

Building Clean Beach Tourism: Analyzing Waste Management for Sustainable Coastal Tourism in East Java, Indonesia

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Abstract. All relevant stakeholders are integral to the execution of waste management and coastal conservation initiatives. A comprehensive qualitative research study was conducted to analyze waste composition on the South Coast of East Java, evaluate its ecological and health impacts, explore the potential contributions of community knowledge, attitudes, and skills in coastal waste management, and develop effective and sustainable waste management strategies through a SWOT analysis. The research included examining waste at Balekambang Beach as a case, involving on-site observations and calculations to determine the relative and absolute densities of waste along 750 coastline segments. The study area is divided into three stations. The findings revealed that organic waste, such as wood, leaves, and twigs, is the dominant waste component at beach, while plastic emerged as the predominant inorganic component. The ecological impact of waste at Tourism Beach fell into the moderate pollution category. Most of the respondents acknowledged the environmental and health implications of beach waste and demonstrated commendable knowledge, attitudes, and skills in waste management. Coastal waste management can be successful if weaknesses and threats are addressed proactively.

Keywords: Clean beach, coastal tourism, sustainable coastal, waste management

1. Introduction

Coastal tourism is one of the main tourist attractions in South Java. The number of visitors to Balekambang Beach in 2019 was 513,264, and by May 2023, it had decreased by 20 per cent [5]. This is due to damaged access to Balekambang Beach and possibly other factors, such as the cleanliness of the beach. Observations indicate that coastal tourism areas along

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the southern route (JLS) are popular tourist destinations for both domestic and international tourists. However, waste is a serious problem, harming marine ecosystems, human health, and the environment. Coastal tourism areas in Malang Regency are known to be significant contributors to waste. Beach visitors appear to be less aware of the importance of keeping the beach clean, resulting in a significant amount of rubbish scattered on the beach due to improper waste disposal [10].

Proper waste management is essential for environmental, economic, and social reasons. Coastal waste damages marine life, reduces biodiversity, and creates visual pollution. In particular, plastic waste poses a serious threat to marine life. The beauty and ecology of beaches drive tourism. The presence of waste can reduce visitor appeal, lead to financial losses, and limit employment opportunities. Waste on beaches can also pose a threat to the health of local communities. Contaminated water from waste can spread diseases, while scattered garbage can attract disease-carrying insects.

Effective waste management in coastal tourism areas requires environmental education for residents and tourists to increase awareness and maintain environmental cleanliness [11]. The problem of coastal waste transcends national borders, so countries must collaborate to address it effectively. Effective coastal waste management is a shared responsibility between the government, local communities, tourism businesses, and visitors. This teamwork is essential to protecting the environment and sustaining tourism in the long term.

All stakeholders play a key role in waste management and coastal conservation. Engaging schools and universities in better waste management practices and promoting environmentally friendly policies fosters positive change, ultimately keeping beaches clean. Supporting waste management involves conducting research to assess current coastal conditions, analyzing the types and quantities of waste, studying ecological and health impacts, evaluating community support and potential, and developing effective and sustainable strategies for coastal areas. Current research in waste management and related fields focuses on information regarding the generation, characterization, minimization, collection, separation, treatment, and disposal of solid waste. Topics include waste management policy, education, and economic and environmental assessments. The primary methods used to study coastal debris accumulation are the line transect method and the shoreline survey method, which involves collecting, classifying, weighing, and identifying debris types along defined paths during low tide. These methods help understand the type, quantity, and distribution of waste. Accurate waste information is necessary for effective management. SWOT methods can also be used to state the strategies to be developed.

2. Methodology

The field observation took place at Balekambang Beach, Malang Regency, Indonesia, as a case of a popular tourist destination. The objective was to gather data on coastal debris along the 750 m coastline (refer to Figure 1). Waste sampling was conducted at three stations, each comprising three 20-meter-long transects. Each transect was divided into 20 plots measuring 1 x 1 m, with a 10m distance between transects. The collected data included information on the condition of the coastal area, abiotic factors, and waste composition, including the relative density and weight of different types of waste, as well as the absolute density and weight of waste pieces per square meter. The data was analyzed using Microsoft Excel and then further described in detail.

The study examined the ecological impact and health implications of waste in beach tourism areas by analyzing waste composition and gathering perceptions from 30 purposively selected respondents on the day of the research. The knowledge, attitudes, and skills of managers, stakeholders, and visitors were assessed through interviews and questionnaires. An infrastructure observation was followed by a SWOT (Strengths, Weaknesses,

Opportunities, Threats) analysis to develop a strategic plan for beach waste management. The resulting strategies aim to promote effective and efficient waste management, contributing to the cleanliness and sustainability of the beaches [8].

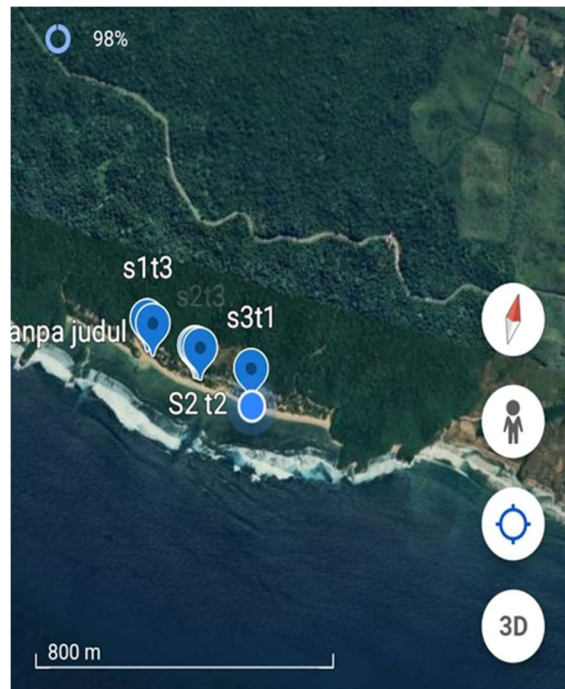


Fig. 1. Location of Research Station ($8^{\circ} 24' 153''$ S; $112^{\circ} 32' 017''$ E - $8^{\circ} 24' 13''$ S; $112^{\circ} 32' 27''$ E)
(Source: Satellite Image of Balekambang Tourism Beach, taken using Google Map Maker)

3. Results and Discussion

Beach litter is influenced by a range of environmental factors, including daily temperature and wind speed, which affect the accumulation and distribution of garbage on the beach. High daily temperatures speed up the decomposition process of organic waste left on the beach. Warmer temperatures increase the activity of microorganisms that break down organic matter, leading to faster decomposition of food waste, leaves, and other organic materials. Additionally, high temperatures accelerate the evaporation of water from wet garbage, thereby reducing the volume and weight of garbage on the beach. However, rapid evaporation also accelerates the decay of organic waste, resulting in an unpleasant odour. High temperatures, especially in combination with UV light, accelerate the process of plastic photodegradation, causing the plastic to break down into smaller pieces or microplastics, which are more difficult to manage and have a wider impact on coastal.

The average daily temperature in the Balekambang tourist beach area ranges from 25°C to 34°C , with an average of 28.80°C (averaged from February to June 2024). These temperatures are categorized as warm. Wind speeds range from 2 to 22 km/h and are classified as calm to moderate, with an average speed of 10.83 km/h. High wind speeds can transport garbage from land to sea or vice versa, spreading it along the coastline. Light waste, such as plastic, paper, and packaging materials, is particularly susceptible to being carried

away by the wind. Strong winds can also generate larger, more powerful waves, resulting in an increase in marine debris being washed ashore. Consistent winds blowing from a single direction can result in the accumulation of trash in specific areas of the beach, creating zones with higher concentrations of debris. Protected coastal areas may exhibit lower levels of litter compared to areas exposed to direct winds.

Daily temperature and wind speed often collaborate to influence the distribution and degradation of coastal debris. Both daily temperature and wind speed play a significant role in shaping the characteristics and distribution of coastal debris. Elevated temperatures and strong winds can accelerate the fragmentation of plastic waste into microplastics, thereby extending their reach through the wind. This combination of high temperatures and strong winds also accelerates the desiccation and decomposition of organic waste, altering the composition of the waste and resulting in a more potent odour on the beach. Furthermore, powerful winds can accelerate the dispersion of degraded garbage affected by high temperatures, resulting in a broader area contaminated with waste.

The coastal waste samples obtained at the research site revealed two main categories of waste: inorganic and organic. Inorganic waste included plastic, styrofoam, glass, rubber, and fabric, while organic waste comprised wood, leaves, twigs, paper, and bones (Table 1). During the observation at Balekambang, no metal waste was found, although metal debris is often present on beaches [13]. A study on the relative density of waste pieces revealed that organic waste, such as wood, leaves, twigs, and bone, accounted for the highest percentage (89.19%), followed by inorganic waste (10.81%). In terms of weight, wood, leaves, twigs, and other organic waste had the highest relative density (87.77%), followed by inorganic (11,86%). This data on relative waste density can be valuable for enhancing the effectiveness of managing waste on tourist beaches. It is essential to pay attention not only to organic waste but also to the handling of plastics and styrofoam, as they constitute a significant portion of inorganic waste.

Table 1. Relative density and absolute density of types of waste at Balekambang tourism beach

Parameters	Types of Waste							
	Organic			Inorganic				
	Wood, twigs, leaves, etc	Paper	Bone	Plastic	Styrofoam	Glass	Rubber	Cloth
Relative density of pieces (%)	88.5	0.59	0.1	7.04	2.41	1.12	0.17	0.07
Relative density of weight (%)	87.48	0.22	0.07	6.92	2.26	1.02	0.1	1.56
Absolute density of cuts (pieces/m ²)	1.12	0.09	0.12	1.12	0.38	0.18	0.03	0.01
Absolute density of weight (g/m ²)	2.57	0.22	0.03	2.57	0.84	0.36	0.04	0.58

Efficient and effective waste management depends on the absolute density of waste pieces and the total weight of waste [9]. The highest absolute density is found in wood, leaves, twigs, and other organic waste, followed by plastic, and then styrofoam. Managing these three types of waste is a top priority in coastal waste management. Waste density plays a key role in

various functions, including the planning and design of waste management facilities, the optimization of waste transportation, landfill management [6], as well as recycling and composting [15]. In addition, waste density also plays a role in cost and resource estimation [3], monitoring and evaluation of performance [4], regulatory compliance, and emergency and contingency response planning [1]. Accurate waste density data is essential for waste managers to make informed decisions about waste management. By calculating the relative and absolute density of garbage pieces and weight, we can categorize Balekambang Beach as a Moderately Polluted Beach. This conclusion is based on the visible increase in organic waste, such as piles of leaves, food scraps, and rotten fruit. These types of garbage are concentrated in specific areas (see Figure 2). The questionnaire results showed that 100% of respondents stated that beach waste was harmful to the environment, and 95.8% of respondents stated that beach waste affected health.



Fig. 2. Garbage is concentrated in certain places

The survey shows that people are aware of the adverse impact of beach waste on the environment and public health. The respondents (managers, stakeholders, and visitors) have good knowledge, positive attitudes, and strong skills in managing waste at the beach. This is probably because 50% of them have a college/university education. This indicates the significant potential of community support. Respondents knew how to distinguish trash from non-trash, understood the environmental damage caused by beach litter, and were familiar with ways to prevent or reduce such damage. Respondents know how to distinguish waste from non-waste, understand the environmental damage caused by beach waste, and know how to prevent or reduce this damage. Regarding attitudes, the respondents believe that beach waste can spread diseases, actively support beach cleaning activities, and carefully avoid eating or drinking anything contaminated by beach waste. Observation skills include efficient waste management, preventing skin irritation from trash, and minimizing respiratory or allergy problems after visiting beaches with excessive waste. Observable skills include efficient waste management, preventing skin irritation from litter, and minimizing respiratory issues or allergies after visiting beaches with significant garbage accumulation. Most respondents have had experience in facing and overcoming health problems caused by the impact of coastal waste. Research reveals the need to promote behavioural and policy changes to reduce waste, manage it properly, and establish sustainable systems.

Internal and external factors that affect the situation are evaluated. A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis is a strategic tool used to evaluate both internal and external factors that impact the situation [8]. The results of the analysis are presented in Table 2.

Table 2. SWOT analysis of internal and external factors of the coastal area

Internal/ External	Positive	Negative
Internal	<p>Strengths</p> <ol style="list-style-type: none"> 1. Good waste management network infrastructure. 2. Community awareness and support. 3. Access and logistics capabilities. 	<p>Weaknesses</p> <ol style="list-style-type: none"> 1. Limited funds and resources. 2. Lack of 3R processing infrastructure in tourist attractions. 3. Uneven public awareness.
External	<p>Opportunities</p> <ol style="list-style-type: none"> 1. Government and policy support. 2. Cooperation with the private sector. 3. Environmental education and campaigns. 	<p>Threats</p> <ol style="list-style-type: none"> 1. Climate change. 2. Marine debris from other areas. 3. Disorderly behavior of tourists.

The final score for Strengths is 7.1, Weaknesses 5.0, Opportunities 8.0, and Threats 6.1. The interpretation of the results shows an Internal factor (Strengths – Weaknesses) of 2.1 and an External factor (Opportunities – Threats) of 1.9. Positive scores for both internal and external factors indicate that strengths and opportunities outweigh weaknesses and threats. This suggests that effective management of areas leads to success if weaknesses and threats are managed effectively.

Strategies, such as innovative and collaborative efforts, can be implemented to overcome the identified weaknesses and threats. These strategies may include partnerships with the private sector and NGOs, crowdfunding and donations, resource efficiency, and community training and empowerment. It's crucial to foster cooperation between various parties, especially the government and NGOs, as they play a crucial role in supporting waste management.

One approach to address the lack of 3Rs (Reduce, Reuse, Recycle) processing infrastructure at tourist attractions involves building 3Rs facilities, implementing integrated waste design and management, and conducting educational campaigns. The educational campaign entails informing visitors about the importance of the 3Rs and demonstrating how to apply them during their visit. Additionally, it's crucial to pursue technological innovation by utilizing modern technology for more efficient and environmentally friendly waste processing. This may include utilising technology in the recycling process to convert waste into valuable resources and assessing its environmental impact [2, 12].

Effective strategies to increase public awareness about waste management include educational programs, environmental awareness campaigns, offering awards and incentives, collaborating with community leaders and influencers, and utilizing social media for outreach [4]. Recent research has demonstrated the effectiveness of sharing environmental sanitation information and encouraging community involvement in promoting cleanliness and environmental sustainability through social media platforms, such as TikTok, as shown by the efforts of influencers from the Pandawara Group [7].

Strategies that can be implemented to address threats include mitigating the problems of climate change, marine debris, and disorderly tourist behaviour. Strategies to address climate change involve adaptation, mitigation, the use of renewable energy, and community involvement. To tackle marine debris, strategies such as cooperation between regions, patrols, and supervision, as well as marine cleanup projects, can be implemented. Dealing with disorderly tourist behaviour can involve implementing tourist awareness campaigns, providing adequate waste disposal facilities, enforcing rules, and offering incentives for responsible behaviour [14]. It is expected that implementing these strategies will help overcome existing weaknesses and threats, creating a more sustainable and environmentally friendly tourism environment.

4. Conclusion

The beach waste found in the Tourist Beach area, particularly in Balekambang, consists of a variety of materials. Organic waste includes wood, leaves, twigs, and other plant-based matter, as well as bone. Inorganic waste comprises plastic, Styrofoam, fabric, paper, glass, and rubber. The largest and heaviest pieces of organic waste are wood, leaves, and twigs, while plastic is the most common type of inorganic waste. The ecological impact of beach waste at Balekambang Tourist Beach was assessed as moderate, and 95.8% of respondents perceived a significant impact of beach waste on the environment and health. The communities in coastal tourist areas are known to have high levels of knowledge, attitudes, and skills in waste management. With proper management of weaknesses and threats, beach waste management can be successful.

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