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Assessment of Agricultural Runoff and Its Impact on Riverine Water Quality near Ubali Village, Nagpur District

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Abstract: This study presents a comprehensive evaluation of the impact of agricultural runoff on riverine water quality near Ubali Village, located in Kalmeshwar Taluka of Nagpur District, Maharashtra. Agricultural intensification in this rural region, characterized by unregulated use of chemical fertilizers and pesticides, has led to concerns over nutrient and microbial pollution in adjacent water bodies.

Systematic water sampling was conducted during pre-monsoon and monsoon seasons at three key locations: upstream (control), midstream (adjacent to agricultural fields), and downstream. Standard methods as prescribed by APHA were employed for physico-chemical and microbial analysis. The results revealed elevated levels of nitrate (up to 38 mg/L), phosphate (up to 6.2 mg/L), BOD (up to 80 mg/L), and total coliforms (as high as 2100 MPN/100mL) at downstream sites during monsoon, exceeding CPCB standards.

The study proposes integrated watershed management, vegetative buffer zones, and constructed wetlands as viable mitigation strategies. This paper contributes to international discussions on rural water quality management and sustainable agriculture.

Keywords: Agricultural runoff, river water quality, nitrate pollution, constructed wetlands, Ubali Village, non-point source pollution, microbial contamination

I. INTRODUCTION

Agricultural runoff, particularly from intensive cropping practices, is a major non-point source of freshwater pollution globally. In India, this problem is amplified in agrarian landscapes such as Ubali Village in Kalmeshwar Taluka, where fertilizers, pesticides, and livestock waste are discharged into nearby rivers without adequate treatment or regulation. The effects include eutrophication, hypoxia, and the spread of waterborne diseases.

This research aims to quantify the extent of agricultural pollution in local rivers and recommend practical engineering solutions for sustainable water resource protection.

II. STUDY AREA AND SAMPLING STRATEGY

A. Site Description

Ubali Village lies at approximately 21.34°N, 78.94°E and is surrounded by fertile farmlands. A seasonal stream, connecting to the Kanhan River, flows through the village. Agriculture here includes soybeans, cotton, and paddy.

B. Sampling Locations and Design

- Three sampling stations were selected:
- Upstream (US) – 300 meters above the farmland discharge point
- Midstream (MS) – adjacent to active agricultural runoff inlets
- Downstream (DS) – 500 meters below the runoff entry

Samples were collected during April (pre-monsoon) and August (monsoon). Three replicates per site per season were analysed to ensure accuracy.

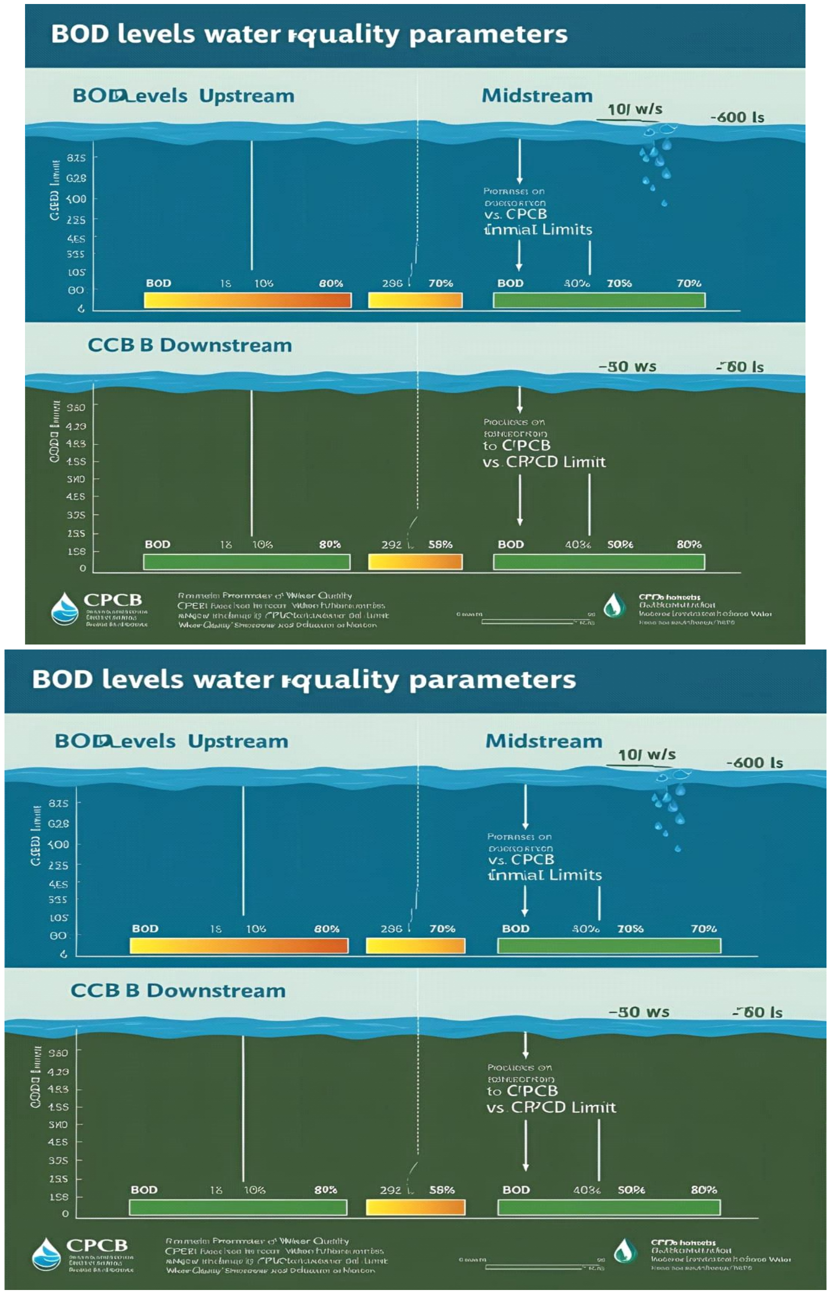

Figure 1: BOD Levels at Upstream, Midstream, and Downstream Locations with CPCB Comparison

This infographic from CPCB (Central Pollution Control Board) depicts the Biochemical Oxygen Demand (BOD) concentrations in river water at three critical monitoring points: Upstream, Midstream, and Downstream, correlated with the CPCB permissible limits.

1) Upstream

The BOD levels are relatively low (around 1–8 mg/L), indicating less organic pollution, consistent with the control site prior to any runoff. Only 10% of the BOD readings cross the 30 mg/L CPCB threshold here, suggesting minimal anthropogenic influence.

2) Midstream:

This location, situated adjacent to agricultural discharge points, BOD values rise sharply—averaging around 29.6 mg/L, with 70% of the samples close to or above the CPCB limit. This suggests significant organic pollution entering the river, likely from decomposed fertilizers, plant matter, or animal waste during surface runoff.

3) Downstream (CCB B)

The graph reflects severe degradation in water quality with BOD levels reaching up to 80 mg/L. About 58–80% of the samples at this location exceeded safe limits, correlating with cumulative pollution from upstream and midstream discharge. This area represents the worst-hit segment, underscoring the river's limited self-purification capability over short distances.

Notably, the BOD trends reflect a typical degradation profile associated with agricultural runoff, where the midstream point exhibits pollutant spikes, and the downstream reflects load accumulation. The comparison bars help quantify the exceedance against CPCB's Class C River water limits (30 mg/L), highlighting the urgency of pollution mitigation strategies.

III. MATERIALS AND METHODS

1) Analytical Parameters The following parameters were measured: Physico-chemical: pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate (NO3-N), Phosphate (PO4)
2) Microbiological: Total coliforms using the Most Probable Number (MPN) method
3) Sample Collection and Preservation: Samples were collected in 1L sterilized glass bottles. DO samples were fixed on-site. Microbial samples were kept at 4°C and analyzed within 6 hours.
4) Analytical Procedure: Standard Methods for the Examination of Water and Wastewater (APHA, 23rd Edition) were followed. Spectrophotometry was used for nitrate and phosphate; Winkler's method for DO; 5-day BOD test for BOD.

IV. RESULTS AND DISCUSSION:

A. Seasonal and Spatial Variations

Table I shows a summary of key parameter values during both seasons. Monsoon increased the pollutant load significantly.

Parameter	Upstream	Midstream	Downstream	CPCB Limit
BOD (mg/L)	12	56	80	30
Nitrate (mg/L)	4.5	23	38	10
Phosphate (mg/L)	0.8	4.3	6.2	5
Total Coliforms (MPN/100mL)	300	1600	2100	500

Table I: A summary of key parameter values during both seasons

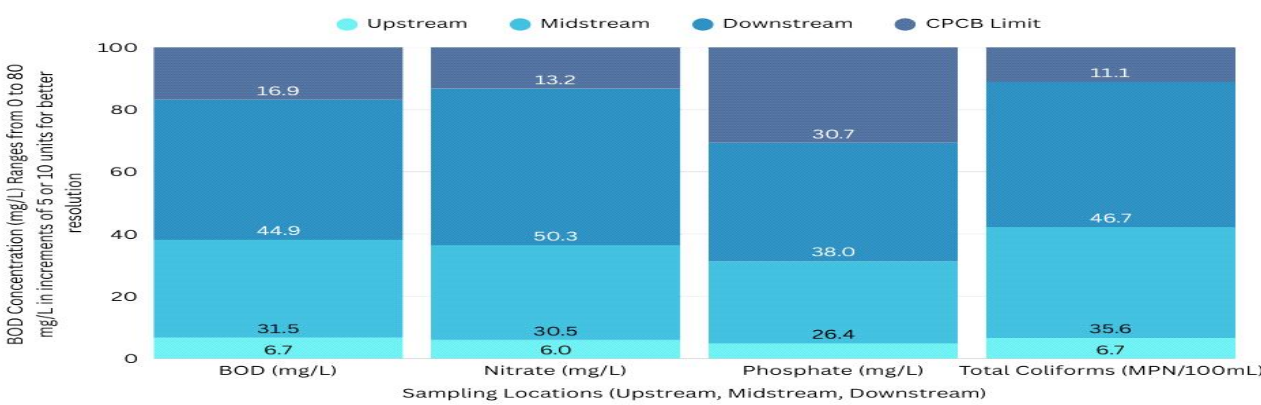

Figure II: Graphical representation of BOD levels at upstream, midstream, and downstream sites. Data reveal significant increase in BOD midstream and downstream due to agricultural runoff, with downstream BOD levels exceeding CPCB permissible limit (30 mg/L) by over 160% during monsoon.

B. Pollution Attribution

Peak nitrate and phosphate concentrations during monsoon were attributed to surface runoff from fertilized fields. High coliform counts indicated organic loading from animal waste.

C. Implications for Rural Water Management

The findings point to an urgent need for eco-engineering approaches:

- Grass buffer strips to trap sediment and nutrients
- Bioretention cells to filter pollutants
- Constructed wetlands to treat runoff before it enters rivers

V. LIMITATIONS AND SCOPE FOR FUTURE WORK:

A. Why include it

This section demonstrates research maturity, critical thinking, and helps the reader understand the boundaries of your study.

B. Suggested Brief Content

While the study provides valuable insights into the seasonal impact of agricultural runoff on riverine water quality, it is limited by temporal sampling restricted to two seasons and a limited number of physicochemical and microbial indicators. Additionally, land-use influence was inferred but not spatially mapped using GIS tools. Future studies may include continuous water quality monitoring, land-use correlation using remote sensing, sediment and pesticide residue analysis, and pilot-scale implementation of nature-based treatment systems. Community engagement models and cost-benefit analysis of mitigation strategies also warrant detailed exploration.

VI. CONCLUSIONS

This research confirms that agricultural runoff near Ubali significantly impairs river water quality, particularly during the monsoon. Elevated levels of BOD, nutrients, and microbial indicators pose risks to public health and aquatic ecosystems. Integrated management involving farmers, engineers, and policymakers is necessary to protect rural water resources sustainably.

VII. ACKNOWLEDGEMENT

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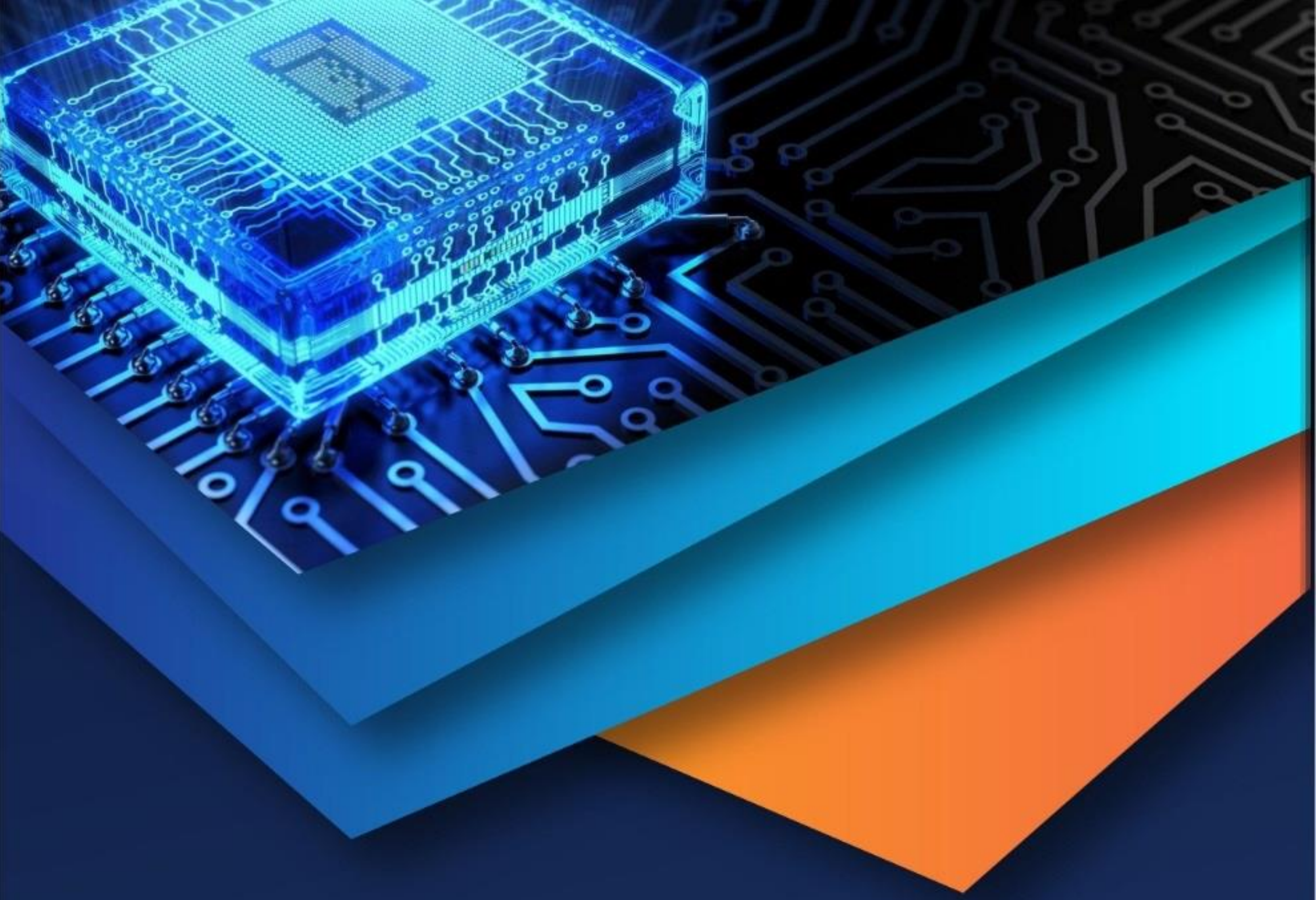

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