance, the Ganga is facing major pollution problems today, which makes its protection very important. In cities like Kanpur, the river is getting increasingly polluted. Dirty water from homes, factories, and drains flows directly into the Ganga. This pollution affects the health of people who use the river for bathing, drinking, and farming. It also harms aquatic life including fishes and Gangetic dolphins; an endangered animal. Although the government has started clean-up missions like Namami Gange, the results are slow. Regular monitoring of water quality, public awareness, stricter rules, and better waste management are necessary to protect the Ganga and ensure its water remains clean for future generations.

## Study Area

*Parmat Ghat:* This ghat is upstream near Anandeshwar temple, Parmat. Many people come here for prayer and holy dips. Nearby drains and solid waste add to the pollution.

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*Jajmau Ghat:* It is located downstream near Siddhanath temple, Jajmau on the Kanpur-Lucknow highway. Several tanneries, leather industries, and many illegal establishments are present on this ghat.

## Objectives of the Study

- To test and compare the water quality of the Ganga River at Jajmau and Parmat Ghats by testing the levels of BOD, COD, and Coliform.
- To find out what changes occur in water quality when the river flow downstream from Parmat to Jajmau Ghat.
- To find out seasonal (Summer/Rainy/Winter) impact on water quality.
- To find out the reasons behind these changes.
- To give simple suggestions to improve the water quality.

## Importance of this study

The Ganga is a holy river that has spiritual, environmental, agricultural, and economic importance. It flows through the Gangetic plane. Major cities like Haridwar, Kannauj, Kanpur, Prayagraj, Varanasi, Patna, etc., are located on the banks of the river. The river water is used for agriculture, and drinking through municipal supply and has religious value. During the course of flow many industrial and domestic sewage pollute the river; affecting its water quality and natural flow. Polluted river water can spread diseases like cholera, typhoid, dysentery, Hepatitis A, Hepatitis E, Amoebiasis, skin infections, etc. The study is useful for finding out the water quality and pollution level of The Ganga River between the two above-mentioned ghats at Kanpur. By comparing two ghats, Jajmau and Parmat, this study will help us to see which one is more polluted.

## Key Parameters of Water Quality

**a) Biochemical Oxygen Demand (BOD)**: BOD measures the amount of oxygen consumed by microorganisms while decomposing organic matter in water. High BOD indicates organic/domestic sewage pollution and low dissolved oxygen which is harmful to aquatic ecosystems. CPCB considers BOD below 3mg/L suitable for bathing.

**b) Chemical Oxygen Demand (COD):** COD measures both biodegradable and non-biodegradable substances. It gives a more comprehensive estimate of the organic/industrial pollutants in water. COD levels above 250mg/L are considered critically polluted.

**c) Coliform Bacteria**: *E. coli* is a gut bacteria inhabiting in colon of the large intestine in Human beings. The presence of coliform bacteria in water, especially total coliforms is an indicator of fecal contamination. Their presence points toward sewage intrusion and poor sanitation.

As per WHO and BIS standards, drinking water should have 0 coliforms per 100 ml.

## 2. Literature Review

A lot of research and studies have already been conducted on the Ganga River and its water quality/pollution. Some of the important research carried out in the past on this subject is reviewed, example given A.A. Ansari et. al., (1999) studied the river sediments and agricultural soils of the Ganga

Plain in the Kanpur-Unnao industrial region in two subsequent years,1994 and 1995 (pre-monsoon periods of April and May). A. R. Khwaja et. al., (2001) studied the influence of waste on the physicochemical characteristics of the Ganga water and sediments. Amit Kumar et. al., (2008) analyzed the impact of man-induced environmental changes on the water quality, energy transformation by the producers and levels of heavy metals in two worst-hit stretches of river Ganga at Kanpur and Varanasi. Shashwat Katiyar (2011) studied the effect of tannery effluent associated with climate change on river water samples collected from the confluence point, upstream and downstream located near the Jajmau area at Kanpur. Sandeep Arya et. al., (2013) researched the water quality evaluation of the Ganga River in Kanpur City. The deteriorating water quality of streams due to anthropogenic activities and reduced freshwater availability. Industrial waste water (effluent) entering the Ganga River directly increases river water pollution. Naseema Khatoon et. al., (2013) collected water samples from six different ghats of the Ganga River in Kanpur City from March 2010 to February 2011 on a monthly basis and carried out a water quality assessment. Madhulekha et. al., (2017) explored the correlation between the physicochemical parameters of water samples of the Ganga River at Kanpur and its significance. Iqbal Ahmad et. al., (2019) analyzed various physico-chemical parameters like pH, turbidity, EC, TDS, TSS, alkalinity, total hardness, calcium, magnesium, chloride, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, sulphate, phosphate, nitrate, total coliform, and fecal coliform. Shashank Shekhar Pathak et. al., (2000) used river water quality monitoring data of the UPPCB for analysis. He used four water quality parameters, namely Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Coliform (TC) and Fecal Coliform (FC). Ajit Kumar Vidyarthi et. al., (2020) assessed the seasonal (summer, monsoon, and winter) variation in the surface water quality (temperature, pH, colour, DO, BOD, COD, and total Cr) of the rivers Ganga and Pandu (a tributary of Ganga) in Kanpur. The water quality of rivers is not static but dynamic mainly due to human civilization and industrialization. Hence, its regular monitoring is essential for the river, environment, ecosystem and human health.

## 3. Materials and Methods

### Sample Collection

Water samples were collected from two locations in the summer, rainy, and winter seasons from Parmat and Jajmau Ghat. Both samples were taken from the river's edge and collected in clean and sterilized bottles.

### Time and Conditions

The samples were collected three times during different seasons for data collection. The first sample was collected during the summer of May 2024. The second sample was collected during the rainy season, particularly a day after heavy rain in September 2024. The third and final sample was collected in late December 2024 during winter. The samples were collected from both the Ghats on the same day for analysis. Gloves were used while collecting water to avoid contamination. Each bottle was labelled properly with the name of the ghat and the date.

### Parameters tested

The following parameters were tested in the lab:

### a) Biochemical Oxygen Demand (BOD):

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*Purpose:*

To measure the dissolved oxygen and BOD to find out the amount of organic/sewage contamination at the two ghats of the river.

*Materials Needed:*

- 2 airtight BOD bottles (300 ml)
- Measuring cylinders
- Burette
- Conical flask (250 ml)
- Pipettes
- Manganous sulfate ($MnSO_4$) solution
- Alkaline potassium iodide (alkaline KI) solution
- Concentrated sulfuric acid ($H_2SO_4$)
- Standard sodium thiosulfate ($Na_2S_2O_3$) solution
- Starch indicator solution
- Incubator or dark cupboard (to keep samples at 20°C for 5 days)
- Sample water from the ghats

*Steps:*

1. Fill two clean BOD bottles with river water samples.
2. Immediately after sampling, add1ml Manganous sulfate ($MnSO_4$) solution and 1 ml alkaline potassium iodide (alkaline KI)
3. Stopper the bottle and mix well by inverting the bottle several times.
4. A brown precipitate of manganese hydroxide forms, indicating DO is fixed.
5. After the precipitate settles, add 1 ml of concentrated sulfuric acid ($H_2SO_4$).
6. Mix well until the precipitate dissolves to release iodine ($I_2$) equivalent to DO present.
7. Now take 203 ml (or a known volume) of the sample into a conical flask.
8. Titrate with standard sodium thiosulphate ($Na_2S_2O3$) solution using a starch indicator (turns blue).
9. Titrate until the blue colour disappears.
10. This is the measurement of DO using Wrinkler's method. Measure DO in bottle one immediately and label it as day 0 reading.
11. Seal the second bottle tightly. Place it in a dark space at 20°c for 5 days (to let microbes work without light).
12. After 5 days, measure DO by using the same method in the second bottle and label it as day 5 reading.
13. After calculating the DO of both bottles, calculate the BOD of the samples.

Formula for calculating DO: $$\text{DO (mg/l)} = \frac{V \times N \times 8 \times 1000}{\text{V Sample}}$$

Where:

V = Volume of sodium thiosulphate used (ml.)

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N = Normality of sodium thiosulphate

8 = Equivalent weight of oxygen (mg/meq)

Vsample = Volume of sample taken for titration (usually 203 ml.)

Formula for calculating BOD: $BOD = D1 - D2$

Where:

D1 = Dissolved oxygen (DO) in the sample before incubation (mg/L)

D2 = DO in the sample after 5 days of incubation at 20°C (mg/L)

## b) Chemical Oxygen Demand (COD)

### Purpose

To measure how much industrial/chemical pollution is present at the two ghats.

### Materials Needed

- COD digestion tubes or glass flasks
- Potassium dichromate
- Sulfuric acid ($H_2SO_4$)
- Silver sulfate ($Ag_2SO_4$) catalyst
- Ferroin indicator
- Sodium thiosulfate or FAS (Ferrous Ammonium Sulfate) for titration
- Heating source (water bath or COD digester)
- Sample water

### Steps

1. Add 10 ml. of water sample to a digestion flask or tube.
2. Add 2.5 ml. of potassium dichromate and 5 ml. of sulfuric acid + silver sulfate mixture.
3. Heat the mixture for 2 hours at 150°C in a water bath or COD digester.
4. Let it cool, then titrate with FAS using the ferroin indicator.
5. COD is calculated from how much FAS was used.

Formula: $COD = \frac{A - B \times N \times 8000}{V}$

Where:

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A = Volume of titrant (ferrous ammonium sulfate, FAS) used for blank (ml.)

B = Volume of titrant used for the sample (ml.)

N = Normality of FAS (eq/L)

V = Volume of water sample taken (ml.)

8000 = Milliequivalent weight of oxygen × 1000 (i.e., 8 × 1000)

### c) Coliform Test

*Purpose:*

To check and measure the level of fecal contamination of the river water.

*Materials used:*

- MacConkey broth in test tubes (with Durham tubes)
- Water sample
- Incubator at 37°C
- Pipettes and sterile tubes

*Steps:*

1. Fill the test tubes with MacConkey broth.
2. Place an inverted Durham tube inside each test tube to capture gas.
3. Take 3 sets of 3 tubes. Add 10 ml., 1 ml. and 0.1 ml. of the sample to each set.
4. Incubate all 9 tubes at 37°C for 24-48 hours.
5. If gas bubbles form in the tubes, coliform bacteria are present.
6. Count the positive tubes and use an MPN chart to find the number of bacteria in 100 ml. of water.

*MPN Formula:*

$$\frac{\text{MPN}}{100\text{ ml}} = \text{MPN index from standard table} \times \frac{100}{\text{Volume of sample in middle of tube set}}$$

- The MPN index is obtained by recording the number of positive tubes in a 3-tube, 5-tube, or 10-tube set, then comparing it to an MPN table.
- The result is expressed as MPN per 100 ml.

## 4. Results

The observed values of pollution indicators from both Jajmau and Parmat ghats during the three seasons are as follows:

### a) Biochemical Oxygen Demand (BOD):

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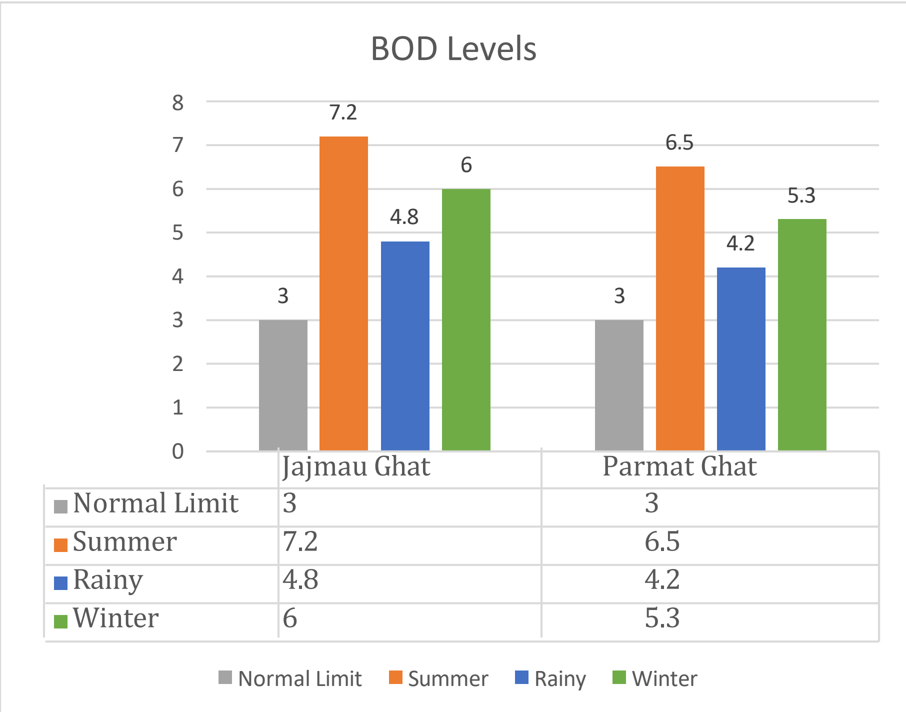
Normal BOD limit: ≤3

| Season | Jajmau Ghat | | Parmat Ghat |
|---|---|---|---|
| Summer (May) | 7.2 | | 6.5 |
| Rainy (September) | 4.8 | | 4.2 |
| Winter (December) | 6.0 | | 5.3 |

*(Table 1: BOD level at Jajmau and Parmat Ghat during summer, rainy and winter season)*




*(Chart 1: Comparison of BOD level by bar graph at Jajmau and Parmat Ghat during summer, rainy and winter seasons)*

BOD at both ghats is above the safe limit for bathing water, ideally below 3 mg/L. Jajmau Ghat showed a higher BOD, indicating more organic waste, possibly from all the illegal housing and establishments near the ghat.

BOD was highest during May in summer and lowest during the rainy season.

## b) Chemical Oxygen Demand (COD):

Normal Limit: ≤ 10

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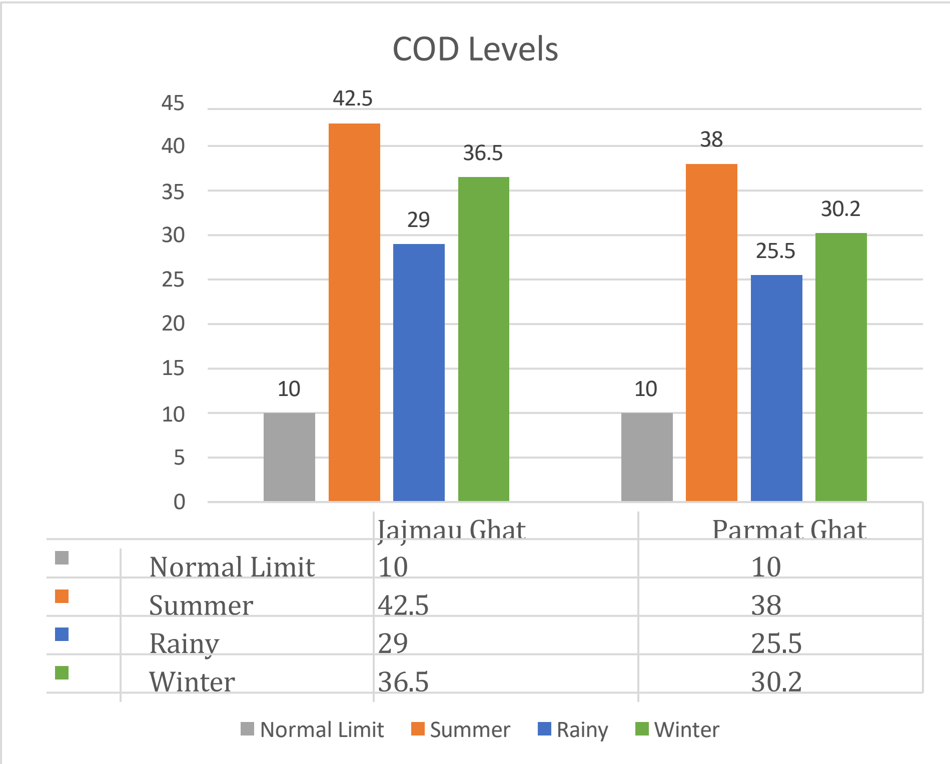
| Season | Jajmau Ghat | Parmat Ghat |
|---|---|---|
| Summer (May) | 42.5 | 38 |
| Rainy (September) | 29 | 25.5 |
| Winter (December) | 36.5 | 30.2 |

*(Table 2: COD level at Jajmau and Parmat Ghat during summer, rainy and winter seasons*




*(Chart 2: Comparison of COD level by bar graph at Jajmau and Parmat Ghat during summer, rainy, and winter seasons)*

COD levels are higher at Jajmau Ghat, which suggests the presence of both biodegradable and non-biodegradable pollutants. This could be due to solid waste dumping and industrial waste poured into the river.

The overall lower COD at Parmat ghat shows suggestively less chemical contamination.

COD was also highest during May in the summer and lowest during September during the rainy season.

## c) Coliform (MPN/100ml.):

Normal Limit: ≤ 500

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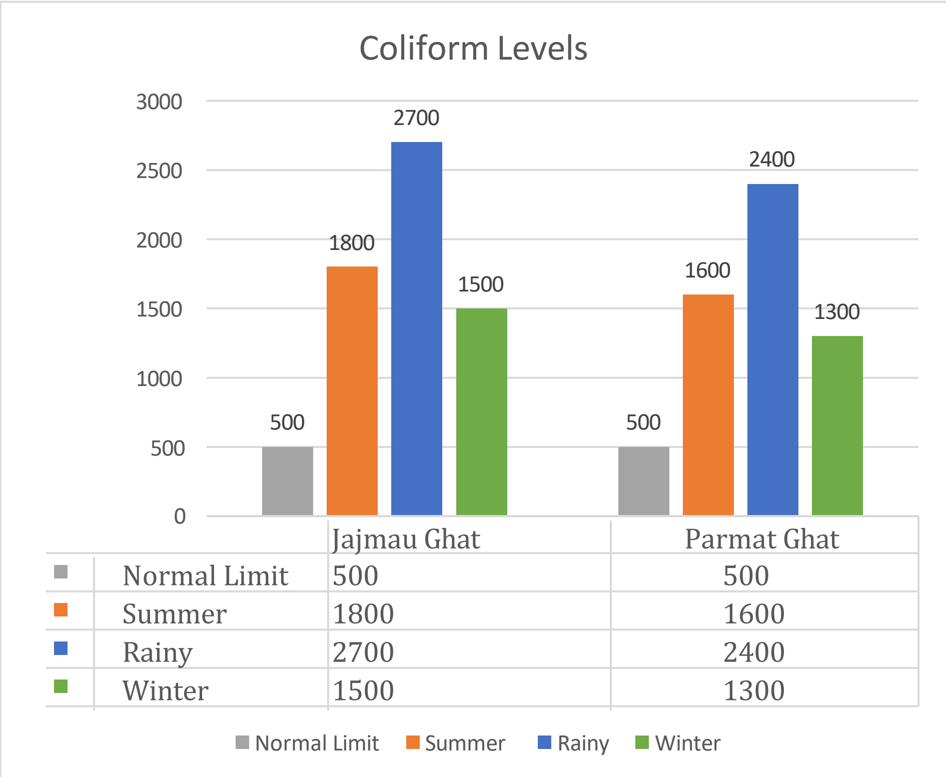
| Season | Jajmau Ghat | Parmat Ghat |
|---|---|---|
| Summer (May) | 1800 | 1600 |
| Rainy (September) | 2700 | 2400 |
| Winter (December) | 1500 | 1300 |

*(Table 3: Coliform level at Jajmau and Parmat Ghat during summer, rainy and winter seasons)*




*(Chart 3: Comparison of Coliform level by bar graph at Jajmau and Parmat Ghat during summer, rainy, and winter seasons)*

Both sites exceed the permitted limit of 500 MPN/100 ml. for bathing water. Jajmau Ghat shows a very high coliform count, likely due to untreated domestic sewage entering the river. This indicates that the water is unsafe for drinking and bathing at both sites.

It is interesting to note that the coliform levels are highest during the rainy season, as waste runoff from roads and land areas enters the rivers causing pollution. This increases the coliform levels in the river to their peak during the rainy season. However, the BOD and COD levels reduce significantly during this time, as all organic and chemical waste already present in the river is washed away with the water flow.

## 5. Discussion

The results clearly show that the water quality parameters of both Jajmau and Parmat ghats exceed the recommended safe limits, indicating significant pollution at both sites.

- BOD and COD levels were much higher than the safe limit at both locations, which means there is a high amount of organic matter in the water that consumes oxygen during decomposition. This can harm aquatic life by reducing dissolved oxygen.
- Jajmau Ghat recorded consistently higher pollution levels in all parameters compared to Parmat Ghat. This may be due to higher human activity and industrial activity around Jajmau.
- Coliform counts were alarmingly high at both sites. This bacterium usually comes from human or animal waste, and its presence means the water is not safe for drinking or bathing without treatment.
- The differences in pollution levels also suggest possible differences in waste management practices or local drainage systems feeding into the river near each ghat.
- While both ghats are polluted, Jajmau Ghat is in a more critical condition and requires urgent attention. Continuous monitoring and improved sewage treatment facilities are essential to restore water quality in these areas.

## 6. Conclusion

This study was conducted to assess and compare the water quality of the Ganga River during different seasons at two significant locations in Kanpur, namely Jajmau Ghat and Parmat Ghat. The three key parameters measured were BOD, COD and coliform levels in the water at both ghats. The results showed that both sites were highly polluted, with all three parameters exceeding the safe limits. However, Jajmau Ghat was found to be more polluted than Parmat Ghat in all the parameters. The high levels of BOD and COD indicate the presence of organic and chemical pollutants, while the elevated Coliform levels point to sewage contamination and a serious threat to public health.

This study highlights the urgent need for-

- Better sewage management systems.
- Public awareness about pollution.
- Regular water quality monitoring.
- Proper waste disposal practices.

Protecting and restoring the health of the Ganga River is not just important for the environment but also for the millions of people who depend on it for day-to-day needs. Small local efforts, supported by strong government action, can make a big difference.

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