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Land suitability analysis for settlement development based on geographic information system in Temanggung Regency

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Abstract. Temanggung Regency has experienced a population growth of 11.12% over the last decade, which implies an increasing demand for settlement land in the future. On the other hand, Temanggung Regency has complex topographic conditions with variations ranging from flat to very steep terrain, necessitating land suitability assessment to support sustainable settlement development. This study aims to provide recommendations for settlement development by generating land suitability analysis for settlement areas. This research employs a quantitative approach utilizing spatial data as the primary analytical material. The methods used include scoring analysis and overlay techniques through geographic information system software. The results of this study classify settlement land suitability into four categories, non-developable, low/difficult development, reserved development, and recommended development. The recommended development land covers an area of 14,216 hectares or 16.41% of Temanggung Regency's total area, with the highest distribution found in Temanggung District, Pringsurat District, Kedu District, Kranggan District, and Parakan District. This research is expected to serve as a recommendation for the Temanggung Regency government in planning settlement development within the region. The findings indicate that settlement expansion opportunities are spatially concentrated in relatively flat, accessible, and low-hazard areas, providing practical guidance for spatial planning and land use control.

Keywords: GIS; Land Suitability; Settlement; Spatial Planning

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1. Introduction

Spatial planning in Indonesia is regulated under Law Number 26 of 2007 on Spatial Planning, which has been supplemented by Government Regulation Number 21 of 2021 on the Implementation of Spatial Planning. This regulation emphasizes that spatial planning must consider environmental carrying capacity and supporting capacity, as well as land suitability to reduce the risks of inappropriate land use. Land suitability is a fundamental aspect in spatial development as it determines the feasibility level of an area for development [1]. In the context of spatial planning in Indonesia, Law Number 26 of 2007 on Spatial Planning confirms that spatial planning must account for environmental carrying and supporting capacity, including the physical potential and limitations of land. Previous research indicates that geographic information system (GIS) based land suitability assessment is effective for evaluating the potential and constraints of a region in settlement development [2]. Settlement land suitability is not only relevant from a regulatory perspective but also represents a scientific necessity in supporting sustainable development planning [3].

Central Java Province, as one of the provinces with rapid population growth, drives the increasing demand for settlement land. The rising need for housing presents challenges in spatial planning, including determining suitable and feasible locations [4]. Previous research in mountainous regions has demonstrated that GIS-based spatial suitability assessment effectively addresses planning challenges in areas with varied topography [5]. That research indicates that terrain complexity needs systematic evaluation of multiple environmental and infrastructural factors for development. Similarly studies in highland region emphasize the necessity of integrating physical constraints with accessibility considerations to ensure settlement development aligns with local geographic conditions [6]. The Regional Spatial Plan (RTRW) of Central Java Province 2024-2044 states that the direction of spatial development emphasizes a balance between land use for settlements, agriculture, and environmental protection. Central Java Province has diverse natural physical conditions comprising lowlands, hills, highlands, and mountains [7]. The Central Java Province RTRW also directs spatial planning in hilly and mountainous areas, including Temanggung Regency, which has the potential to experience increased settlement development and is prone to disasters. Previous study emphasizes that spatial planning in Indonesia needs integrate spatial data analysis to generate more better spatial planning in appropriate locations based on designated land use [8].

Temanggung Regency has geographic characteristics consisting of highlands, hills, and mountains, marked by the presence of Mount Sumbing and Mount Sindoro. The varied topographic conditions, with slope gradients ranging from flat, gentle, to steep, make Temanggung Regency vulnerable to land movement if land use does not align with land suitability and environmental carrying capacity [9]. Research in similar mountain show indicates that safe site selection for development building must account for geohazard risks including landslides and flooding, particularly in regions with steep slopes and high rainfall, where systematic multi-criteria evaluation becomes essential for preventing environmental damage and ensuring community safety [10]. Based on the Temanggung Regency Spatial Plan

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2024-2044, the direction of spatial utilization prioritizes a balance between protected areas, agriculture, and settlement areas, while considering the physical limitations of the region. Previous research state that land suitability needs to be assessed by considering physical variables, disaster risks, and land status simultaneously, with the aim of producing areas that match their designated use and minimize environmental damage [1,11]. Land suitability analysis for settlements in hilly and mountainous areas such as Temanggung Regency is important to generate planning recommendations and spatial utilization that are more adaptive to the geographic conditions of the area [12]. These findings reinforce the importance of spatial-based planning before establishing settlement development directions in hilly regions like Temanggung Regency. The Central Statistics Agency of Temanggung Regency shows that Temanggung Regency has experienced population growth over the last 10 years. Temanggung Regency had a population of 738,915 in 2014, which increased to 821,118 in 2024, representing an increase of 11.12%. This condition indicates that Temanggung Regency is currently in a phase of population growth and has the potential for increased housing demand in the future.

Land suitability analysis aims to assess the feasibility and appropriateness of an area for developing specific functions. Geographic Information Systems provide a better platform for analysis land suitability for settlement by integrating multiple spatial criteria. Studies in UK demonstrate that GIS-based approaches enable planners to systematically evaluate locations for settlement development by integrating multi factor such as accessibility, infrastructure compatibility, and environmental considerations [13]. Previous studies show that the use of geographic information systems can provide more realistic and clear spatial information for policymakers in determining areas suitable for settlement development [14]. Additionally, other studies also state the same, that physical land suitability will be more easily identified with a geographic information system approach and multi-aspect mapping [15]. Land suitability assessment with the aid of geographic information system software can help planners identify optimal locations for urban development including settlements, while avoiding areas with environmental limitations such as steep terrain, flood-prone areas, or protected zones [16]. Several of these studies indicate that geographic information systems facilitate the identification of areas with varying levels of suitability for area development, including settlements. In hill and mountain regions specifically, GIS-based approaches have proven valuable for delineating settlement suitability by systematically weighing criteria such as slope, elevation, proximity to infrastructure, and hazard exposure, thereby enabling planners to identify optimal locations while avoiding environmentally constrained zones [5,6].

In the context of settlements, settlement land suitability is needed to obtain areas that technically and based on existing conditions have high suitability for settlement development, with appropriate variables [2]. Natural physical aspects serve as the primary aspect in land suitability for settlements, such as rainfall, soil type, slope gradient, geological type, and aquifer productivity/hydrogeology [17]. This aspect plays an important role because natural physical conditions directly affect the environmental carrying and supporting capacity for settlement activities. In addition, accessibility aspects such as road access, distance from

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existing settlements, and distance to service centers play a role in determining ease of mobility, distribution of goods and services, and settlement infrastructure development [18]. Good accessibility will promote affordability to service centers and economic activities, thereby supporting the socio-economic sustainability of communities.

Based on land conditions and status, factors such as LP2B status, forest area status, river buffer zones, and land cover become considerations in settlement planning [19]. Land status functions as a determinant of legality and sustainability of spatial utilization, as each land status has protection or cultivation functions that need to be balanced. Another crucial aspect is the disaster risk aspect, which serves as a limiting factor in determining land suitability, because disaster-prone areas are certainly not suitable for settlements [20]. The disaster risk aspect in settlement land suitability functions as a basis for preventing losses and damage from disasters, as well as a guideline to ensure settlement development is truly safe and sustainable [21]. Thus, there are four aspects in land suitability analysis for settlements in Temanggung Regency, namely natural physical aspects, accessibility, land status, and disaster risk.

Based on this background, this study examines settlement land suitability in Temanggung Regency using 15 data/variables grouped into four main aspects: natural physical, accessibility, land status, and disaster risk. The analysis results in a land suitability map with four classifications S1, S2, S3, N [18]. These analysis results are then compared with the spatial pattern plan of the Temanggung Regency Spatial Plan to assess the alignment of spatial planning policies with actual physical conditions. This research is expected to serve as a technical basis for controlling spatial utilization and formulating sustainable settlement development recommendations in Temanggung Regency.

2. Methods

2.1. Study area

This research is located in Temanggung Regency with an area of 1,019.27 km², administratively divided into 20 districts, 266 villages, and 23 urban villages (Fig. 1). Geographically, Temanggung Regency is situated in the central part of Central Java Province, surrounded by Kendal Regency to the north, Wonosobo Regency to the west, Magelang Regency to the south, and Semarang Regency to the east. Temanggung Regency is traversed by the Ajibarang-Secang National Road, which serves as a primary arterial road connecting Semarang City and Semarang Regency toward Wonosobo Regency and Purwokerto Urban Area. In addition, Temanggung Regency is also crossed by the planned Trans Java Toll Road connecting Semarang-Bawen-Yogyakarta. The presence of this transportation network makes Temanggung Regency a location for mobility movement between regencies/cities and between provinces.

Received: November 08, 2025; Accepted: March 12, 2026; Available online: July 31, 2026

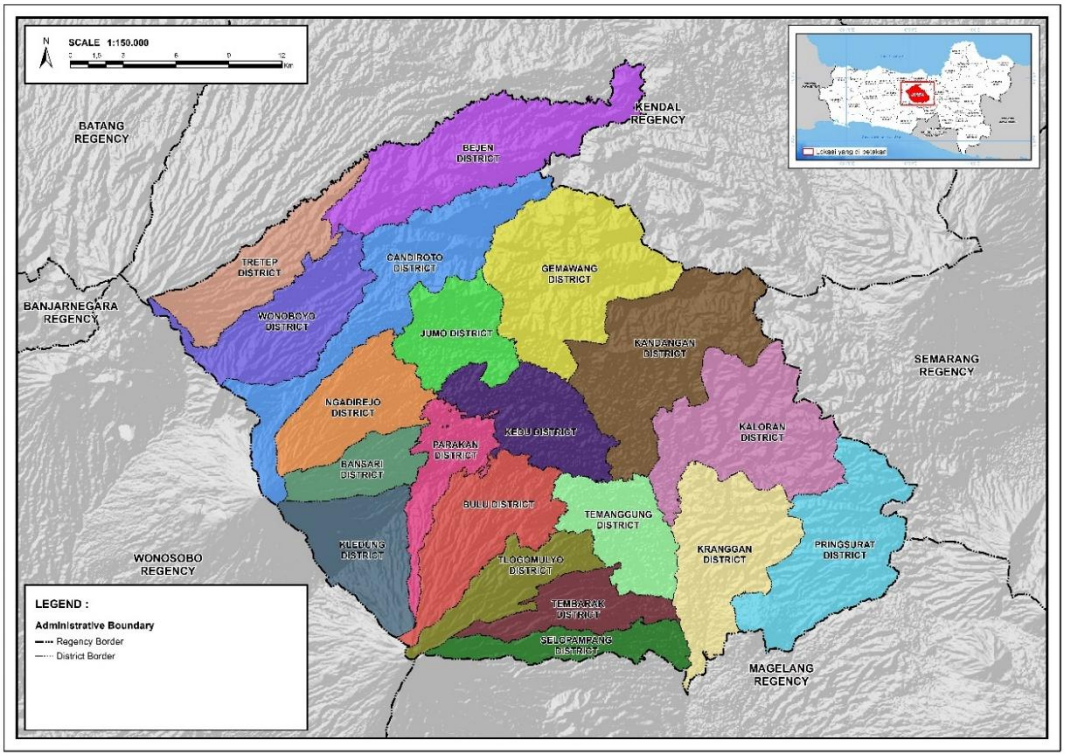

Figure 1. Administrative map of Temanggung Regency.

2.2. Data

Geographic Information System (GIS)-based settlement land suitability analysis requires spatial data as material for analysis formulation and data processing. All spatial data used are secondary data with sources in accordance with the decree of the Head of the Geospatial Information Agency (BIG) Number 16 of 2023 concerning custodians of thematic geospatial information data. Table 1 is a table of data requirements for settlement land suitability analysis in Temanggung Regency.

Table 1. Data requirements.

Data Name	Data Unit	Data Source
Administrative Boundaries	Shapefile	Geospatial Information Agency (BIG)
Rainfall	Shapefile	Meteorology, Climatology, and Geophysics Agency (BMKG)
Slope Gradient	Raster	Geospatial Information Agency (BIG)
Soil Type	Shapefile	Ministry of Agriculture
Geological Type	Shapefile	Ministry of Energy and Mineral Resources (ESDM)
Aquifer Productivity	Shapefile	Ministry of Energy and Mineral Resources (ESDM)
Road Network	Shapefile	Ministry of Public Works (PU)
LP2B Land	Shapefile	Ministry of Agriculture
Land Cover	Shapefile	Geospatial Information Agency (BIG)
Disaster Hazard	Raster	National Disaster Management Agency (BNPB)

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2.3. Analytical framework

This research employs a quantitative method using spatial data to generate settlement land suitability. The analytical technique used consists of spatial data analysis (Geographic Information System) using ArcGIS software, including scoring, overlay, union, merge, buffer, and reclassify. Figure 2 present a processing diagram for settlement land suitability analysis in Temanggung Regency.

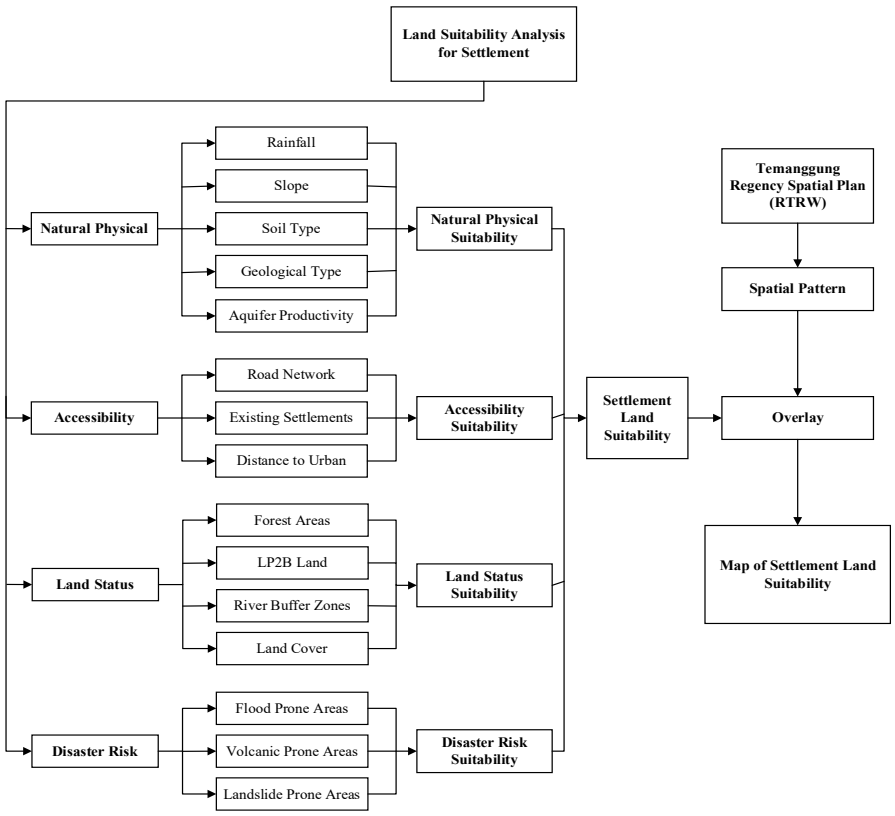

Figure 2. Analysis method framework.

The analysis method is classified into four main analyses: natural physical analysis, accessibility analysis, land status analysis, and disaster risk analysis. The analyses conducted are as follows.

2.3.1. Natural physical analysis. Natural physical analysis aims to assess the capacity and limitations of the environment in supporting settlement development. This aspect was selected because Temanggung Regency has diverse natural physical conditions. The variables analyzed in the natural physical aspect are rainfall, slope gradient, soil type, geological type, and aquifer productivity. Table 2 present the scoring analysis and classification for the natural physical aspect.

Received: November 08, 2025; Accepted: March 12, 2026; Available online: July 31, 2026

Table 2. Natural physical analysis technique.

No	Variable	Classification	Score
1	Rainfall	1500-2000 mm/year	3
		2000-2500 mm/year	3
		2500-3000 mm/year	2
		3000-3500 mm/year	2
		3500-4000 mm/year	1
2	Slope	0-8%	3
		8-15%	2
		15-25%	2
		25-45%	1
		>45%	1
3	Soil Type	Latosol	3
		Regosol	2
		Grumosol	1
4	Geological Type	Sumbing volcanic rock	3
		Sindoro volcanic rock	3
		Kaligetas Formation	2
		Penyatan Formation	2
		Kerek Formation	2
		Old Volcanic Rock	1
		Gilipetung Volcanic Rock	1
5	Aquifer Productivity	High Extensive Productivity	3
		Moderate Extensive Productivity	3
		Moderate Productivity	2
		Limited Productivity	2
		Low Limited Productivity	1
		Barren	1

2.3.2. Accessibility analysis. Accessibility analysis aims to assess land suitability based on ease of access and connectivity to facilities and infrastructure. This aspect was selected considering that settlements definitely require supporting facilities to fulfill their needs. The variables analyzed in the accessibility aspect are road access, distance from existing settlements, and distance to the city center. Table 3 present the scoring analysis and classification for the accessibility aspect.

Table 3. Accessibility analysis technique.

No	Variable	Classification	Score
1	Road Acces and Network	< 300 meters (Primary Arterial)	3
		< 200 meters (Primary Collector)	3
		300-500 meters (Primary Arterial)	2
		200-300 meters (Primary Collector)	2
		< 100 meters (Local Primary)	2
		500-1000 meters (Primary Arterial)	1
		300-500 meters (Primary Collector)	1
		100-200 meters (Local Primary)	1

Received: November 08, 2025; Accepted: March 12, 2026; Available online: July 31, 2026

No	Variable	Classification	Score
2	Distance from Existing Settlement	< 100 meters	3
		100-200 meters	2
		200-300 meters	1
3	Distance to Urban Center	< 2000 meters (PKL/Orde 1)	3
		< 1000 meters (PPK/Orde 2)	3
		< 500 meters (PPL/Orde 3)	3
		2000-4000 meters (PKL/Orde 1)	2
		1000-2000 meters (PPK/Orde 2)	2
		500-1000 meters (PPL/Orde 3)	2
		> 4000 meters (PKL/Orde 1)	1
		> 2000 meters (PPK/Orde 2)	1
		> 1000 meters (PPL/Orde 3)	1

2.3.3. Land status analysis. Land status analysis aims to assess the level of land suitability based on the existing status and function of land, namely protection functions or cultivation functions. In this study, land status is analyzed through four variables: forest areas, Sustainable Food Agricultural Land (LP2B), river buffer zones, and land cover. Table 4 present the scoring analysis and classification for the land status aspect.

Table 4. Land status analysis technique.

No	Variable	Classification	Score
1	Forest Area	Except Forest Areas	3
		Limited Production Forest	1
		Production Forest	1
		Protection Forest	0
2	LP2B (Agriculture Land)	Non-LP2B	3
		LCP2B (Reserve Protection Agriculture)	1
		LP2B (Protection Agriculture)	0
3	River Buffer Zones	Non-River Buffer	3
		River Buffer	0
4	Land Cover	Settlement	3
		Bare Land	2
		Mixed Plantation	2
		Shrubland	2
		Rice Field	1
		Farmland	1
		Plantation/Estate	1
		Pond	0
		River	0
		Lake	0

2.3.4. Disaster risk analysis. Disaster risk analysis aims to determine the level of resilience of an area against existing disasters. Temanggung Regency is included in areas prone to floods, land movement, and volcanic disasters. Table 5 present the scoring analysis and classification for the disaster risk aspect.

Received: November 08, 2025; Accepted: March 12, 2026; Available online: July 31, 2026

Table 5. Disaster risk analysis technique.

No	Variable	Classification	Score
1	Flood Prone Areas	Safe	3
		Moderate	2
		High	1
2	Landslide Prone Areas	Very Low	3
		Low	3
		Moderate	2
		High	1
3	Volcanic Prone Areas	Safe	3
		Moderate	2
		High	1

2.3.5. Scoring and overlay. Each analysis produces scores and classifications which are then overlaid from the four variables. The overlay was conducted using the union tool in ArcGIS from four previously analyzed maps. Score assignment was based on several relevant literature sources, with processing performed using attribute tables in ArcGIS. The overlay process generates a settlement land suitability analysis map, however this map has not yet been integrated with the spatial pattern plan of the Temanggung Regency Spatial Plan (RTRW). Table 6 present the scoring and overlay analysis along with its classification.

Table 6. Scoring and overlay analysis technique.

No	Score	Classification	Code
1	11 - 19	Not Suitable	N
2	20 - 28	Marginally Suitable	S3
3	29 - 37	Moderately Suitable	S2
4	38 - 45	Highly Suitable	S1

2.3.6. Overlay with spatial pattern plan. Overlay is necessary to integrate the land suitability analysis results with the spatial pattern plan of the Temanggung Regency Spatial Plan.

Table 7. Overlay analysis technique with spatial pattern plan.

No	Suitability Analysis	Spatial Pattern Plan	Final Classification
1	Highly Suitable (S1)	Settlement Area	Recommended Development
2	Moderately Suitable (S2)	Settlement Area	Recommended Development
3	Marginally Suitable (S3)	Settlement Area	Reserved Development
4	Moderately Suitable (S2)	Agricultural Area	Low/Difficult Development
5	Moderately Suitable (S2)	Industrial Designated Area	Low/Difficult Development
6	Marginally Suitable (S3)	Agricultural Area	Low/Difficult Development
7	Marginally Suitable (S3)	Settlement Cultivation Area	Low/Difficult Development
8	Marginally Suitable (S3)	Protection Area	Non-Developable
9	Not Suitable (N)	All Areas	Non-Developable

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Table 7 present the overlay analysis with the spatial pattern plan. This overlay produces land with moderately suitable and highly suitable classifications as well as settlement spatial patterns. Thus, high suitability and settlement designation in the spatial pattern plan are obtained.

3. Result and discussion

3.1. Result

3.1.1. Natural physical analysis. Land suitability based on natural physical conditions was analyzed using rainfall data, slope gradient, soil type, geological type, and aquifer productivity. From these five variables, a scoring and overlay process was conducted to produce a natural physical suitability map for settlement development in Temanggung Regency. Figure 3 present the natural physical suitability analysis map.

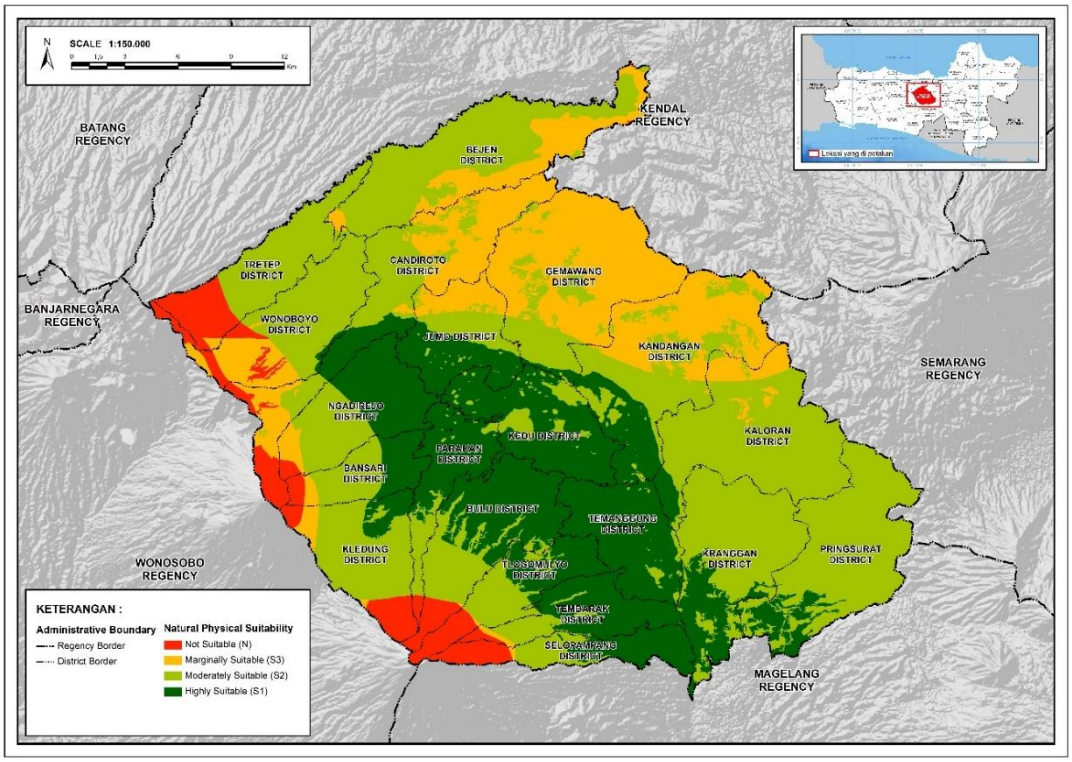

Figure 3. Map of natural physical analysis.

The natural physical analysis results show that areas with very high suitability are located in the central region of Temanggung Regency, predominantly in Temanggung District, Parakan, and Kedu. In addition, highly suitable areas are also found in parts of Bulu, Tlogomulyo, Tembarak, Selopampang, Kranggan, Bansari, Ngadirejo, and Jumo Districts. One of the most influential indicators for the natural physical aspect is topographic conditions and slope

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gradient. This statement is proven by the fact that highly suitable areas are located in areas dominated by flat or slightly sloping topography.

3.1.2. Accessibility analysis. Land suitability based on accessibility conditions was analyzed using road access data, distance from existing settlements, and distance to city center. From these three variables, a scoring and overlay process was conducted to produce an accessibility suitability map for settlement development in Temanggung Regency. Figure 4 present the accessibility suitability analysis map.

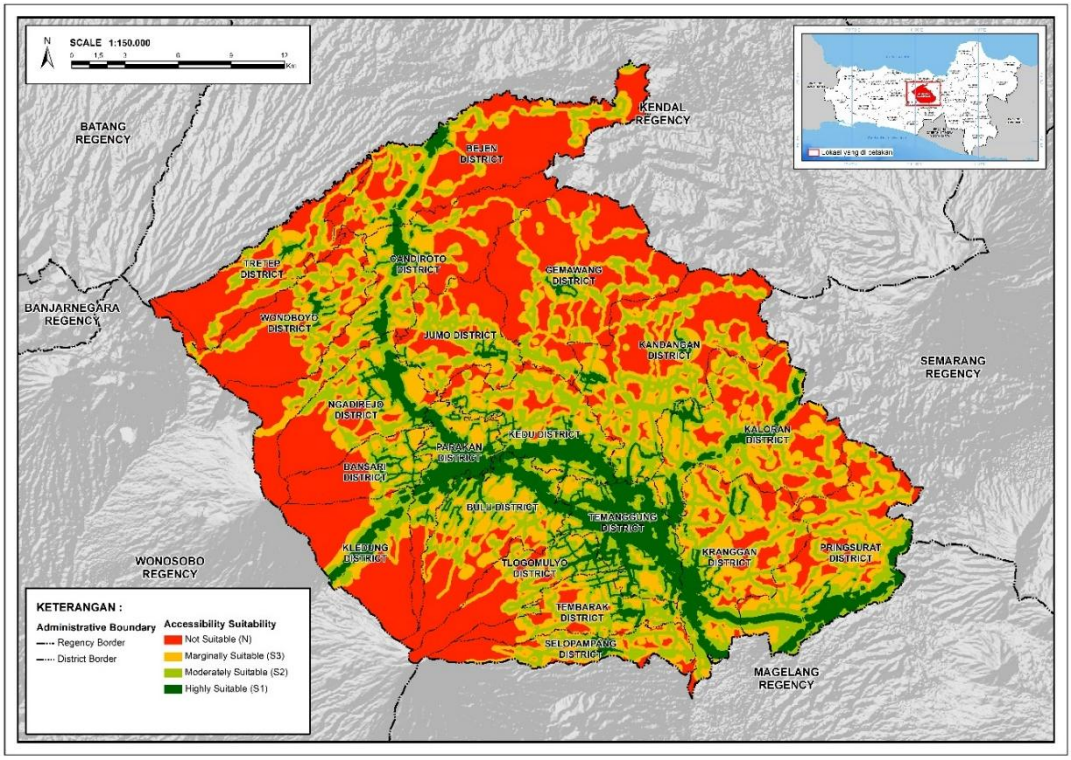

Figure 4. Map of accessibility analysis.

The accessibility analysis results show that areas with very high suitability are located in areas close to the main road network in Temanggung Regency. Temanggung Regency is traversed by the Primary Arterial road network (National Road) and Primary Collector Road Class Two (Provincial Road), making areas around these main roads have higher accessibility than areas farther from the main roads. Areas with very low accessibility suitability are located in areas far from or not traversed by road networks, such as mountainous areas, hills, or highlands.

3.1.3. Land status analysis. Land suitability based on land status conditions was analyzed using forest area data, Sustainable Food Agricultural Land (LP2B), river buffer zones, and land cover. From these four variables, a scoring and overlay process was conducted to produce a land status suitability map for settlement development in Temanggung Regency. Figure 5 present the land status suitability analysis map.

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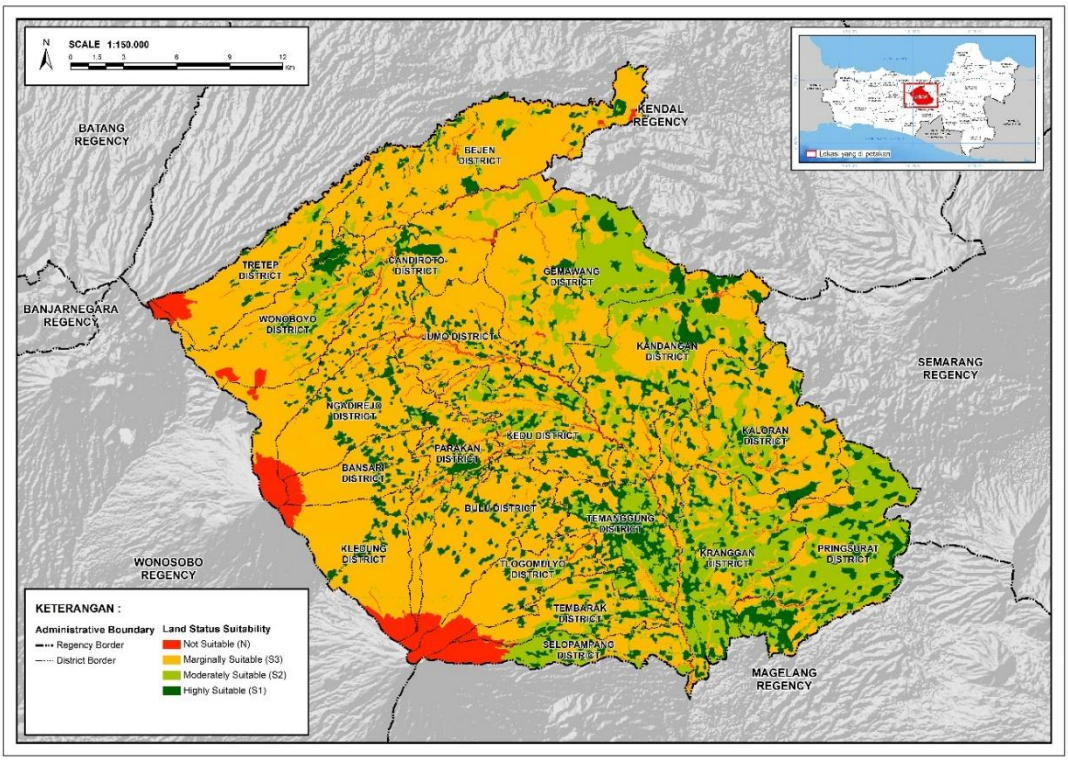

Figure 5. Map of land status analysis.

The land status analysis results show that areas with very high suitability are located around urban areas, but are distributed evenly and not concentrated in one area only. High land status suitability typically indicates that the area is not LP2B, not a forest area, not a buffer/protected zone, and consists of built-up land. The areas in question have no restrictions for development, thus having a high classification in this analysis. Protected areas in Temanggung Regency, when viewed on the map, have very low suitability because most of the protected areas consist of forest areas, mountain peaks, LP2B, and buffer zones.

3.1.4. Disaster risk analysis. Land suitability based on disaster risk conditions was analyzed using flood hazard, landslide, and volcanic hazard data. From these three disaster hazard variables, a scoring and overlay process was conducted to produce a disaster risk suitability map for settlement development in Temanggung Regency. Figure 6 present the disaster risk suitability analysis map.

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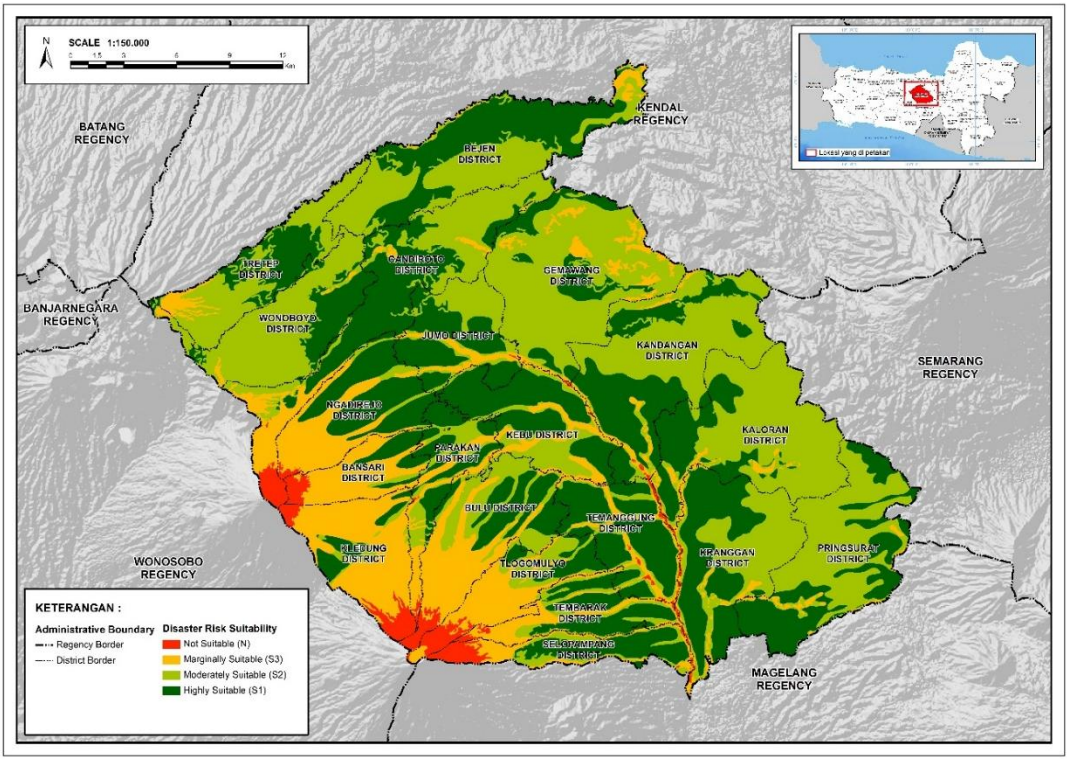

Figure 6. Map of disaster risk analysis.

The disaster risk analysis results show that areas with very high suitability are located in areas with low disaster risk. Low disaster risk areas are distributed fairly evenly across each district. Areas with low disaster suitability mean that these areas have high disaster vulnerability, such as areas around Mount Sumbing and Mount Sindoro, as well as areas near major river banks such as the Progo River and Galeh River.

3.1.5. Settlement land suitability. The land suitability analysis for settlement development was obtained from overlaying the four previous analyses: natural physical, accessibility, land status, and disaster risk. The overlay results from these four analyses were then overlaid again with the Temanggung Regency Spatial Pattern Plan to produce development recommendations based not only on existing conditions analysis but also considering regulatory aspects, namely the Regional Spatial Plan (RTRW) of Temanggung Regency. Figure 7 present the final result map of the settlement land suitability analysis for Temanggung Regency.

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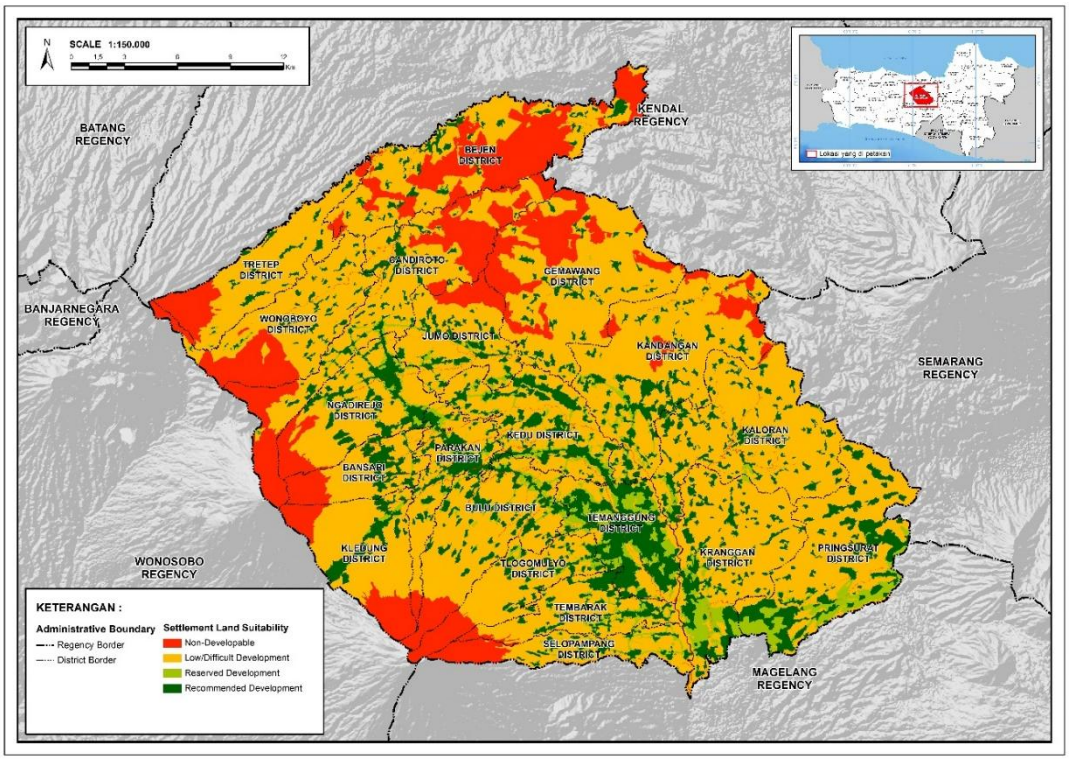

Figure 7. Map of settlement land suitability Temanggung Regency.

The final results of the settlement land suitability analysis produced four classifications: non-developable, low/difficult development, reserved development, and recommended development. The map shows that areas with recommended development and reserved development are still very limited, and Temanggung Regency is actually dominated by the low/difficult development classification. This condition is supported by various factors, such as natural physical conditions dominated by hills and limited flat land, low accessibility in areas far from main roads, extensive protected land that cannot be freely planned, and high disaster risk in several areas. From this map, the results can be detailed in table form per development class. Table 8 is a table of the settlement land suitability analysis results for Temanggung Regency.

Table 8. Settlement land suitability classification result.

Classification	Area (Hectares)	Percentage (%)
Non-Developable	14,096.80	16.28%
Low/Difficult Development	52,486.67	60.60%
Reserved Development	5,813.95	6.71%
Recommended Development	14,216.01	16.41%
Total	**86,613.45**	**100.00%**

From this table, it can be concluded that the recommended development classification covers an area of 14,216 hectares or 16.41% of Temanggung Regency's total area. In addition, there

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is a reserved development classification with an area of 5,812 hectares or 6.71% of Temanggung Regency's total area. The settlement development recommendations in Temanggung Regency per district can be seen in the Table 9.

Table 9. Recommended development area distribution by district.

District	Area (Hectares)	Percentage (%)
Bansari District	381.67	2.68%
Bejen District	489.92	3.45%
Bulu District	825.31	5.81%
Candiroto District	540.62	3.80%
Gemawang District	473.39	3.33%
Jumo District	466.63	3.28%
Kaloran District	872.57	6.14%
Kandangan District	879.97	6.19%
Kedu District	1,188.45	8.36%
Kledung District	425.67	2.99%
Kranggan District	1,131.47	7.96%
Ngadirejo District	885.83	6.23%
Parakan District	964.54	6.78%
Pringsurat District	1,417.35	9.97%
Selopampang District	247.13	1.74%
Temanggung District	1,678.50	11.81%
Tembarak District	558.31	3.93%
Tlogomulyo District	323.96	2.28%
Tretep District	205.59	1.45%
Wonoboyo District	259.14	1.82%
Total	**14,216.01**	**100.00%**

Based on the table of settlement land development recommendations with data units per district, it was found that each district has varying areas of land with development recommendations. The district with the highest recommended development land area is Temanggung District with 1,678 hectares or 11.81% of the total recommended development land area. This is followed by Pringsurat District with 1,417 hectares, Kedu District with 1,188 hectares, Kranggan District with 1,131 hectares, and Parakan District with 964 hectares. When viewed from their conditions and locations, these five districts have flatter topographic conditions compared to other districts. Moreover, these five districts are traversed by the Primary Arterial Road (National Road) and Primary Collector Road Class Two (Provincial Road), giving them high connectivity indices and accessibility capabilities. From the land status aspect, these five districts are quite far from forest areas and mountains, and have low disaster risk levels.

On the other hand, the district with the lowest recommended development land area is Tretep District with 205 hectares or only 1.45% of the total recommended development land area. In addition, there are Selopampang District with 247 hectares or 1.74% and Wonoboyo District with 259 hectares or 1.82%. These three districts are characterized by topographic conditions

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dominated by hills with steep slopes. Furthermore, parts of these three districts are mountain slopes and peaks: Selopampang District with Mount Sumbing, and Tretep and Wonoboyo Districts with Mount Sibutak and Mount Prau.

3.2. Discussions

Land suitability analysis for settlement development in Temanggung Regency reveals that only 16.41% of the area, covering approximately 14,216 hectares, falls under the recommended development classification, while the majority of the region (60.60%) is categorized as having low development potential or being difficult to develop. This condition reflects the geographical characteristics of Temanggung Regency, which is predominantly composed of hilly and mountainous topography with the presence of Mount Sumbing and Mount Sindoro. These findings align with research conducted by Hasibuan & Rahayu [9] in Temanggung Regency, which concluded that areas with hilly or mountainous topography face significant limitations for settlement development due to steep slopes and high vulnerability to landslide hazards. Their study even found that during the 2011-2015 period, settlement areas continued to expand into landslide-prone zones with high and very high vulnerability levels. Similar conditions were also identified by Prasetia et al. [22] in West Lampung Regency, who employed multiple regression analysis to demonstrate that rainfall and slope gradient are the two most influential factors affecting landslide occurrence, where higher rainfall and steeper slopes substantially increase landslide potential. Similar findings from mountainous regions, studies have documented that settlement planning in steep terrain requires comprehensive hazard assessment integrating slope stability, hydrological patterns, and vulnerability mapping to prevent infrastructure damage and ensure community safety [10]. Research in Rwanda's Western Highlands similarly that approximately 70% of rural settlements occupy slopes below 20 degrees, demonstrating a natural preference for terrain with reduced landslide and erosion susceptibility that supports long-term community resilience [6].

The distribution of recommended development areas, which is concentrated in the central part of Temanggung Regency, particularly in Temanggung, Pringsurat, Kedu, Kranggan, and Parakan Districts, is strongly influenced by three primary factors, relatively flat topography, high accessibility through primary arterial and primary collector road networks, and low disaster vulnerability levels. This concentration pattern corresponds with findings from Sakarov & Fahik [23] in Belu Regency, which identified road network accessibility as one of the key factors in determining settlement land suitability, where areas with closer proximity to primary arterial roads received the highest suitability scores. This pattern reflects broader spatial dynamics observed in hilly regions, where settlements tend to concentrate in locations balancing terrain favorability with infrastructure accessibility. Studies in India's Himalayan hill areas have shown that integrated suitability assessment considering both natural constraints and locational advantages enables identification of priority zones for sustainable development while avoiding environmentally sensitive areas [5]. Luan et al. [14] in their study of Ili Valley, China, demonstrated how multi-criteria GIS analysis with integrates infrastructure accessibility, topographic conditions, and ecological factors can determine suitable settlement areas. Their research employed ordered weighted averaging combined with logic scoring

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methods to generate land suitability maps that balance urban expansion needs with environmental protection priorities.

The application of spatial analysis methods using Geographic Information System (GIS) in this research has proven effective for integrating various land suitability parameters. This is supported by findings from Pigawati et al. [24] in the coastal area of Semarang City, who employed overlay methods with nine Land Capability Units to generate settlement land suitability maps. A similar approach was also applied by Nurhidayah et al. [25] in Gowa Regency, South Sulawesi, who classified land suitability based on geomorphological aspects by overlaying maps of slope gradient, rainfall, soil type, and land cover. Their research produced four suitability classes, with highly suitable land accounting for 8.04% of the total area, distributed across fluvial and volcanic plains. The effectiveness of GIS-based multi criteria for settlement planning has been further validated in complex mountainous landscapes, where systematic weighting of factors such as elevation, slope, proximity to water sources, and hazard exposure enables planners to delineate suitable zones with greater spatial precision and policy relevance [5,6]. Such approaches prove particularly valuable in regions with heterogeneous topography, where spatial suitability varies significantly across short distances and requires detailed assessment to guide appropriate land use decisions.

The overlay analysis between the land suitability map and the Spatial Plan Pattern of Temanggung Regency demonstrates that recommended settlement development is not solely based on physical conditions, but also considers regulatory aspects and spatial policy directives. This approach aligns with research by Junaid et al. [3] in Serang Regency, which integrated land suitability analysis results with spatial plan patterns to generate more comprehensive development recommendations. Their evaluation of settlement plans showed that 90.7% of planned development was already located in suitable areas, indicating that planning documents have successfully guided settlement development appropriately. Lasaiba [26] in Ambon City also emphasized the importance of integrating land suitability analysis with spatial planning documents, finding that 204.19 hectares of settlements had developed in unsuitable zones, requiring local government to enforce regulations more strictly to ensure land sustainability.

Although this research has integrated various aspects in determining settlement land suitability, several limitations need to be acknowledged. The study has not yet incorporated socio-economic aspects of the community and carrying capacity analysis to determine land capacity for accommodating population growth, which has reached 11.12% over the past decade. According to Junaid et al.[3], environmental carrying capacity and supporting capacity analysis are essential to ensure sustainable settlement development. Future research should complement land suitability analysis with housing needs assessment and population growth projections to generate more applicable and comprehensive recommendations for the government in controlling spatial utilization and formulating sustainable settlement development policies.

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4. Conclusions and Reccomendations

4.1. Conclusions

This research produces settlement land suitability in Temanggung Regency by considering four criteria: natural physical, accessibility, land status, and disaster risk. The processing method uses a geographic information system with scoring analysis and spatial data overlay. In addition, the formulation of land recommendations as settlement development recommendations also considers the Spatial Pattern Plan of the Temanggung Regency Spatial Plan as the currently applicable regulatory aspect. The settlement land suitability analysis results produced four classifications: non-developable, low/difficult development, reserved development, and recommended development. The non-developable classification covers 14,096 hectares or 16% of Temanggung Regency's area, low/difficult development classification covers 52,486 hectares or 60%, reserved development classification covers 5,812 hectares or 6.71%, and recommended development classification covers 14,216 hectares or 16.41%.

The recommended development classification, which is the priority for development, is distributed evenly across all districts with varying areas. Temanggung District has the highest recommended development area with 1,678 hectares or 11.81% of the total recommended development land area, followed by Pringsurat District with 1,417 hectares, Kedu District with 1,188 hectares, Kranggan District with 1,131 hectares, and Parakan District with 964 hectares. On the other hand, the district with the lowest recommended development land area is Tretep District with 205 hectares or only 1.45% of the total recommended development land area. Thus, land suitability for settlement development is still predominantly located in areas with relatively flat topographic conditions, far from mountains and forest areas, close to main road networks, and not located in disaster-prone areas.

4.2. Recommendations

Based on the processing and conclusions above, recommendations can be proposed for future research on settlement land suitability using geographic information systems.

a) In data processing for settlement land suitability analysis, it should be supplemented with population analysis to determine the environmental carrying and supporting capacity in supporting settlement plans.
b) In the disaster risk aspect, a preparedness aspect should be added so that disaster indicators will be more comprehensive.
c) In subsequent research, housing demand analysis can be added to accurately determine needs and whether the available land can meet those housing demands.

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Reference

[1] Nurfikasari MF, Yuliani E. Studi Literatur : Analisis Kesesuaian Lahan Terhadap Lokasi Permukiman. Jurnal Kajian Ruang 2022;1:78. https://doi.org/10.30659/jkr.v1i1.19981.

[2] Amir AK, Wunas S, Arifin M. Settlement development based on land suitability. IOP Conf Ser Earth Environ Sci 2020;419:012083. https://doi.org/10.1088/1755-1315/419/1/012083.

[3] Junaid M, Anggara RB, Nagara RP, Wibowo A. Land Suitability Assessment for Sustainable Settlement in Serang Regency, Banten Province. Indonesian Journal of Environmental Management and Sustainability 2024;8:118–25. https://doi.org/10.26554/ijems.2024.8.3.118-125.

[4] Setiawan H. Analisis Tingkat Kesesuaian Lahan Permukiman Berdasarkan Jaringan Jalan di Kota Jambi. Geodika: Jurnal Kajian Ilmu Dan Pendidikan Geografi 2023;7:186–95. https://doi.org/10.29408/geodika.v7i2.15901.

[5] Kapoor N, Bansal VK. Spatial suitability assessment for planning infrastructure facilities at site level in hill areas. Journal of Urban Management 2021;10:27–45. https://doi.org/10.1016/j.jum.2021.02.003.

[6] Niyogakiza A, Liu Q. GIS-Driven Multi-Criteria Assessment of Rural Settlement Patterns and Attributes in Rwanda's Western Highlands (Central Africa). Sustainability 2025;17:6406. https://doi.org/10.3390/su17146406.

[7] Isnaini R. Analisis Bencana Tanah Longsor di Wilayah Provinsi Jawa Tengah. Islamic Management and Empowerment Journal 2019;1:143–60. https://doi.org/10.18326/imej.v1i2.143-160.

[8] Budianto B, Susiloningtyas D, Dimyati M. Spatial Analysis of Land Use and Land Utilization Based on Suitability Spatial Planning on Food Estate Planning Site in Kapuas Regency, Central Kalimantan. Indonesian Journal of Earth Sciences 2024;4:A834. https://doi.org/10.52562/injoes.2024.834.

[9] Hasibuan HC, Rahayu S. Kesesuaian lahan permukiman pada kawasan rawan bencana tanah longsor di Kabupaten Temanggung. Teknik PWK (Perencanaan Wilayah Kota) 2017;6:242–56.

[10] Mallick J, Ibnatiq AA, Kahla N Ben, Alqadhi S, Singh VP, Hoa PV, et al. GIS-Based Decision Support System for Safe and Sustainable Building Construction Site in a Mountainous Region. Sustainability 2022;14:888. https://doi.org/10.3390/su14020888.

[11] Rachmah Z, Rengkung MM, Lahamendu V. Kesesuaian lahan permukiman di kawasan kaki Gunung Dua Sudara. Jurnal Spasial 2018;5:118–29.

Received: November 08, 2025; Accepted: March 12, 2026; Available online: July 31, 2026

[12] Rahmah IM. Analisis Spasial Kesesuaian Lahan Permukiman Kabupaten Badung Provinsi Bali. Geodika: Jurnal Kajian Ilmu Dan Pendidikan Geografi 2025;9:210–23. https://doi.org/10.29408/geodika.v9i2.29415.

[13] Kazempour M, Sabboubeh H, Pirouz Moftakhari K, Najafi R, Fusco G. GIS-based geospatial analysis for identifying optimal locations of residential on-street electric vehicle charging points in Birmingham, UK. Sustain Cities Soc 2025;120:105988. https://doi.org/10.1016/j.scs.2024.105988.

[14] Luan C, Liu R, Peng S. Land-use suitability assessment for urban development using a GIS-based soft computing approach: A case study of Ili Valley, China. Ecol Indic 2021;123:107333. https://doi.org/10.1016/j.ecolind.2020.107333.

[15] Al-Ghorayeb A, Al-Shaar W, Elkordi A, Faour G, Al-Shaar M, Attalah Y. Land Suitability Analysis for Sustainable Urban Development: A Case of Nabatiyeh Region in Lebanon. J (Basel) 2023;6:267–85. https://doi.org/10.3390/j6020020.

[16] Topuz M, Deniz M. Application of GIS and AHP for land use suitability analysis: case of Demirci district (Turkey). Humanit Soc Sci Commun 2023;10:115. https://doi.org/10.1057/s41599-023-01609-x.

[17] Ratnawati H, Djojomartono PhD, PN. Analisis Kesesuaian Lahan Permukiman di Kecamatan Playen Kabupaten Gunungkidul menggunakan Pendekatan Analytic Hierarchy Process. JGISE: Journal of Geospatial Information Science and Engineering 2020;3:123. https://doi.org/10.22146/jgise.59057.

[18] Arwanto DS, Wijaya AP, Wahyuddin Y. Pemetaan Kesesuaian Lahan Kawasan Permukiman Di Sekitar Pengembangan Kawasan Srategis Pariwisata Nasional (KSPN) Menggunakan Sistem Informasi Geografis (Studi Kasus: Kecamatan Prambanan dan Kecamatan Kalasan). Jurnal Geodesi Undip 2025;13:548–57.

[19] Hambali FR, Sutaryono S, Pinuji S. Kesesuaian Kawasan Lahan Pertanian Pangan Berkelanjutan dengan Rencana Tata Ruang Wilayah di Kabupaten Sumenep. Tunas Agraria 2021;4:276–92. https://doi.org/10.31292/jta.v4i3.164.

[20] Putera RE, Valentina TR, Rosa SAS. Implementasi Kebijakan Penataan Ruang Berbasis Mitigasi Bencana Sebagai Upaya Pengurangan Resiko Bencana di Kota Padang. Publik (Jurnal Ilmu Administrasi) 2020;9:155. https://doi.org/10.31314/pjia.9.2.155-167.2020.

[21] Kristini W, Widiatmaka, Mulya SP. Disaster mitigation-based land suitability for settlements using Multi-Criteria Evaluation (MCE) method in The Northern Part of South Barito Regency. IOP Conf Ser Earth Environ Sci 2022;950:012015. https://doi.org/10.1088/1755-1315/950/1/012015.

[22] Prasetia A, Armijon A, Rahmadi E. ANALISIS KESESUAIAN LAHAN PERMUKIMAN DI ZONA RAWAN BENCANA TANAH LONGSOR PADA KAWASAN RAWAN BENCANA KABUPATEN LAMPUNG BARAT. Datum: Journal of Geodesy and Geomatics 2022;2:1–10. https://doi.org/10.23960/datum.v2i2.2876.

Received: November 08, 2025; Accepted: March 12, 2026; Available online: July 31, 2026

[23] Sakarov OD. Analisis Kesesuaian Lahan Untuk Lokasi Permukiman di Kabupaten Belu Nusa Tenggara Timur. Jurnal Planologi 2019;16:16. https://doi.org/10.30659/jpsa.v16i1.3945.

[24] Pigawati B, Yuliastuti N, Suryani TA. Land Suitability for Settlement Development in Semarang Coastal Area. IOP Conf Ser Earth Environ Sci 2023;1264:012032. https://doi.org/10.1088/1755-1315/1264/1/012032.

[25] Nurhidayah T, Massinai MA, Arif S. Land Suitability Analysis Based On Geomorphological Aspects For Settlements In Gowa Regency, South Sulawesi. IOP Conf Ser Earth Environ Sci 2024;1386:012038. https://doi.org/10.1088/1755-1315/1386/1/012038.

[26] Lasaiba MA. Evaluation of Settlement Land Suitability Based on Remote Sensing and Geographical Information Systems in The City of Ambon. Jurnal Spatial Wahana Komunikasi Dan Informasi Geografi 2023;23:70–84. https://doi.org/10.21009/spatial.231.006.

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