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Environmental Impact Analysis of a Landfill in Segobang Village, Banyuwangi

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ABSTRACT

One of the growing environmental problems in many places is waste management. Landfills that are not managed effectively can affect public health and the quality of the surrounding environment. The purpose of this study is to examine how the landfill in Segobang Village, Banyuwangi, impacts the environment. This study was conducted using qualitative descriptive approach and semi quantitative approach data were collected through documentation, interviews, and field observations. The results show that the landfill pollutes the air with unpleasant odors, contaminates the soil due to waste accumulation, and pollutes water through leachate. In addition, a decline in environmental comfort and the emergence of minor illnesses such as coughs and skin irritation are social effects experienced by the community. Among the primary causes of these environmental impacts are a poor waste management system, a lack of supporting facilities, and low public awareness regarding environmental hygiene. Therefore, proper waste management is necessary to reduce the impact of pollution through improved facilities, environmental monitoring, and community training.

INTRODUCTION

Indonesia is the fourth most populous country in the world, and its population growth rate is projected to reach 1% from 2023 to 2026. As a result, the amount of waste generated by humans may increase (Tafakur et al., 2025). Waste is commonly found throughout Indonesia, causing people to become accustomed to it both at home and outdoors (Nggilu et al., 2022). Every year, the amount of waste produced increases along with the number of people living in a given area. Existence (Putra et al., 2021). The rising standard of living is another factor complicating the waste problem in Indonesia (Sitepu, 2024). This is compounded by a lack of knowledge about waste management and insufficient community participation in maintaining cleanliness and disposing of waste properly (Akbar et al., 2021). One area in Banyuwangi Regency, Segobang Village, faces waste management issues. Almost everyone in the community litters—not only the poor but also highly educated people (Yuniarti et al., 2020). Moreover, if waste is not managed properly, it can pollute the environment, disrupt and damage ecosystems, and cause unpleasant odors (Lestari & Ramandhayani, 2022). It is necessary to evaluate existing waste management systems and determine how effective they are in addressing waste problems (Rusliana et al., 2022).

Furthermore, given the unique social and geographic characteristics of Segobang Village in Banyuwangi, research is needed on the environmental impact of the landfill. The livelihoods of the villagers depend on the agricultural sector and the natural environment, so environmental quality is crucial for their sustainability (Hasanuddin & Iskandar, 2025). Waste pollution can have long-term effects on the ecosystem and public health if left uncontrolled (Khoiriyah, 2021). This

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study is also expected to provide an overview of the state of waste management at the village level and assist local governments and communities in improving waste management systems to be more efficient and environmentally sustainable (Lupiyanto et al., 2023). It is hoped that this study will raise awareness about the importance of effective waste management in preserving the environment and the quality of life for the community (Zafira & Damanhuri, 2019).

The objective of this study is to evaluate the impact of the landfill in Segobang Village, Banyuwangi, on the physical environment, health, and social life of the surrounding community. It is hoped that this study will make a scientific contribution to the advancement of environmental research. Additionally, it will serve as a reference for more sustainable waste management efforts at the village level (Mahendra & Salsabila, 2024).

RESEARCH METHODS

This study examined the environmental impacts of a landfill in Segobang Village, Banyuwangi Regency, using a qualitative descriptive approach. This method was chosen because it provides an in-depth understanding of environmental conditions and how communities near the landfill are affected by it. The study focused on air, soil, and water quality, as well as the social and health impacts on the community in the study area.

Data collection was conducted through observation, interviews, and documentation. The conditions of the landfill and its surrounding environment were observed directly. Interviews were conducted with village officials and local residents to determine the impacts of the landfill. Throughout the study, field notes and photographs were used as supporting data.

Environmental risk assessment is a process involving the collection, organization, and analysis of data to estimate the likelihood and uncertainty of undesirable impacts on the environment (humans, organisms, and other populations) (Manurung et al., 2025). Broadly speaking, the assessment process is as follows:

1. Preparation and Risk Identification Phase

Field Study and Environmental Profile: Conducting observations and collecting secondary data on the environmental profile of the study area (Segobang Village), including the physical-chemical, biological, and socioeconomic characteristics of the communities surrounding the TPS3R.

Hazard Identification and Operational Workflow: Comprehensively identifying and mapping all operational activities and facilities at the TPS3R (from reception and sorting to final processing).

Identification of Risk-Receiving Components: Determining the sources of hazards and the environmental components at risk (such as air quality, groundwater, surface water, and environmental aesthetics) that are threatened by dominant stressors at the TPS3R (leachate and gas emissions).

2. Risk Analysis and Estimation Stage

Qualitative Risk Analysis: Conducting an environmental risk assessment at the TPS3R using qualitative methods, namely:

a. Determining the Likelihood of Risk Occurrence (Probability: A through E).
b. Determining the Severity of the Risk (Consequences/Impact: Levels 1 through 5).
c. Combining these two matrices to obtain a Qualitative Risk Score (High, Medium, Significant, or Low) for each environmental component.

Semi-Quantitative Risk Analysis: Conduct an environmental risk assessment using a semi-quantitative method, as follows:

a. Determine the Event Frequency (F).
b. Determine the Event Magnitude (S1).
c. Determine the Sensitivity (S2) (level of public concern).
d. Calculating the Risk Value (R) using the formula R = F × (S1 + S2) to categorize risks (Low: 1–150, Medium: 151–300, High: 301–450).

Risk Prioritization: Identifying and determining which environmental components fall into the High-Risk category based on both analysis methods.

3. Risk Management Formulation Stage

Designing a Detailed Management Program: Developing and formulating a detailed and practical risk management program, focusing on environmental components classified as High-Risk.

Proposed Mitigation Measures for Dominant Stressors: Providing specific technical recommendations for:

a. Leachate Treatment Processes (upgrading the mini-wastewater treatment plant or managing leachate seepage at the base layer).
b. Gas/Odor Management (a simple ventilation system or adding a cover layer).

RESULTS AND DISCUSSION

Waste is a byproduct of human activity, and its volume continues to rise in tandem with population growth and changes in consumer patterns (Zumma et al., 2024). The higher the level of human activity, the greater the volume of waste generated. This situation can lead to environmental problems if not accompanied by proper and sustainable waste management (Widjaja, 2022).

Suboptimal waste management has the potential to cause air, soil, and water pollution due to the release of gases and leachate from the decomposition process. Therefore, an effective waste management system is needed through the implementation of the Reduce, Reuse, and Recycle (3R) concept to minimize negative impacts on the environment and public health (Kanda & Sari, 2024). Waste Management Concepts and Their Impacts

1. Urban Waste and 3R Waste Processing Sites (TPS3R)

Disposing of urban waste at landfills is the most widely used method in several cities across Indonesia. Although this is the most conventional and least ideal method in the spectrum of urban waste management technologies, landfills result in negative environmental impacts. Therefore, the application of the Reduce, Reuse, Recycle (3R) principles through 3R Waste Processing Facilities (TPS3R) is crucial for reducing the volume of waste sent to landfills.

2. Major Stressors at Waste Treatment Sites

The most significant negative impacts at waste treatment sites are the generation of gases and leachate, which have a high potential to damage the environment.

A. Leachate Stressor:
   a. Leachate is a stressor that is likely to pose a significant risk.
   b. Leachate is produced by the degradation of waste and contains many hazardous chemicals.
   c. Leachate can spread into various environmental components such as soil, groundwater, and surface water.
   d. Environmental risks arise if the Wastewater Treatment Plant (WWTP) is unable to treat leachate to meet quality standards, or if the landfill's liner does not meet requirements, allowing leachate to seep into the soil.

B. Gas Emissions as a Stressor:
   a. Gas emissions are also a dominant stressor.
   b. Gases produced by the decomposition of waste can cause unpleasant odors and pollute the air.

Environmental Risk Management and Assessment

1. Definition of Environmental Risk Assessment

Environmental Risk Assessment is a process involving the collection, organization, and analysis of data to estimate the likelihood and uncertainty of undesirable impacts on the environment (humans, organisms, and other populations). Risk assessment is based on the understanding that decisions are made under conditions of uncertainty and the desire to manage outcomes while maximizing potential benefits (Rahmah et al., 2024).

In the field of Industrial Engineering, this process of identification and assessment is often referred to as the HIRA (Hazard Identification and Risk Assessment) method. According (Zuchriyastomo & Purnomo, 2020), HIRA is a fundamental technique for identifying hazards in work or operational areas and assessing their risk levels to determine the priority of preventive actions. A risk assessment document generally outlines the combined health risks resulting from exposure to environmental contaminants at a given site and establishes the justification for taking remediation steps or removing the contaminants (Prisilla et al., 2024).

2. Risk Assessment Framework and Stages

The risk assessment process generally follows stages such as Planning, Problem Formulation, Analysis (Exposure Characterization and Impact Characterization), Risk Characterization, Risk Communication, and Risk Management and Communication. The detailed stages of risk assessment include: Risk Identification, Risk Analysis, Risk Assessment or Risk Estimation, and Risk Evaluation (Putra et al., 2021). The use of the HIRA method reinforces these stages by providing a more technical framework for classifying hazard levels based on field observation results (Siregar & Nasution, 2020).

1. Environmental Risk Analysis Methods

Risk analysis employs qualitative and semi-quantitative methods.

a. Qualitative Methods

Risk analysis is conducted by combining the probability of a risk occurring with the severity of the risk. This combination yields risk ratings consisting of high risk (H), medium risk (M), moderate risk (S), and low risk (L).

Table 1. Risk Occurrence Probability Matrix

Level	Probability of Risk Occurrence	Description
A	Almost certain	The activity is estimated to almost certainly pose a risk to the surrounding environme
B	Highly likely	The activity is estimated to highly likely pose a risk to the surrounding environment. This is a high-risk rating
C	Moderate likelihood	he activity is expected to pose a moderate risk to the surrounding environment. This is a moderate rating
D	Low likelihood	The activity is expected to pose a low risk to the surrounding environment. This is a low rating
E	Rare	he activities being carried out are estimated to pose no or only a rare risk to the surrounding environment. This is classified as a low risk

Source: Kasam, 2011

Table 2. Risk Measure Matrix

Level	Risk Hierarchy (Impact / Consequences)	Description
1	Insignificant Impact	The activity is expected to have an insignificant impact on the surrounding environment. This is classified as a low-level impact
2	Minor Impact	The activity is expected to have a minor impact on the surrounding environment. This is classified as a minor-level impact.

Source: Analysis Results

Table 3. Qualitative Risk Assessment

	Risk Severity Hierarchy (Impact/Consequences)					
Probability of risk occurrence (likelihood)		1	2	3	4	5
	A	M	M	H	H	H
	B	S	M	M	H	H
	C	L	S	M	H	H
	D	L	L	S	M	H
	E	L	L	S	M	M

Source: Analysis Results

b. Semi-Quantitative Data Method

This method is performed by combining three assessment elements: frequency of occurrence (F), magnitude of occurrence (S1), and sensitivity (S2). The risk value (R) is calculated using the following equation:

The risk value (R) categories for the semi-quantitative method are:

1. R=1–150 : Low risk; managed through routine procedures.
2. R=151–300 : Moderate risk; requires high-level management attention.
3. R=301–450 : High risk; requires detailed investigation and management.

Applying this formula within the HIRA framework helps industrial engineering practitioners determine risk ratings objectively, ensuring that mitigation measures are targeted effectively (Anthony, 2024).

2. Risk-Receiving Environmental Components

Risk assessments are conducted on various environmental components. Negative impacts that are likely to occur and have the potential to pose risks include:

1. Changes in land use.
2. Air pollution.
3. Groundwater pollution.
4. Surface water pollution.
5. Decline in terrestrial and aquatic flora.
6. Decline in terrestrial and aquatic fauna.
7. Decline in public health.
8. Deterioration of environmental aesthetics.

Table 4. Frequency Of Occurrence (F), Magnitude Of Occurrence (S1), And Sensitivity (S2)

Level	Description		
	Frequency of Occurrence	**Magnitude Of Occurrence**	**Sensitivity (S2)**
1	Unlikely to occur	No risk	Not a concern for the public
2	low	Low risk and impact	A concern for specific groups
3	Medium	Moderate risk	A concern at the regional/local level
4	Frequent	High risk	A national concern
5	Occurs very frequently	Extremely high risk	A matter of concern International / global / media

Source: Analysis Results

A. Qualitative Risk Analysis

The qualitative method used to partially describe the data and combine the probability of a risk occurring with its magnitude yields data indicating that risks fall into the following categories: high risk, medium risk, moderate risk, and low risk, as shown in the following table:

Table 5. Risk Probability Matrix for the Segobang Village TPS3R

Risk	Level Probability	Description
Land-Use Change	D	Land assets owned by the Village Government do not yet have a Land-Use Conversion Decision Letter, so there is a potential for them to be used for other purposes, although the likelihood of land-use change is low.
Air Pollution	A	Air pollution may occur because waste residues are still burned to reduce disposal costs at the landfill; this severely damages air quality. The likelihood of air pollution is high
Groundwater Pollution	D	Groundwater pollution is closely monitored in the leachate collection pond, particularly regarding organic waste and the cleaning of sorting areas. Therefore, the likelihood of groundwater pollution is low
Surface water pollution	B	Surface water pollution is virtually nonexistent because the waste received consists of fresh household and non-household waste; all has been sorted at the source, and all waste is managed at the Segobang TPS3R facility. Therefore, the likelihood of pollution is very low.
in terrestrial flora	D	A decline in the number of terrestrial plants due to odors resulting from the waste degradation process is unlikely

Source: Analysis Results

Table 6. Risk Value Matrix for the Segobang TPS3R

Risk	Risk Probability	Severity Level	Risk Value
Land-use change	D	2	L
Air pollution	A	4	H
Groundwater pollution	D	2	L
Surface water pollution	B	2	M
Decline in terrestrial flora (terrestrial)	D	2	L
Decrease in the number of aquatic flora	D	1	M
Decrease in the number of terrestrial fauna	D	2	L
Decrease in the number of	C	2	S
Decline in public health	C	3	M
Deterioration of environmental	C	3	M

Source: Analysis Results

Legend: H: High risk; M: Medium risk; S: Significant risk; L: Low risk

Based on the analysis results, the risk values for each indicator of the total risk value were determined. Of the 10 environmental components at risk, 1 component has a high risk (H) value, accounting for 10%: air pollution. Four components (40%) have a medium risk (M) value, including: surface water pollution, a decline in aquatic flora, a decline in public health, and a reduction in environmental aesthetics. Four components (4) have a low risk value (L) of 10%, including: land-use changes, groundwater pollution, a decline in terrestrial flora, and a decline in terrestrial fauna.

Table 7. Summary of Risk Assessment Results

Indicator	Score	Percentage
H	1	10%
M	4	40%
S	1	10%
L	4	40%
Total	10	100%

Source: Analysis Results

From the results of combining these matrices (Tables 6 & 7), it was found that Air Pollution has a high (H) risk value, accounting for 10% of the total risk components. According to Anthony (2024), identifying high risks at this early stage of the HIRA is crucial for determining resource allocation. Waste management at the TPS3R in Segobang Village has a varied risk profile, but overall it is dominated by low- to medium-risk categories. Nevertheless, existing potential risks must still be mitigated from the outset and remain a special concern for the Sumber Berkah Community-Based Management Group (KSM).

High-risk potential with a small total percentage is found in the air pollution component; low-risk potential with a large total percentage is found in the land-use change, groundwater pollution, decline in terrestrial flora, and decline in terrestrial fauna components; and medium-risk potential is found in surface water pollution, decline in aquatic flora, decline in public health, and reduced environmental aesthetics. Therefore, even though these risks are low, mitigation measures must still be implemented to address potential future risks. Resources for hazard mitigation.

B. Semi-Quantitative Risk Analysis

The risk analysis used in this practice is semi-quantitative, presenting data in numerical form and interpreted on a graded scale; this process combines the indicators of event frequency, event severity, and event sensitivity. To provide more precise numerical validation, risk scores are calculated according to HIRA standards using the parameters Frequency (F), Severity (S1), and Sensitivity (S2).

Risk = Frequency of occurrence × (Severity of occurrence + Sensitivity)

1. R = 1–150: Low risk; managed through routine procedures
2. R = 151–300: Moderate risk; requires high-level management attention
3. R = 301–450: High risk; requires detailed investigation and management

Table 8. Risk Value Matrix

Risk	Frequency (F)	Impact (S1)	Sensitivity (S2)	Risk Value Fx(S1+S2)
Land-use change	2	2	2	8
Air pollution	5	4	5	100
Groundwater pollution	2	2	2	8
Surface water pollution	2	2	2	8
Decline in terrestrial flora (terrestrial)	2	2	2	8
Decrease in the number of aquatic	2	1	2	6
Decrease in the number of terrestrial	2	2	2	8
Decrease in the number of aquatic	1	2	2	4
Decline in public health	3	3	3	18
Deterioration of environmental	3	3	3	18
Risk Total				186

Source: Analysis Results

Notes:
1. 0–150 = Low risk; managed through routine procedures.
2. 151–300 = Moderate risk; requires high-level management attention.
3. 301–450 = High risk; requires detailed investigation and management

The assessment results above show that the Segobang TPS3R risk value matrix indicates a score of 186, which is classified as moderate risk and requires high-level management attention. The frequency of potential environmental damage resulting from waste management—specifically air pollution—has the highest value. This is because the Segobang Village TPS3R still burns some residual waste due to the high tipping fees set and the facility's inability to cover those costs. Furthermore, the volume of residual waste generated from the sorting process and placed in containers is substantial, yet the containers can only hold this residual waste for one week. This should be a special concern for both the Village Government and the Sumber Berkah Community-Based Organization (KSM) to mitigate the risk of residual waste accumulation at the TPS3R. The following mitigation measures can be recommended based on these calculations:

1. The Segobang Village Government should prioritize budgeting for waste disposal.
2. Advocate to the Regional Government that it is the Regional Government's obligation to transport waste and provide incentives to villages that are able to reduce waste by 70%, in accordance with Regent Regulation No. 1 of 2024 on the Banyuwangi Regency Waste Management Master Plan.
3. Waste reduction efforts should be further enhanced by seeking off-takers for large volumes of low-value waste; with off-takers in place, residual waste can be minimized, resulting in high-quality sorted materials that are in high demand by off-takers. Examples include snack wrappers, styrofoam, and screen-printed plastic—which are classified as low-value and are often discarded as residual waste.
4. Efforts to improve the capacity of waste sorters in waste sorting techniques at the TPS3R should prioritize the effectiveness and efficiency of the sorting workforce.
5. The payment scheme for waste sorters should ideally be based on sorted material output targets.

CONCLUSION

The results of this study indicate that waste management at the Segobang TPS3R poses a moderate level of risk, with a risk matrix value of 186, thus requiring a high level of attention and mitigation measures. The primary risk stems from air pollution caused by the incineration of residual waste, which impacts public health and environmental quality. Therefore, the Sumber Berkah Community-Based Organization (KSM), together with the village government, needs to implement strategic mitigation measures to reduce the impact of pollution and improve the effectiveness of waste management. A recommendation for this study is to extend the data collection period to ensure greater data accuracy and to enable the study to be continued as a follow-up study using the Life Cycle Assessment (LCA) method.

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