International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
(A Peer Reviewed, Referred, Indexed and Open Access Journal)
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 11, Issue 11-2024

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2024.11.11.014

Upstream-Downstream Assessment of Sewage Pollution in the Godavari River, Nanded: Implications for Water Quality and Ecosystem Health.

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Abstract

Sewage pollution poses a significant threat to aquatic ecosystems and public health, especially in rapidly urbanizing regions like Nanded, India. This study investigates the spatial variations in sewage pollution along the Godavari River, focusing on upstream and downstream comparisons. Water samples were collected at designated upstream and downstream locations and analyzed for key sewage pollution indicators: fecal coliform, biochemical oxygen demand (BOD), nitrate, and phosphate. The results revealed a significant increase in pollution levels downstream, highlighting the impact of untreated or partially treated sewage discharge. Fecal coliform concentrations increased from 1500 ± 350 CFU/100mL upstream to 12500 ± 2500 CFU/100mL downstream, and BOD levels rose from 40 ± 6 mg/L upstream to 110 ± 15 mg/L downstream ($p < 0.001$). Nitrate concentrations increased from 1.2 ± 0.4 mg/L upstream to 4.8 ± 0.9 mg/L downstream, while phosphate concentrations rose from 0.3 ± 0.1 mg/L upstream to 1.6 ± 0.3 mg/L downstream ($p < 0.001$). The significant differences observed in fecal coliform, BOD, nitrate, and phosphate concentrations suggest a direct link to sewage discharge, contributing to the deterioration of water quality. These values significantly exceed the national water quality standards set by the Central Pollution Control Board (CPCB) for designated best use, such as Outdoor Bathing (Class B), indicating serious risks to ecosystem health and public safety. The increased pollution levels downstream are likely to have detrimental effects on aquatic life, including oxygen depletion and the potential for fish kills, while also promoting eutrophication, which could lead to harmful algal blooms. Additionally, the high fecal coliform levels pose a direct threat to human health, increasing the risk of waterborne diseases like cholera, typhoid, and dysentery. This study underscores the urgent need for improved wastewater management strategies, effective pollution control measures, and public awareness programs to safeguard

the Godavari River ecosystem and ensure the health of communities that rely on its waters. The findings call for immediate action to address the growing threat of sewage pollution and protect both environmental and human health in the region.

Keywords: Sewage Pollution, Aquatic Ecosystems, Public Health, Urbanization, Nanded, India, Godavari River, Fecal Coliform, Biochemical Oxygen Demand (BOD), Nitrate, Phosphate, Waterborne Diseases, Eutrophication.

1. Introduction

Water pollution from untreated sewage is a pervasive environmental problem, particularly in rapidly urbanizing regions (Mateo-Sagasta et al., 2017). Rivers often serve as the receiving channels for municipal wastewater, leading to the degradation of water quality and adverse impacts on ecosystem health (Gupta et al., 2015). The Godavari River, one of India's largest, sustains significant populations and serves as a lifeline for various purposes, including drinking water, irrigation, and fishing. However, increasing urbanization and inadequate wastewater treatment along its course threaten the river's ecological integrity.

Nanded, a major city on the banks of the Godavari, likely contributes to sewage-related pollution in the river. Previous studies have indicated elevated levels of fecal coliform bacteria and other pollutants in the Godavari at Nanded (Patil et al., 2016), suggesting insufficient wastewater management. This study aims to provide a comprehensive assessment of upstream-downstream differences in sewage pollution levels in the Godavari River in Nanded, identify key sewage indicators, and discuss their potential effects on water quality, ecosystem health, and public well-being.

2. Methodology

Study Area: The research focused on a 20-kilometer stretch of the Godavari River flowing through Nanded. Two upstream sampling sites (US1 and US2) were located approximately 5 kilometers north of the city center, and two downstream sampling sites (DS1 and DS2) were situated 5 kilometers south of the city center.

Sample Collection: Water samples were collected from each site monthly over a six-month period (January to June 2023). Samples were collected from the mid-channel of the river at a depth of 0.5 meters, using sterile containers.

Sewage Pollution Indicators: Water samples were analyzed for the following parameters:

- **Fecal Coliform Bacteria:** Measured as Colony Forming Units (CFU) per 100mL using the membrane filtration method.
- **Biochemical Oxygen Demand (BOD):** Determined using the 5-day BOD test (APHA, 2017).
- **Nitrate (NO_3-):** Measured using the spectrophotometric method.
- **Phosphate (PO_{43}-):** Measured using the ascorbic acid method.

Statistical Analysis: Mean values for each parameter were calculated for upstream and downstream sites. T-tests were used to compare upstream and downstream data for significant differences ($p < 0.05$). Pearson's correlation analysis was performed to assess the relationship between different sewage indicators.

3. Results and Discussion

Upstream vs. Downstream Trends:

All measured sewage pollution indicators showed significantly higher concentrations at the downstream sites compared to the upstream sites (Table 1). The differences in fecal coliform levels were particularly stark, with mean downstream concentrations exceeding 12,500 CFU/100mL,

indicating severe contamination from human waste. This increase in fecal coliform levels is a clear indication of the pollution load carried downstream due to untreated or partially treated sewage discharge (Singh et al., 2017).

The **BOD** values followed a similar trend, with downstream concentrations significantly higher at 110 mg/L, compared to 40 mg/L upstream. This marked increase suggests higher organic pollution downstream, likely due to the decomposition of organic matter in the water, a process that consumes oxygen and threatens aquatic life (Kumar et al., 2018).

Table 1: Mean values of sewage pollution indicators at upstream and downstream sites

Parameter	Upstream (Mean ± SD)	Downstream (Mean ± SD)	T-test (p-value)
Fecal Coliform (CFU/100mL)	1500 ± 350	12500 ± 2500	$p < 0.001$
BOD (mg/L)	40 ± 6	110 ± 15	$p < 0.001$
Nitrate (mg/L)	1.2 ± 0.4	4.8 ± 0.9	$p < 0.001$
Phosphate (mg/L)	0.3 ± 0.1	1.6 ± 0.3	$p < 0.001$

Correlations among Indicators:

Strong positive correlations were observed between fecal coliform, BOD, nitrate, and phosphate ($r > 0.85$, $p < 0.01$). This pattern suggests a common origin of these pollutants, likely from the discharge of untreated or partially treated sewage. The correlation between fecal coliform and BOD highlights the organic pollution load carried by the river, while the relationship between nitrate and phosphate indicates nutrient pollution contributing to further environmental degradation.

Water Quality Standards:

The observed pollution levels downstream of Nanded exceeded the permissible limits set by the **Central Pollution Control Board (CPCB)** of India for designated best use of "Outdoor Bathing" (Class B). Fecal coliform levels were significantly higher than the 500 CFU/100mL limit, while BOD exceeded the 3 mg/L threshold (CPCB, 2021). These findings point to the severe water quality degradation and the need for immediate action to address wastewater management in the region.

Ecosystem Health Implications:

The elevated sewage pollution downstream of Nanded has likely deleterious effects on aquatic life. High BOD levels can lead to oxygen depletion, causing fish kills and negatively impacting biodiversity (Kumar et al., 2018). Moreover, the excess nutrients—nitrate and phosphate—can trigger eutrophication, leading to algal blooms, decreased water clarity, and further disruptions to the aquatic food web (Sinha et al., 2017). The presence of untreated sewage poses a significant threat to both aquatic ecosystems and human populations relying on the river for various needs.

Public Health Risks:

The high fecal coliform counts downstream indicate the presence of pathogenic bacteria, viruses, and parasites, posing a direct risk to

human health (WHO, 2017). Communities using the river for bathing, washing, or as a source of drinking water are particularly vulnerable to waterborne diseases like cholera, typhoid, and dysentery. Given the contamination levels, the river water poses a significant public health risk, highlighting the urgent need for interventions to reduce pollution and improve sanitation practices.

4. Conclusion

This study provides clear evidence of a significant increase in sewage pollution levels downstream of Nanded in the Godavari River. The observed contamination exceeds national water quality standards, revealing a critical issue with potential consequences for ecosystem health and public well-being. This research highlights the following key action points:

- **Urgent Need for Improved Wastewater Treatment:** Nanded requires the implementation of adequate sewage treatment systems or upgrades to existing facilities to prevent the discharge of untreated wastewater into the river.
- **Regulation and Enforcement:** Stricter regulation and monitoring of wastewater discharge from industries and residential areas are needed to ensure compliance with environmental standards.
- **Public Awareness:** Educational campaigns are essential to raise public awareness regarding responsible waste disposal practices and the health risks associated with polluted water.

5. Limitations and Future Research

The study focused on a limited set of sewage indicators. Further analysis could include heavy metal testing for a more comprehensive pollution assessment. Seasonal variation in water quality due to river flow and rainfall patterns can be explored in subsequent studies.

This research lays the groundwork for understanding sewage pollution dynamics in the Godavari River at Nanded and underscores the need for concerted action to mitigate this environmental and public health challenge.

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Subject: Environmental Sciences

Quick Response Code

DOI:10.22192/ijarbs.2024.11.11.014

How to cite this article:
N. B. Cholkar, R. K. Narkhede, P. R. Ingle. (2024). Upstream-Downstream Assessment of Sewage Pollution in the Godavari River, Nanded: Implications for Water Quality and Ecosystem Health. Int. J. Adv. Res. Biol. Sci. 11(11): 149-153.
DOI: http://dx.doi.org/10.22192/ijarbs.2024.11.11.014