# Comparative Study of Physico-Chemical and Ecological Parameters of Selected Freshwater Canals in Ramnagar, Purba Medinipur District, West Bengal, India

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## ABSTRACT

The present study was carried out to compare the physico-chemical and ecological condition of two freshwater canals in Ramnagar Block I, Purba Medinipur district, West Bengal, namely Ramnagar Canal near Ramnagar Rail Bridge (S1) and Champa Canal near Lalua Bridge (S2). Water and soil samples were collected monthly from June to October 2025 and analysed for selected parameters including water temperature, water pH, dissolved oxygen, free carbon dioxide, biochemical oxygen demand (BOD) and soil pH following standard methods. The results revealed clear site-wise and seasonal variation. S1 showed comparatively higher free CO2 and BOD values, indicating greater organic load and stronger local anthropogenic influence. S2 generally showed higher dissolved oxygen and slightly higher pH, suggesting relatively better ecological condition. Seasonal changes were also evident, with the monsoon months showing lower dissolved oxygen and increased organic indicators in both sites. The overall findings suggest that both canals remain ecologically functional, but S1 is more vulnerable to organic enrichment and needs better local management. The study provides baseline information for future monitoring and conservation of canal ecosystems in the coastal belt of Purba Medinipur.

## INTRODUCTION

Freshwater ecosystems are among the most important natural resources on earth because they support biodiversity, maintain ecological balance, and provide water for domestic, agricultural, and fisheries purposes. Among freshwater bodies, canals constitute an important but often neglected component of rural and semi-urban landscapes. In many parts of West Bengal, canals serve multiple roles such as irrigation channels, drainage pathways, fish habitat, and local water sources for various household and agricultural activities. Because of their close connection with surrounding land use, canal ecosystems are highly sensitive to seasonal variation, runoff, organic matter input, and anthropogenic disturbances.

The ecological condition of a canal is largely reflected by its physico-chemical characteristics. Parameters such as water temperature, pH, dissolved oxygen, free carbon dioxide, biochemical oxygen demand, and soil pH are commonly used to evaluate the quality and productivity of freshwater bodies. Water temperature directly affects metabolic activity, gas solubility and biological processes. pH influences chemical reactions and the survival of aquatic organisms. Dissolved oxygen is one of the most important indicators of water quality because it determines the ability of water to support aquatic life. Free carbon dioxide is related to respiration, decomposition, and photosynthesis, while biochemical oxygen demand indicates the degree of organic pollution present in water. Similarly, soil pH of the canal bank is important because it influences nutrient availability, microbial activity, and the overall chemical environment of the aquatic system.

In recent years, deterioration of freshwater quality has become a serious environmental concern in many parts of India. Rapid population growth, agricultural expansion, domestic waste disposal, and unplanned land-use changes have significantly affected small water bodies, in recent years, deterioration of freshwater quality has become a including canals. These impacts are often more pronounced in coastal and low-lying regions where runoff, siltation, and human interference continuously alter the structure and function of aquatic habitats. Therefore, periodic assessment of physico-chemical parameters is necessary to understand the health status of such ecosystems and to identify signs of ecological stress.

Purba Medinipur district of West Bengal is characterized by a network of ponds, wetlands, drainage channels, and canals that play an essential role in irrigation and local livelihood. The Ramnagar area, located in the coastal belt of this district, is influenced by monsoonal rainfall, agricultural activity, and expanding settlement patterns. The canals of this region are ecologically important, yet they remain comparatively less studied than rivers, ponds, or wetlands. Since canal water in this area may receive organic matter, surface runoff, and domestic inputs from surrounding localities, a comparative evaluation of different canal sites is necessary.

The present study was therefore undertaken to assess and compare selected physico-chemical and ecological parameters of two freshwater canals in Ramnagar, Purba Medinipur district, namely Ramnagar Canal near Ramnagar Rail Bridge (S1) and Champa Canal near Lalua Bridge (S2). By examining monthly variation in important parameters during the study period, the work aims to provide baseline scientific information on the environmental condition of these canals. Such information is valuable not only for understanding local aquatic ecology but also for future monitoring, conservation planning, and sustainable management of freshwater canal systems in the region.

## REVIEW OF LITERATURE

### Importance of Physico-Chemical Assessment of Freshwater Bodies

Freshwater ecosystems such as rivers, ponds, wetlands, lakes, and canals play a vital role in sustaining ecological stability, sustaining biodiversity, and providing the resources of human activities including irrigation, fisheries, and domestic use. The quality of freshwater systems is determined by various physical, chemical, and biological parameters that collectively influence aquatic productivity and ecological health.

Physico-chemical parameters such as temperature, pH, turbidity, electrical conductivity, dissolved oxygen (DO), biochemical oxygen demand (BOD), nutrients (nitrogen and phosphorus), and total dissolved solids (TDS) are widely used indicators to assess water quality. These parameters directly affect metabolic activities, nutrient cycling, and species composition in aquatic ecosystems.

Water quality deterioration due to anthropogenic activities such as urbanization, industrial discharge, agricultural runoff, and improper waste disposal has become a global concern. As a result, monitoring and assessment of freshwater systems using physicochemical parameters have become a central focus of environmental research worldwide.

### Global Studies on Physico-Chemical Parameters of Freshwater Systems

Several international studies have emphasized the importance of physicochemical parameters in assessing water quality in rivers, canals, ponds, and wetlands. Sharma and Walia (2017) conducted a comprehensive study on the Satluj River in Himachal Pradesh, India, where multiple physicochemical parameters including turbidity, conductivity, hardness, BOD, COD, nitrates, and phosphates were analysed. Their findings showed that many parameters exceeded WHO permissible limits due to domestic sewage discharge and agricultural runoff, indicating significant anthropogenic pressure on river water quality.

Similarly, Nguyen et al. (2020) studied the canal system of Ho Chi Minh City, Vietnam and reported elevated levels of heavy metals and organic pollutants due to industrial effluents and urban waste discharge. Their results demonstrated that canal ecosystems in rapidly urbanizing regions are highly susceptible to pollution.

In a study conducted in Bangladesh, Islam et al. (2015) analysed water quality parameters in wetlands and rivers and found that high nutrient levels and organic pollutants caused eutrophication and reduced dissolved oxygen levels, negatively affecting aquatic biodiversity.

Another study by Dixit et al. (2024) investigated seasonal variations in coastal water quality along the Odisha and West Bengal coastline and reported that seasonal changes strongly influenced parameters such as temperature, dissolved oxygen, BOD, and nutrient concentrations.

Tamrakar et al. (2022) conducted a study on urban ponds in Raipur, Chhattisgarh, where they analysed sixteen physicochemical parameters and calculated the Water Quality Index (WQI) to assess pond water quality. Their results showed that 75% of the ponds were in excellent condition, while 25% were unsuitable for domestic use due to nutrient pollution from runoff and wastewater discharge. The study highlighted the importance of continuous monitoring of urban ponds to prevent degradation. Another important study by Palit and Mukherjee (2011) investigated the physico-chemical properties of water and soil in Lalbandh wetland in Birbhum district, West Bengal. The study analysed parameters such as temperature, turbidity, pH, alkalinity, hardness, dissolved oxygen, BOD, nitrate-nitrogen, and phosphate-phosphorus across different seasons. The results indicated significant seasonal variation, with higher nutrient concentrations during the monsoon season due to runoff from surrounding areas. The study also emphasized that wetland ecosystems play an important role in nutrient cycling and biodiversity conservation. However, increased eutrophication caused by detergents and domestic wastewater threatens the ecological stability of such wetlands.

These studies collectively highlight the global importance of monitoring seasonal physicochemical parameters to evaluate freshwater ecosystem health.

**Studies on Freshwater Water Quality in India**

India has a large network of freshwater bodies including rivers, lakes, ponds, wetlands, and irrigation canals. However, rapid urbanization and industrialization have led to significant degradation of water quality across the country. Several researchers have investigated the physicochemical characteristics of freshwater bodies in India.

Mishra et al. (2023) studied physicochemical parameters of freshwater ecosystems and reported that increased anthropogenic

**Studies**

Activities lead to higher BOD, COD, and nutrient levels, which ultimately affect aquatic biodiversity.

Kumar and Singh (2018) studied water quality in the Ganga River basin and found that urban sewage discharge significantly increased BOD and nitrate concentrations.

In another study, Kumar et al. (2019) investigated water quality in the Yamuna River and reported elevated concentrations of ammonia, phosphates, and organic matter due to untreated wastewater discharge.

In northern India, Sharma et al. (2016) examined water quality in irrigation canals and observed seasonal variation in pH, dissolved oxygen, and conductivity levels, indicating the influence of agricultural runoff.

These studies demonstrate that water quality in Indian freshwater systems is significantly influenced by human activities and seasonal environmental changes.

**Studies on Irrigation Water Quality in India**

Assessment of irrigation water quality is also crucial because water chemistry directly affects soil health and crop productivity.

Yadav et al. (2023) studied irrigation water quality in Phulpur block of Prayagraj district, Uttar Pradesh, where several physicochemical parameters such as pH, electrical conductivity, bicarbonates, chlorides, calcium, magnesium, sodium, and potassium were analyzed. The study

also calculated irrigation water quality indices such as Sodium Absorption Ratio (SAR), Residual Sodium Carbonate

**Anthropogenic Impacts on Freshwater Water Quality**

Human activities are the primary drivers of freshwater pollution worldwide. The sources of water contamination include Domestic waste, Agricultural overflow containing fertilizers or pesticides, Industrial effluents, Solid waste disposal, Urban storm water runoff. Tamrakar et al. (2022) reported that urban ponds located near industrial and commercial zones showed higher conductivity and TDS values due to industrial runoff. Palit and Mukherjee (2011) observed that detergents from domestic activities increased phosphate concentrations in the Lalbandh wetland, contributing to eutrophication.

Anthropogenic activities can also disrupt natural biogeochemical cycles, leading to excessive nutrient enrichment and algal blooms in freshwater ecosystems.

**Research Gap and Relevance of the Present Study**

(RSC), and Permeability Index (PI). Results showed that most water samples were suitable for irrigation but indicated moderate sodium hazard in certain areas.

The authors concluded that continuous monitoring of irrigation water is necessary to maintain soil fertility and agricultural productivity.

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Although numerous studies have investigated water quality in rivers, lakes, and ponds, there is limited research focusing specifically on canal ecosystems, especially in coastal regions of West Bengal.

Canals are unique freshwater systems that often receive water from multiple sources including rivers, agricultural runoff, and urban drainage systems. As a result, their water quality can vary significantly depending on surrounding land use patterns.

The Ramnagar region of Purba Medinipur district contains several canals that play an important role in irrigation, fisheries, and local livelihoods. However, increasing urbanization and agricultural activities may threaten the ecological health of these canals.

Therefore, a comparative study of physicochemical parameters in canals of the Ramnagar area is necessary to assess water quality and identify potential environmental risks.

## AIMS AND OBJECTIVES

- To assess physico-chemical parameters of two canals in Ramnagar by studying collected water and soil samples from the canal sites.
- To compare seasonal variation between two canal sites.
- To evaluate ecological health using biological indicators.
- To perform statistical comparisons between the two sites.
- To analyze anthropogenic impact.
- To suggest conservation measures.

## MATERIALS AND METHODS DETAILS OF STUDY SITES

Two study sites were selected in the Ramnagar Block I of Purba Medinipur district. The detailed locations of the sites are given below:

i. Ramnagar canal near Ramnagar rail bridge **(S1)**:

Longitude: 87°33'38.2"E

Latitude: 21°40'50.7"N

ii. Champa canal near Lalua bridge **(S2)**:

Latitude: 21°42'33.5"N

Longitude: 87°

## COLLECTION OF SAMPLES

Water samples were collected 20–30 cm below surface in clean polyethylene bottles. Soil samples were collected from canal banks and were kept in polyethylene containers. Monthly sampling was conducted from June to October 2025 and sampling was done between 8-10 AM.

## ANALYTICAL METHODS USED TO STUDY THE SAMPLES

All analyses were carried out following standard methods as described in APHA (2012). Each method of analysis is briefly described below:

### Soil pH (with pH Meter):

The method gives explicit, because of its perfection and rapidity, it is considered one of the best methods for soil pH determination.

11 gm of air-dried soil was taken in a 55 ml beaker and 24 ml of distilled water was added maintaining a soil: water ratio of 1:3.5. The suspension was stirred well at regular intervals for about 20 minutes. The pH meter was calibrated, the electrode was immersed into the suspension, and the pH was recorded.

The range of pH of water range of 6.3 to 7.6is generally considered impartial. Values under 6.5 indicate acidic soil containg iron sulfides while values above 7.6 indicate alkaline soil. Soil The pH of the soil helps in understanding the nature of chemical the canal bank soil and its influence on nutrient availability and aquatic productivity.

**Water Temperature:** A Celsius thermometer was dipped directly into the canal at the sampling point. After allowing the mercury column to stabilize for a short time, the reading was noted. Temperature gives an idea about the seasonal condition of the cannal and strongly influences the distribution and survival of aquatic organisms.

**pH of Water:** This method provides a quick and accurate measurement of the hydrogen ion concentration of water. It is essential because pH controls many chemical and biological processes in aquatic ecosystems.

The pH meter was first standardized using buffer solutions. The electrode was then dipped into the collected water sample, and the pH was recorded after the reading became constan. The range of Ph of water is 6.3 to 8.4 are generally used for most freshwater living thing. Water with pH below 6.5 is acidic, and above 8.5 is alkaline. Thus, measurement of water pH is useful in assessing whether the canal water is favourable for aquatic life.

**Dissolved Oxygen (DO) (by Winkler's Iodometric Method):** In Winkler's iodometric procedure, a fixed amount of manganous sulphate solution and alkali alkaline -azide reagent is added the sample of the water bottle. A brownish precipitate is formed. After adding concentrated sulphuric acid, the impetuous dissolves and releases iodine comparable to the oxygen present in the sample. This release iodine is compared with titrated with standard sodium thiosulphate solution using starch as indicator until the blue colour disappears.

The dissolved oxygen level of freshwater generally ranges from 4.0 to 8.0 mg/L. Values below 4.0 mg/L are not suitable for many aquatic animals, while values above 5.0 mg/L are generally considered good for fish life. Thus, dissolved oxygen helps in understanding the good physical condition of the canal ecosystem and its capacity to support aquatic organisms Free carbon dioxide (by titration method): A measured quantity of the sample of water was taken in conical flask and phenolphthalein indicator is added to it. The sample is titrate with the sodium hydroxide solution until a faint pink Colour dissolve. The capacity of alkali used to calculate the free carbon dioxide content.

In freshwater bodies, free carbon dioxide commonly ranges from 0 to 10 mg/L. Higher values may occur in water receiving organic.

**Activity Matter or Showing High Respiratory**

Thus, estimation of free carbon dioxide is important for understanding the balance between photosynthesis and decomposition in canal water.

**Biochemical Oxygen Demand (BOD):** This method establishes the amount of BOD required by microorganisms for decomposition of biomas substance present in Adam's ale water. It is an important signal of organic contamination.

Dissolved oxygen of the fresh sample is measured first. Another side of the same test is incubated in a closed bottle for 5 days at 20°C.Post maturation DO is again calculate. Difference between the initial and final DO gives the BOD value.

The clean freshwater, BOD usually ranges from 1 to 3 mg/L. Values above 3–5 mg/L indicate increasing organic pollution, while very high BOD suggests heavy contamination. Thus, BOD helps in assessing the pollution load and the degree of biomass substance present in the canal water.

## RESULTS

**Table 1: Monthly Values of Measured Parameters at The Two Study Sites**

| Month | S1 Temp | S2 Temp | S1 pH | S2 pH | S1DO (mg/L) | S2DO (mg/L) | S1Co2 (mg/L) | S2 CO2 (mg/L) | S1 BOD (mg/L) | S2 BOD (Mg/L) | S1 Soil pH | S2 Soil pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| June | 31.2 | 30.4 | 6.8 | 7.1 | 5.6 | 6.3 | 8.8 | 7.3 | 3.8 | 2.9 | 6.2 | 6.6 |
| July | 29.4 | 28.7 | 6.6 | 6.9 | 5.1 | 9.4 | 9.4 | 8.1 | 4.3 | 3.3 | 6.0 | 6.4 |
| Aug | 28.6 | 27.9 | 6.5 | 6.8 | 4.8 | 10.2 | 10.2 | 8.6 | 4.9 | 3.7 | 5.9 | 6.3 |
| Sep | 30.1 | 29.2 | 6.9 | 7.1 | 5.3 | 9.0 | 9.0 | 7.8 | 4.1 | 3.1 | 6.2 | 6.5 |
| Oct | 31.8 | 30.7 | 7.0 | 7.2 | 6.0 | 8.1 | 8.1 | 7.1 | 3.5 | 2.8 | 6.3 | 6.5 |

**Table 2: Mean Values of Measured Parameters in The Two Canals**

| Perameter | S1 Mean | S2 Mean |
|---|---|---|
| Water temperature | 30.22 | 29.38 |
| Water Ph(mg/L) | 6.76 | 7.02 |
| Dissolved oxygen (mg/L) | 5.36 | 6.04 |
| Free Co2 (mg/L) | 9.1 | 7.78 |
| BOD (mg/L) | 4.12 | 3.16 |
| Soil pH | 6.12 | 6.48 |

## DISCUSSION

The present study clearly demonstrates that the two selected canals differ in their physico-chemical condition, even though both are located within the same regional climatic zone. Water temperature remained high in both sites during the study period, which is normal for the monsoon and post-monsoon months in coastal West Bengal. Slightly higher temperature at S1 may be associated with shallower flow, lower shade cover or greater exposure to surrounding disturbed-land. The values of pH of both canals keep to the tolerable sweep for most freshwater organisms, but S1 was slightly more acidic than S2. This difference, together with the lower soil pH observed at S1, suggests the influence of local runoff and decomposition of organic matter. Dissolved oxygen (DO) is important indicators of water quality of ecological health, and in the present study it was consistently lower in S1. Lower dissolved oxygen, particularly during August, indicates greater biological oxygen consumption and (natural/photosynthetic) during the rainy season. Free carbon study Higher free possibly reduced reaeration (natural/ rainy season Free carbon dioxide and BOD were both higher in S1 photosynthetic) during the carbon dioxide may arise from active respiration, decomposition and reduced photosynthetic utilization, while higher BOD throughout the possibly reduced reaeration points to increased biodegradable organic matter in the water.

These results together suggest that S1 receives more organic input than S2. Possible sources may include nearby settlement activities, market waste, drainage input, leaf litter accumulation and stagnant water pockets. In contrast, S2 showed a relatively better balance of parameters, with higher dissolved oxygen and lower BOD, indicating comparatively better ecological condition. The seasonal pattern observed in this study agrees with earlier limnological studies from India and West Bengal, where monsoon runoff often increases suspended and organic matter load, leading to temporary fall in dissolved oxygen and rise in carbon dioxide or BOD. Although the present values do not indicate extreme pollution, the trend suggests that Ramnagar canal near Ramnagar Rail Bridge is more vulnerable to gradual deterioration. Hence, periodic monitoring, control of local waste input and maintenance of canal flow are necessary to conserve the ecological health of the canal system.

## CONCLUSION

From the present investigation it may be concluded that both selected canals of Ramnagar possess measurable seasonal variation in important physico-chemical parameters. Among the two sites, Ramnagar Canal near Ramnagar Rail Bridge (S1) showed comparatively lower dissolved oxygen and higher free carbon dioxide and BOD, indicating greater organic stress. Champa Canal near Lalua Bridge (S2) showed relatively better water quality and appeared to be ecologically more stable during the study period. The soil pH data also supported this site-wise difference. Overall, the study suggests that both canals are still capable of supporting freshwater ecological functions, but S1 requires more careful management to prevent further degradation. The findings provide baseline scientific information for future water quality monitoring and local conservation planning in the Ramnagar region of Purba Medinipur.

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