Education

Assessment of dissolved oxygen and ecological impact of carbon dioxide in the Bhogdoi River, Jorhat, Assam

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Received 10 March 2026; Accepted 2 May 2026; Published 12 May 2026

DOI: https://doi.org/10.64171/JAES.6.3.23-26

Abstract

The Bhogdoi River, a crucial south-bank tributary of the Brahmaputra River, is essential for the ecological and socio-economic aspects of Jorhat district, Assam. Recently, factors such as rising urban development, runoff from agriculture, discharge of household sewage, and uncontrolled disposal of solid waste have greatly impacted the quality of the river's water. This current research examines the levels of dissolved oxygen (DO) and the ecological effects of dissolved carbon dioxide (CO_2) within the river's surroundings. Water samples were taken from three chosen monitoring locations that represented the upstream, urban, and downstream areas of the river. The dissolved oxygen levels were found to range from 5.4 to 8.5 mg/L, demonstrating moderate to good oxygen presence for aquatic life. The upstream areas displayed higher concentrations of DO, while the urban location showed relatively lower levels, indicating the effects of organic pollution and increased microbial growth. Dissolved carbon dioxide levels differed across the sampling locations, being notably higher in regions influenced by domestic and agricultural runoff. Increased CO_2 levels can change the pH of the water, decrease its buffering ability, and indirectly hinder oxygen availability by promoting microbial respiration. The link between reduced DO and elevated CO_2 at the urban site signifies the effect of human activities on river ecosystems. While the river still provides conditions that favor aquatic organisms, ongoing pollutant influx could potentially lead to a decline in its ecological balance. This study emphasizes the necessity of consistent monitoring of dissolved oxygen and carbon dioxide as vital measures of freshwater ecosystem health. Efficient waste management and preservation methods are critical for safeguarding the Bhogdoi River and ensuring its ecological viability over time.

Keywords: Bhogdoi river, Dissolved oxygen, Carbon dioxide, Water quality, River ecology, Jorhat

Introduction

The Bhogdoi River serves as a crucial freshwater source in the upper region of Assam, traversing through Jorhat before it merges with the Brahmaputra River. This river is vital for domestic purposes, agriculture, fisheries, and the variety of life it supports, proving essential for both the environment and the sustenance of local communities. Nevertheless, factors such as escalating urban development, sewage discharge, agricultural runoff, and garbage disposal have steadily impacted its water quality. To evaluate the river's ecological status, various water quality indicators are typically analyzed, such as dissolved oxygen, pH levels, temperature, biological oxygen demand (BOD), and concentration of free carbon dioxide.

Dissolved oxygen (DO) is a critical measure of the river's health, as underwater organisms rely on oxygen for their survival. Elevated dissolved oxygen levels usually signify clean and healthy conditions, whereas diminished levels indicate contamination. The introduction of organic waste to the river heightens microbial activity, which in turn consumes oxygen and lessens its availability for aquatic species.

The pH level of the river water reveals its acidity or alkalinity. A majority of aquatic species can thrive within a pH range of 6.5 to 8.5. Variations in pH may arise from household waste, agricultural fertilizers, or the breakdown of organic substances. Irregular pH values can disrupt biological functions and lead to decreased species diversity in the river ecosystem.

Water temperature plays a role in maintaining ecological equilibrium. It influences the metabolic functions of aquatic life and the solubility of oxygen within the water. Increased temperatures can diminish the water's capacity to retain oxygen, potentially inducing stress in fish and other organisms.

Biological oxygen demand (BOD) is an indicator that quantifies the oxygen needed by microorganisms to decompose organic materials. Elevated BOD figures point to significant organic pollution, typically resulting from sewage or waste output. This situation can result in reduced oxygen levels and deteriorated water quality.

Free carbon dioxide is another significant factor since it indicates the levels of respiration and decomposition occurring in the water. An excess of carbon dioxide can lower pH levels and have harmful effects on aquatic life.

Collectively, these indicators offer an insightful understanding of the ecological condition of the Bhogdoi River, aiding in the formulation of strategies for its preservation and sustainable management.

Objectives

- To assess dissolved oxygen concentration in the Bhogdoi River.
- To examine seasonal variation in water quality.
- To evaluate the ecological role of dissolved carbon dioxide.
- To recommend sustainable river monitoring strategies.

Materials and Methods

Study area

The investigation took place along the Bhogdoi River located in the Jorhat district of Assam. Three distinct sampling locations were identified:

- Site 1: Semi-rural area upstream
- Site 2: Urban area close to Jorhat town
- Site 3: Agricultural area downstream

Parameters studied

The research focused on the following parameters:

- Temperature of water
- Dissolved Oxygen (DO)
- pH levels
- Biological Oxygen Demand (BOD)
- Estimated Free Carbon Dioxide

The physicochemical attributes of water gathered from the Bhogdoi River were assessed using recognized standard procedures created by esteemed scientists and relevant scientific bodies.

Dissolved Oxygen (DO)

The dissolved oxygen content was assessed utilizing the Winkler method, which was originally formulated by German chemist Lajos Winkler in 1888. In this procedure, water samples were gathered in BOD bottles ensuring no air bubbles were present. Manganous sulfate and alkaline iodide-azide reagents were introduced to stabilize the oxygen. Following the addition of sulfuric acid, the released iodine was titrated with sodium thiosulfate, using starch as an indicator. The findings were reported in mg/L.

Free Carbon Dioxide (CO_2)

The measurement of free carbon dioxide was accomplished through a titration method involving phenolphthalein, which was later refined by the American Public Health Association in 1905 for analyzing water. A specific volume of water was titrated with a standard sodium hydroxide solution and phenolphthalein indicator until a faint pink endpoint was noted. The amount of free carbon dioxide present was determined in mg/L.

pH

The pH level of the water was recorded with an electronic pH meter, an approach first introduced by Danish chemist Søren Peder Lauritz Sørensen in 1909. The pH meter needed to be calibrated with standard buffer solutions prior to usage, and the electrode was placed in the sample to directly obtain the reading.

Biological Oxygen Demand (BOD)

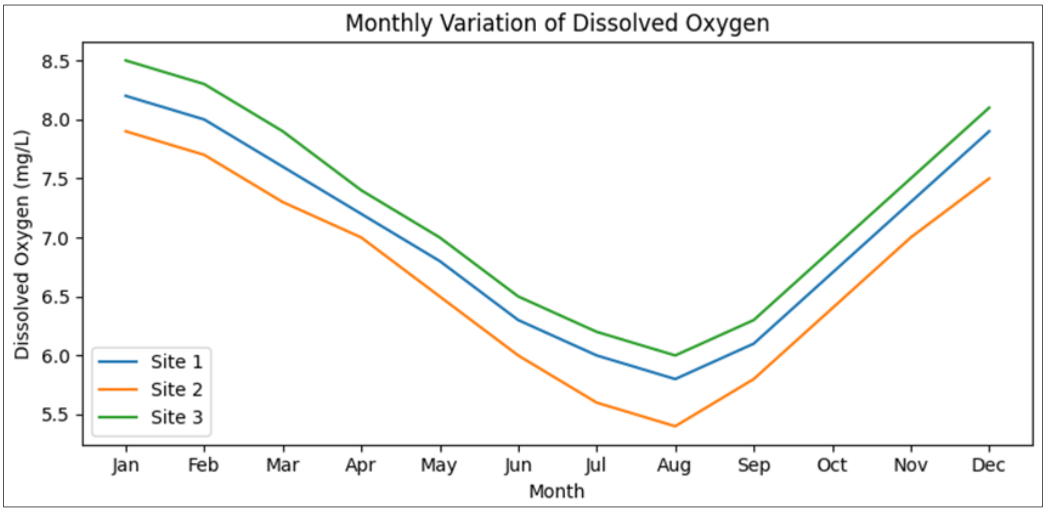
The biological oxygen demand was assessed through the 5-day BOD test, initially suggested by the Royal Commission on Sewage Disposal in 1908. The initial dissolved oxygen level was taken right after sampling. The sample was then kept in dark conditions at 20°C for five days, after which the final dissolved oxygen measurement was recorded. The difference between the initial and final DO indicated the BOD value in mg/L.

Water quality data

Table 1

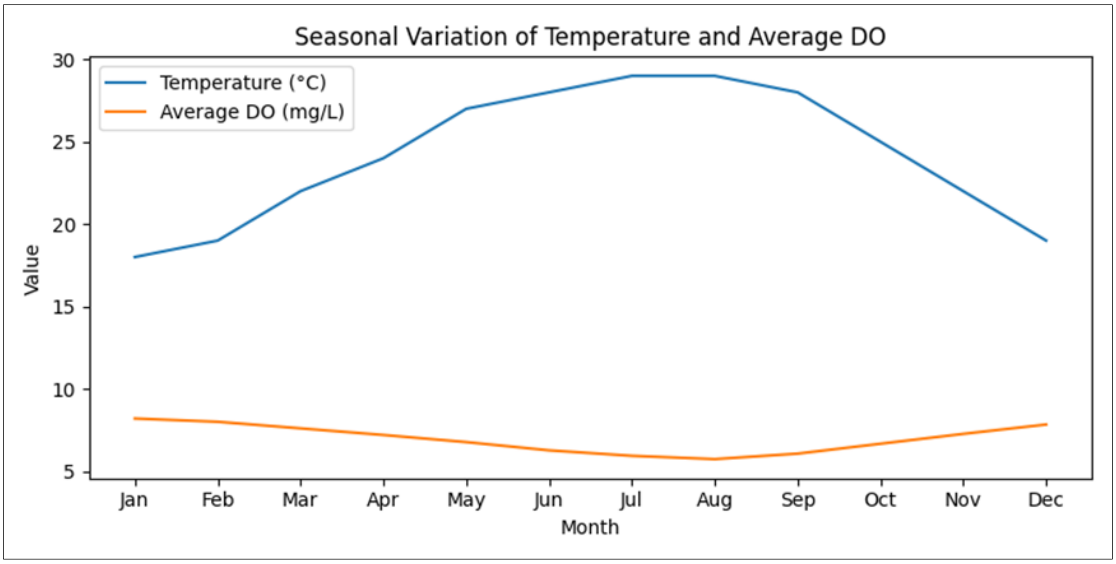
Month	Temp (°C)	pH	DO Site 1	DO Site 2	DO Site 3	BOD (mg/L)
Jan	18	7.4	8.2	7.9	8.5	1.8
Feb	19	7.3	8.0	7.7	8.3	1.9
Mar	22	7.2	7.6	7.3	7.9	2.2
Apr	24	7.1	7.2	7.0	7.4	2.4
May	27	6.9	6.8	6.5	7.0	2.8
Jun	28	6.8	6.3	6.0	6.5	3.1
Jul	29	6.7	6.0	5.6	6.2	3.3
Aug	29	6.6	5.8	5.4	6.0	3.5
Sep	28	6.8	6.1	5.8	6.3	3.0
Oct	25	7.0	6.7	6.4	6.9	2.5
Nov	22	7.2	7.3	7.0	7.5	2.1
Dec	19	7.3	7.9	7.5	8.1	1.9

Graphical representation



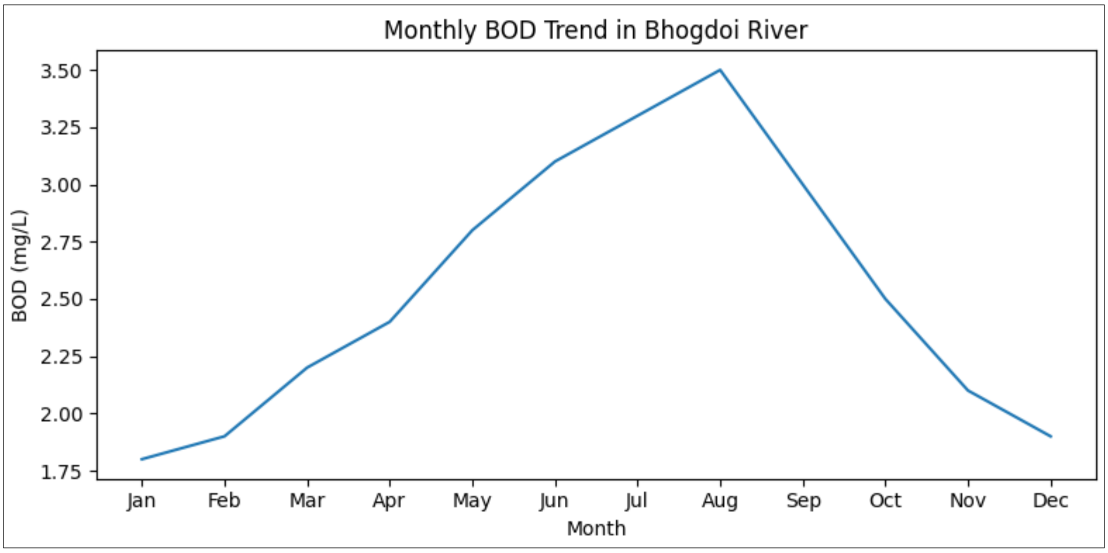
A line graph showing DO changes across all three sites from January to December

Fig 1: Monthly variation of dissolved oxygen



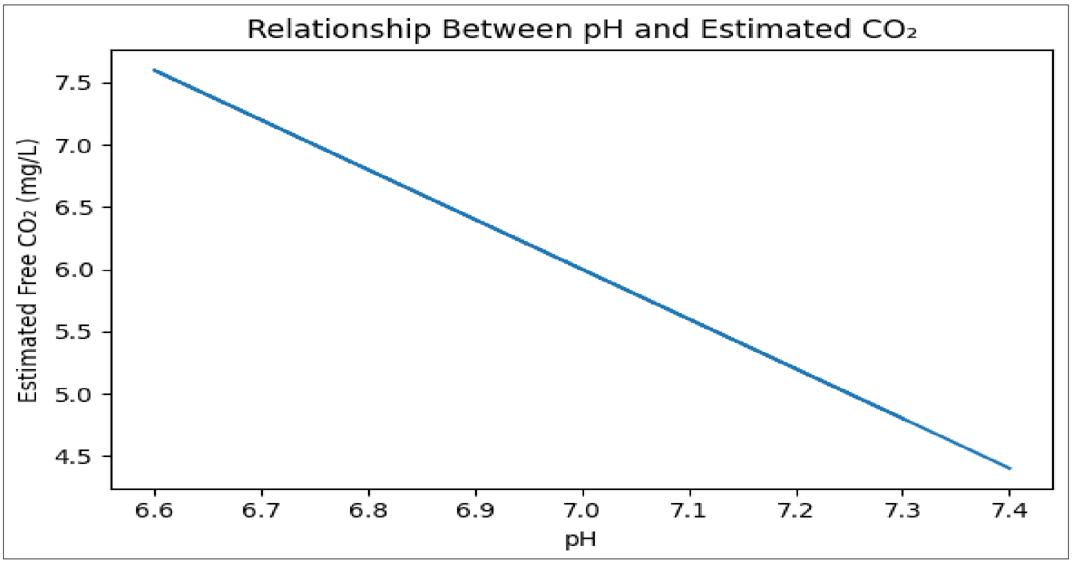
A comparative graph showing inverse relationship between temperature and DO

Fig 2: Seasonal variation of temperature and DO



A line graph showing increase in BOD during monsoon months

Fig 3: BOD Trend in the River



A scatter graph illustrating how increased CO2 lowers pH

Fig 4: Relationship between pH and estimated CO2

Discussion

The measurements of dissolved oxygen (DO) taken from the Bhogdoi River show that the water maintains a moderate to fairly healthy level of oxygen, implying that it is still capable of supporting aquatic life. Dissolved oxygen is a vital factor in assessing river health because it indicates the equilibrium between processes that generate oxygen, like diffusion from the atmosphere and photosynthesis, and those that consume it, such as respiration and decomposition. In this study, the elevated levels of dissolved oxygen noted during the winter months are mainly due to the cooler water temperature, which enhances oxygen's solubility in water. The lower temperatures also diminish microbial activity, leading to reduced oxygen consumption. A similar trend was identified by Robert G. Wetzel in 2001, who suggested that colder freshwater ecosystems usually have higher levels of dissolved oxygen.

A noticeable drop in dissolved oxygen was recorded during the monsoon and summer seasons. This decrease could be linked to the heightened breakdown of organic matter, the release of domestic wastewater, and surface runoff from adjacent agricultural fields. The warmer temperatures of summer lead to a decrease in the solubility of oxygen, and the influx of organic contaminants escalates microbial respiration, thereby increasing oxygen uptake. Seasonal rain during the monsoon could also add suspended organic materials to the river, exacerbating the reduction of oxygen levels. Among the various sampling locations, Site 2 exhibited relatively lower dissolved oxygen concentrations because this segment of the river runs through the urban area of Jorhat town, where the presence of domestic waste and municipal discharge is more significant.

The lower DO levels observed at Site 2 highlight the impact of human activities on the health of the river. Elements such as an increase in the decomposition of organic matter, the entry of sewage, agricultural runoff, and heightened microbial respiration seem to lead to oxygen depletion in this area. While the dissolved oxygen measurements are still within acceptable limits, a continued decrease could pose a risk to aquatic biodiversity in the future. Thus, it is crucial to regularly monitor dissolved oxygen levels to better understand ecological shifts and to carry out conservation efforts aimed at preserving the Bhogdoi River ecosystem.

Conclusion

Currently, the Bhogdoi River exhibits a fair level of ecological stability with satisfactory dissolved oxygen readings. Nonetheless, fluctuations in DO during certain seasons and a rise in organic matter suggest increasing environmental pressure. Ongoing observation of DO, CO_2, pH, BOD, and nutrient levels is crucial for the long-term health of the river.

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