

# Environmental Sustainability: Waste Management of Textile Industries special reference to U.P

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## ABSTRACT

*Environmental sustainability involves managing natural resources to meet present needs without compromising the well-being of future generations. The textile industry, a crucial sector in India's economic growth, plays a vital role in modern life but also contributes significantly to solid waste generation and environmental pollution. Textile industry effluents contain heavy metals, dyes, and other harmful contaminants that adversely affect both ecosystems and human health. This study, conducted in the Pilkhuwa industrial area of Hapur district, western Uttar Pradesh, surveyed local residents through interviews and group discussions. Findings revealed that water quality in the region is severely compromised, making it unsafe for consumption and leading to widespread health issues such as skin diseases, asthma, and typhoid. The growing challenges of waste disposal, depleting natural resources, and rising environmental concerns highlight the urgent need for cost-effective, eco-friendly, and sustainable wastewater treatment technologies before industrial effluents are released into the environment.*

**Keywords:** *Textile Industry, Water Contamination, Health Impact, Effluent Treatment, Sustainable Development.*

## INTRODUCTION

The textile industry is a cornerstone of India's economy, contributing significantly to employment, exports, and industrial growth. With a rich heritage that dates back centuries, India has evolved into one of the world's leading producers of textiles and garments. As of 2023, the textile sector accounts for approximately **14% of industrial production and 4% of the GDP, employing over 45 million people** across various segments, from spinning and weaving to dyeing and finishing.

However, this burgeoning industry comes with its own set of environmental challenges, particularly in the realm of waste management. The textile manufacturing process is inherently resource-intensive, leading to the generation of substantial amounts of waste. This includes not only solid waste—such as fabric cuttings and defective products—but also liquid waste containing harmful chemicals and dyes, as well as air emissions from various processes. According to estimates, the textile industry contributes around **20% of global water pollution** and is responsible for a significant portion of solid waste, much of which ends up in landfills.

Water is essential for human survival. However, population growth, urbanization, and industrial development have significantly increased waste, affecting water quality. By 2030, it is predicted that 47% of the

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global population will face severe water scarcity. Industries, particularly medium and large-scale ones, contribute to economic growth by providing jobs and foreign exchange. Unfortunately, many textile industries do not adhere to effluent discharge regulations, releasing untreated or partially treated dye effluents into the environment. These effluents, rich in persistent pollutants like heavy metals and dyes, pose a global environmental problem. Dyes, used in various industries, are difficult to remove from wastewater due to their stability. The continuous release of untreated dye wastewater negatively impacts the environment, aquatic life, and human health. Dyes reduce sunlight penetration, increase oxygen demand, inhibit photosynthesis, and affect aquatic flora and fauna. They also pose serious health risks, being mutagenic and carcinogenic. The United Nations aims to ensure sustainable water and sanitation for all by 2030. Currently, 780 million people lack access to safe water, and 2.5 billion lack adequate sanitation, exposing many to health risks. In India, where 65% of the population relies on agriculture, untreated industrial effluents used for irrigation harm soil and crop growth. This study focuses on the Pilkhuwa industrial area in Hapur district, a major textile hub, to assess the impact of textile industry effluents on agriculture, water quality, and residents' health.

Effective waste management is critical for several reasons:

- **Environmental Impact:** Improper disposal of textile waste can result in severe environmental degradation. Solid waste in landfills leads to soil and groundwater contamination, while untreated effluents can pollute rivers and lakes, harming aquatic ecosystems and affecting local communities.
- **Economic Implications:** Waste management is not only an environmental concern but also an economic one. Inefficient waste practices can lead to increased operational costs and loss of valuable raw materials. Conversely, adopting sustainable waste management practices can create new revenue streams through recycling and reuse.
- **Regulatory Compliance:** The Indian government has implemented stringent regulations regarding waste disposal and environmental protection. Compliance with these regulations is vital for companies to avoid penalties and maintain their market reputation.

Despite the pressing need for effective waste management, many textile industries in India face significant challenges:

- **Lack of Awareness and Training:** There is often a lack of awareness among workers about the importance of waste segregation and proper disposal methods. This knowledge gap can lead to improper waste management practices.
- **Infrastructure Limitations:** Smaller textile manufacturers, in particular, may lack the infrastructure and resources to implement effective waste management systems, such as effluent treatment plants or recycling facilities.
- **Financial Constraints:** The initial investment required for advanced waste management technologies can be prohibitive, especially for small and medium-sized enterprises (SMEs) that dominate the Indian textile landscape.

This research aims to explore the waste management practices of the U.P textile industry, with a specific focus on a case study of a leading textile manufacturer. Here in this research, we focus on

1. **The current waste management practices employed by textile manufacturers in U.P.**
2. **To propose recommendations for improving waste management practices in the textile in industry.**

The textile industry's impact on the environment, particularly through waste generation, has been a subject of extensive research globally and within the Indian context. This chapter literature review synthesizes findings from various studies, reports, and policy documents to provide a comprehensive understanding of waste management in the Indian textile industry.

### **Waste Generation and Environmental Impact**

A seminal work by Kadolph (2014) provides an overview of the environmental challenges posed by the textile industry, including the generation of solid and liquid waste. Kadolph's research emphasizes the volume of waste produced during the manufacturing process, from raw material processing to garment production. In India, studies by Patil and Vyas (2017) have quantified the waste, noting that a single textile mill can generate up to 1 ton of fabric waste per day, highlighting the scale of the issue.

### **Waste Management Practices**

Research on waste management practices within the textile industry reveals a spectrum of approaches. Sharma and Shah (2018) conducted a survey of Indian textile factories and found that while most have basic waste collection systems in place, fewer have comprehensive waste management strategies that include reduction, reuse, and recycling. The work of Gupta and Chaudhary (2019) further explores the adoption of cleaner production techniques and the barriers to their implementation, citing financial and technological constraints as significant hurdles.

## **POLICY AND REGULATORY FRAMEWORK**

The regulatory landscape governing waste management in India's textile sector has evolved, as documented by Singh et al. (2020). Their analysis of environmental regulations points to a tightening of norms, particularly concerning effluent treatment and discharge. However, they also note a gap between policy formulation and enforcement, which is echoed in the findings of Kumar and Dua (2021), who argue that compliance is uneven across the industry.

## **INNOVATIONS IN WASTE MANAGEMENT**

Innovative waste management solutions are emerging as a key area of interest. Mehta and Chatterjee (2022) provide case studies of successful waste-to-wealth initiatives, where textile waste is converted into value-added products. Similarly, research by Iyer et al. (2023) focuses on the potential of circular economy models in the textile industry, demonstrating how closed-loop systems can significantly reduce waste.

### **Gaps in the Literature**

While the existing literature provides valuable insights into waste management in the textile industry, there are noticeable gaps. Few studies offer in-depth analyses of the economic implications of waste management practices, and there is a lack of comprehensive case studies from the Indian context that combine environmental, economic, and regulatory perspectives. Moreover, research on the long-term sustainability of current waste management practices and their scalability is limited.

### **Need of waste management**

The literature indicates that while there is an awareness of the need for effective waste management in the Indian textile industry, the implementation of sustainable practices is inconsistent. There is a pressing need for research that bridges the gap between policy and practice and explores the economic viability of innovative waste management solutions. This study aims to contribute to this area by providing a detailed case study analysis of waste management practices in a leading Indian textile company.

### **Types of Waste in Textile Industries**

The textile industry is known for its complex production processes, each contributing to a diverse range of waste types. Understanding the various forms of waste is crucial for developing effective management

strategies. This section delves into the primary categories of waste generated by textile industries.

### Pre-Production Waste

Pre-production waste is generated during the design and sampling phases before mass production begins. This includes:

- **Sample Waste:** Excess material from creating prototypes and samples.
- **Pattern Making Waste:** Offcuts from pattern cutting, which often involves complex shapes leading to inefficient use of fabric.
- **Yarn Waste:** Leftover yarns from the warping, winding, and threading processes.

### Production Waste

Production waste is the most significant waste stream in terms of volume and includes:

- **Fabric Waste:** Offcuts and selvages from cutting processes, defective textiles, and trimmings.
- **Process Waste:** Substandard yarn, thread snips, and defective products that do not meet quality standards.
- **Packaging Waste:** Cardboard, plastic, and other materials used for packaging raw materials and finished products.

### Post-Production Waste

After the manufacturing process, post-production waste includes:

- **End-of-Roll Fabric:** Material left on the roll after cutting operations, often too small for large production runs.
- **Garment Manufacturing Waste:** Defective garments, excess thread, and buttons from the assembly line.
- **Consumables Waste:** Items such as gloves, masks, and cleaning cloths that are used once and then discarded.

### Chemical Waste

The use of chemicals in dyeing, printing, and finishing processes leads to:

- **Dye Waste:** Residual dyes and chemicals from dye baths that are not fully exhausted.
- **Auxiliary Chemicals Waste:** Unused fixatives, detergents, and other chemicals.
- **Sludge:** Solid waste from effluent treatment plants that treat wastewater before discharge.

### Water Waste

Textile production is water-intensive, particularly in the dyeing and finishing stages, resulting in:

- **Effluent:** Wastewater containing a mix of dyes, chemicals, and organic matter.
- **Process Water:** Water that has been used for washing, rinsing, and other wet processing steps.

### Energy Waste

Energy waste is often overlooked but includes:

- **Heat Waste:** Excess heat from machinery and equipment that is not recovered or utilized.
- **Energy Consumption Waste:** Inefficient use of electricity due to outdated equipment or poor maintenance.

### Air Emissions

Various stages of textile production contribute to air pollution:

- **Volatile Organic Compounds (VOCs):** Emitted from solvents and chemicals used in dyeing and finishing.
- **Particulate Matter:** Dust and fibers released into the air, particularly from weaving and cutting operations.

### Solid Waste

Solid waste encompasses a broad category of non-liquid waste:

- **Non-Hazardous Waste:** Includes general office waste, canteen waste, and other non-toxic materials.
- **Hazardous Waste:** Waste that can pose a risk to health or the environment, such as contaminated containers and used oil from machinery.

### Current Waste Management Practices

The textile industry in India has begun to adopt various waste management practices in response to increasing environmental concerns and regulatory pressures. However, the effectiveness and implementation of these practices vary widely across different manufacturers. This section explores the current waste management practices employed in the textile sector, highlighting both traditional methods and innovative approaches.

#### Waste Segregation

One of the foundational practices in waste management is the segregation of waste at the source. Many textile manufacturers are implementing systems to separate different types of waste—such as fabric scraps, chemical waste, and packaging materials—immediately after they are generated. This practice facilitates recycling and reduces the volume of waste sent to landfills. Effective segregation also helps in the proper treatment of hazardous materials, ensuring compliance with environmental regulations.

#### Recycling and Reuse

Recycling is a critical component of waste management in the textile industry. Some manufacturers have established partnerships with recycling firms to repurpose fabric scraps and offcuts into new products. For instance, leftover fabric can be transformed into insulation materials, bags, or even new garments. Additionally, companies are increasingly exploring the reuse of materials, such as using old garments for patchwork or upcycling them into new fashion items. This not only reduces waste but also promotes a circular economy within the industry.

#### Effluent Treatment

Given the significant amount of wastewater generated during textile production, effluent treatment is a crucial aspect of waste management. Many textile manufacturers have invested in Effluent Treatment Plants (ETPs) to treat wastewater before it is discharged into the environment. These plants utilize various processes, such as biological treatment, filtration, and chemical treatment, to remove harmful substances from the water. However, the effectiveness of ETPs can vary, and some smaller manufacturers may struggle to meet the required standards due to financial constraints.

#### Waste-to-Energy Initiatives

Some innovative textile companies are exploring waste-to-energy initiatives, where waste materials are converted into energy through processes like incineration or anaerobic digestion. This approach not only

reduces the volume of waste but also provides an alternative energy source for manufacturing operations. By harnessing energy from waste, companies can decrease their reliance on fossil fuels and lower their overall carbon footprint.

### **Employee Training and Awareness**

Effective waste management is not solely reliant on technology and infrastructure; it also requires a cultural shift within organizations. Many textile manufacturers are investing in employee training programs to raise awareness about the importance of waste management. These programs educate workers on best practices for waste segregation, recycling, and the environmental impacts of textile waste. By fostering a culture of sustainability, companies can enhance their waste management efforts and encourage employees to take an active role in reducing waste.

### **Compliance with Regulations**

The Indian government has implemented various regulations aimed at reducing waste and promoting sustainable practices in the textile industry. Compliance with these regulations is essential for manufacturers to avoid penalties and maintain their market reputation. Many companies are actively working to align their waste management practices with national and state-level environmental policies, which often include guidelines for waste disposal, effluent treatment, and emissions control.

### **A Case Study of Hapur**

The textile industry is a major contributor to economic growth in India, but it also significantly impacts environmental sustainability, particularly in wastewater management. The effluents from textile industries contain heavy metals, dyes, inorganic and organic contaminants, which adversely affect water quality, soil health, and human well-being. This study focuses on the impact of textile industry effluent in the Pilkhuwa industrial area of Hapur district, Western Uttar Pradesh, highlighting local environmental and health concerns.

### **Study Area and Methodology**

The Pilkhuwa industrial area was selected for this study due to its high concentration of textile units. A survey was conducted among 200 randomly chosen local residents from villages in the Pilkhuwa industrial area, aged between 18 and 65 years, to assess their awareness and experiences regarding water contamination, agricultural impact, and health concerns. Data collection involved personal interviews and group discussions using a structured questionnaire.

## **FINDINGS AND DISCUSSION**

### **Water Quality and Environmental Impact**

- The study revealed that most residents perceive the water in the Pilkhuwa industrial area as unsafe for drinking due to contamination.
- Industrial effluents from textile units, characterized by dark color and foul odor, are frequently discharged untreated into local water bodies.
- Approximately 97.5% of respondents stated that textile industries generate significant amounts of wastewater, with 96% observing that effluents are improperly treated before discharge.
- The mixing of industrial waste with groundwater and rivers has led to a decline in water quality, adversely affecting aquatic flora and fauna.
- More than 60% of respondents reported reduced soil fertility and increased salinity in agricultural lands, leading to lower crop productivity.

## HEALTH CONCERNS AMONG LOCAL RESIDENTS

- Around 99% of respondents reported deterioration in groundwater and surface water quality, leading to an increase in waterborne diseases.
- 84% of residents linked the establishment of textile industries with rising cases of health disorders, including skin diseases, asthma, and typhoid.
- A significant number (71%) observed a rise in mosquito and housefly populations, contributing to the spread of vector-borne diseases.
- Nearly 47% of workers in textile industries suffer from occupational health issues due to prolonged exposure to toxic chemicals and poor working conditions.

## RECOMMENDATIONS AND CONCLUSION

The findings underscore the urgent need for improved wastewater management and regulatory compliance within the textile sector. The following measures are recommended:

1. **Implementation of Advanced Effluent Treatment Plants (ETPs):** Industries should adopt cost-effective and eco-friendly wastewater treatment technologies to ensure proper effluent disposal.
2. **Stricter Environmental Regulations:** The government should enforce stringent pollution control norms, conduct regular inspections, and impose penalties on non-compliant industries.
3. **Awareness and Training Programs:** Educational initiatives should be conducted for industry workers and residents to promote environmental responsibility and hygiene practices.
4. **Sustainable Industrial Practices:** Encouraging water recycling, zero-liquid discharge (ZLD) technologies, and the use of biodegradable dyes can significantly reduce pollution.
5. **Community Engagement:** Local participation in monitoring industrial activities and reporting violations can improve environmental governance.

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