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Water Pollution in Two Canals Across the Ajay River Due to Coal Mining: A Seasonal Analysis

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Abstract - Coal mining activities significantly contribute to the degradation of water quality, especially in areas close to mining operations. This study examines the water quality in two different canals across the Ajay River, assessing seasonal variations in physicochemical parameters and heavy metal concentrations during the rainy, winter, and summer seasons. Parameters such as pH, turbidity, conductance, hardness, alkalinity, total solids, and concentrations of heavy metals including arsenic, iron, zinc, and others were evaluated. Results indicate that water pollution fluctuates seasonally, with the highest contamination observed in the rainy season. These findings underscore the need for continuous monitoring and effective water management strategies to mitigate the adverse effects of coal mining on water quality.

Keywords - Water pollution, Ajay River, coal mining, physicochemical parameters, heavy metals, seasonal variation

INTRODUCTION

Water pollution from industrial activities, particularly coal mining, has become a critical environmental issue, especially in riverine ecosystems. Coal mining generates large amounts of pollutants, including heavy metals and other toxic substances, which can degrade water quality and impact aquatic life (Chakraborty et al., 2020). The Ajay River, located in West Bengal and Jharkhand, India, is heavily affected by coal mining runoff, particularly in canals that provide water for agriculture and human consumption (Das & Ghosh, 2021).

This study focuses on two canals along the Ajay River that are subject to contamination due to their proximity to coal mining sites. Water samples were collected from these canals during the rainy, winter, and summer seasons to assess variations in key water quality parameters. This research aims to evaluate the extent of water pollution caused by coal mining and its seasonal variations, with an emphasis on physicochemical and microbial contamination.

II. MATERIALS AND METHODS

Water samples were collected from two different canals along the Ajay River during three seasons: rainy, winter, and summer. Standard procedures were followed to measure various physicochemical parameters such as pH, temperature, turbidity, electrical conductance, hardness, alkalinity, total solids, and concentrations of heavy metals like arsenic, iron, zinc, chromium, and others. Biological parameters such as chemical oxygen demand (COD), biological oxygen demand (BOD), dissolved oxygen (DO), and total coliform counts were also analyzed following methods described by the American Public Health Association (APHA, 2017).

III. RESULTS AND DISCUSSION

Rainy Season

During the rainy season, significant variations in water quality were observed between the two canals. The pH values for Canal 1 and Canal 2 were recorded at 7.13 and 7.02, respectively, indicating neutral to slightly acidic conditions. The water temperature was higher in Canal 1 (32.7°C) compared to Canal 2 (29.8°C). Turbidity values remained high in both canals at 20.0 NTU, which can be attributed to surface runoff and increased sediment load due to rainfall.

Electrical conductance was measured at 138 µS/cm for Canal 1 and 112 µS/cm for Canal 2, indicating moderate ion concentration. Hardness values were 39.4 mg/L for Canal 1 and 30 mg/L for Canal 2, likely due to dissolved calcium and magnesium ions from coal mining effluent. Alkalinity was found to be 65.1 mg/L in Canal 1 and 57.1 mg/L in Canal 2. Total solids were higher in Canal 1 (87.7 mg/L) compared to Canal 2 (61.2 mg/L).

Heavy metal concentrations, including arsenic, zinc, chromium, and lead, were all below detection limits in both canals (<0.01 mg/L), except for iron, which was detected at 0.01 mg/L in both canals. Biological parameters such as COD were recorded at 5.0 mg/L and 7.0 mg/L in Canals 1 and 2, respectively. BOD values were consistent at 2 mg/L in both canals, while dissolved oxygen (DO) levels were 6.1 mg/L in Canal 1 and 5.9 mg/L in Canal 2. The total coliform counts were

recorded at 1 x 10^2 CFU/100 mL in both canals, indicating moderate microbial contamination.

Winter Season

In the winter season, water quality improved compared to the rainy season. The pH levels increased to 8.15 in Canal 1 and 7.27 in Canal 2, reflecting more basic water conditions. Temperatures dropped to 26.6°C in both canals. Turbidity was negligible in Canal 1 (0.0 NTU) but remained high in Canal 2 (25.0 NTU), possibly due to reduced water flow in Canal 1 during winter.

Conductance values increased to 182 µS/cm in Canal 1 and 177 µS/cm in Canal 2. Hardness values were recorded at 47.9 mg/L in Canal 1 and 38.2 mg/L in Canal 2, reflecting increased concentrations of dissolved minerals due to reduced water volumes. Alkalinity decreased to 61.4 mg/L in Canal 1 and 49.5 mg/L in Canal 2, while total solids were 116.3 mg/L in Canal 1 and 73.2 mg/L in Canal 2.

Heavy metal concentrations remained below detection limits for arsenic, zinc, chromium, and lead (<0.01 mg/L). COD values were higher in Canal 1 (8.0 mg/L) compared to Canal 2 (4.0 mg/L), while BOD decreased to 2 mg/L in Canal 1 and 1 mg/L in Canal 2. DO levels remained similar at 5.7 mg/L in Canal 1 and 5.8 mg/L in Canal 2. Coliform counts increased to 2 x 10^2 CFU/100 mL in Canal 1 and 1.7 x 10^2 CFU/100 mL in Canal 2, indicating higher microbial contamination in Canal 1.

Summer Season

During the summer season, water quality remained stable with some slight variations. The pH values were recorded at 7.19 for Canal 1 and 7.04 for Canal 2. Water temperatures increased to 32.0°C in Canal 1 and 32.5°C in Canal 2. Turbidity values decreased to 7.0 NTU in Canal 1 and 1.0 NTU in Canal 2, reflecting clearer water conditions.

Electrical conductance values were recorded at 151 µS/cm in Canal 1 and 150 µS/cm in Canal 2, while hardness increased slightly to 44.8 mg/L in Canal 1 and 44.2 mg/L in Canal 2. Alkalinity values were 88.7 mg/L in Canal 1 and 86.7 mg/L in Canal 2. Total solids were measured at 106.2 mg/L in Canal 1 and 96.2 mg/L in Canal 2.

Heavy metal concentrations for arsenic, zinc, chromium, lead, and cadmium remained below detection limits, similar to previous seasons. COD values were consistent at 5.0 mg/L for both canals, while BOD values remained at 2 mg/L. DO levels were recorded at 5.7 mg/L in Canal 1 and 5.8 mg/L in Canal 2. The total coliform counts were 1.2 x 10^2 CFU/100 mL in Canal 1 and 1.1 x 10^2 CFU/100 mL in Canal 2, indicating slight microbial contamination.

IV. CONCLUSION

The seasonal study of water quality in two different canals across the Ajay River shows significant variations due to coal mining activities. The rainy season exhibited the highest levels of turbidity and microbial contamination, while the winter season demonstrated better water quality with reduced contamination. Heavy metal concentrations remained below permissible limits throughout the seasons. However, the fluctuations in physicochemical parameters, such as hardness, total solids, and COD, indicate the continuous impact of coal mining runoff on water quality. Monitoring and management strategies must be implemented to mitigate the environmental effects of coal mining on the Ajay River and its associated water bodies.

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