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Analysis of Waste Generation and Buffering of Temporary Disposal Sites (TPS) in Kambu District.

La Ode Ahmad Saktiansyah

Universitas Halu Oleo, Jln. H.E.A. Mokodompit, Kendari, 93232, Indonesia

ABSTRACT

Waste is one of the major environmental challenges in Indonesia, affecting public health, cleanliness, and environmental aesthetics. Waste generation in Indonesia continues to increase in line with population growth and changing consumption patterns. Reports from the Environmental and Forestry Agency (DLHK) of Kendari City indicate a yearly increase in waste volume. In 2021, waste generation reached 264 tons per day, and in 2022 it increased to 290 tons per day. This research employed a descriptive quantitative approach aimed at illustrating the distribution and characteristics of the Final Disposal Sites (TPA) in Kambu District using spatial data. Through this approach, the study seeks to obtain an in-depth understanding of the location, capacity, accessibility, and condition of the TPAs with the aid of Geographic Information Systems (GIS). The results showed that the total waste generation amounted to 93,375.91 tons per year. The amount of waste reduction was 53.47 tons per year, or 0.06%. The study concludes that waste generation that does not meet the required standards often contains poorly sorted compositions of organic, inorganic, and hazardous waste, thereby posing a higher risk of environmental pollution.

Keywords: Waste Generation, Buffering, TDS

INTRODUCTION

Waste is one of the major environmental challenges in Indonesia, affecting public health, cleanliness, and environmental aesthetics. Waste generation in Indonesia continues to increase in line with population growth and changing consumption patterns. Data from the National Waste Management Information System (SIPSN), issued by the Ministry of Environment and Forestry (KLHK), show that in 2024, Indonesia generated approximately 31.9 million tons of waste. Of this total, around 64.3% (20.5 million tons) was managed properly, while 35.7% (11.4 million tons) was not well managed (1).

Indonesia is also the third-largest producer of plastic waste in the world, with total plastic waste generation reaching about 3.4 million metric tons per year (2). Improperly managed plastic waste can pollute the oceans and ecosystems, threaten marine life, and pose health risks to humans.

To address this issue, the government has set a target to reduce waste by 30% and properly manage 70% of waste by 2025 through various policies, including the *Clean Indonesia Movement* and strengthening waste management infrastructure in various regions (3).

Reports from the Environmental and Forestry Agency (DLHK) of Kendari City show a yearly increase in waste volume. In 2021, waste generation reached 264 tons per day, and in 2022 it increased to 290 tons per day (4). This increase is attributed to population growth and changing consumption patterns among the community.

A Geographic Information System (GIS) is a tool that enables users to collect, store, manipulate, and analyze geographic data for various purposes, including environmental management, regional planning, and mapping. GIS is a system that integrates hardware, software, and geographic data to facilitate location-based data analysis and visualization, producing more accurate and useful information (5).

In the context of mapping temporary waste disposal sites (TPS), GIS can provide essential information about the optimal location, capacity, and waste transportation routes. GIS supports decision-making processes in environmental management through its ability to display multiple spatial data layers, making it easier to analyze real-world problems in the field.

The use of GIS in waste management also enables the government and related stakeholders to identify waste distribution patterns and assess the efficiency of waste collection routes. Thus, GIS helps accelerate decision-making processes, particularly in managing TPS sites that are at risk of overcapacity and require infrastructure improvements.

METHOD

This research employed a descriptive observational approach, in which the researcher conducted field surveys, plotted coordinates using GPS, and measured waste generation among respondents. The collected data were processed and analyzed spatially and according to normative standards, followed by a description of the research location and period. The data were analyzed using a Geographic Information System (GIS).

RESULTS AND DISCUSSION

1. Description of Waste Transport Equipment

Table 1. Types of Waste Transport Equipment

No	Description	Unit Type	Quantity	Remarks
1. Number of TPS				
	TPS	Unit	934	Functional
	Container	Unit	115	Functional
	Bin Container (Orange)	Unit	25	Functional
2. Number of Transport Vehicles				
	Compactor Truck	Unit	2	Functional
	Armroll Truck	Unit	13	Functional
	Dump Truck	Unit	38	12 units (Severely Damaged)
	Three-Wheeled Motorcycle	Unit	27	Functional
3. Heavy Equipment				
	Bulldozer D6	Unit	2	Functional
	Bulldozer D3	Unit	1	Functional
	Excavator	Unit	2	1 unit (Severely Damaged)
	Backhoe Loader	Unit	1	Functional
	Weighbridge	Unit	1	Severely Damaged

Table 2 shows the facilities and infrastructure used by the Environmental and Forestry Agency (DLHK) of Kendari City for waste transportation. Some of the equipment is in functional condition, while others are damaged. For example, out of 38 dump trucks, 12 units are in a damaged condition.

2. Description of Waste Generation

Table 2. Waste Generation

Indicator	Target (Ton/Year)	(%)	Achievement (Ton/Year)	(%)
Waste Generation	93,375.91	-	93,375.91	-
Reduction	26,145.25	28	64.1	0.07
Handling	66,296.9	71	73,176.66	78.37

Source: Secondary Data, 2023

Based on the table, the total waste generation is **93,375.91 tons per year**. The amount of waste reduction is **53.47 tons per year**, or **0.06%**.

3. Map of Waste TPS Buffer in Kambu District

Buffering in a Geographic Information System (GIS) is the process of creating a buffer zone around specific points, lines, or areas on a map. Buffering can be used to determine areas within a certain distance from rivers, roads, or buildings.

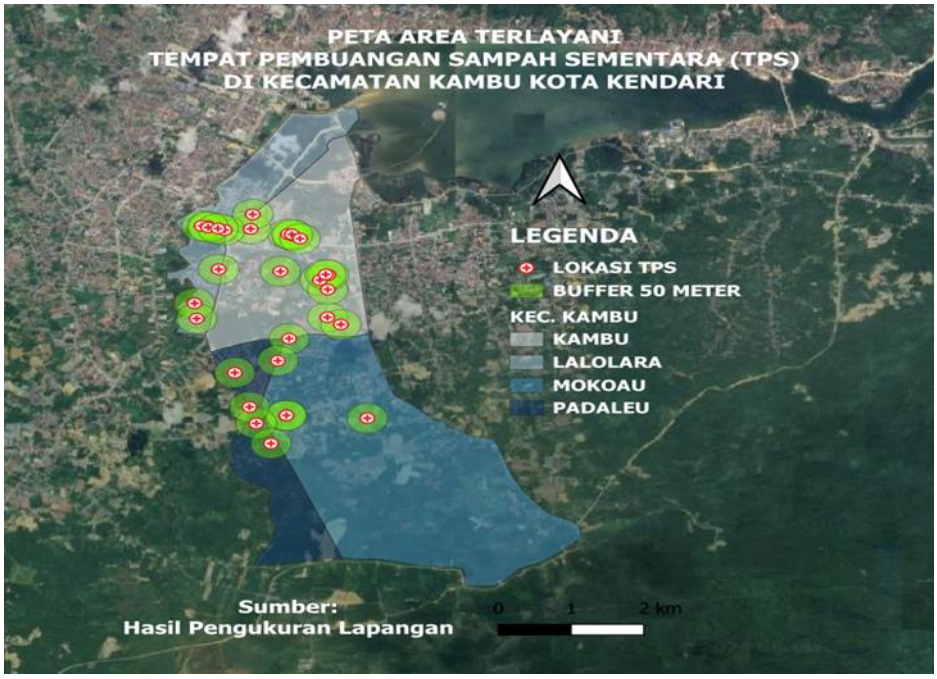

Figure 1. Map of TPS Service Buffer Area

TPS buffering is carried out by creating a radius or buffer zone based on a specific distance from the TPS. This distance is determined by regulatory standards or environmental impact analysis, with the aim of mapping areas that may be affected by the presence of TPS.

The results of this buffering can be used for better spatial planning — for example, ensuring that residential or public facilities are not located too close to TPS sites. Based on the figure, it shows the proximity of TPS locations to residential areas, which has the potential to cause environmental pollution, particularly in terms of declining environmental quality indicators.

B. Discussion

1. Overview of Waste Transportation Equipment

Waste transportation equipment is a crucial element in the waste management system that functions to transport waste from collection points (such as households, offices, or markets) to final disposal sites (landfills) or recycling facilities. Several factors link the amount of waste produced with the need for transportation equipment, as follows:

Increasing Waste Volume: Along with the growth of population and economic activity, the volume of waste also increases. Large cities such as Jakarta, with high population density, generate around 7,500 tons of waste per day. To handle this large amount of waste, the number and capacity of waste transportation equipment (such as garbage trucks, containers, and arm-roll vehicles) must be adjusted accordingly.

Transport Capacity: The carrying capacity of garbage trucks or other transportation equipment greatly determines the frequency of waste collection. In areas with high waste volumes, inadequate equipment often causes delays in waste transportation, eventually leading to waste accumulation at collection points.

Operational Efficiency: Inadequate or insufficient waste transportation fleets can reduce efficiency in waste collection. For example, in Jakarta, waste accumulation occurs when the waste transportation fleet is unable to handle the increasing daily waste volume. This issue is exacerbated by urban traffic congestion, which reduces collection frequency.

Environmental and Health Impacts: Delays in waste collection due to insufficient equipment can lead to waste accumulation, increasing public health risks through disease transmission, foul odors, and environmental pollution.

Previous studies have found that a shortage of garbage trucks in the city of Semarang is one of the main causes of waste buildup at temporary waste disposal sites (TPS). The city produces more than 1,000 tons of waste daily, but only 200 trucks are operational, most of which are unfit for use. As a result, significant waste accumulation occurs at TPS before being transported to the landfill (7).

A 2012 study in Yogyakarta also revealed that a lack of waste transport equipment (such as containers and trucks) hindered efficient waste management. The study found that Yogyakarta's waste transport capacity could only handle 60% of the total daily waste production, leading to sanitation problems and public health risks (8).

2. Overview of Waste Generation

Waste generation is an increasingly urgent issue in many regions, particularly in urban areas. Research on waste generation provides essential insights into its causes, impacts, and potential solutions.

Studies have shown that population growth in major cities significantly contributes to increasing waste generation. Each individual tends to produce more waste as consumption needs grow (9).

Urbanization also increases economic and social activities, thereby raising waste volumes. Research in India found that urbanization increased household waste generation by up to 50% in the past decade (10).

Kaza et al. highlighted that lifestyle changes and the rise of single-use products are the main causes of increased waste generation. Modern societies tend to prefer packaged products that are not environmentally friendly (11).

According to Asim et al., waste accumulation is directly related to higher disease risks. In some regions, waste buildup has triggered outbreaks of infectious diseases (12).

Environmental Pollution: A study by Wang et al. stated that poorly managed waste can contaminate soil and water, damaging ecosystems. The study found that soil pollution caused by plastic waste threatens biodiversity (13).

Socioeconomic Issues: Research by Arbués et al. revealed that areas with high waste generation experience lower quality of life, which affects property values and public health (14).

3. Buffer Mapping of Temporary Waste Disposal Sites (TPS) in Kambuh District

Temporary Waste Disposal Sites (TPS) are essential facilities in the waste management system that serve as temporary storage locations before waste is transported to final disposal sites (landfills) or other processing facilities. However, environmental and social issues often arise due to the proximity of TPS to residential areas. Common problems include unpleasant odors, groundwater contamination, health disturbances, and poor environmental aesthetics.

To address these issues, the concept of "buffering" TPS—creating buffer zones between TPS and residential areas—has become an important solution that has been increasingly researched and implemented in recent years.

A buffer zone is a physical distance that often includes elements such as vegetation or fencing to separate TPS from sensitive areas such as residential zones, schools, or public facilities. The purpose of buffering is to minimize the negative impacts of TPS on the surrounding community's quality of life and to reduce environmental contamination risks.

Recent studies have focused on how well-designed buffer zones can provide both environmental and social benefits.

A recent study by Wang et al. found that maintaining a minimum safe distance between TPS and residential areas is necessary to reduce exposure to harmful gases and environmental contamination. Decomposing organic waste can produce gases such as methane, which negatively impact nearby residents' health. Moreover, leachate seeping into the ground can contaminate wells or groundwater sources if TPS are too close to settlements (15).

According to research by Arbués et al., placing TPS too close to residential areas increases the risk of infectious diseases, especially in regions with poor sanitation infrastructure. They recommended a minimum distance of 500 meters between TPS and residential zones as a mitigation measure.

A study by Asim et al. also emphasized the importance of considering wind direction and groundwater flow when determining TPS locations to prevent pollution spread.

The use of green buffers (vegetation or green belts) has been identified as an effective method for reducing visual and pollution impacts from TPS. Ranjan et al. found that planting vegetation around TPS helps reduce odor emissions and airborne particles. Vegetation acts as both an air pollutant absorber and a visual barrier (16).

Kaza et al. noted that many developing countries still lack strict regulations regarding the safe placement of TPS away from residential areas. They recommended that local governments adopt a risk-based approach and apply more precise spatial planning when designating TPS locations (17).

Besides distance, TPS infrastructure design also plays a crucial role in mitigating negative impacts. Reddy and Jagadis emphasized that incorporating technology for preliminary waste processing at TPS can reduce health and environmental risks. Enclosed TPS designs with proper leachate management systems can also help prevent contamination (18).

CONCLUSION

1. Waste generation that does not meet proper standards often contains a mix of organic, inorganic, and hazardous waste that has not been properly separated, thereby posing a higher risk of pollution.
2. Inadequate waste transportation equipment, such as a limited number of fleets or outdated vehicles, leads to inefficiency in the waste collection and transportation process.

3. Buffer areas of temporary waste disposal sites (TPS) that are located too close to residential neighborhoods pose risks to the surrounding environmental quality and public health. TPS placement that does not consider a safe distance from residential areas can cause negative impacts such as unpleasant odors, air pollution, and deterioration of groundwater quality due to waste leachate.

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