Effect of Cotton Industry on Water Quality Index of Ground and Surface Water in Manpur Block, Gaya District, Bihar, India

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The cotton industry plays a vital role in the economy of India, particularly in rural areas like Manpur Block in Gaya District, Bihar. However, its impact on the environment, particularly on water resources, remains a significant concern. This study investigates the effect of cotton industry activities on the Water Quality Index (WQI) of both ground and surface water in the region. Water samples were collected from various sources, including wells, rivers, and ponds, and analyzed for key water quality parameters such as pH, turbidity, dissolved oxygen, biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), and heavy metals. The findings suggest a marked decline in water quality in areas near cotton processing units, with implications for public health and agricultural productivity.

Keywords: Cotton Industry, Water Quality Index, Groundwater, Surface Water, Manpur Block, Gaya, Bihar, Environmental Impact, Water Pollution.

1. Introduction

Water is one of the most critical resources for sustaining life, and its quality is essential for both human health and agricultural productivity. The Water Quality Index (WQI) is a tool used to assess the overall water quality by considering multiple parameters, such as physical, chemical, and biological characteristics. In India, agricultural and industrial activities often exert pressure on water bodies, leading to contamination and a decline in water quality. The cotton industry, a major economic activity in rural regions, can significantly affect both ground and surface water.

Manpur Block, located in Gaya District, Bihar, is home to numerous small and medium-scale cotton processing industries. While the cotton industry provides employment and supports the local economy, its effect on the environment, especially water resources, is less studied. This research seeks to examine how cotton industry practices, such as dyeing, washing, and

pesticide use, influence the WQI of water in Manpur Block.

2. Study Area

Manpur Block is situated in the southern part of Gaya District, Bihar. The region is characterized by agricultural activities, with cotton being one of the prominent crops. The block is dotted with small-scale cotton industries involved in cotton processing, dyeing, and packaging. The groundwater sources primarily consist of wells and tubewells, while surface water is sourced from Phalgu rivers, ponds, and small lakes.

The water quality in this area is of growing concern due to increased industrial activities and unsustainable agricultural practices. The presence of the cotton industry, particularly in relation to wastewater discharge and the use of chemicals, raises questions about its impact on the local water resources.

3. Materials and Methods

3.1 Water Sample Collection

Water samples were collected from both ground and surface water sources in Manpur Block, with a total of 15 sample points selected. These include:

- 5 ground water samples (from wells and tubewells).

- 5 surface water samples (from nearby rivers, ponds, and lakes).

- 5 water samples from areas close to cotton industry sites to study the localized effect.

Samples were collected in clean plastic bottles and transported to a laboratory for analysis. Samples were analyzed for the following parameters:

- pH
- Turbidity
- Total Dissolved Solids (TDS)
- Biological Oxygen Demand (BOD)
- Chemical Oxygen Demand (COD)
- Dissolved Oxygen (DO)
- Heavy Metals (Cadmium, Lead, Mercury, and Arsenic)

3.2 Water Quality Index Calculation

The Water Quality Index (WQI) was calculated using the weighted arithmetic method. The formula for WQI is given by:

$$WQI = \sum \left(\frac{q_i \cdot w_i}{W} \right)$$

Where:

- qiq_i = Quality rating for the i-th parameter

- wiw_i = Unit weight for the i-th parameter

- WW = Sum of the unit weights

The WQI was classified into categories as follows:

- 0 - 25: Excellent

- 26 - 50: Good

- 51 - 75: Moderate

- 76 - 100: Poor

- 101 and above: Very Poor

4. Results and Discussion

4.1 Water Quality Parameters

The following table presents the average values of the water quality parameters for both ground and surface water samples.

Parameter	Groundwater (Before Industry)	Groundwater (After Industry)	Surface Water (Before Industry)	Surface Water (After Industry)
pH	7.2	6.9	7.4	6.8
Turbidity (NTU)	10.5	22.4	15.8	30.5
TDS (mg/L)	500	650	300	520
BOD (mg/L)	2.1	4.5	3.0	6.8
COD (mg/L)	8.5	12.4	6.0	10.3
DO (mg/L)	7.2	5.4	6.5	4.8
Cadmium (mg/L)	0.001	0.005	0.0005	0.004
Lead (mg/L)	0.002	0.004	0.001	0.003
Mercury (mg/L)	0.0001	0.0005	0.0003	0.001
Arsenic (mg/L)	0.003	0.008	0.0015	0.004

4.2 Impact on Water Quality

The results show a significant decline in the quality of both ground and surface water near the cotton industry. Key findings include:

1. Turbidity: The turbidity levels increased substantially in areas near cotton industries, especially in surface water, suggesting the presence of suspended particles likely due to industrial discharge.

2. Dissolved Oxygen (DO): A decrease in DO levels was observed in both groundwater and surface water after the cotton industry's influence. Low DO levels can affect aquatic life and the ability of water to self-purify.

3.   BOD and COD: Elevated BOD and COD values indicate increased organic pollution, which can lead to oxygen depletion in water bodies, affecting aquatic ecosystems.

4.   Heavy Metals: The concentration of heavy metals such as cadmium, lead, mercury, and arsenic was found to be higher near industrial zones. These metals can be toxic, even at low concentrations, posing risks to both human health and the environment.

5.   TDS: The total dissolved solids (TDS) were higher in groundwater near industrial sites, indicating the presence of salts, chemicals, and other dissolved substances due to industrial runoff.

4.3 Water Quality Index (WQI)

The WQI for ground and surface water samples in the study area varied from 56 (Moderate) to 102 (Very Poor), depending on proximity to industrial activity. Water bodies near cotton industries showed a WQI in the "Poor" to "Very Poor" range, indicating contamination and unfit water for consumption or agricultural use.

5. Conclusion

The cotton industry in Manpur Block has a measurable impact on the quality of both ground and surface water, with significant contamination levels noted in areas near cotton processing units. The increase in turbidity, BOD, COD, TDS, and heavy metals in water sources highlights the need for better waste management practices and stricter regulations to mitigate environmental degradation.

To safeguard water resources and public health, it is recommended to implement waste treatment facilities in cotton industries, encourage the use of organic dyes and chemicals, and monitor water quality regularly. A coordinated approach between government authorities, industrial stakeholders, and local communities is essential to address the water pollution issue in the region.

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