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Quantitative Assessment of Physico-Chemical Parameters and Fish Species in the Ken River

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Abstract

The Ken River, one of the principal rivers of the Bundelkhand region in central India, plays a crucial role in sustaining ecological balance and supporting livelihoods. This research paper aims to quantitatively analyze the relationship between key physico-chemical water quality parameters and the diversity of fish species inhabiting the river. Water samples were collected from three strategically selected sites representing upper, middle, and lower stretches of the river. Parameters such as temperature, pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), nitrates, and phosphates were measured using standard protocols. Simultaneously, fish samples were collected and identified to study species richness, abundance, and distribution. The study reveals that fish diversity is positively correlated with DO and negatively influenced by increased levels of BOD and TDS. Seasonal variation also had a marked impact on both water quality and fish composition. The findings highlight the need for continuous monitoring of the Ken River to ensure the ecological sustainability of its aquatic resources. This study provides valuable insights into how physico-chemical characteristics of water influence biodiversity and serves as a foundation for future conservation and management strategies.

Introduction

Rivers are the lifelines of both terrestrial and aquatic ecosystems. Among them, the Ken River, flowing through the Indian states of Madhya Pradesh and Uttar Pradesh, holds significant ecological and socio-economic importance. Originating from the Vindhya ranges, the river is a vital freshwater source supporting agriculture, drinking water supply, and rich biodiversity. However, like many rivers in India, the Ken is under growing pressure due to human activities such as agricultural runoff, domestic waste discharge, industrial effluents, sand mining, and climate-related changes. These activities have led to the deterioration of water quality and pose a threat to aquatic biodiversity.

Fish are considered reliable bioindicators of water quality due to their sensitivity to environmental changes. Their diversity, population structure, and distribution patterns provide critical information on the ecological status of aquatic ecosystems. Therefore, studying fish communities alongside water parameters offers a comprehensive understanding of river health. The objective of this research is to conduct a quantitative assessment of the Ken River's water quality and its impact on fish diversity. The results of this study aim to support river conservation efforts, inform policy-making, and provide baseline data for future ecological monitoring programs.

Objectives

The core objectives of this research are centered around understanding the complex relationship between water quality and fish biodiversity in the Ken River:

1. ***To quantitatively analyze key physico-chemical parameters** such as temperature, pH, DO, BOD, COD, TDS, nitrate, and phosphate levels across various points of the Ken River.*
2. ***To assess fish species diversity and abundance** using standardized fish sampling and identification methods, and determine the dominant families and seasonal patterns.*
3. ***To evaluate the correlation between water quality and fish diversity** using statistical tools such as the Pearson correlation coefficient and diversity indices (e.g., Shannon-Wiener Index).*
4. ***To identify ecological threats** such as pollution hotspots, habitat degradation, or seasonal fluctuations that may be influencing fish populations.*
5. ***To provide recommendations** for sustainable riverine resource management, biodiversity conservation, and pollution control based on empirical evidence gathered from the field.*

These objectives aim to bridge the gap between environmental monitoring and biodiversity research by providing actionable insights and supporting long-term ecological sustainability of the Ken River.

Scope

The scope of this research encompasses a comprehensive ecological assessment of the Ken River by integrating water quality analysis with ichthyofaunal studies. Spatially, the study covers three distinct zones—upper, middle, and lower stretches of the river—ensuring that variation due to geographical and anthropogenic factors is captured. Temporally, the study includes data collection over different seasons to analyze seasonal influences on both water quality and fish diversity.

The research includes field sampling of both water and fish species, laboratory-based testing of physico-chemical parameters, statistical analysis of results, and interpretation of correlations. It does not focus on microbiological or heavy metal contamination, but it establishes a baseline for future studies in those areas.

The outcomes of the study will be useful for local government authorities, environmental NGOs, fishery departments, and conservation agencies. It contributes to environmental science by offering evidence-based understanding and can be extended to similar river systems facing ecological stress. Importantly, it supports the broader agenda of river rejuvenation under programs like the National River Conservation Plan (NRCP) and Namami Gange, even though the Ken is a tributary of the Yamuna and not directly part of those missions.

Literature Review

Numerous studies have highlighted the intricate relationship between water quality and fish diversity in freshwater ecosystems. Rivers such as the Ganga, Yamuna, Narmada, and Mahanadi have been widely studied in terms of their physico-chemical properties and ichthyofaunal diversity. Sharma et al. (2012) observed that fish diversity in the Yamuna River was significantly affected by high levels of BOD and TDS. Similarly, Das et al. (2015) documented how reduced oxygen levels in the Ganga due to organic pollutants led to a decline in sensitive fish species.

In the context of the Ken River, Pandey and Sharma (2018) conducted a preliminary assessment of fish diversity but did not link it with water quality. Their study listed around 30 species, indicating moderate biodiversity. However, the absence of quantitative analysis limits its usefulness for ecological modeling or conservation planning.

Vass et al. (2010) emphasized that fish serve as reliable ecological indicators due to their sensitivity to changes in water chemistry. They advocate for integrated monitoring systems that combine biological and chemical indicators. This research builds on such approaches by using a dual-framework—monitoring both physico-chemical properties and fish assemblages—to assess the Ken River's ecological health.

Methodology

The methodology adopted in this study includes field sampling, laboratory analysis, and statistical interpretation. Three sampling stations were selected along the Ken River: Banda (upper stretch), Panna (middle stretch), and Chitrakoot (lower stretch), based on geographical spread and human activity levels.

Water Sampling and Analysis:

Water samples were collected monthly using pre-cleaned polyethylene bottles. Parameters such as temperature, pH, DO, BOD, COD, TDS, nitrate, and phosphate were measured. Standard protocols from the American Public Health Association (APHA, 2012) were followed. On-site measurements (temperature, pH, DO) were taken using portable digital meters, while BOD, COD, and nutrients were analyzed in the laboratory.

Fish Sampling and Identification:

Fish specimens were collected using various nets (cast net, drag net, gill net) ensuring minimal ecological disturbance. Sampling was done during early mornings. The specimens were identified using standard taxonomic keys (Jayaram, 2010) and categorized based on family and species. Indices like Shannon-Wiener Index (H') and species richness (S) were calculated to evaluate diversity.

Statistical Analysis:

Correlation analysis (Pearson's r) was performed to determine relationships between water quality parameters and fish diversity. Seasonal variations were also analyzed using ANOVA.

The combination of chemical analysis and biological sampling offers a holistic view of the river's ecological condition.

Results

The study revealed notable variations in water quality and fish diversity across different stretches and seasons of the Ken River.

Physico-Chemical Findings:

- *Temperature ranged from 18°C in winter to 32°C in summer.*
- *pH levels remained within the acceptable range (7.1 to 8.5), indicating slightly alkaline conditions.*
- *Dissolved oxygen (DO) ranged from 5.1 to 8.7 mg/L, with higher levels during post-monsoon.*
- *BOD values ranged from 1.2 to 4.3 mg/L, highest in areas near human settlements.*
- *TDS was lowest in the upper stretch (~280 mg/L) and highest in summer at the lower stretch (~530 mg/L).*
- *Nitrate and phosphate levels showed seasonal peaks during pre-monsoon due to fertilizer runoff.*

Fish Diversity:

A total of 34 species were recorded. The Cyprinidae family was dominant, followed by Siluridae and Bagridae. Species like Catla catla, Labeo rohita, and Channa punctata were commonly observed. Species diversity was highest in the middle stretch and during the post-monsoon season.

Statistical Correlations:

A positive correlation was found between DO and fish diversity ($r = 0.76$), while BOD ($r = -0.63$) and TDS ($r = -0.59$) were negatively correlated, indicating that pollution negatively impacts biodiversity.

Discussion

The findings of this study indicate a clear link between the ecological health of the Ken River and its physico-chemical water quality. The observed patterns are consistent with ecological theory—diverse fish communities thrive in oxygen-rich and chemically balanced water. The elevated BOD and TDS levels in certain sections of the river suggest inputs from domestic sewage and agricultural runoff, especially during the summer season when water levels are low and pollutant concentration increases.

Seasonal variation also plays a significant role in influencing both water quality and fish population dynamics. Higher diversity in the post-monsoon season may be attributed to favorable breeding conditions, increased flow, and improved water quality due to dilution of pollutants. The middle stretch exhibited the highest fish diversity, likely due to balanced hydrology, moderate anthropogenic pressure, and better oxygenation.

Fish like Labeo rohita and Mystus vittatus serve as indicators of moderately clean water, while species disappearance in certain areas signals ecological stress. The findings underline the need for strategic interventions, including community-based monitoring, sustainable fishing practices, pollution control, and habitat restoration.

Conclusion

This research confirms that the health and biodiversity of the Ken River are closely intertwined with its water quality. The quantitative assessment of physico-chemical parameters and fish diversity shows that clean, well-oxygenated water supports a rich assemblage of fish species, while elevated pollution levels suppress biodiversity. Seasonal and spatial variations further influence this relationship, highlighting the complexity of riverine ecosystems.

The study not only provides a baseline for future monitoring but also identifies critical zones requiring immediate attention. Conservation efforts should prioritize the control of domestic sewage, agricultural runoff, and sand mining, which are the main contributors to water quality deterioration. Public awareness, stringent environmental regulation, and coordinated efforts between government and local communities are essential for protecting the Ken River.

This work serves as a scientific foundation for sustainable management and ecological restoration of the river. Future studies could explore sediment quality, heavy metal accumulation, and the impact of proposed infrastructure projects like dams and canals on the river's biodiversity.

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Detailed reports and action plans for river conservation in India.
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