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Research Article

Feasibility Study on the Relocation of the Mrican Ponorogo Landfill in 2024

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Abstract

The problem of waste management in Ponorogo Regency is increasingly complex along with the growth of the population and the increase in the volume of waste. One of the waste management locations that is facing problems is the Mrican Landfill, which has been operating since 1995 and is now experiencing excess capacity. This study aims to evaluate the feasibility of relocating the Mrican Landfill to a new location that is wider and in accordance with technical, social, and environmental criteria. This feasibility study uses a multicriteria analysis approach involving Simple Additive Weighting (SAW) methods and SWOT analysis, as well as GIS techniques for site suitability evaluation. The results of the study show that the new 9.38-hectare site can accommodate waste for 28 years with a capacity of around 2,900,000 m^3 or 750,000 tons. This relocation is feasible from various aspects, including environmental, social, economic, and technical. The selection of a new location meets the criteria of SNI No. 03-3241-1994, with considerations such as safe distance from settlements, topographic conditions, accessibility, and minimal risk of pollution. This research also recommends improving supporting infrastructure, an efficient waste management system, and socialization programs to the community. The relocation of this landfill is expected to improve the quality of waste management and support environmental sustainability in Ponorogo Regency.

Keywords: Waste management; Mrican Landfill; Relocation; Feasibility Study; SAW; GIS; SNI No. 03-3241-1994

INTRODUCTION

The problem of waste management in Indonesia is increasingly complex along with the significant increase in the volume of waste from various sources. Based on data from the Directorate General of Waste, Waste, and B3 Management of the Ministry of Environment and Forestry, at the beginning of 2020, national waste generation was recorded at 67.8 million tons, with the household sector as the largest contributor at 48%, followed by traditional markets (24%) and street waste (7%) (Central Statistics Agency, 2023). The increase in the volume of waste is directly proportional to the rate of population growth, increased consumption, and increasingly high community activities. This phenomenon is reflected in Ponorogo Regency, which is projected to increase the population by 2% every year (Central Statistics Agency, 2023). This increase in population has a direct impact on waste management, where the volume of waste produced is also increasing. Without a better management system, this increase risks causing negative impacts such as environmental pollution, waste accumulation, and increased methane gas pollution from organic waste that risks disrupting public health (Bappenas, 2019).

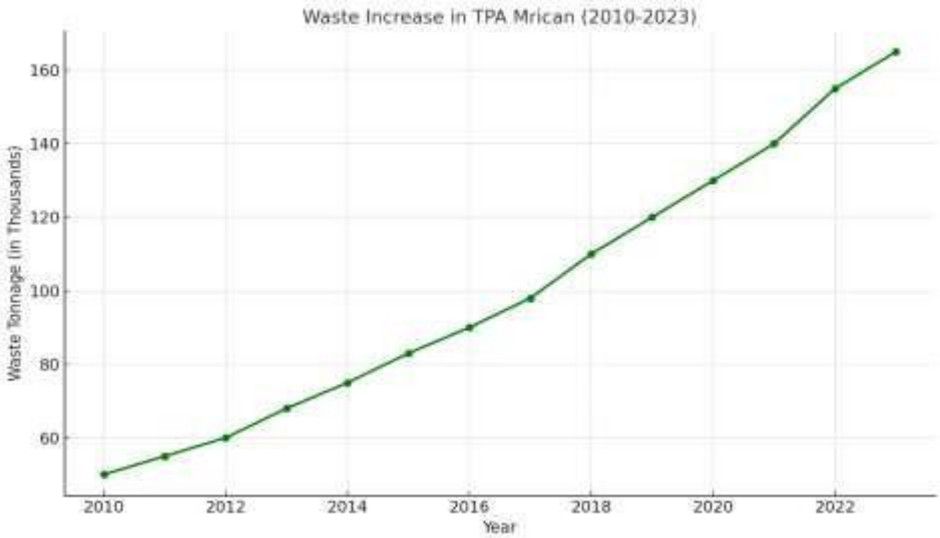


Figure 1. Increase in waste volume at the Mrican Landfill (2010-2023)

One example of the problem faced is at the Mrican landfill, Ponorogo Regency, which began operating in 1995 with an area of about 2.4 hectares. This location was initially chosen because of the availability of vacant land, without considering the appropriate technical criteria for a landfill. Based on a report by the Ponorogo Regency Environmental Agency (DLH) in 2023, the Mrican Landfill receives around 130 m^3 of waste per day, which makes it overloaded. To date, the Mrican landfill has accommodated a total waste volume of 786,240 m^3, which far exceeds its optimal capacity (Ministry of Environment and Forestry, 2023). In addition, this landfill is only less than 500 meters away from settlements, which does not meet minimum distance standards and causes negative impacts in the form of air pollution, soil pollution due to leachate liquid, and social disturbances in the surrounding community.

The Mrican landfill is currently still using the open dumping method for waste management, which is known to have various adverse impacts on the environment and health. Alternatively, more environmentally friendly management methods such as sanitary landfills or controlled landfills need to be considered. Relocating landfills to a more suitable location is an indispensable solution. In this effort, the Ponorogo Environment Agency has coordinated with Perhutani Ponorogo Region to find an alternative location. The new location is planned in the F1 and F2 plots area in Mrican Village, Jenangan District, with a land area of about 9.8 hectares, which is three times the current capacity of the Mrican landfill. With a 20-year land use loan scheme, this new location is expected to be able to accommodate waste optimally and meet landfill capacity standards for urban areas. This relocation is also in line with the Adipura award criteria, where the minimum landfill area must reach 5 hectares (Ponorogo Regency Regional Development Planning Agency, 2023).

Figure 2. Location of IPLT Infrastructure in Ponorogo Regency

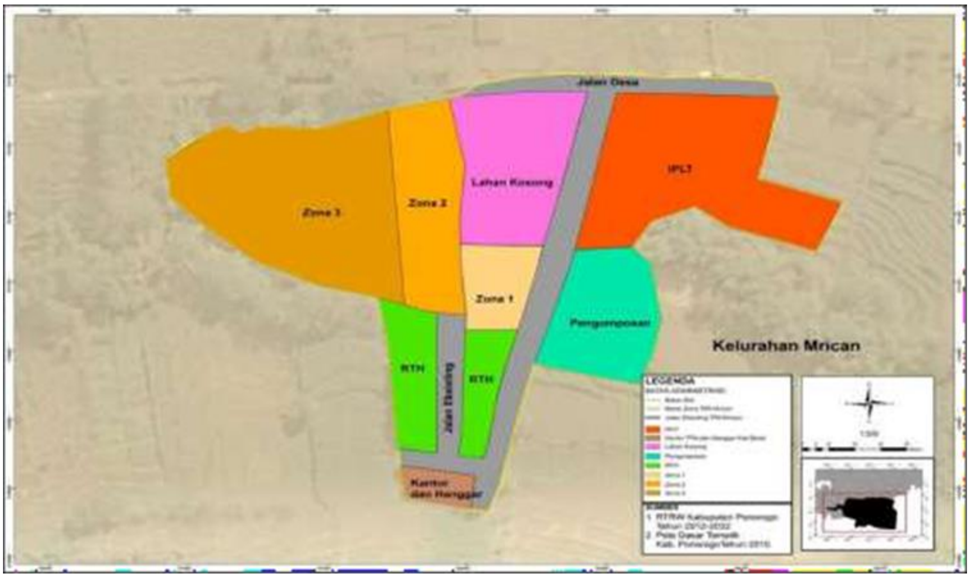


Figure 3. Map of the Study Area of the Mrican Landfill

The relocation of the Mrican Landfill is an urgent need to ensure more sustainable and environmentally friendly waste management. The selection of a new location for the landfill must refer to SNI 03-3241-1994 which provides technical guidelines in determining the appropriate location based on technical, social, and environmental aspects. In addition, the participation of the surrounding community and the implementation of a communal-based management system are also important factors in the success of the new landfill management. To support accurate location selection, a decision support system based on the SAW (Simple Additive Weighting) method is applied, in order to evaluate the technical, social, and environmental criteria that have been set (Ministry of Public Works, 1994).

This research entitled "Feasibility Study of Relocation of Mrican Ponorogo Landfill" aims to evaluate the feasibility of relocating Mrican Landfill and determine new locations that meet sustainability criteria. This study not only considers technical and environmental aspects, but also economic and social aspects. In addition, this study aims to provide data-based recommendations to support sustainable waste management in Ponorogo Regency. This study will also identify the ideal landfill location criteria based on SNI criteria No. 03-3241-1994 and conduct spatial analysis using the GIS (Geographic Information System) method to evaluate the suitability of new locations (Pratama, 2020).

The formulation of the problem in this study focuses on two main questions that must be answered. First, do the proposed new locations meet the technical, social, and environmental requirements for landfill relocation? Second, how is the suitability of the new location based on GIS spatial analysis and SNI criteria No. 03-3241-1994? This study aims to evaluate the feasibility of the relocation site by paying attention to various factors that affect the success of this project, such as technical, social, and environmental aspects. In addition, this study will produce recommendations for more sustainable waste management solutions in Ponorogo Regency.

The purpose of the Research Feasibility Study of the Mrican Ponorogo Landfill Relocation is to evaluate the feasibility of the proposed new location as a replacement landfill, taking into account technical, social, and environmental criteria. This study aims to analyze the suitability of new locations using GIS-based spatial methods and SNI criteria No. 03-3241-1994. In addition, the main purpose of this study is to provide strategic recommendations regarding landfill relocation that can support sustainable waste management in Ponorogo Regency and meet the necessary legality aspects.

The scope of this research includes the evaluation of the existing conditions of waste management in Ponorogo Regency, the analysis of the ideal location criteria for landfills based on SNI No. 03-3241-1994, as well as the collection of geospatial data to evaluate the potential for new locations. This research will also explore the use of GIS technology in analyzing the suitability of the location and the socio-economic impact of the relocation.

LITERATURE REVIEW

Definition of Feasibility Study

A feasibility study, or feasibility study, is a study conducted to determine whether a project or plan can be implemented by considering various aspects, such as technical, economic, social, environmental, and legal. This feasibility study is an important first step in project planning to ensure that the proposed project can run effectively and efficiently, and provide optimal benefits for all stakeholders (Whyte, 2013). In the context of landfill relocation, the feasibility study serves to ensure that the selected location can support the operational needs of the landfill, minimize negative impacts on the environment and society, and ensure the sustainability of waste management in the area.

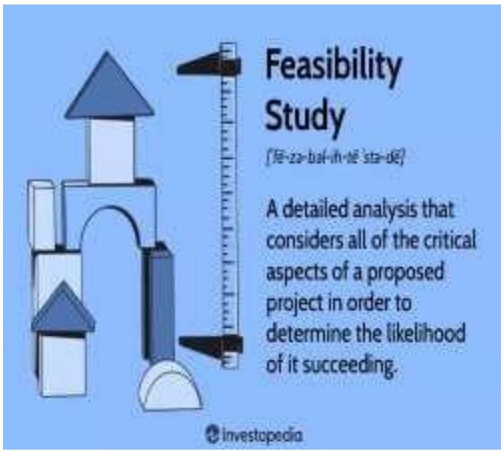


Figure 4. Feasibility Study

According to Whyte (2013), the main objective of this feasibility study is to ensure that the landfill relocation plan is not only technically feasible, but can also support the sustainability goals of waste management. In this case, the feasibility study will include various analyses, such as landfill capacity, environmental impact, spatial suitability, and costs required for relocation.

The Importance of Feasibility Study

Feasibility studies play a very important role in strategic decision-making, especially for projects that have a major impact on the environment and society, such as landfill relocation. According to Henderson (2004), feasibility studies provide a framework for identifying, analyzing, and evaluating factors that can affect the success of a project. In the context of landfills, feasibility studies allow authorities to evaluate risks and formulate effective mitigation strategies, optimize resources, and support data-driven decision-making.

In addition, Lewis and Litman (2009) emphasized that the feasibility study also ensures the legality of the project by meeting the applicable standards and regulations, as stipulated in SNI No. 03-3241-1994 for landfill relocation. The study not only includes technical analysis, but also examines the social and environmental impacts that can affect the surrounding community.

Definition of Waste

Waste or solid waste, according to the World Health Organization (WHO), is a material that is not reused, unused, and has no economic value so that it can have a negative impact on the environment if not managed properly. Factors that affect waste management include population, socioeconomic conditions, technological advancements, collection systems, topography, and climate, all of which can affect the quality and quantity of waste generation (Tchobanoglous & Kreith, 2002).

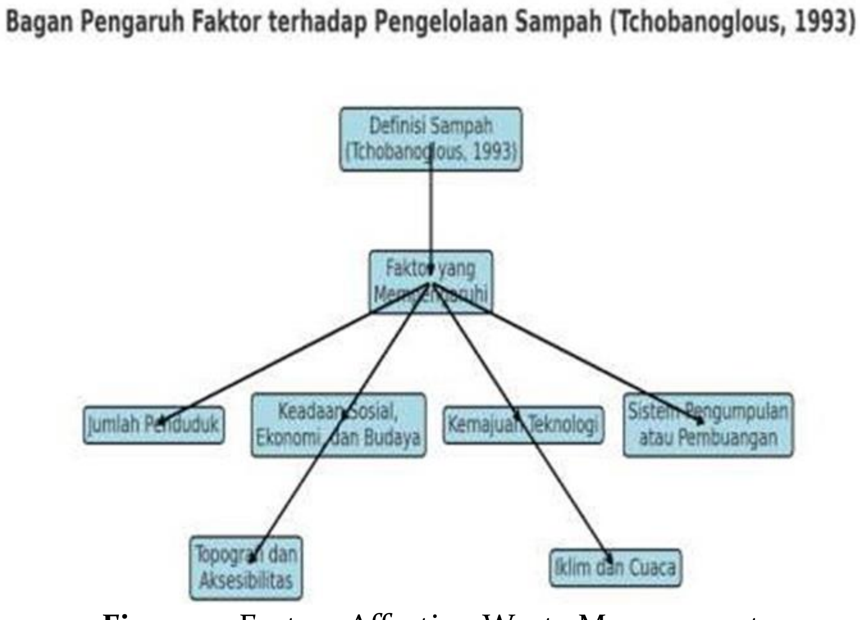


Figure 5. Factors Affecting Waste Management

Tchobanoglous (1993) stated that waste comes from human and animal activities which are then discarded because they are undesirable (Tchobanoglous & Kreith, 2002). As the population and human activities increase, the resulting waste generation is also getting larger, which requires better management to prevent environmental pollution.

Waste Management Techniques

Waste management includes all activities carried out to handle waste from incursion to disposal at the Final Processing Site (TPA). These processes include waste collection, on-site handling, collection, transportation, processing, and final disposal. One of the commonly used management methods is Sanitary Landfill, where waste is stockpiled and compacted, then covered with soil as a covering layer to avoid pollution.

Figure 6. Electronic Waste

In Indonesia, several modern technologies such as Mallsampah and Mas Eco Dispenser have been developed to support more environmentally friendly waste management. Mallsampah, for example, connects waste producers with waste pickers, while Mas Eco Dispenser encourages the use of its own drinking packaging to reduce plastic waste.

Figure 7. Influencing Factors in Topography and Accessibility

Procedures for Selecting Final Processing Sites (TPA)

Choosing the right landfill location is very important to prevent various operational problems in the future. SNI No. 03-3241-1994 provides guidelines on location criteria that must be met for the location of the appropriate landfill, including not being in a flood-prone area, a minimum distance from a settlement of 500 meters, and not polluting water sources.

Table 1. Location Criteria, Supporting Factors, Inhibiting Factors, and Landfill Accessibility Aspects

No.	Landfill Location Criteria	Explanation
1	**Not Located in a Flooded Area**	The location of the landfill must be in an area that is not prone to flooding to prevent waste from being carried away by water and causing pollution.
2	**Distance from Settlement**	The landfill location must be located half a mile (about 800 meters) from settlements and other territorial boundaries.
3	**Does Not Pollute Water Sources**	Landfills should not be located close to water sources, both groundwater and surface water, to avoid water pollution.
4	**Soil Slope Less than 25%**	Low soil slope to avoid erosion and maintain the stability of the accumulated waste.
5	**Easy Accessibility**	The location of the landfill must be easily accessible by waste transport vehicles and have good access for waste management operations.

No.	Supporting Factors for Landfill Location	Explanation

1	**Areas With Utility Lines**	Have access to utility facilities (such as electricity, water) to support landfill operations.
2	**Soil Type Conditions**	The soil has a clay texture and is well-drained which can reduce the potential for pollution.
3	**Areas of Landlessness Less than 20%**	The slope of the soil is less than 20% to avoid erosion and facilitate the waste transportation process.

No.	Inhibiting Factors in Determining Landfill Location	Explanation
1	**Protected Areas**	Must not be in nature conservation areas or protected areas that serve as a buffer against pollution.
2	**Flood Inundation Areas**	Avoid areas prone to waterlogging or flooded areas after heavy rains, such as riverbanks or swamps.
3	**Built Areas**	Landfills should not be located in areas that have been built or densely populated, to avoid social and economic disturbances.
4	**Proximity to Main Road Network**	The location of the landfill should not be too close to the main road network to reduce the impact of air pollution and traffic disruptions.
5	**Hydrogeological Regions**	Ensuring that the location of the landfill does not interfere with hydrogeological flow or groundwater quality that can cause pollution.

No.	Accessibility and Landfill Management	Explanation
1	**Accessibility**	The accessibility of the landfill location must be good, easy to reach by waste carriers but still maintain a distance from settlements to reduce the impact of pollution milieu.

This table summarizes the criteria used to determine the feasibility of a landfill location.

Other criteria that must also be considered are the slope of the land, the accessibility of the location, and the existence of utility lines to support effective and efficient landfill operations.

Landfill Support Facilities

Landfill supporting facilities are very important to support the sustainability of landfill operations. Some of the basic facilities needed include entrances, electricity, drainage, and offices. In addition, environmental protection facilities such as waterproof coatings and leachate treatment plants are also very important to avoid pollution.

Figure 8. Waste Treatment Facilities at Landfills

Buffering Zone

Buffering zones are GIS techniques used to create buffer zones around specific geographical objects such as rivers, roads, or settlements to ensure a safe distance from landfill locations. This technique is very useful in determining a safe location from potential contamination.

Figure 9. Buffering Zone Concept

From the literature review that has been conducted, it can be concluded that the feasibility study of landfill relocation must consider various technical, social, and environmental aspects. The use of GIS techniques in the selection of landfill locations is very important to ensure that the selected location meets the eligibility criteria set by SNI 03-3241-1994. This includes the application of Buffering, Overlay, and Scoring techniques to assess the suitability of a location based on relevant technical, social, and environmental factors.

RESEARCH METHODS

The research methodology in the technical feasibility study for the relocation of the Mrican Landfill in Ponorogo Regency was carried out through several structured stages. The first stage is a literature review and collection of supporting data that aims to gather information related to theories and previous studies relevant to this research topic. In this stage, literature obtained from journals, books, and government policies becomes the main source to explore the technical, social, economic, and environmental aspects related to landfill relocation. Furthermore, an analysis of the existing condition of the Mrican Landfill was carried out which included an examination of the current capacity and waste management, the social and environmental impacts caused, and other issues that need to be fixed at the current location.

The next step is to conduct a feasibility study based on several aspects that have been determined, including physical and technical, social, economic, and environmental aspects. This process integrates data from various sources to evaluate the feasibility of relocating landfills. The analysis used in this feasibility study involves the Simple Additive Weighting (SAW) method, which provides weights and scores for each criterion based on physical, technical, social, economic, and environmental parameters. The results of this analysis will determine whether the relocation of landfills to alternative locations can be carried out efficiently and environmentally friendly.

The methodology of this study combines a mixed methods approach that includes qualitative and quantitative methods. This approach aims to provide a deeper and more comprehensive understanding of the feasibility of landfill relocation. By combining qualitative data obtained through interviews and field observations as well as quantitative data from technical surveys and spatial analysis, this study aims to produce robust and relevant data-based recommendations. The following figure illustrates the framework of thinking from the feasibility study of the relocation of the Mrican landfill.

Source: Processed from various related research sources
Figure 10. Framework for Feasibility Study of Landfill Relocation

Qualitative methods were used to explore the perception of the community and related parties regarding existing landfills and relocation plans. Qualitative data was obtained through in-depth interviews with the surrounding community, stakeholders, and local governments. This interview aims to explore their views on the current existence of landfills, as well as receive input on the potential social and environmental impacts caused by relocation. In addition, field observations were also carried out to assess the current physical condition of the landfill and its potential impact on the surrounding environment.

The quantitative method in this study focuses on collecting technical data related to the feasibility criteria for alternative landfill locations. This data collection is carried out through field surveys to measure various parameters such as distance from settlements, road accessibility, land slope, and hydrological conditions. In addition, spatial analysis (GIS) is used to map alternative locations and evaluate their suitability based on existing geospatial data. The SAW method is used to provide scores based on predetermined criteria, such as proximity to settlements and topographic conditions of the land.

After qualitative and quantitative data are collected, the next stage is to triangulate the data to validate the findings obtained from interviews, field observations, and technical surveys. Data from these three sources are compared to ensure consistency and reliability of the findings. In addition, multicriteria analysis is carried out by combining social perceptions, existing conditions, and technical analysis to produce recommendations regarding the most suitable landfill location.

The data collection in this study consists of two main sources, namely primary data and secondary data. Primary data was obtained through direct observation at the location of the Mrican Landfill and the prospective relocation location. The survey of the technical aspect was carried out using drone technology to obtain a picture of the topography and distribution of waste at the location. In addition, interviews were conducted with the surrounding community, stakeholders, and relevant officials at the Environment Agency. Meanwhile, secondary data includes literature studies from journals, statistical data on waste volume, as well as regulatory and policy documents relevant to waste management and landfill relocation.

Data analysis was carried out using several techniques, including the Likert Scale, SAW, and SWOT. The Likert Scale technique is used to measure the level of community support for existing landfills and potential new locations. The results of the interviews will be coded and analyzed narratively to illustrate public perception. The SAW is used to assess the feasibility of alternative locations based on physical and technical, social, economic, and environmental criteria. The data obtained from drone surveys and mapping will also be analyzed to provide more accurate results. In addition, a SWOT analysis is used to evaluate the advantages, disadvantages, opportunities, and threats that exist in this landfill relocation process.

By integrating both qualitative and quantitative approaches and using multicriteria analysis, this study aims to provide a comprehensive picture of the feasibility of relocating the Mrican landfill. The results of this study are expected to provide a strong basis for decision-making in relocating landfills by considering technical, social, economic, and environmental factors in a balanced manner.

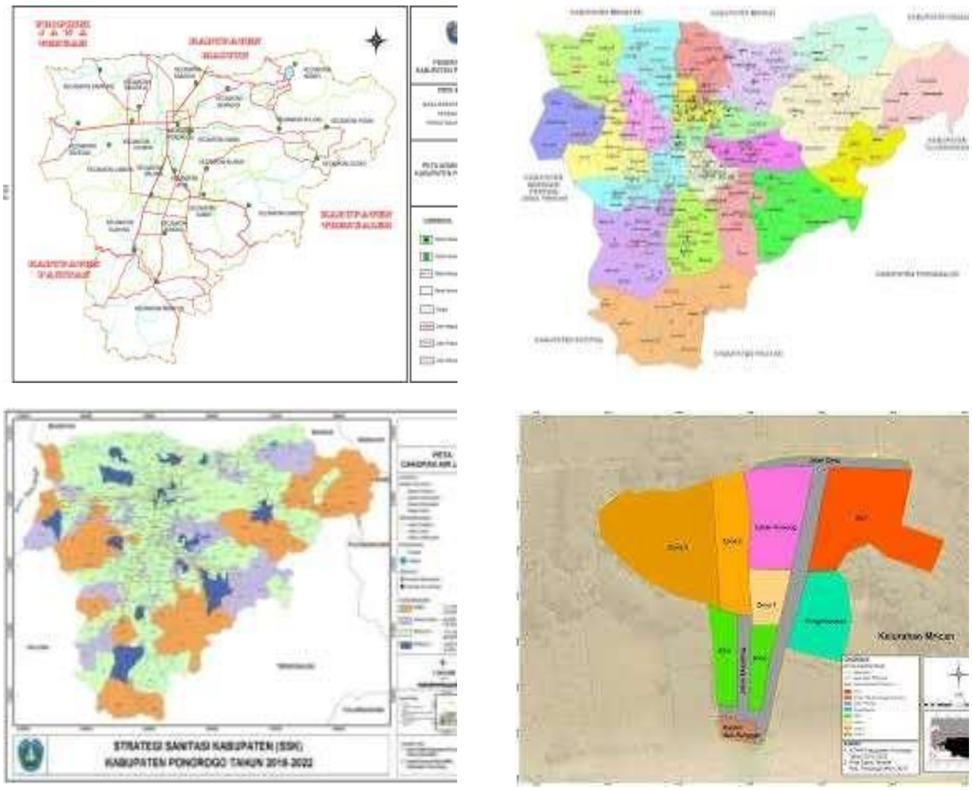
RESULTS AND DISCUSSION

This study aims to analyze the existing condition of the Mrican Final Processing Site (TPA) and conduct a feasibility study related to the relocation of landfills in Ponorogo Regency. In this section, the results obtained will be discussed with reference to the data and analysis that has been carried out, as well as their relation to the technical, social, and environmental aspects relevant to relocation planning.

Geographical and Administrative Conditions of Ponorogo Regency

Ponorogo Regency is located between 111°17' to 111°52' East Longitude and 7°49' to 8°20' South Latitude, with an area of 1,371.78 km². Topographically, Ponorogo is surrounded by mountain ranges, ranging from Mount Wilis in the east to Mount Lawu in the west. This district is bordered by Madiun, Magetan, Nganjuk Regency in the north, Tulungagung and Trenggalek Regency in the east, Pacitan Regency in the south, and Wonogiri Regency in the west. Administratively, Ponorogo is divided into 21 sub-districts and 305 sub-districts/villages, with a population of around 895,921 people. The demographics of Ponorogo Regency show relatively stable population growth with an average annual growth of 0.52%, despite the imbalance in population density between sub-districts.

The following image shows an overview of the Mrican Landfill relocation planning area, including the administrative map of Ponorogo Regency, the zoning map of the waste management of the Mrican Landfill, and the map of wastewater coverage in this area.



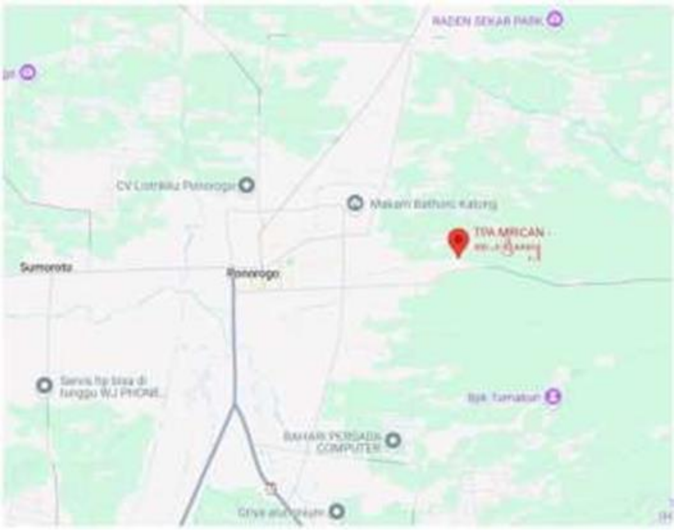
Source: BPS, SSK Year 2018-2023, DLH Drinking Water Working Group
Figure 11. Overview of the Mrican Landfill Relocation Planning Area

Topography and Hydrology

Ponorogo Regency has a varied topography, ranging from lowlands to highlands with an altitude between 25 meters to 1000 meters above sea level. Most of the area is at an altitude between 100 meters to 500 meters above sea level. The region consists of lowlands that dominate 79% of the total area and highlands that cover 14.4%. In addition, the district has 17 rivers that function as a source of agricultural irrigation, with the Sungkur River, which has a length of 58.10 km, being the longest in the region. This hydrological condition is important in analyzing the feasibility of relocating landfills, especially in ensuring that there is no pollution of water sources around the new landfill.

Condition of the Mrican Landfill

The Mrican Landfill, located in Mrican Village, Jenangan District, Ponorogo Regency, has been operating since 1995 and has an area of 2.4 hectares. This landfill serves waste disposal from four main sub-districts in Ponorogo Regency. Although it has functioned to manage waste, this landfill is now overloaded and has a bad impact on the surrounding environment. The waste produced every day reaches 70 to 90 tons, which exceeds the capacity of the final processing site. This condition causes air pollution and potential water pollution, as well as increases risks to the health of the surrounding community.



Source: Internal documents, 2024
Figure 12. Old Mrican Landfill Location

Waste Source and Waste Management

Waste sources in Ponorogo Regency come from various sectors, including households, trade, and the public sector. Based on data from the Ponorogo Regency Landfill Masterplan, domestic waste accounted for 74.09% of the total waste generation, followed by non-domestic waste such as market and office waste. Waste management in Ponorogo Regency is carried out using recycling technology such as Recycling Centers (PDUs) and Waste Banks, but the limited capacity of the Mrican Landfill causes waste management to be less than optimal.

Table 2. Sources of Waste in Ponorogo Regency

Waste Source	Weight of Waste (Ton)	Percentage (%)
Domestic Waste	66.700,55	74,09
Non-Domestic Waste		

Market Waste	8.759,99	9,73
Office Waste	3.406,62	3,78
Shop Waste	3.275,26	3,64
Industrial Waste	2.919,99	3,24
Food Waste	1.530,57	1,70
Garbage of Places of Worship	1.355,36	1,51
Garbage from School	1.287,23	1,43
Terminal Waste	729,99	0,81
Garbage from the Hotel	70,57	0,08
	90.036,13	**100,00**

Source: Ponorogo Regency Landfill Masterplan, 2015

Landfill Relocation Analysis

To overcome the problem of overload and negative impacts of the Mrican Landfill, this study recommends relocating the landfill to a new location that is more strategic and meets technical, social, and environmental criteria. The process of selecting a new location was carried out using an evaluation method based on Simple Additive Weighting (SAW) and SWOT Analysis, which combines factors such as distance to settlements, topography, road accessibility, and environmental impact.

From the results of the analysis, the new location in the Perhutani KPH Madiun area was identified as having a higher score in terms of compliance with technical and environmental criteria than the old location. This new location has a safe distance of more than 500 meters from settlements, flat to sloping topography, and is far from water sources that are sensitive to pollution.

Source: Satellite Imagery, 2024

Figure 13. Satellite Imagery Showing Changes in Volume of Waste Generation

Projection of Waste and Land Needs

Projected waste generation based on projected population growth shows that the volume of waste entering landfills is expected to continue to increase, reaching 313,186 m^3 by 2050. With limited capacity at the Mrican landfill, relocating the landfill to a new, larger location is important. Based on calculations, to accommodate the estimated volume of waste, an area of 9.38 hectares is needed, with the use of a more environmentally friendly Sanitary Landfill system.

Table 3. Analysis of the Land Needs of the Mrican Landfill

Description	Unit	Year to																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
		2023	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
Incoming Waste	m3/day	271,23	272,68	274,13	275,60	277,07	278,55	280,04	281,53	283,04	284,55	286,07	287,60	289,13	290,68	292,23	293,79	295,36	296,94	298,52	300,12	301,72	303,33	304,95	306,58	308,22	309,87	311,52	313,19
Volume of Waste after Compacting	m3/day	113,01	113,62	114,22	114,83	115,45	116,06	116,68	117,31	117,93	118,56	119,20	119,83	120,47	121,12	121,76	122,41	123,07	123,72	124,39	125,05	125,72	126,39	127,06	127,74	128,43	129,11	129,80	130,49
Cover Soil Volume	m3/day	16,95	17,04	17,13	17,22	17,32	17,41	17,50	17,60	17,69	17,78	17,88	17,97	18,07	18,17	18,26	18,36	18,46	18,56	18,66	18,76	18,86	18,96	19,06	19,16	19,26	19,37	19,47	19,57
Total Backlog	m3/day	129,96	130,66	131,36	132,06	132,76	133,47	134,18	134,90	135,62	136,35	137,07	137,81	138,54	139,28	140,03	140,78	141,53	142,28	143,04	143,81	144,58	145,35	146,12	146,90	147,69	148,48	149,27	150,07
Total Backlog	m3/year	47.436,76	47.690,14	47.944,88	48.200,98	48.458,44	48.717,28	48.977,50	49.239,12	49.502,13	49.766,54	50.032,37	50.299,62	50.568,29	50.838,40	51.109,95	51.382,96	51.657,42	51.933,34	52.210,75	52.489,63	52.770,00	53.051,87	53.335,25	53.620,14	53.906,55	54.194,49	54.483,97	54.774,99
Estimated cell height	m	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00
Land Requirements	**Ha**	**0,32**	**0,32**	**0,32**	**0,32**	**0,32**	**0,32**	**0,33**	**0,33**	**0,33**	**0,33**	**0,33**	**0,34**	**0,34**	**0,34**	**0,34**	**0,34**	**0,34**	**0,35**	**0,35**	**0,35**	**0,35**	**0,35**	**0,36**	**0,36**	**0,36**	**0,36**	**0,36**	**0,37**
Cumulative Land Needs	**Ha**	**0,32**	**0,63**	**0,95**	**1,28**	**1,60**	**1,92**	**2,25**	**2,58**	**2,91**	**3,24**	**3,57**	**3,91**	**4,25**	**4,58**	**4,93**	**5,27**	**5,61**	**5,96**	**6,31**	**6,66**	**7,01**	**7,36**	**7,72**	**8,07**	**8,43**	**8,80**	**9,16**	**9,52**

Source: Drafting Team Analysis, 2024

Community Recommendations and Responses

Based on the results of surveys and interviews with the surrounding community and stakeholders, most respondents support the relocation of the Mrican landfill to a new location, provided it is equipped with a better waste management system and adequate infrastructure. Public responses show concerns about environmental impacts, particularly related to potential water and air pollution. Therefore, it is important to educate the public about the benefits of relocation as well as the environmental impact mitigation measures that will be implemented in the new location.

Table 4. Likert Scale Results of the Assessment of the Relocation of the Mrican Landfill

Statement	Average Likert Score
The new location is more technically appropriate.	4.8
The relocation has no impact on settlements.	4.5
Public education and socialization are necessary.	4.7

Source: Community Survey, 2024

SWOT Analysis and T-Paired Test

The results of the SWOT analysis show that the new location has a higher score in terms of advantages and opportunities, making it very feasible to use it as a more sustainable waste final processing site. The results of the paired t-test also showed significant differences between the old and new locations, especially in terms of distance from settlements, topography, and distance from the river.

Table 5. Results of Identification of Landfill Location Criteria

No.	Parameters	Weight	Score	
			LANDFILL Old	LANDFILL New
	PHYSICAL AND TECHNICAL			
1.	Protected Areas/Nature Reserves	2		
	No protected areas/reserves Surrounding Nature	10	20	20
	Exist area Protected / Nature Reserve in the vicinity that is not negatively affected	5		

No.	Parameters	Weight	Score LANDFILL Old	Score LANDFILL New
	Exist area Safeguard/Reserve nature at Surrounding negatively affected	1		
2.	Region *Karst*	2		
	Not territorial and not close With *karst*	10	20	20
	Not region but near With *karst*	5		
	Karst area (land change)			
3.	Flood Hazards	2		
	No flood hazard	10		20
	Possible floods > 25 years	5		
	Likelihood flood < 25 annual. Reject (except there is a technological input)	1	2	
4.	Slope Slope (*Slope*)	3		
	Slope slope 0 – 2%	5	15	15
	Slope slope >2%	1		
5.	Hydrogeological Conditions	5		
	It is > 2,000 meters away from river	10		
	200 – 2,000 against river	5		
	0 – 200 meters away from river	1	5	5
6.	Groundwater Surface Depth	3		

	Groundwater level >13 meters	5	15	15
	Groundwater level < 13 meters	1		
7.	Traffic	3		
	Located < 500 m from public roads at low traffic	10	30	30
	Located < 500 from the public road m in moderate traffic	5		
	Located in high traffic	1		

No.	**Parameters**	**Weight**	**Score**	
			LANDFILL Old	**LANDFILL New**
8.	The Road to the Location	5		
	Flat with good condition	10		
	Flat with poor condition	5		
	Up/down	1	5	5
9.	Waste Transport (one way)	5		
	Less than 15 minutes from centroid garbage	10	50	50
	Between 16 minutes – 30 minutes from Centroid Waste	8		
	Between 31 minutes – 60 minutes from Centroid Waste	3		
	More than 60 minutes from centroid garbage	1		
10.	Entrance	4		
	Garbage trucks do not pass through the area Settlement	10	40	

	Truck garbage through Medium-density residential areas (<300 inhabitants/ha)	5		20
	Truck garbage through High-density residential areas (>300 inhabitants/ha)	1		
11.	Aesthetic	3		
	Invisible hoarding operations from the outside	10	30	30
	Operation Hoarding little visible from the outside	5		

No.	Parameters	Weight	Score LANDFILL Old	 LANDFILL New
	Stockpiling operations are visible from outside.	1		
12.	Distance to the airport	3		
	Is >6,000 m towards airport	10	30	30
	It is 3,000 – 6,000 m away from airport	5		
	0 – 3,000 m away from airport	1		
13.	Land Capacity	5		
	>10 Land	10		50
	5 years – 10 years	8		
	3 years – 5 years	5		
	Less than 3 years	1	5	
	SOCIAL			

1.	Owner of Land Rights	3			
	Local/central government		10	30	30
	Personal (one)		7		
	Private/corporate (one)		5		
	More than one rights owner and or ownership status		3		
	Social/religious organizations		1		
2.	Community Consent	3			
	Spontaneous		10		30
	Driven		5	15	
	Negotiation		1		
3.	Number of Landowners	3			
	One (1) kk		10	30	30

No.	Parameters	Weight		Score LANDFILL Old	Score LANDFILL New
	2 – 3 pcs		7		
	4 – 5 kg		5		
	6 – 10 pcs		3		
	More than 10 families		1		
	ECONOMICS				
1.	Freight Costs	3			
	Waste centroid travel time < 15 minutes		10	30	30
	Waste centroid travel time 15 – 30 minutes		5		
	Centroid waste travel time > 30 minutes		1		
	MILIEU				

No.	Parameters	Weight	Score	
			LANDF ILL Old	**LAND FILL New**
1.	Soil (above groundwater level)	5		
	Conductivity Hydraulic $<10^{-9}$ cm/det	10		
	Conductivity Hydraulics 10^{-9} cm/det – $^{10-6cm}$/det	7	35	35
	Conductivity Hydraulic > 10^{-6} cm/det Reject (except exist technology input)	5		
2.	Groundwater	5		
	≥ 10 m with approval 10-6 cm/sec	10	50	50
	< 10 m with < 10-6 approval cm/det	8		
	≥ 10 m with approval 10-6 cm/det – 10-4cm/sec	3		
	<10 m with 10-6 approval cm/det – 10-4cm/det	1		
3.	Land Use	5		
	Have impact little on the surrounding land use	10	50	
	Have impact keep on the surrounding land use	5		25
	Have impact big on the surrounding land use	1		

4.	Relevance to Water Utilization Soil	3			
	Likelihood Utilization low with hydraulic limit		10	30	30
	Projected to be utilized with border Hydraulic		5		
	Projected to Utilized without hydraulic limits		1		
5.	Ground Cover	4			
	Sufficient cover soil		10		40
	Sufficient cover soil to 1/2 service life		5		
	No ground cover		1	4	
6.	Intensity of Rain	3			
	Below 500 mm per year		10		

No.	**Parameters**	**Weight**		**Score**	
				LANDFILL Old	**LANDFILL New**
	Between 500 mm to 1000 mm per year		5	15	15
	Above 1000 mm per year		1		
7.	Biological	3			
	Low habitat values		10	30	30
	High habitat value		5		
	Critical habitat		1		
8.	Noise and Smell	2			
	There is a buffer zone		10		

	There is a buffer zone that limited		5		10
	No buffer		1	2	
9.	Agriculture	3			
	Located on unproductive land		10	30	
	Not exist impact towards Surrounding agriculture		5		
	Located at soil agriculture Productive		1		3
TOTAL SCORE				**618**	**698**

Source: Drafting Team Analysis, 2024

Based on these findings, it can be concluded that the relocation of the Mrican landfill to a new location is an urgent and indispensable step to support more efficient, environmentally friendly, and sustainable waste management.

CONCLUSION

Based on the results of the analysis that has been carried out on the relocation plan of the Mrican Final Processing Site (TPA) in Ponorogo Regency, it can be concluded that the relocation of the Mrican Landfill to a new location which has an area of 9.38 hectares is very feasible. This new location can accommodate waste for the next 28 years based on projected population growth and an estimated recycling percentage of 40%. In 28 years of landfill operation, this new location is estimated to be able to accommodate a volume of waste of approximately ±2,900,000 m³ or ±750,000 tons (before compaction). With this capacity, the new location can answer the needs of waste management that continue to grow along with the increasing population in Ponorogo Regency.

The results of the feasibility assessment based on SNI-03-3241-1994 show that this relocation is feasible from various aspects. In terms of the environment, parameters such as hydraulic conductivity, soil use, groundwater utilization, availability of cover soil, rainfall intensity, and biological conditions at the new location received higher scores compared to the old landfill location. This shows that this relocation program meets better environmental feasibility criteria. On the social aspect, parameters such as land rights owners, community consent, and the number of landowners in the new location also showed higher scores, indicating that this relocation was well received socially. In the economic aspect, although the cost of transporting waste from the old and new locations has the same score, the infrastructure and technical conditions in the new location provide more benefits in the long run. Meanwhile, on the technical aspect, various parameters such as flood potential, slope slope conditions, accessibility, and land capacity also show that the new location is much better technically compared to the old location, thus ensuring the long-term sustainability of landfill operations.

Overall, the Feasibility Study for the relocation of the Mrican Landfill concluded that this relocation is feasible from environmental, social, economic, and technical aspects. This relocation will not only increase waste management capacity, but also reduce the negative impact of old landfills that are already overloaded on the environment and the health of the surrounding community. Therefore, to ensure the success of relocation and more efficient waste management in Ponorogo Regency, several recommendations need to be implemented.

First, the selection of new locations that have been identified has met technical and environmental criteria. Therefore, there needs to be an improvement in supporting infrastructure, such as better road access, effective drainage systems, and the establishment of buffer zones to reduce environmental impacts on the surrounding community. Second, improving waste management systems must be prioritized by designing more efficient recycling facilities, managing B3 waste appropriately, and implementing environmentally friendly leachate and methane gas treatment systems. It also includes the use of waste as an alternative energy source. Third, socialization to the community is needed to increase understanding and support for relocation. This socialization program should include information on the benefits of relocation, environmental impact mitigation measures, and the active role of the community in supporting more sustainable waste management.

By implementing these recommendations, it is hoped that the relocation of the Mrican Landfill to a new location can run smoothly and make a significant contribution to more effective, environmentally friendly, and sustainable waste management in Ponorogo Regency. This relocation will also support sustainability and improve the quality of the environment for the community around the landfill, as well as improve the quality of waste management in this area in the long term.

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