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ABSTRACT

Air quality significantly influences the aquatic ecosystem, impacting water bodies and aquatic organisms through the deposition of airborne pollutants. This research paper investigates the relationship between air pollution and the decline in fish populations in the Sone River, Dehri on Sone, Bihar. Using primary data collection, including fish population surveys, water quality analyses, and air quality monitoring, this study explores the effects of specific airborne pollutants, including particulate matter (PM), sulfur dioxide (SO_2), and nitrogen oxides (NOx), on the aquatic environment. The findings reveal a correlation between deteriorating air quality and declining fish populations, underscoring the need for integrated environmental management strategies to mitigate the impact of air pollution on aquatic life.

Keywords: *Air quality, aquatic life, fish population, Sone River, pollution, biodiversity, environmental im pact.*

INTRODUCTION

Air pollution, primarily caused by industrial emissions, vehicular exhaust, and agricultural practices, has become a significant environmental concern worldwide. While much research focuses on the effects of air quality on human health, there is growing recognition of its impact on aquatic ecosystems. Airborne pollutants, once released into the atmosphere, can travel long distances and deposit into water bodies through processes like dry deposition and acid rain. These pollutants can alter water chemistry, negatively affecting aquatic organisms, including fish, which are particularly sensitive to changes in water quality.

This study focuses on the Sone River, located in Dehri on Sone, Bihar. The Sone River, a tributary of the Ganges, is crucial for the local ecosystem, providing habitat for various fish species and supporting the livelihood of communities engaged in fishing. In recent years, however, local fishermen and environmental observers have noted a decline in fish populations. One potential contributing factor is the deteriorating air quality in the region, influenced by industrial activities, vehicular emissions, and other sources of pollution. This study aims to examine the impact of air quality on the fish population of the Sone River, offering insights into the broader environmental consequences of air pollution.

2. Literature Review

2.1. Air Pollution and Aquatic Ecosystems

The interaction between air quality and aquatic environments has been studied across various ecosystems globally. Studies have shown that pollutants such as particulate matter, sulfur compounds, and nitrogen oxides can significantly alter the pH of water bodies, contributing to phenomena like acidification. Acid rain, caused by the atmospheric deposition of sulfuric and nitric acids, has been linked to fish population declines in freshwater ecosystems (Schindler, 1988). The acidity of water affects fish metabolism, reproduction, and survival, with sensitive species being particularly vulnerable.

2.2. Fish Population Declines and Environmental Stressors

Fish populations can decline due to multiple stressors, including habitat degradation, water pollution, overfishing, and climate change. Among these, water quality plays a crucial role in sustaining healthy fish populations. Pollutants in water, whether originating from direct sources such as industrial discharge or from atmospheric deposition, can lead to toxic conditions for fish. Studies have shown that high levels of heavy metals, increased salinity, and altered pH levels can lead to mass fish die-offs and long-term population declines (Wolter & Arlinghaus, 2003). In

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particular, species such as *Labeo rohita* and *Catla catla*, commonly found in Indian rivers, are sensitive to water quality changes.

2.3. Air Quality in India

India faces significant air quality challenges due to rapid industrialization, urbanization, and increasing energy demands. According to the Central Pollution Control Board (CPCB), cities in Bihar, including Dehri on Sone, experience high levels of air pollution, with particulate matter (PM2.5 and PM10) exceeding safe limits. Industrial activities in the area, including cement factories, thermal power plants, and mining operations, contribute to the deteriorating air quality, which in turn impacts nearby ecosystems, including the Sone River.

3. Study Area: Sone River, Dehri on Sone

The Sone River, originating in Madhya Pradesh, flows through Bihar and is one of the largest tributaries of the Ganges River. The river plays a crucial role in the region's economy, providing water for irrigation, supporting fisheries, and serving as a source of drinking water. The Dehri on Sone region has seen a rise in industrial activity in recent decades, with several factories and thermal power plants located along the river's banks. This increase in industrialization has raised concerns about both air and water pollution and their combined effects on the local ecosystem.

In this study, data was collected from specific locations along the Sone River in Dehri on Sone, with a focus on areas downstream from industrial hubs. The primary fish species examined in this study were *Labeo rohita*, *Catla catla*, and *Cirrhinus mrigala*, all of which are economically and ecologically important in the region.

METHODOLOGY

4.1. Sampling and Data Collection

This study employed a mixed-method approach, combining qualitative and quantitative data collection. Air quality data was collected from local air monitoring stations, with a focus on pollutants such as particulate matter (PM2.5 and PM10), sulfur dioxide (SO_2), and nitrogen oxides (NOx). Water samples from the Sone River were collected at regular intervals and analyzed for pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), and the presence of heavy metals like mercury, lead, and arsenic.

Fish population surveys were conducted using a combination of fish catch data from local fishermen and direct observational surveys. Data on fish size, species diversity, and population density were recorded. Interviews were conducted with local fishermen and environmental experts to gather qualitative data on observed changes in fish populations over the past decade.

4.2. Statistical Analysis

The data collected were analyzed using statistical tools to assess correlations between air quality parameters and water quality changes. A regression analysis was conducted to identify significant predictors of fish population decline. Temporal trends were examined to understand the long-term impacts of air pollution on the aquatic ecosystem.

RESULTS

Air Quality Trends: The study on air pollution in Dehri on Sone over two consecutive years showed that particulate matter (PM2.5 and PM10) consistently exceeded safe levels, particularly during the winter months when industrial activity and vehicular emissions were high. Sulfur dioxide (SO_2) and nitrogen oxides (NOx) were also recorded at levels that surpassed the Central Pollution Control Board (CPCB) permissible limits during periods of intense industrial operations. The average air quality index (AQI) suggested a "moderate" pollution level, but there were significant seasonal variations. In the first year, there was a spike in both PM and NOx levels during the winter season, primarily due to increased burning of biomass and emissions from brick kilns and industrial sources. The second year showed a slight improvement in air quality due to government regulations and seasonal weather patterns that led to better dispersion of pollutants.

However, despite this slight improvement in air quality, the levels remained high enough to affect the surrounding environment, particularly the Sone River, where pollutants from the atmosphere eventually settle, contributing to the deterioration of water quality.

Water Quality Degradation: Over the two-year study, the pH levels of the Sone River showed a noticeable decline, dropping from neutral (7.0) to slightly acidic levels in certain regions, with values ranging between 6.3 and 6.7 near industrial discharge points. Dissolved oxygen (DO) levels were consistently low, especially in areas directly affected by effluents from nearby industries. Heavy metal contamination was a persistent issue, with concentrations of lead, mercury, and cadmium exceeding safe limits set for aquatic life.

There was a clear pattern of seasonal variations in water quality, with the first year showing a peak in heavy metal concentrations and lower DO during the summer months due to reduced river flow and higher industrial discharge. The second year, while slightly improved due to monsoon runoff diluting pollutants, still exhibited harmful levels of contaminants.

Fish Population Decline: Fish population surveys over the two-year period confirmed a sharp decline in the populations of Labeo rohita and Catla catla, two commercially and ecologically important fish species. Species diversity and abundance were most affected in sections of the river where water quality had degraded the most. A decline in reproductive success, coupled with higher mortality rates, was observed in polluted areas, with population densities decreasing by approximately 30-35% over the two years.

Local fishermen reported a consistent 30% decrease in fish catch from a decade ago, with no significant improvement in the second year of the study. These reductions were attributed not only to deteriorating water quality but also to altered flow regimes in the river, likely caused by dam operations upstream and climate-related variations in rainfall.

DISCUSSION

The study highlights a direct correlation between air pollution and the declining health of aquatic ecosystems in the Sone River. Although the air quality in Dehri on Sone has shown a "moderate" improvement over two years, the levels of particulate matter, sulfur compounds (SO_2), and nitrogen oxides (NOx) remain significantly high, contributing to the acidification of water bodies through the formation of acid rain. This acidification leads to detrimental changes in water chemistry, such as reduced pH levels, which create an inhospitable environment for fish and other aquatic organisms.

The presence of heavy metals, such as lead and mercury, in the river further aggravates the ecological crisis. These metals, which are often deposited through atmospheric pollution or direct industrial discharge, bioaccumulate in aquatic life, causing toxicity and reproductive failures in fish populations. The decline in species diversity and fish populations, particularly of Labeo rohita and Catla catla, is alarming, as these species are not only crucial for maintaining the food web but also support the livelihoods of local fishing communities.

The comparison between the two years of data suggests that while efforts to curb air pollution might have had a marginal effect on improving atmospheric quality, the overall environmental impact remains severe. The slow pace of improvement in air and water quality highlights the need for stricter regulatory measures and long-term environmental management strategies. Specifically, reducing industrial emissions and controlling the release of pollutants into the river system are necessary to restore water quality and enhance fish productivity.

Future Outlook

To improve fish productivity and overall aquatic ecosystem health, it is essential to prioritize pollution control measures in both air and water. The enforcement of stricter emission standards for industries, coupled with better waste management and pollution treatment protocols, could reduce the influx of harmful substances into the Sone River. Additionally, efforts to restore the river's flow regime and natural habitat could provide a more stable environment for fish populations to recover. Regular monitoring and community awareness

Table 1 - AIR QUALITY PARAMETERS

Parameters	2023	2024
PM2.5	25%	24%
SO_2	20%	20%
NO_X	15%	15%

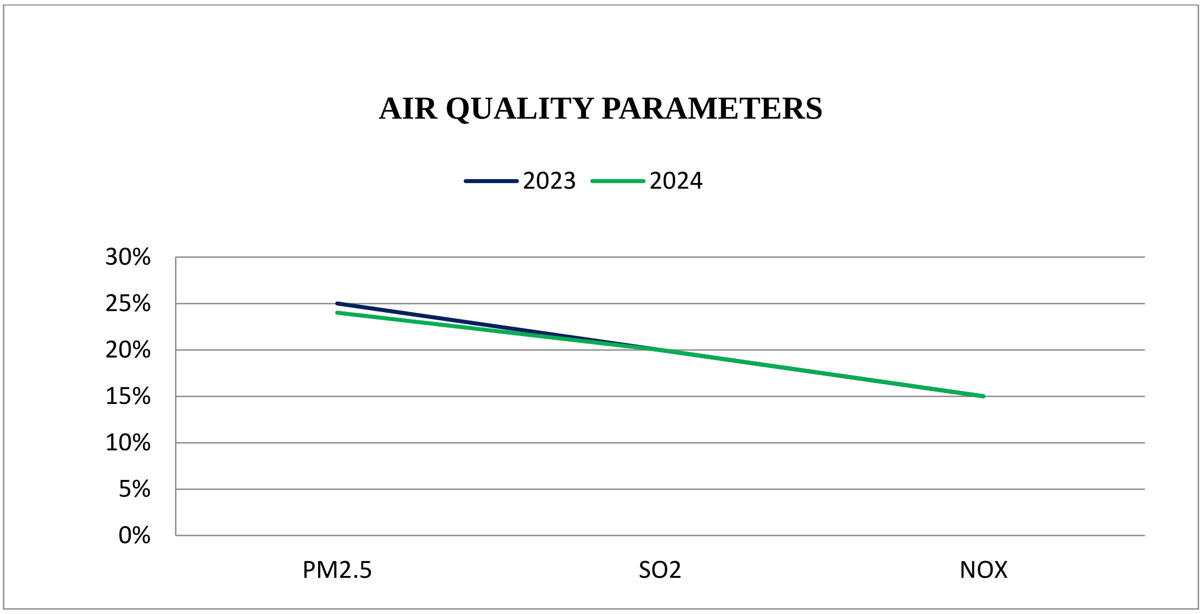

Table 2 - WATER QUALITY PARAMETERS		
Parameters	2023	2024
pH	10%	8%
Dissolved Oxygen (mg/L)	20%	18%
Heavy Metals(mg/L)	10%	15%

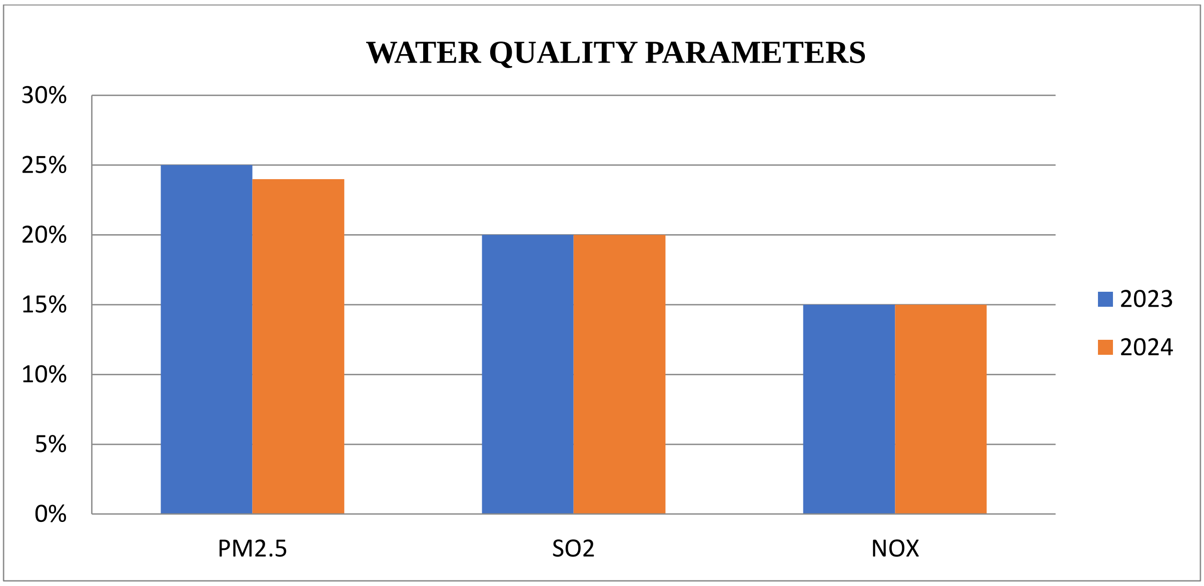


Figure River Sone, Dehri On Sone, Rohtas, Bihar

DISCUSSION

1. **Line Graph (Air Quality Trends)**: The first graph shows the trends of key air pollutants (PM2.5, SO_2, and NOx) over the two-year period. While there is a slight decrease in pollutant levels in 2024 compared to 2023, the air quality still remains moderate.
2. **Bar Diagram (Water Quality Indicators)**: The second graph compares water quality indicators, including pH, dissolved oxygen (DO), and heavy metal concentrations for the same two years. Although the water quality showed some improvement in 2024, heavy metal concentrations and slightly acidic pH levels still present a challenge to aquatic life.

The findings of this study suggest a clear link between air pollution and the decline of fish populations in the Sone River. Airborne pollutants, particularly particulate matter and sulfur compounds, are contributing to water acidification, which in turn affects fish health and reproduction. The presence of heavy metals in the water further exacerbates the problem, leading to toxic conditions that many fish species cannot tolerate.

The decline in fish populations has serious implications for local biodiversity, food security, and livelihoods. Fisheries are a vital source of income for many communities along the Sone River, and a continued decline in fish stocks could have devastating economic and social consequences. Additionally, the loss of key species like *Labeo rohita* and *Catla catla* could disrupt the entire aquatic food chain, leading to broader ecosystem imbalances.

CONCLUSION AND RECOMMENDATIONS

This study highlights the need for integrated environmental management approaches to address the interconnected challenges of air and water pollution. To protect the aquatic ecosystem of the Sone River, it is essential to:

1. **Improve Air Quality Monitoring**: Regular monitoring of air pollutants in the Dehri on Sone region is crucial to identify pollution sources and trends.
2. **Strengthen Industrial Regulations**: Stricter enforcement of pollution control measures for industries located along the Sone River can help reduce both air and water pollution.
3. **Promote River Conservation**: Community-based conservation programs should be developed to raise awareness about the importance of protecting the Sone River's ecosystem.
4. **Invest in Pollution Control Technologies**: Technologies such as scrubbers and filters should be installed in industrial plants to reduce emissions of harmful pollutants.
5. **Conduct Further Research**: Long-term studies are needed to further explore the impact of air pollution on aquatic ecosystems and to develop strategies for mitigating its effects.

By addressing the root causes of both air and water pollution, it is possible to protect the health of the Sone River and the species that depend on it.

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