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Research article

Evaluation of the Feasibility of Ngembak Purwodadi Landfill Site Along with Recommendations for a New Landfill Site in Grobogan Regency

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Abstract

Technological developments in various sectors encourage development activities that can improve people's lives, but on the other hand, the rampant exploitation of nature can potentially damage environmental quality. Another threat to environmental quality is the growth of the population, with all its activities creating something that is no longer needed, namely waste. Grobogan Regency's population increases every year, causing an increase in the region's waste. The objectives of this research are (1) to evaluate and determine the feasibility of the Ngembak landfill location based on land suitability for landfills and (2) to determine recommendations for new landfill locations in Grobogan Regency using Geographic Information System (GIS) spatial modeling. The research method applied is the scoring or scoring method with the parameters rock type, slope, land use, rainfall, and soil type, and the following process is Overlaying the map of each parameter used. The evaluation of the suitability of the Ngembak landfill site obtained a result of 133, which is in class II Worth considering. With spatial modelling, several new Landfill sites were found whose land was suitable as a recommendation in Sumber Jatipohon and Sedayu Villages, Grobogan District, Godan Village, Tawangharjo District and in Tambahrejo Village, Wirosari District.

Keywords: landfill Suitability, GIS spatial modelling, waste management.

1. Introduction

The technological development of an area is getting faster from time to time and in various sectors, both infrastructure and population growth which is very complicated and demands a high level of energy mobility (Sabrina et al, 2023). The phenomenon of urban population growth will become a cause for concern (Saputra et al, 2023). Population growth will create opportunities for urbanization which will have an impact on significant changes in various aspects of society, including economic, cultural, ecological, and environmental (Medayese et al, 2023). Development activities to improve the quality and standard of living of the community, along with easy access in any case, create the development of a consumptive lifestyle, namely the act of transaction and using an item excessively without any consideration with the aim of self-satisfaction by appearing luxurious (Mijahidah, 2020). This lifestyle has a negative side in the form of increasing exploitation of nature with the threat of environmental damage. Population growth, with population figures increasing every year is a crucial factor that has a fundamental role in reducing environmental quality with all the hustle and bustle of settlements, industry, trade, and government activities in it, creating various regional problems, one of which is in the form of piles of garbage (Margaretha, 2021).

Waste is a material produced by human activities and living things that carry out natural processes that can cause environmental problems, health, order, comfort, and aesthetics (Audina, 2018). The problem of waste is a crucial topic because it involves culture or habits from a reflection of the side of life, so its existence requires a means capable of processing all waste so that the negative impact of its existence can be suppressed. The existence of waste that continues to arise will become a complex problem in a society that lacks responsibility and concern for the surrounding environment. Various conditions that can interfere with comfort will arise both physically and aesthetically. The creation of unpleasant odors will attract rodents to roam and be comfortable inhabiting the location, which, of course, will significantly disturb health with the threat of loss of productivity in carrying out daily activities that are overshadowed by discomfort and discomfort when the view sees garbage (Chabuk et al, 2016). If waste is not handled and managed thoughtfully and based on standards, it can sustainably create significant problems.

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Various countries have their waste management systems, one of which is South Korea. This country implements a waste management system called Volume-based Waste Fee (VBWF), which is a waste management system that requires residents to sort waste that can be reprocessed and set rates based on volume size (Kim et al, 2012). Waste management in Indonesia is essentially regulated by the Law of the Republic of Indonesia Number 18 Year 2008. According to this law, waste management aims to improve public health and environmental quality and make waste a resource. The location of the landfill is one of the facilities supporting the needs of the community regarding the output of households, which is generally waste, at the beginning of the determination to development must be carefully studied because it involves various factors and regulations so that when the operational process runs well it will be able to minimize the negative impact on people's lives, especially health and comfort and on environmental quality around the landfill site (Sener, 2004).

A landfill site, according to SNI 03-3241-1994, is a location that has facilities for the continuation of final waste disposal, which includes safe quarantine of waste as the final stage. Managed waste will reduce its adverse effects provided it is built according to the requirements and standards (Jonatan & Zain, 2019). Landfill sites have a technical operating life of at least ten years and a maximum of 20 years. This data is an indicator that a landfill in the future cannot avoid operational closure because it has exceeded the technical age and certainly has the risk of overloading the capacity of the ability to process waste before the estimated technical age is complete. The construction of a waste landfill in determining its location requires much consideration because not all locations meet the criteria and can be made as landfill sites. Physical, environmental, and social factors are considered in the construction of landfills so that the application of their function as the final location of waste can be optimal (Azizi et al, 2022).

The availability of waste disposal facilities and facilities has been regulated and guided by SNI 19-3241-1994, prepared by the Ministry of Public Works as a representative of the Central Government. The stages of determining the location of landfills in this standard are divided into three stages: the first stage is the regional stage, the elimination stage is the second stage, and the last stage is the determination stage. Waste landfills that meet the standards are an essential part of the needs that must be met by a region or city, including Grobogan Regency, with the function of landfills as locations that can protect the environment against various threats to soil, water, and air pollution caused by waste (Osra & Kajjumba, 2019).

The Central Bureau of Statistics of Grobogan Regency released an increase in population in 2023 of 1,492,891 people with a population growth rate for the period 2020 - 2023 of 0.88% with an average population of 748 people/ km² and the majority or concentration of the population inhabiting Purwodadi District, namely 9.52% (BPS Grobogan Regency, 2024). According to data from the Regional Development Planning Agency and the Grobogan

Regency Environment Office, the volume of waste generated reached 306,547.32 tons per year in 2020, with unmanageable waste reaching 34.8% (BAPPEDA Grobogan, 2021) and increased to 312,313.22 tons per year in 2023 based on data from the National Waste Management Information System. The annual increase in waste generation will force Ngembak Landfill to carry out its duties very heavily, so the estimated time and capacity are potentially less than the target. This landfill is under the auspices of the Grobogan Regency Environmental Agency (DLH) and is officially named Ngembak Purwodadi Landfill Service Technical Implementation Unit. The location of this landfill has a land area of 4.5 hectares with a distance to the nearest settlement of 0.5 km. It has been operating since 1997 with an initial plan until 2011, 14 years with the initial waste treatment system applied is open dumping (DLH Grobogan Regency, 2011).The open dumping system is an open waste disposal system with the help of combustion that produces gases into the air containing harmful compounds (Yazdani et al, 2015).

A location that can meet SNI 19-3241-1994 standards as a landfill requires an effective way or method to know the suitability of the land used. Geographic Information System (GIS) can do so, and this technology is effectively applied because it can manage spatial data from various sources to reduce time and costs in terms of managing, describing, and analyzing information by research objectives (Alavi et al, 2013).

Similar previous studies related to the feasibility and suitability of land for landfill sites were conducted by Rumbruren, Tarore and Sembel (Rumbruren, 2015) in South Manokwari District,

Nugroho and Firmansyah (Nugroho & Firmansyah, 2017) in Sumedang Regency, Pattiasina, Tondobala and Lakat (Pattiasina et al, 2018) in Tomohon City, Savira (Savira & Rizky, 2021) in Margorejo District and Azizi, Hadibashir and Cahyadi (Azizi et al, 2022) in Kudus Regency. Based on previous studies, it is dominated by a narrower area coverage and does not analyze the location of existing landfills.

The description of these problems is an essential background as a basis for conducting research that aims to (1) Evaluate and determine the feasibility of the Ngembak landfill location based on land suitability for landfills and (2) Determine recommendations for new landfill locations in Grobogan Regency using Geographic Information System (GIS) spatial modeling. The results of this research are expected to be used as input material in regional planning and improve the community's quality of life in the sense of avoiding disturbances that can be caused by the presence of waste that is not fully managed in Grobogan Regency.

2. Research Methods

2.1. Research Area

Grobogan Regency is located between 110º15' East - 111º25 East and 7º N - 7º30' N or stretches from west to east for 86 km while north to south for 37 km with an area of 1,975.86 km² making it the second largest Regency in Central Java Province. It consists of 19 sub-districts with the Regency capital and all government centers located in Purwodadi Sub-district. The general condition of Grobogan Regency is that it is a valley flanked by two limestone mountains, the Kendeng Mountains in the south and the Northern limestone mountains in the north. The average slope ranges from 8º - 15º, and most soil types scattered throughout the region are gray and brown alluvial. Figure 1 depicts the administrative boundaries of Grobogan Regency in terms of sub-districts and surrounding regency, due to its large area so that it borders many other Regency.

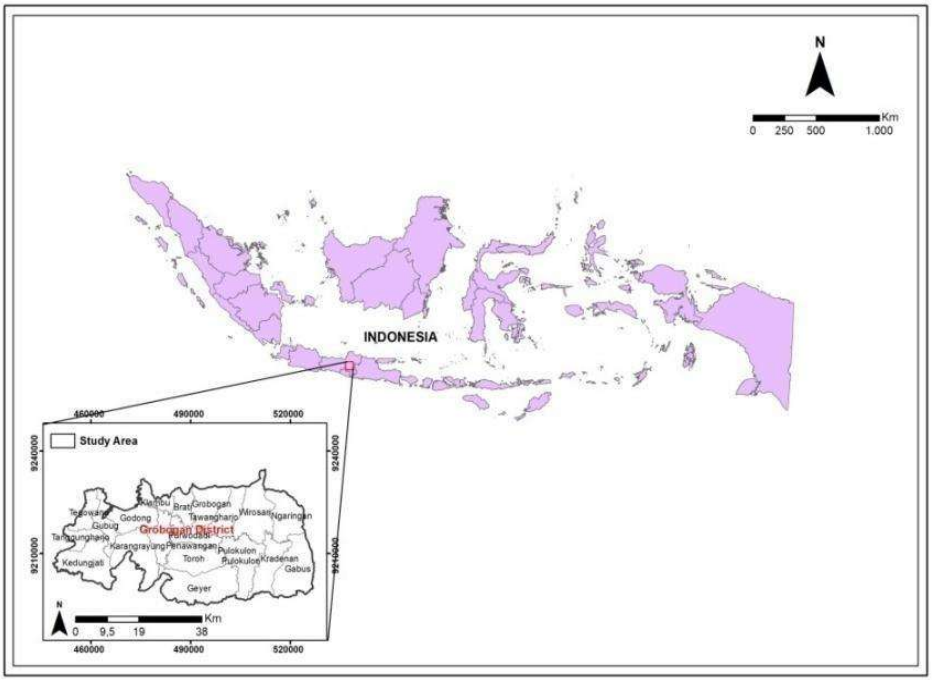

Figure 1. Map of the Study Area

2.2. Data Collection and Processing

This research uses secondary data sources. The secondary data used are Geology (Rock Type), Slope, Land Use, Rainfall, and Soil Type. This data is used to analyze the feasibility of landfill sites and recommendations for new landfill sites in the Grobogan Regency. Parameter selection for spatial modeling is based on SNI 19-3241-1994 standards, but not all parameters in SNI 19-

3241-1994 will be used, and only some parameters will be used. Other data to support this research is in the form of landfill data in Grobogan Regency, which can be accessed at https://sipsn.menlhk.go.id/sipsn/public/data/timbulan and https://katalog.data.go.id/dataset/jumlah-produksi-sampah-menurut-kecamatan-di-kabupaten-grobogan-tahun-2022 . Data similarity is essential in the utilization of Geographic Information Systems (Nwambuonwo & Mughele, 2012). The data is presented in part below:

Table 1. Data Source

Data	Source	Usability
Grobogan Regency RBI Spatial Data	Geospatial Information Agency (BIG)	Making Administrative Boundary Maps
Geological Spatial Data (Rock Types) Grobogan Regency	Geological Agency, Ministry of Energy and Mineral Resources https://geologi.esdm.go.id/geomap	TPA parameters
Grobogan Regency Contour Network Spatial Data	Geospatial Information Agency (BIG)	Generation of Slope Data and Landfill Parameters
Grobogan Regency Land Use Spatial Data	Ministry of Environment and Forestry (KLHK) 2019	TPA parameters
Spatial Climate Data (Rainfall) Grobogan Regency	Grobogan Regency Geoportal http://geoportal.grobogan.go.id/	TPA parameters
Soil Type Spatial Data	BBSDLP Ministry of Agriculture	TPA parameters
Ngembak Landfill Spatial Data	BAPPEDA and 2024 Digitization Results	NgembakPurwodadi TPA area and feasibility of TPA location

This research uses a quantitative descriptive analysis method to determine the feasibility of the Ngembak landfill and the potential location of a new landfill in the Grobogan Regency, which is standardized by utilizing Geographic Information System (GIS) analysis techniques. The scoring method is a determinant of the suitability of landfill waste location. Input parameters will be given weights or predetermined criteria, and their influence will be a combination of values and weights, resulting in high values that indicate feasible and appropriate suitability for a landfill site (Akoc, 2014). This method is commonly used in ArcGIS data classification. The following process overlays the maps of each parameter used to obtain a land suitability map of landfill sites or potential new landfill sites in the Grobogan Regency. Below is the value of each parameter as follows:

Table 2. Values and Weights of Rock Type (Geology)

Rock Types (Geology)	Value	Weight
Alluvial	10	5
Andesite	7	
Breccia	1	

Table 3. Values and Weights of Slope

Slope	Value	Weight
<20	10	5
>20	1	

Table 4. Values and Weights of Land Use

Land Use	Value	Weight
Shrubs, Moors, Forests, Grass Areas	10	5
Rice Field	5	
Built-up land (Settlement, Industrial Area, Plantation, Water Bodies)	1	

Table 5. Climate (Rainfall) Values and Weights

Climate (Rainfall)	Value	Weight
<500 millimeters per year	10	3
500 mm – 1.000 millimeters per year	5	
>1.000 millimeters per year	1	

Table 6. Values and Weights of Soil Type

Soil Type	Value	Weight
Grumusol	10	5
Latosol	8	
Alluvial	3	
Andosol and Regosol	1	

The feasibility class of a landfill site is determined using a weighted tiered method or scoring. Input parameters are rock type, slope, and land use. Climate, and soil type contain the necessary weights for the level of suitability to influence the feasibility of a landfill site. The land suitability class classification for the ideal location of a landfill is calculated using the following formula:

$$K_i = \frac{\Sigma\ Highest\ Value \quad Lowest\ Value}{\Sigma\ Desired\ Class} \qquad (1)$$

Description:
K_i : Suitability Classes
∑ Highest Value: The multiplication result obtained from the weight and the highest score
∑ Lowest Value: The multiplication result obtained from the weight and score of the lowest value
∑ Desired Class: Number of Suitability Classes applied
Can be obtained:

$$K_i = \frac{(50+50+50+30+5\ ) - (5+5+5+3+5)}{3}$$

$$K_i = \frac{230 - 2}{3}$$

$$K_i = \frac{207}{3}$$

$$K_i = 69$$

The calculation results show that the minimum value of the multiplication and summation of each value and weight is 23, while the maximum value is 230.

The results of the above calculations also obtained an interval class of 69 with the desired class of 3, so the suitability class is presented in the table as follows

Table 7. Feasibility and Land Suitability Classes for Landfill Sites

Class	Value	Feasibility & suitability level
I	162 - 230	Appropriate
II	93 - 161	Worth considering
III	23 - 92	Not feasible/not suitable

2.3. Framework

Evaluation of the feasibility of the location of landfills in an area is appropriate or not is something vital and indispensable, and this is inseparable from the impact that may invite both environmental problems and disruption of social activities if the location of the landfill does not meet the standard criteria that have been set. Evaluation of the location of the landfill that has been operating at this time is helpful to determine its feasibility, accompanied by recommendations for a suitable location for a new landfill as a choice in the future, considering that a landfill site has a period in its operating period and certainly one day will experience overload. Parameters that are input in this study include rock type, slope, land use, climate, and soil type.

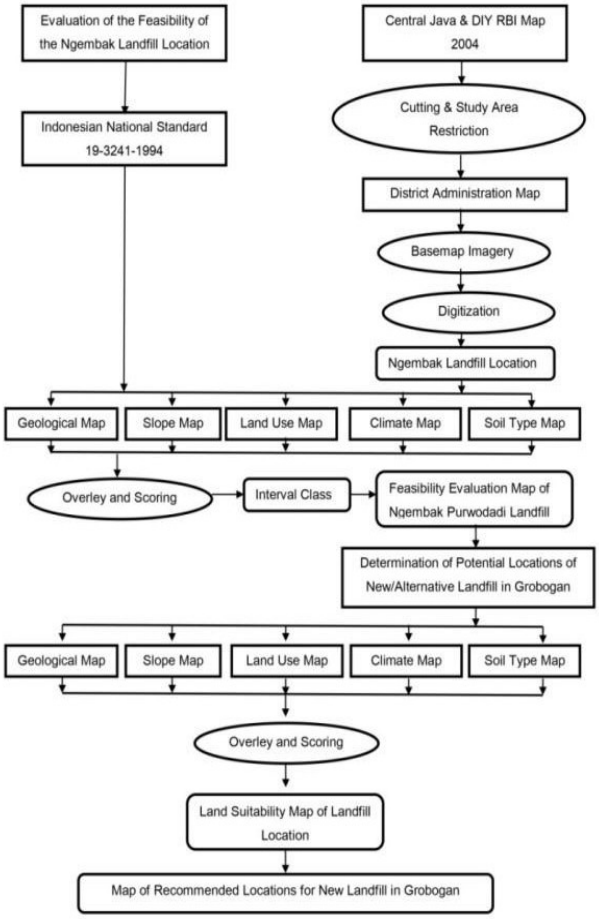

Figure 2. Flowchart of Processing Method

The type of rock on which the current and prospective new landfill sites are located is crucial to consider because it will affect the flow of waste leachate containing various contaminated materials that naturally move towards the groundwater table or move with groundwater, which can threaten the existence of water resources around the landfill site (Marínet et al, 2012). Thus, landfill sites are not recommended for breccia rocks such as sandstone, limestone, etc. The slope parameter of the landfill site has an essential role in terms of waste collected in the landfill site, which is not recommended to be located in hilly areas or slopes by considering the possibility of land slides that can occur during rain or from water seepage, which can be fatal to the infrastructure of the landfill area and the spread of soil pollution underneath and pollution of groundwater sources around the landfill site which will be very dangerous for health.

Land Use does not escape the main parameters in this study. Land use that has much social activity will be complicated to use or recommend as a landfill site because settlements and locations that have established a center of community activity (villages, housing, etc.) are impossible to relocate entirely and endanger the health of the surrounding community if it is still forced to be established in that location with the scenario of the community refusing to bemoved and living close to the location of the Landfill Site. Climate is included as a parameter, considering that high-intensity rain can cause flooding in the landfill's location even though the area is sloping, which can cause piles of waste concentration to spread and does not rule out the possibility of one large area having different rain intensity. Soil type becomes the last important parameter with the type of soil that should be used for landfill sites and is recommended to be a type of land that is not productive for agricultural or plantation activities so that it would be wiser to be used as productive land when compared to being a location for piles of garbage.

3. Results and Discussions

3.1. Evaluation of the Feasibility of Ngembak Landfill Site

Assessment of the feasibility or physical suitability of land built in the Landfill location is an activity to determine the accuracy of land use as the last means of waste processed and processed optimally (Ohri et al, 2015). Evaluation of the feasibility of land suitability for the establishment of the Ngembak landfill site, which is included in the Purwodadi District area, uses several parameters that have an influence on the suitability of the land as a landfill site, namely rock type, slope, land use, rainfall, and soil type. The results obtained after data processing in the form of giving values and spatial analysis show that the location of the Ngembak Landfill Site is in class II. It is worth considering the table and calculation results as follows

Table 8. Results of the Land Feasibility Evaluation Analysis for the Ngembak Landfill Site

Rock Type (Geology)	Slope	Land Use	Rainfall	Soil Type
Breccia Sediment	8 – 15% (<20)	Gardens and Rice Fields	1.500 – 2.000 (>1.000 millimeters per year)	Grey Grumusol

Total Dignity = (S_GL × W) + (S_SL × W) + (S_LU × W) + (S_RF × W) + (S_ST × W) (2)
Description:
S_GL: Geological Score
S_SL: Slope Score
S_LU: Land use Score
S_RF: Rainfall Score
S_ST: Soil Type Score
W: Weight
Can be obtained:
= (1×5) + (10×5) + (5 × 5) + (1 × 3) + (10 × 5)
= (5 + 50 + 25 + 3 + 50)
= 133

The results obtained after calculating the assessment using the scoring method on the feasibility of the Ngembak Landfill with input parameters are rock type, slope, land use, rainfall, and soil type of 133 (One Hundred Thirty-Three). Referring to the Table of feasibility Classes and Land Suitability for Landfill Sites, it can be seen that the Ngembak waste landfill is included in class

II, which is worth considering. The suitability class obtained is only in class II worth considering because it is located on land where the rock type is breccia, which is not recommended on the basis that waste leachate water can seep and spread due to the nature of breccia rocks that can pass water so that it can threaten soil conditions and water sources around the Ngembak landfill location. In addition, this landfill is located in the area of gardens and rice fields, so it is unfortunate if it is located on productive land that can be processed and bring more significant benefits than as a landfill site. The location of the Ngembak landfill and areas in Grobogan Regency that are categorized as not feasible, worthy of consideration, and feasible and suitable for landfill sites are presented in the map below :

This chapter contains the results of research. The results can be presented in the form of text, tables, images, maps and accompanied interpretation associated with the results that have been reported. Images and Maps are made as simple as possible so it can be understood easily. Drawings, maps and titles given source image with the numbering sequence (see Figure 1). The table given above is also accompanied by sequential numbering. Both Pictures, Maps and tables should be cited in the body text. Maps must be made either in color or grayscale format, but the differences of each value / object is clearly visible. Design layout simplified map that can be included in the text without reducing the content of the map (Figure 2).

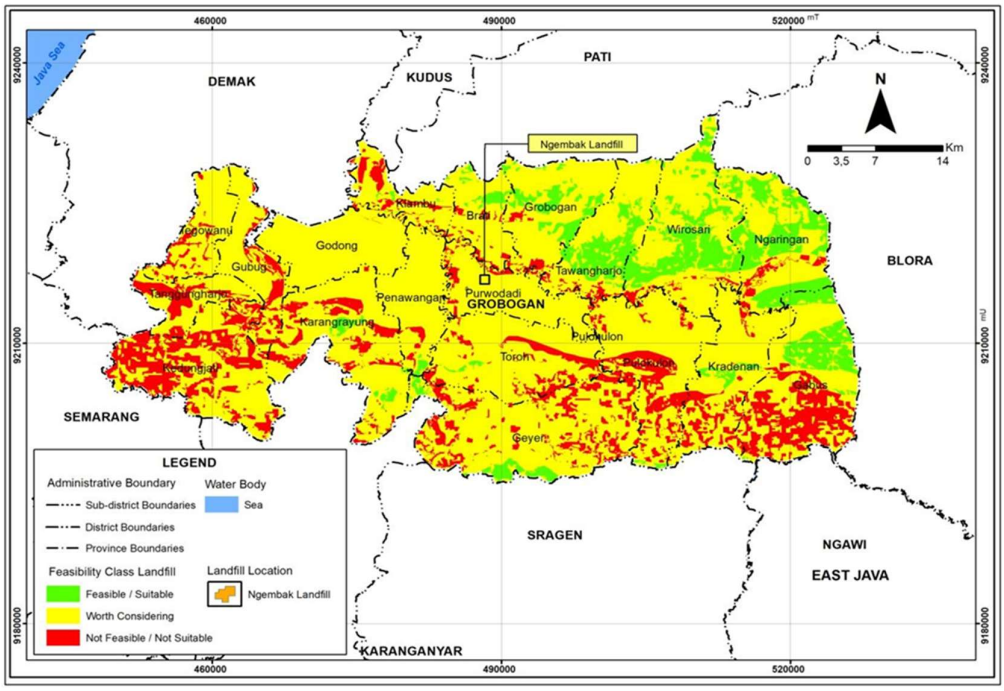

Figure 2. Feasibility Evaluation Map of Ngembak Landfill in Purwodadi Subdistrict, Grobogan Regency in 2024

The map illustrates the analysis of landfill site suitability in Grobogan Regency, Central Java. Based on the map, there are three categories of site suitability: suitable, worth considering, and not suitable. Areas marked in green indicate the most suitable locations for landfills as they meet criteria such as sufficient distance from residential areas, water sources, or protected zones. These regions are mainly located in the central to eastern parts of Grobogan Regency, including areas like Ngarengan, Wirosari, and parts of Kradenan.

The yellow areas on the map represent zones with potential for landfill use but require further evaluation due to several limitations. Most of Grobogan Regency falls into this category, indicating that while these areas have potential, mitigation measures or adjustments are necessary before they can be utilized as landfill sites. Meanwhile, the red areas represent locations that are not suitable for landfills. These zones are often situated near densely populated areas, such as Purwodadi and Karangrayung, or in regions with a high risk of environmental pollution. The

selection of the Ngembak landfill site, located in the green zone, demonstrates that this location meets the suitability criteria, making it an appropriate choice for waste disposal.

This map highlights the need for careful spatial planning, particularly to maximize the potential of yellow zones as alternative landfill sites in the future. Additionally, red zones require special attention, especially in domestic waste management, to minimize the risk of environmental pollution. Therefore, integrated planning using GIS-based approaches is essential to improve waste management efficiency in Grobogan Regency. This includes optimizing waste transportation systems and adopting modern technologies at the Ngembak landfill. These measures will not only enhance environmental sustainability but also support the well-being of communities surrounding these areas. The suitability class dominates the other two classes with the largest land area. The area of the three land suitability classes for landfill locations in Grobogan Regency is presented in Table 9.

Table 9. Level of Feasibility and Land Suitability of Landfill Sites

Class	Value	Level of Feasibility and Suitability	Area (Ha)
I	162 - 230	Appropriate	20202
II	93 - 161	Worth considering	146440
III	23 - 92	Not feasible/not suitable	31643

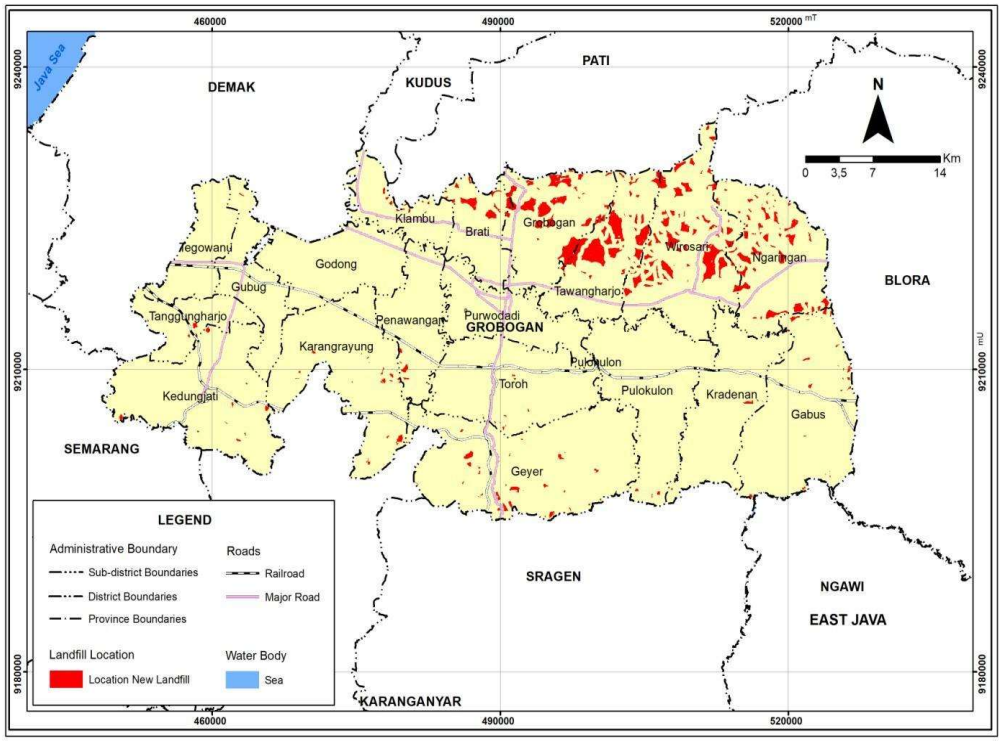

Figure 3. Map of Recommended New Landfill Sites for Grobogan Regency in 2024

Table 10. Potential Area of New Landfill Locations per Sub-district in Grobogan Regency

No	Sub-district	New Landfill Potential Area (Hectares)
1	Brati	324,46
2	Gabus	148,12
3	Geyer	264,93
4	Grobogan	1239,21
5	Ngaringan	957,8
6	Tawangharjo	1530,64
7	Wirosari	1763,92
8	Godong	-
9	Penawangan	56,16
10	Purwodadi	-
11	Kradenan	29,67
12	Tegowanu	-
13	Klambu	63,9
14	Karangrayung	110,36
15	Kedungjati	71,12
16	Gubug	5,28
17	Tanggungharjo	31,06
18	Pulokulon	21,72
19	Toroh	28,26

Based on the analysis and data processing using Geographic Information Systems (GIS) for the recommendation of landfill sites in Grobogan Regency, it was found that not all of the 19 districts in the region have suitable land for waste disposal sites (TPA). Three districts that were not recommended based on the map results are Purwodadi, Godong, and Tegowanu. Purwodadi, as the capital of Grobogan Regency, has land use closely tied to residential, industrial, and government facilities, limiting the available land for TPA. According to the feasibility evaluation, the Ngembak TPA location, which is in Purwodadi District, is only categorized as "worth considering," making it advisable to avoid developing a TPA in this area in order to maintain a balance between land function and the sustainability of other land uses. Similarly, the Godong and Tegowanu districts also do not have suitable land, as most of their areas are already used for agricultural or residential purposes, making them unsuitable for TPA locations.

On the other hand, other districts such as Grobogan, Tawangharjo, and Wirosari show great potential as TPA locations. Grobogan District has an appropriate land area of 1,239.21 hectares, mostly located in SumberJatipohon and Sedayu villages. The land in Grobogan is dominated by dryland and forest, with a slope of less than 20%, and the soil types are Mediterranean and alluvial, which are ideal for TPA development. Additionally, the rainfall in this area, exceeding 2,000 mm per year, supports effective and environmentally friendly waste management. Tawangharjo District, with a land area of 1,530.64 hectares, mostly located in Godan Village, also holds significant potential, with low slope conditions, latosol soil suitable for TPA, and high rainfall. Wirosari District, with the largest land area of 1,763.92 hectares, also has land that is highly suitable for TPA, especially in Tambahrejo Village, with grumusol soil and alluvial rock types that provide good support for holding organic waste.

Furthermore, environmental aspects and sustainability should be considered when selecting TPA locations. Suitable soil conditions, such as latosol and grumusol, and low slope gradients can reduce the risk of erosion and environmental pollution. High rainfall also supports the decomposition of waste, although attention should be given to ensure that drainage systems and

water management are in place to avoid water logging that could disrupt waste management. Therefore, once the TPA location is established, regular environmental monitoring, such as groundwater and air quality, should be carried out to ensure the sustainability of TPA management.

Considering all these factors, Grobogan, Tawangharjo, and Wirosari Districts are the most recommended locations for establishing a TPA in Grobogan Regency. Proper management and continuous monitoring will ensure that the TPA operates effectively and provides long-term benefits to the community and the environment.

4. Conclusion

Based on the results of the Landfill feasibility evaluation results, it is known that this location is in class II, namely only suitable for consideration with a score of 133 with several parameters that most influence it so that it is not in the appropriate class, namely the type of rock and land use. The results of the evaluation of the Ngembak Landfill, which is the only waste landfill in Grobogan Regency, only show that the feasibility class is worthy of consideration so that recommendations for the location of a new Landfill site are needed with spatial modeling using Geographic Information System (GIS) technology. Several locations have been found with suitable land. Alternatively, it is suitable as a recommendation for the establishment of a Landfill Site for waste, namely in Grobogan District, which is part of the administrative area of SumberJatipohon and Sedayu Villages, Tawangharjo District in Godan Village and in Wirosari District in Tambahrejo Village.

Future research should focus on optimizing landfill site selection by utilizing advanced GIS techniques and multi-criteria decision analysis (MCDA) to ensure the identification of the most suitable locations, incorporating additional parameters such as groundwater vulnerability, transportation accessibility, and socio-economic impacts. A comprehensive environmental impact assessment (EIA) should be conducted for the recommended sites in SumberJatipohon, Sedayu, Godan, and Tambahrejo Villages to evaluate potential environmental risks and propose mitigation strategies. Additionally, exploring sustainable waste management alternatives, such as waste-to-energy technologies or composting, could reduce dependency on landfills and enhance waste management efficiency. Community participation and awareness programs should be prioritized to engage local residents in the planning and decision-making process, ensuring acceptance and minimizing conflict. Furthermore, monitoring and evaluation of the existing Ngembak Landfill's operations should be implemented to improve management practices and ensure compliance with environmental standards. Finally, the implications of climate change on landfill feasibility should be investigated, considering potential impacts such as increased rainfall or temperature fluctuations, to enhance the long-term sustainability of waste management in Grobogan Regency.

Future Studies : Further research could expand the use of GIS technology to analyze waste distribution patterns in the Grobogan area, identify potential areas for technology-based waste management, and predict future waste growth. Additionally, analyzing the impact of climate change on rainfall and temperature patterns could be used to model the potential effects of climate change on the sustainability of landfill operations in the future.

This article has strengths in providing an in-depth analysis of landfill site feasibility using GIS technology for spatial modeling, enabling more accurate site selection. Additionally, it suggests alternative, more suitable locations and considers sustainability factors, such as environmentally friendly waste management technologies and community participation. Emphasis on conducting environmental impact assessments (EIA) and the importance of monitoring and evaluating landfill operations also highlights a focus on better and more sustainable management.

Article Limitations : This article has not thoroughly discussed the limitations of data and the accuracy of the location selection model used in the landfill feasibility evaluation. There is potential for inaccuracies in the parameters used, particularly those related to rock types and land use, which may affect the evaluation results and location recommendations.

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Author Contributions

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Conflict of interest

All authors declare that they have no conflicts of interest..

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