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Tackling the Waste Dilemma in Ecologically Sensitive Areas: An Analysis of Solid Waste Management in Uttarakhand's Homestay Tourism

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Abstract

The management of solid waste in homestay tourism locations across Uttarakhand's Himalayan region presents significant environmental challenges. Tourism activities generate over five million metric tons of waste annually in the Indian Himalayan Region, with Uttarakhand contributing approximately 1,500 tons daily *(Pandey 2022)* This volume increases substantially during peak tourist seasons, particularly affecting popular destinations like Mussoorie and Nainital. Analysis reveals a concerning trend, with non-biodegradable waste constituting 96.3% of total waste by weight in certain areas like the Valley of Flowers and Hemkund Sahib region *(Thakur 2021).* The region faces unique challenges due to its geographical and climatic conditions, including limited suitable land for waste disposal, poor accessibility, and slower organic waste decomposition in cold climates *(Prakash 2024)*

Current waste management practices vary significantly, with some areas implementing door-to-door collection services while others rely on inadequate community bins or informal collection methods *(Tepper 2024)* Approximately 60% of waste in the Indian Himalayan Region is either dumped or burnt in the open. The environmental impacts include water and soil contamination, air pollution from waste burning, and wildlife behavioural changes, with studies showing that Himalayan Brown Bears now derive over 75% of their food from garbage dumps *(Byers 2020)* This paper explores the underlying causes of the waste management crisis in Uttarakhand's homestay tourism, investigates current practices, and proposes a framework for sustainable solid waste management.

Innovative solutions being implemented include community-based waste management initiatives, decentralized processing facilities, and eco-tourism practices *(Singh 2014)* Success stories like the Govind Wildlife Sanctuary Initiative, which recycled over 7,500 kg of waste in 2021-22, demonstrate the potential for effective waste management even in remote areas *(E-Waste rules 2023)* Addressing this challenge requires a multifaceted approach combining technological innovations, community engagement, policy reforms, and

sustainable tourism practices to preserve the region's ecological integrity while supporting tourism development *(Liu 2023)*

Keywords: Solid Waste Management, Homestay Tourism, Ecologically Sensitive Areas, Uttarakhand, Indian Himalayan Region

Introduction

The Himalayan region of Uttarakhand, known for its breathtaking landscapes and religious significance, has experienced a surge in tourism, particularly in homestay accommodations *(Chandra & Kumar, 2021)* This growth, however, has brought significant challenges in managing solid waste in these ecologically sensitive areas. This abstract summarizes the current scenario, challenges, and potential solutions for solid waste management in homestay tourism locations in Uttarakhand *(Pilgrimage Tourism, 2024)* The influx of tourists has led to a substantial increase in solid waste generation, with tourism-related activities in the Indian Himalayan Region producing over five million metric tons of waste annually. Uttarakhand alone generates around 1.5 thousand tonnes of waste per day, increasing significantly during peak tourist seasons *(Srivatsan 2021)* The waste composition shows a concerning trend, with non-biodegradable waste, particularly single-use plastics, constituting a major portion. Managing solid waste in this region presents unique challenges due to geographical, climatic, and socio-economic factors. The mountainous terrain limits suitable land for waste disposal and complicates waste collection and transportation. The cold climate slows down organic waste decomposition, while seasonal accessibility issues disrupt regular waste management operations. Infrastructure and resource limitations, including a lack of processing facilities and insufficient collection systems, further exacerbate the problem *(Tepper 2024)*

Current waste management practices vary widely across the region. While some areas have implemented door-to-door collection services, many still rely on inadequate community bins or informal collection methods. Waste segregation is not widely practiced, leading to mixed waste disposal. Open dumping and burning remain common, with an estimated 60% of waste in the Indian Himalayan Region being dumped or burnt in the open (Tackling Solid Waste in the Himalayan Region, 2023) The environmental and social impacts of inadequate waste management are significant. Water and soil contamination, air pollution from waste burning, and impacts on wildlife are major concerns. The accumulation of waste also degrades the aesthetic value of the region and poses health risks to local communities. In some cases, waste mismanagement has led to severe social and economic consequences.

To address these challenges, innovative approaches and solutions are being explored and implemented. These include community-based waste management initiatives, technological innovations such as decentralized waste processing units, and the promotion of eco-tourism practices *(Tomo 2023)* Success stories, such as the Waste Warriors project in Dharamsala and initiatives by Eco-Development Committees in Uttarakhand, demonstrate the potential for effective waste management even in challenging environments *(Byers, 2020)* Recommendations for sustainable solid waste management in the region include implementing comprehensive waste segregation systems, developing decentralized waste processing facilities, improving collection and transportation systems, promoting eco-friendly alternatives to single-use plastics, enhancing tourist education

and engagement, strengthening policy and governance, fostering collaborations and partnerships, and implementing robust monitoring and evaluation systems.

The management of solid waste in homestay tourism locations in Uttarakhand requires a multifaceted approach that combines technological innovations, community engagement, policy reforms, and sustainable tourism practices. Effective waste management is crucial not only for preserving the region's pristine beauty and ecological balance but also for ensuring the long-term sustainability of tourism, a vital economic driver for the state. With concerted efforts from all stakeholders – government bodies, local communities, tourists, and the tourism industry *(Azhari 2023) (Rachaju 2023)*– Uttarakhand can set an example in responsible and sustainable tourism, preserving its status as "Dev Bhoomi" for generations to come. *(Melkani & Kumar, 2021) (Chandra & Kumar, 2021)* The successful implementation of these strategies could serve as a model for other ecologically sensitive tourism destinations facing similar waste management challenges.

Literature review

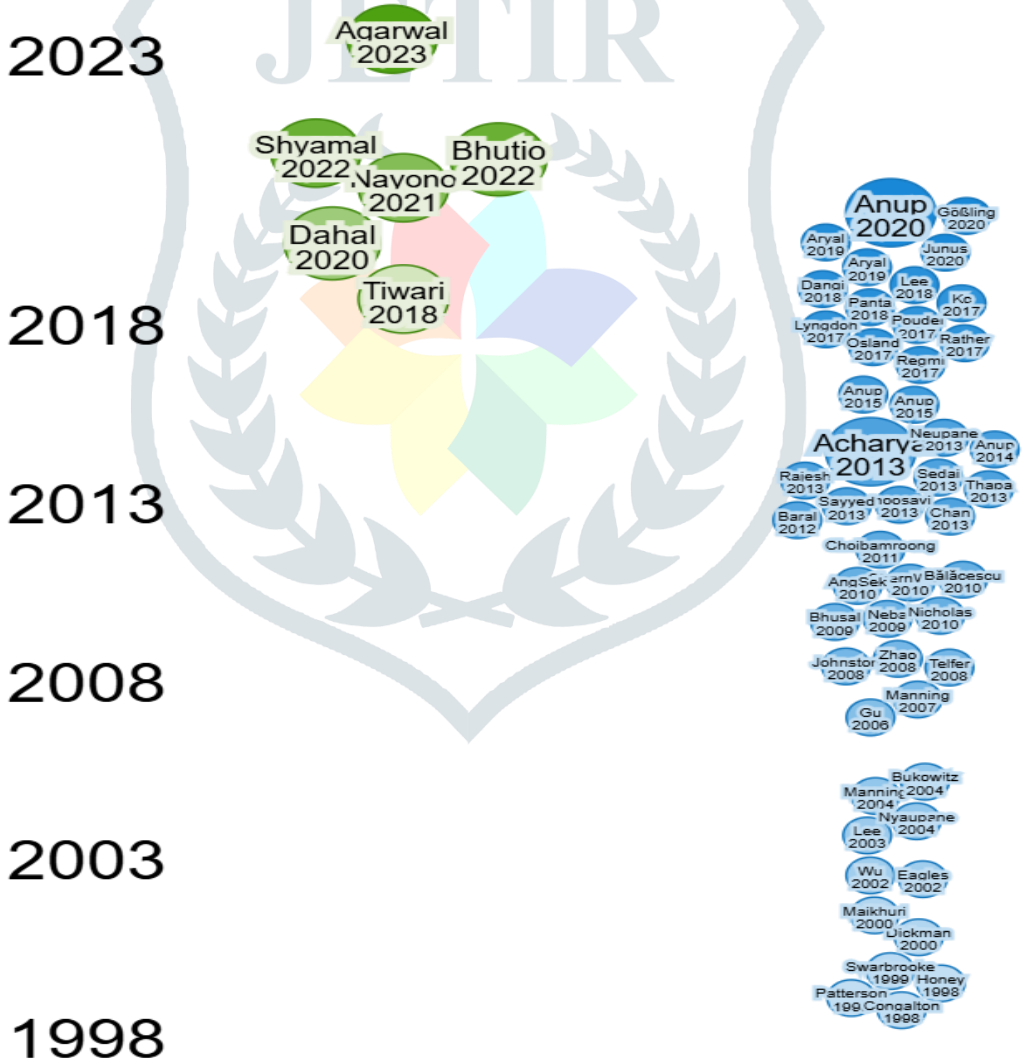

Figure 1. Literature Review Timeline

Kuniyal conducted a pioneering study in the VoF, revealing that non-biodegradable waste made up 96.3% of the total waste, with approximately 29 metric tonnes generated along a 19-km trek during a 4-month tourist season. *(Ananda & Halappa, 2022) Kumar found* that waste-to-energy plants have failed in the Himalayan region due to the high biodegradable content of mixed waste, lowering the overall calorific value. The study also noted the failure of sensor-based underground dustbins in Dharamshala and Dehradun due to accessibility issues. The World Bank identified unique challenges in mountain areas, including topography, scattered settlements, and sensitive ecosystems that complicate waste management systems. *(Tackling Solid Waste in the Himalayan Region, 2023) (What a Waste 2.0, 2023)*

A study by the Central Pollution Control Board found that urban India generates about 51 million metric tonnes of solid waste, with per capita generation rates varying between 0.2 to 0.6 kg/day. Research in Rishikesh revealed the absence of source segregation practices, though some waste collectors and street rag pickers segregate recyclable materials like plastics, glass, and metallic items. *(Shreya, 2022) (Srivatsan, 2021)*

The World Bank's regional study emphasized the concurrent challenges of high poverty and increasing tourism pressures in ecologically fragile areas, recommending region-specific models for sustainable waste management. *("The Economics of Plastic Use and Cleanup Priorities for West African Coastal Countries," 2023) ("Plastic Pollution in Coastal West Africa - Synthesis," 2023)*

Research in Uttarakhand's tourist areas showed that waste generation patterns vary significantly with seasonal tourist arrival, particularly during religious pilgrimages and summer vacations. Studies have shown that the informal sector, particularly rag-pickers, plays a crucial role in waste segregation across Indian cities, *(Rathore, 2020)* suggesting the need for their formal integration into waste management systems. Research indicates that mountain areas require specialized waste transportation vehicles due to terrain challenges, with conventional waste collection methods proving ineffective. *(Shukla 2021) (Thakur 2021)*

Studies in the Himalayan region demonstrate that tourist areas generate waste comparable to some metro cities, despite having significantly smaller permanent populations. *(Kuniyal 2003)* Analysis of waste management infrastructure revealed that Uttarakhand ranked lowest in waste management systems in 2018, primarily due to lack of processing facilities and high operational costs. Research shows that app-based waste management solutions have failed in many Himalayan regions due to limited electricity access and poor road connectivity. *(Kuniyal 1998)*

Methodology

The research utilizes secondary data from government reports, academic studies, and official documents. Key sources include the Uttarakhand Pollution Control Board, World Bank reports, and municipal records from various districts. Data analysis focuses on waste generation patterns, management practices, and environmental impacts across different homestay locations. The study examines statistical data on waste generation, composition, and processing capabilities. This quantitative analysis is complemented by qualitative assessment of management practices and their effectiveness in different geographical contexts

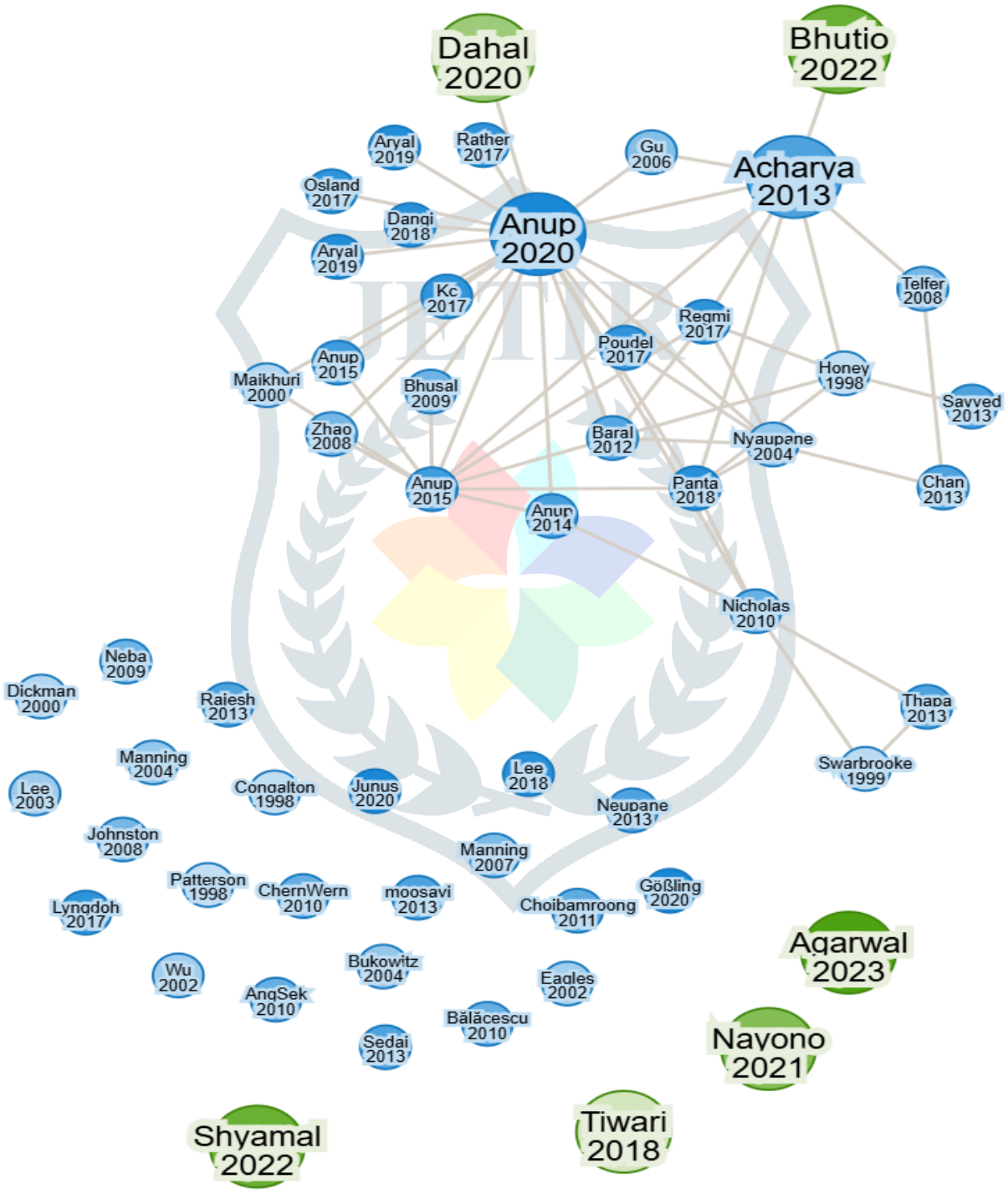

Figure 2. Bibliometric Analysis

Current Scenario of Solid Waste Generation

Tourism-Related Waste Generation

The arrival of tourists to the Himalayan region has led to a substantial increase in solid waste generation. According to a World Bank report, tourism-related activities in the Indian Himalayan Region generate over five million metric tons (MT) of waste per annum *(Waste Management in Touristic Regions,2015)*

This figure is projected to rise rapidly in the coming years as tourism continues to boom. In Uttarakhand specifically, the situation is equally concerning. The Uttarakhand Pollution Control Board estimates that waste generation in the state is around 1,500 tonnes per day, which increases significantly during the tourist and pilgrimage seasons *(Pandey, 2022)*

Popular destinations like Mussoorie and Nainital, as well as relatively remote locations such as Mukteshwar and Harsil, are particularly affected by this surge in waste generation.

Seasonal Variations

The waste generation in Uttarakhand exhibits notable seasonal variations, closely tied to tourist inflow:

Peak Tourist Season: During summer vacations and the Char Dham yatra period, waste generation spikes dramatically. For instance:

- Uttarkashi generates around 20 tonnes of waste daily during the tourist season, double its usual amount
- Rishikesh and Haridwar's waste generation increases to more than 500 tonnes daily, nearly twice the usual amount
- Nainital's daily waste generation rises from 20 tonnes to 35 tonnes *(Waste Management Used in Hospitality Industries, 2023) (Pandey 2022)*

Off-Season: Even during off-peak periods, the waste generation remains significant, with the state producing approximately 1,500 tonnes of waste per day

Composition of Waste

The waste generated in homestay tourism locations typically consists of both biodegradable and non-biodegradable materials. However, the increasing use of single-use plastics has led to a significant rise in non-biodegradable waste, even in remote areas

A study conducted in the Valley of Flowers and Hemkund Sahib region revealed that non-biodegradable waste constituted a staggering 96.3% of the total waste by weight, while biodegradable waste accounted for merely 3.7% *(Srivatsan 2021)*

Challenges in Solid Waste Management

Managing solid waste in the Himalayan region of Uttarakhand presents unique challenges due to its geographical, climatic, and socio-economic characteristics.

Geographical Constraints - The mountainous terrain of Uttarakhand poses significant obstacles to effective waste management:

Limited Suitable Land: The hilly topography makes it difficult to find appropriate sites for waste disposal and treatment facilities

Accessibility Issues: Many homestay locations are in remote areas with poor road connectivity, making waste collection and transportation challenging

Dispersed Settlements: The scattered nature of rural settlements increases the complexity and cost of waste collection *(Handbook on Community-Based Rural Household Waste Management, 2023) (Anggraini 2021) (Senekane 2021) (Azimi 2020)*

Climate-Related Challenges - The harsh climate of the Himalayan region impacts waste management practices:

Slower Decomposition: The cold climate slows down the natural decomposition process of organic waste

Seasonal Accessibility: Heavy snowfall in winter can cut off access to certain areas, disrupting regular waste collection and disposal

Infrastructure and Resource Limitations - Uttarakhand faces significant infrastructure and resource constraints in managing solid waste:

Lack of Processing Facilities: In 2018, Uttarakhand ranked the lowest for waste management systems as per a Pollution Control Board report, primarily due to a critical lack of infrastructure for waste processing

Insufficient Collection Systems: Many areas lack proper door-to-door waste collection services, leading to open dumping and burning of waste

Limited Financial Resources: The high operational costs of waste management facilities in mountainous terrain strain the limited budgets of local authorities *(Campitelli & Schebek, 2020)*

Tourism-Related Challenges - The seasonal entry of tourists exacerbates waste management issues:

Fluctuating Waste Volumes: The dramatic increase in waste generation during peak tourist seasons overwhelms existing waste management systems

Diverse Waste Types: Tourists often bring packaged goods, increasing the volume of non-biodegradable waste that local systems may not be equipped to handle

Lack of Awareness: Many tourists are unaware of the fragile ecosystem and may not follow proper waste disposal practices *(Tang 2022) (Pandey 2022)*

Current Waste Management Practices

The current solid waste management practices in homestay tourism locations in Uttarakhand vary widely, ranging from rudimentary to more organized systems.

Collection and Transportation

Door-to-Door Collection: In some areas, local authorities have implemented door-to-door waste collection services. For example, in Mussoorie, the Municipal Council has tasked an NGO, KEEN, to collect door-to-door garbage

Community Bins: In many locations, community bins are used as collection points. However, these are often inadequate and poorly maintained, leading to overflow and scattering of waste

Informal Collection: In some remote areas, resort owners and local communities take it upon themselves to manage waste. For instance, in Mukteshwar and Sheetla, resort owners route garbage to Haldwani *(Chowti, 2018) (Coletto & Bisschop, 2017) (Bhat, 2014)*

Waste Segregation - Despite regulations mandating waste segregation, the practice is not widely implemented:

Lack of Source Segregation: Most homestay locations do not practice source segregation of waste into biodegradable, non-biodegradable, and domestic hazardous waste as required by the Solid Waste Management Rules 2016

Mixed Waste Disposal: The absence of segregation leads to mixed waste being collected and disposed of together, making recycling and proper treatment difficult *(Kala, 2022) (Liang & Gu, 2021) (Rajpal 2020)*

Disposal Methods - The disposal of solid waste in many homestay locations remains problematic:

Open Dumping: A significant portion of collected waste ends up in open dumps. It's estimated that over 60% of waste in the Indian Himalayan Region is dumped or burnt in the open

Burning: Open burning of waste is a common practice, especially in areas lacking proper disposal facilities

Landfilling: Where available, landfills are used for waste disposal. However, many of these are unscientific and pose environmental risks *(Mazhandu 2023) (Kumari 2017) (Gupta & Rajamani, 2016) (Manfredi 2010)*

Recycling and Resource Recovery - Efforts towards recycling and resource recovery are limited but growing:

Informal Recycling: In some areas, informal waste pickers and recyclers play a role in recovering recyclable materials

NGO Initiatives: Some NGOs are working to promote recycling. For example, in 2021-22, over 7,500 kg of waste from the Govind Wildlife Sanctuary was sent for recycling *(Tiwari 2023) (Kala 2022)*

Environmental and Social Impacts

The inadequate management of solid waste in homestay tourism locations in Uttarakhand has far-reaching environmental and social consequences.

Environmental Impacts

Water Pollution: Improper waste disposal leads to contamination of water bodies. Even high-altitude lakes are not spared from pollution

Soil Contamination: Open dumping and unscientific landfills result in soil contamination, affecting local agriculture and ecosystems

Air Pollution: The practice of open burning of waste releases harmful pollutants into the air, including dioxins and furans

Wildlife Impact: Waste dumped in eco-sensitive areas affects wildlife. A study on the critically endangered Himalayan Brown Bear revealed that over 45% of their food comes from garbage dumps, altering their natural diet and behavior

Aesthetic Degradation: Littering and improper waste disposal mar the natural beauty of the region, potentially affecting tourism in the long run *(Maheshwari 2021) (Byers 2020) (Hayati 2020)*

Social Impacts

Health Risks: Improper waste management poses significant health risks to local communities, including the spread of diseases and respiratory issues from burning waste

Economic Consequences: In extreme cases, waste mismanagement can have severe economic repercussions. For instance, in the village of *Sudhed near Dharamshala*, young men face difficulties in finding brides due to the village's reputation as a "toxic village" choked with plastic waste

Cultural Degradation: The accumulation of waste in religiously significant areas undermines the cultural and spiritual value of these locations

Social Tensions: The inflow of tourist-generated waste can create tensions between local communities and visitors, potentially affecting the hospitality of homestay experiences *(Partarakis 2023) (Nayono & Nayono, 2021) (Widyarsana & Agustina, 2020)*

Innovative Approaches and Solutions

Addressing the solid waste management challenges in homestay tourism locations in Uttarakhand requires innovative, context-specific solutions. Several promising approaches are being explored and implemented:

Community-Based Waste Management

Local Initiatives: In some areas, local communities have taken the lead in waste management. For example, in the Adi Kailash and Parvati Kund areas of Pithoragarh, locals formed the Adi Kailash Vikas Samiti specifically for waste management after tourism picked up post-2020

Collaborative Models: In Kasar Devi, Almora, the hotels' association and the local panchayat have joined forces to dispose of waste, demonstrating the potential of community-driven solutions *(Tomo 2023) (Giri, 2021)*

Technological Innovations

Decentralized Waste Processing: Given the geographical constraints, small-scale, decentralized waste processing units could be effective. These could include small biogas plants for organic waste and mini material recovery facilities for recyclables

Cold-Climate Composting: Developing and implementing composting techniques suitable for the cold Himalayan climate could help address the issue of slower decomposition

Waste-to-Energy Solutions: Exploring small-scale waste-to-energy technologies that are suitable for the hilly terrain and can handle fluctuating waste volumes *(Peng 2023) (Choden 2021) (Lohani, 2021)*

Eco-Tourism and Responsible Travel

Zero Waste Homestays: Promoting and incentivizing homestays that adopt zero waste practices, including composting, recycling, and using eco-friendly alternatives to single-use items

Tourist Education: Implementing comprehensive awareness programs for tourists about responsible waste management practices in fragile mountain ecosystems

Trekking Waste Management: Developing specific strategies for managing waste along popular trekking routes, including carry-back policies and strategically placed waste collection points *(Biswakarma 2023) (Wang 2019) (Upadhayaya, 2018) ("Waste Management in Touristic Regions," 2015) (Canepa, 2011)*

Policy and Governance

Integrated Waste Management Plans: Developing comprehensive, region-specific waste management plans that consider the unique challenges of homestay tourism in the Himalayan region

Extended Producer Responsibility: Implementing and enforcing extended producer responsibility policies to reduce packaging waste, particularly for products commonly used by tourists

Green Tax: Exploring the possibility of implementing a "green tax" on tourists to fund waste management initiatives in popular homestay destinations

Case Studies and Success Stories

While solid waste management in Uttarakhand's homestay tourism sector faces significant challenges, there are also inspiring examples of successful initiatives:

Waste Warriors in Dharamsala

The NGO Waste Warriors has been working in Dharamsala, Himachal Pradesh, implementing a model that could be adapted for Uttarakhand:

- They conduct door-to-door collection of segregated waste.
- The organization has set up a material recovery facility for sorting and recycling.
- They've implemented an extensive awareness campaign, engaging both locals and tourists

Eco-Development Committees in Uttarakhand

In some areas of Uttarakhand, Eco-Development Committees (EDCs) have been formed to manage waste in and around protected areas:

- These committees involve local communities in waste management.
- They organize regular clean-up drives and awareness programs.
- Some EDCs have set up small-scale recycling units to process waste locally

The Govind Wildlife Sanctuary Initiative

In 2021-22, a significant milestone was achieved in the Govind Wildlife Sanctuary:

- Over 7,500 kg of waste was collected and sent for recycling.
- This initiative demonstrated the potential for effective waste management even in remote, ecologically sensitive areas

Recommendations for Sustainable Solid Waste Management

Based on the analysis of the current situation and the challenges faced, the following recommendations are proposed for improving solid waste management in homestay tourism locations in the Himalayan region of Uttarakhand:

Recommendations	Guidelines
Implement Comprehensive Waste Segregation	• Introduce a three-bin system (biodegradable, non-biodegradable, and hazardous waste) in all homestays and tourist areas. • Provide clear guidelines and training to homestay owners and staff on proper waste segregation. • Conduct regular awareness programs for tourists on the importance of waste segregation.
Develop Decentralized Waste Processing Facilities	• Establish small-scale composting units for biodegradable waste in each homestay cluster. • Set up mini material recovery facilities for sorting and recycling non-biodegradable waste. • Explore the feasibility of small biogas plants to convert organic waste into energy.
Improve Collection and Transportation Systems	• Implement regular door-to-door collection services, even in remote areas. • Use appropriate vehicles designed for mountainous terrain to transport waste. • Establish a network of strategically located transfer stations to optimize waste transportation.

Promote Eco-Friendly Alternatives	• Encourage homestays to use biodegradable or reusable alternatives to single-use plastics. • Introduce a "plastic-free" certification for homestays that meet certain criteria. • Provide incentives for homestays that significantly reduce their waste generation.
Enhance Tourist Education and Engagement	• Develop a comprehensive "Responsible Tourist" guide for visitors to the region. • Implement a "Carry Back" policy for non-biodegradable waste, especially on trekking routes. • Organize regular clean-up drives involving both tourists and local communities.
Strengthen Policy and Governance	• Develop and enforce strict regulations on waste management for homestays and tourism operators. • Implement a "polluter pays" principle, with fines for improper waste disposal. • Allocate adequate funds for waste management infrastructure and operations.
Foster Collaboration and Partnerships	• Encourage partnerships between homestay associations, local governments, and NGOs for waste management. • Facilitate knowledge sharing and best practices among different homestay clusters. • Engage with research institutions to develop innovative, context-specific waste management solutions.
Implement Monitoring and Evaluation Systems	• Establish a robust data collection and monitoring system for waste generation and management. • Conduct regular audits of waste management practices in homestay areas. • Use this data to continuously improve and adapt waste management strategies.

Conclusion

This table provides a comprehensive *conclusive overview* of the solid waste management situation in Uttarakhand's homestay tourism sector, highlighting key challenges and potential solutions for each aspect of waste management

Aspect	Details	Challenges	Potential Solutions
Waste Generation	• Over 5 million MT/year in Indian Himalayan Region • 1,500 tonnes/day in Uttarakhand • Increases significantly during peak tourist seasons	• Seasonal fluctuations • High proportion of non-biodegradable waste (96.3% in some areas)	• Implement waste reduction strategies • Promote eco-friendly alternatives to single-use plastics
Geographical Constraints	• Mountainous terrain • Limited suitable land for disposal • Poor accessibility in remote areas	• Difficult waste collection and transportation • Lack of space for waste treatment facilities	• Use specialized vehicles for mountainous terrain • Develop decentralized waste processing units
Climate-Related Issues	• Cold climate slows decomposition • Seasonal accessibility problems	• Ineffective composting • Disrupted waste collection in winter	• Develop cold-climate composting techniques • Implement weather-resistant waste storage solutions
Infrastructure and Resources	• Lack of processing facilities • Insufficient collection systems • Limited financial resources	• Inadequate waste treatment • Open dumping and burning • Difficulty in implementing advanced solutions	• Invest in small-scale, decentralized processing units • Explore public-private partnerships for funding
Current Practices	• Door-to-door collection in some areas • Community bins • Informal collection methods • Limited waste segregation	• Inconsistent waste management across regions • Lack of proper segregation • Improper disposal methods	• Standardize waste collection practices • Implement comprehensive waste segregation systems • Educate homestay owners and tourists
Environmental Impacts	• Water and soil contamination • Air pollution from waste burning	• Degradation of ecosystems • Health risks to local communities	• Enforce strict regulations on waste disposal • Implement "Carry Back" policies for non-

	• Wildlife behavioral changes	• Aesthetic damage to tourist areas	biodegradable waste
Innovative Approaches	• Community-based initiatives • Decentralized waste processing • Eco-tourism practices	• Limited awareness and adoption • Need for context-specific solutions	• Promote and incentivize zero-waste homestays • Develop region-specific waste management plans

Conceptual Framework Table

The management of solid waste in homestay tourism locations in the Himalayan region of Uttarakhand presents a complex challenge that requires a multifaceted approach. The unique geographical, climatic, and socio-economic characteristics of the region necessitate innovative and context-specific solutions. While the current scenario reveals significant gaps in waste management practices, there are also promising initiatives and potential solutions emerging. The key to success lies in a balanced approach that combines technological innovations, community engagement, policy reforms, and sustainable tourism practices. By implementing comprehensive waste segregation, developing decentralized processing facilities, improving collection systems, promoting eco-friendly alternatives, enhancing tourist education, strengthening governance, fostering collaborations, and implementing robust monitoring systems, Uttarakhand can move towards a more sustainable model of waste management in its homestay tourism sector. The stakes are high – effective waste management is crucial not only for maintaining the pristine beauty and ecological balance of the Himalayan region but also for ensuring the long-term sustainability of tourism, which is a vital economic driver for the state. With concerted efforts from all stakeholders – government bodies, local communities, tourists, and the tourism industry – Uttarakhand can set an example in responsible and sustainable tourism, preserving its status as "Dev Bhoomi" for generations to come.

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