WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Physicochemical and Biological Assessment of the Son River in Madhya Pradesh, India

Rashmi Shukla[1], Dr Amit Tiwari[2]

[1]Ph.D Scholar
[2]HOD Zoology, APS University

Abstract

This study presents a comprehensive assessment of the physicochemical and biological parameters of the Son River, covering a 209-kilometer stretch within Madhya Pradesh. Ten strategically selected sampling sites were analyzed to understand the river's environmental conditions and ecological health. Parameters such as water color, pH, turbidity, water temperature, dissolved oxygen (DO), CO2, alkalinity, and total hardness were measured. Additionally, fish diversity was evaluated using the Shannon Diversity Index. The findings highlight the river's seasonal variations and provide critical insights into its ecological status, contributing to effective water quality management and conservation efforts.

Introduction

Rivers are vital freshwater resources that support diverse ecosystems and human activities. The Son River, a major tributary of the Ganges, flows through Madhya Pradesh, India, and sustains various ecological and socioeconomic functions. This study aims to assess the physicochemical and biological characteristics of the Son River, providing a detailed analysis of water quality and fish diversity.

Materials and Methods

Study Area and Sampling Sites

Ten sampling sites along the 209-kilometer stretch of the Son River in Madhya Pradesh were selected to represent various ecological conditions and anthropogenic influences. A consistent distance of approximately ±5 kilometers was maintained between each site to ensure thorough coverage of the river's characteristics.

Physicochemical Parameters

Water samples were collected monthly and analyzed for the following parameters:

- **Water Color:** Observed visually, ranging from bluish green to brownish green.
- **pH:** Measured using a pH meter, with values ranging from 7.1 to 8.5.
- **Turbidity:** Determined using a turbidimeter, with seasonal variations recorded.
- **Water Temperature:** Measured using a thermometer, showing seasonal patterns.
- **Dissolved Oxygen (DO):** Measured using a DO meter, with values fluctuating seasonally.
- **CO2:** Analyzed using titration methods.
- **Alkalinity:** Measured using titration methods.
- **Total Hardness:** Determined using EDTA titration.

Statistical Analysis

Standard deviation, mean, and variance were calculated for each parameter to assess variability and stability within the sample population.

Biological Parameters

Fish diversity was assessed using the Shannon Diversity Index (H'), evenness, richness, and the total number of individuals. Fish samples were collected and identified, covering 44 species from 18 families across 8 orders.

Results and Discussion

Physicochemical Parameters

Water Color

Water color varied seasonally, influenced by sedimentation, algae growth, and anthropogenic activities. It transitioned from bluish green to brownish green during early months, became clear in May and June, and turned light muddy or light green towards the end of the year.

pH

The pH levels ranged from 7.1 to 8.5, indicating slightly alkaline to neutral conditions suitable for aquatic life. Higher pH values were observed during warmer months (April to July) and lower values during cooler months (January to March and November to December).

Turbidity

Turbidity levels peaked during the monsoon months (July to September) due to increased sedimentation and suspended solids from heavy rainfall and runoff. Lower turbidity values were recorded during the drier months (November to May).

Water Temperature

Water temperature followed a seasonal pattern, with the highest temperatures observed in June and the lowest in December and January.

Dissolved Oxygen (DO)

DO levels were higher during cooler months and lower during warmer months, influenced by temperature, biological activity, and water flow dynamics.

CO2

Carbon dioxide levels varied seasonally, with higher concentrations during warmer months and lower concentrations during cooler months, affecting water quality and aquatic organisms.

Alkalinity

Alkalinity levels fluctuated seasonally but remained within a moderate range throughout the year, influenced by geological factors and anthropogenic inputs.

Total Hardness

Total hardness levels showed variability across different months, influenced by mineral content and water flow dynamics.

Statistical Analysis

- **pH:** Moderate variability with a standard deviation of 0.42, mean of 7.53, and variance of 0.18.
- **Turbidity:** Significant variability with a standard deviation of 111.88, mean of 474.16, and variance of 12517.42.
- **Water Temperature:** Moderate variability with a standard deviation of 4.20, mean of 24.75°C, and variance of 17.65.
- **Dissolved Oxygen:** Moderate to high variability with a standard deviation of 1.62, mean of 7.1 mg/L, and variance of 2.64.
- **CO2:** Moderate variability with a standard deviation of 0.83, mean of 1.06 PPM, and variance of 0.70.
- **Alkalinity:** Significant variability with a standard deviation of 38.37, mean of 290 PPM, and variance of 1472.72.
- **Total Hardness:** Moderate variability with a standard deviation of 26.09, mean of 165.83 mg/L, and variance of 681.06.

Fish Diversity

Forty-four species of fish were identified, belonging to 18 families across 8 orders. The Shannon Diversity Index (H') was 3.67, indicating high diversity. Evenness was 0.995, suggesting a balanced distribution of individuals among species. Richness (number of species) was 44, and the total number of individuals recorded was 1440.

Discussion:

The study area encompasses ten strategically selected sampling sites along the 209-kilometer stretch of the Son River within Madhya Pradesh. These sites were chosen to represent a spectrum of ecological conditions and anthropogenic influences, ensuring a holistic understanding of the river's dynamics. The collaboration between the MP Shahdol regional office and the MP Pollution Control Board regional office lends credibility and support to the study's framework and implementation, reinforcing its significance in advancing our understanding of aquatic ecosystems in the region. Through this interdisciplinary approach, we endeavor to contribute valuable insights into the environmental conditions and ecological health of the Son River, laying the groundwork for informed conservation and management strategies. pH levels remained relatively stable throughout the year, ranging from 7.0 to 8.1. These values indicate slightly alkaline to neutral conditions, conducive to supporting aquatic life. However, the variability in pH, as indicated by the high standard deviation and variance, suggests significant fluctuations within the sample population, possibly influenced by factors such as organic matter decomposition, nutrient inputs, and photosynthetic activity. Turbidity levels exhibited pronounced seasonal variations, peaking during the monsoon season and declining during the dry season. High turbidity values during the monsoon months indicate increased sedimentation and suspended solids in the water, likely due to runoff and erosion. These fluctuations in turbidity can affect light penetration, water clarity, and sediment deposition, impacting aquatic habitats and species. Water temperature followed a typical seasonal pattern, with warmer temperatures observed during the summer months and cooler temperatures during the winter months. These variations in temperature influence biological processes, metabolic rates, and species distributions within aquatic ecosystems. The moderate variability in water temperature, indicated by the standard deviation and variance, suggests relatively stable thermal conditions within the study area. Dissolved oxygen (DO) levels exhibited seasonal fluctuations, with higher values during the cooler months and lower values during the warmer months. Adequate DO levels are crucial for supporting aquatic organisms' respiration and metabolism, and variations may be influenced by factors such as temperature, biological activity, and water flow dynamics. Carbon dioxide (CO2) levels showed some variability throughout the year, with higher concentrations observed during the warmer months and lower concentrations during the cooler months. Elevated CO2 levels can impact water quality and aquatic organisms, potentially affecting pH levels and oxygen solubility. Alkalinity and total hardness levels fluctuated seasonally but generally remained within a moderate range throughout the year. These parameters play essential roles in buffering pH changes, maintaining chemical equilibrium, and supporting aquatic life. The moderate variability in alkalinity and hardness suggests relatively stable water chemistry conditions within the study area. Overall, the analysis of physicochemical parameters provides valuable insights into the seasonal dynamics and ecological conditions of the Son River, highlighting the complex interactions between environmental factors and aquatic ecosystems' health and resilience. pH levels showed slight fluctuations throughout the year, remaining within the range of 7.1 to 8.1. Despite these variations, the relatively low standard deviation and variance indicate a stable pH level within the sample population, conducive to supporting aquatic life. However, the pH tended to be higher during warmer months and lower during cooler months, reflecting seasonal influences on water chemistry.

Turbidity levels exhibited pronounced seasonal variations, peaking during the monsoon months and declining during the drier months. High turbidity values suggest increased sedimentation and suspended solids in the water, likely driven by heavy rainfall and runoff during the monsoon season. These fluctuations in turbidity can affect light penetration, water clarity, and sediment deposition, influencing the overall habitat quality. Water temperature followed a typical seasonal pattern, with warmer temperatures recorded during the summer months and cooler temperatures during the winter months. These variations influence biological processes, metabolic rates, and species distributions within aquatic ecosystems, highlighting the importance of thermal regimes in shaping ecosystem dynamics. Dissolved oxygen (DO) levels fluctuated seasonally, with higher values generally observed during the cooler months and lower values during the warmer months. Adequate DO levels are essential for supporting aquatic organisms' respiration and metabolism, with variations likely influenced by temperature, biological activity, and water flow dynamics. Carbon dioxide (CO2) levels varied throughout the year, with higher concentrations observed during the warmer months and lower concentrations during the cooler months. Elevated CO2 levels can impact water quality and aquatic organisms, potentially affecting pH levels and oxygen solubility, thereby influencing ecosystem health.

Alkalinity and total hardness levels fluctuated seasonally but generally remained within a moderate range throughout the year. These parameters play essential roles in buffering pH changes, maintaining chemical equilibrium, and supporting aquatic life, with fluctuations likely influenced by both natural processes and human activities. Overall, the analysis of physicochemical parameters at Point-02 provides valuable insights into the seasonal dynamics and water quality variations in the Son River, underscoring the complex interactions between environmental factors and aquatic ecosystem health. These findings contribute to a comprehensive understanding of the river's ecological condition and inform management and conservation efforts aimed at preserving its biodiversity and ecosystem services. The estimation of Pollution Index (PI) values for selected heavy metals in water samples from the Son River provides critical insights into the extent of contamination and its implications for aquatic ecosystems and human health. By comparing concentrations of heavy metals in pre- and post-monsoon samples, the PI values serve as a quantitative measure to assess the pollution levels and inform remediation strategies. For zinc (Zn), the PI values ranging from approximately 0.037 to 0.274 indicate that the concentration of zinc in the post-monsoon samples is lower than in the pre-monsoon samples, suggesting an absence of pollution. Similarly, for copper (Cu) and chromium (Cr), all PI values are less than 1, indicating no pollution, and affirming the unpolluted status of water concerning these metals. However, the interpretation varies for iron (Fe) due to the presence of PI values both below and above 1. While most PI values are less than 1, signifying a decrease in iron concentration in the post-monsoon samples, one PI value exceeds 1, indicating an increase in iron concentration. Further analysis is required to understand the underlying factors contributing to this variability and assess the overall status of iron contamination accurately. The analysis underscores the importance of monitoring heavy metal pollution in water bodies, as elevated concentrations can have detrimental effects on aquatic organisms and ecosystem health. By employing the Pollution Index as a diagnostic tool, policymakers and environmental authorities can prioritize remedial actions and implement targeted measures to mitigate pollution and safeguard water quality. In addition to heavy metal contamination, the presence of diverse fish species in the Son River highlights the rich biodiversity and ecological significance of the freshwater ecosystem. With forty-four species belonging to eighteen families across eight different orders, the river supports a wide range of fish with various ecological roles and economic values. Understanding the distribution and abundance of fish species provides valuable information for conservation efforts and sustainable management practices aimed at preserving aquatic biodiversity and maintaining ecosystem integrity. On the basis of standard deviation, mean, and variance provides valuable insights into the population characteristics of various fish species in the Son River. Gidusiachapra, for instance, exhibits a moderate total count with relatively low standard deviation, indicating moderate variability in the counts across samples, and a mean population size of 5.2 individuals per sample. Conversely, Notopteruschitala demonstrates a lower total count with a high standard deviation, suggesting considerable variability in counts across samples, with a mean population size of 3.11 individuals per sample. Several species, such as Amblypharyngodon mola and Catla catla, display moderate total counts with either low or moderate standard deviations, indicating relatively consistent population sizes across samples. Others, like Setipinnaphasa and Puntius conchonius, show moderate total counts with higher standard deviations, signifying significant variability in population sizes. Furthermore, some species, including Labeocalbasu and Wallago attu, exhibit moderate total counts with higher standard deviations, indicating substantial variability in population sizes across samples. Conversely, species like Mystustengara and Clupisomagarua demonstrate lower total counts with very low standard deviations, indicating minimal variability in population sizes. The mean population sizes across different species range from as low as 0.24 individuals per sample for Amphiponuscuchia to as high as 4.7 individuals per sample for Cirrhinusmrigala. This variation in mean population sizes reflects the diverse ecological roles and abundance levels of different fish species within the Son River ecosystem. Overall, this analysis highlights the complex dynamics of fish populations in the Son River, emphasizing the need for comprehensive monitoring and management strategies to ensure the conservation and sustainable management of aquatic biodiversity in the region. The analysis of fish diversity indices in the Son River ecosystem provides valuable insights into the structure and composition of the fish community. The Shannon diversity index, a widely-used metric in ecology, quantifies the diversity of species within the community by considering both species richness and evenness. With a calculated value of 3.67, the Shannon diversity index indicates a high level of species diversity within the community, reflecting the presence of a diverse array of fish species. Evenness, another important aspect of diversity, measures how evenly individuals are distributed among species within the community. A value of 0.995 suggests a high level of evenness, indicating a relatively uniform distribution of individuals across the 44 species present in the community. This balanced distribution contributes to the overall stability and resilience of the ecosystem. The richness of the community, represented by the total number of species present, is reported to be 44. This indicates a diverse assemblage of fish species inhabiting the Son River, highlighting the ecological significance of the area as a habitat for a wide variety of aquatic organisms. Furthermore, the total number of individuals recorded in the dataset, totaling 1440, underscores the substantial population size within the fish community. This abundance of individuals across different species reflects the productivity and ecological health of the ecosystem. The average population size, calculated to be 32.72 individuals per species, provides additional insights into the distribution of individuals within the community. This metric indicates the average abundance of each species, further contributing to our understanding of the relative importance of different species within the ecosystem. Overall, the combination of these diversity indices paints a comprehensive picture of the fish community in the Son River, highlighting its richness, evenness, and overall diversity. These findings are essential for informing conservation strategies and management efforts aimed at preserving the biodiversity and ecological integrity of the river ecosystem.

The correlation coefficients extracted from the dataset shed light on the intricate relationships among the variables under study. The Shannon Diversity Index, a metric of ecological diversity, exhibits a notable positive correlation with pH and calcium, implying that environments with higher pH levels and calcium concentrations tend to harbor greater ecological diversity. Conversely, the index shows negative associations with TDS, temperature, chloride, and sulphate, suggesting that elevated levels of these factors may suppress biodiversity. pH emerges as a pivotal factor, positively correlating with both Shannon Diversity Index and conductivity while exhibiting a strong negative correlation with chloride. Conductivity, in turn, demonstrates a robust positive correlation with temperature and moderate positive associations with sulphate, indicating a potential rise in environmental conductivity with increasing temperature. TDS, inversely related to both Shannon Diversity Index and temperature, showcases strong negative correlations with chloride and sulphate, suggesting intricate interactions between dissolved solids and specific ions. Moreover, intriguing patterns emerge between ion concentrations, with sodium and potassium displaying a strong positive correlation, mirroring the interplay between salinity and potassium levels. These findings hint at interconnected dynamics within aquatic systems, where changes in one variable may cascade through others, influencing ecosystem health and management strategies. In conclusion, these correlations offer valuable insights into the complex web of environmental interactions, laying the groundwork for informed decision-making in ecosystem conservation and management. However, further investigation and contextual understanding are essential to decipher the underlying mechanisms and broader ecological implications of these relationships.

Conclusion

This study provides a detailed assessment of the physicochemical and biological parameters of the Son River in Madhya Pradesh. The findings highlight seasonal variations in water quality and the high diversity of fish species, underscoring the ecological importance of the river. These insights are crucial for effective water quality management, conservation efforts, and sustainable utilization of the river's resources

Reference

1. Dimowo, B.O., et al. "Assessment of some physico-chemical parameters of River Ogun (Abeokuta, Ogun State, southwestern Nigeria) in comparison with national and international standards." International Journal of Aquaculture, vol. 3, no. 15, 2013, pp. 79-84.
2. Kirk O. Winemiller, et al. "Fish Assemblage Structure in Relation to Environmental Variation among Brazos River Oxbow Lakes." Transactions of the American Fisheries Society, vol. 129, 2000, pp. 451–468.
3. A.M. Nikanorov, et al. "Water Chemical Composition Of Rivers, Lakes And Wetlands." Types and Properties of Water, vol. II, edited by A.M. Nikanorov and L.V. Brazhnikova.
4. William J. Matthews, et al. "Influence of Physico-Chemical Factors on Habitat Selection by Red Shiners, Notropislutrensis (Pisces: Cyprinidae)." Vol. 1979, no. 1, Feb. 20, 1979, pp. 70-81.
5. Jhingran, V.G. Fish and Fisheries of India, 1st and 2nd ed., Hindustan Publishing Corporation, Delhi, India, 1975.
6. Agarwal, P.K. "A review of Ganga river pollution-reasons and remedies." Journal of Indian Water Resources Society, vol. 35, no. 3, 2015, pp. 46-52.
7. CPCB 2009 and 2013, Pollution Assessment: River Ganga, Central Pollution Control Board MoEF July. Suthar, A.K., Nema, M., Chabukdhara, S.K., Gupta, A. "Assessment of metals in water and sediments of Hindon river, India: impact of industrial and urban discharges." Journal of Hazardous Materials, vol. 171, 2009, pp. 1088-1095.
8. Hejabi, A.T., Basavarajappa, H.T., Karbassi, A.R., Monavari, S.M. "Heavy metal pollution in water and sediments in the Kabini river, Karnataka, India." Environmental Monitoring and Assessment, vol. 182, 2011, pp. 1-3.
9. Lokhande, R.S., Singare, P.U., Pimple, D.S. "Pollution in water of Kasardi river flowing along Taloja industrial area of Mumbai, India." World Environment, vol. 1, 2011.
10. Motwani, M.P., and A. David. "Fishes of the river Sone with observations on the Zoogeographical Significance." Journal of the Zoological Society of India, vol. 9, no. 1, 1957, pp. 9-15.