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Relative Elevation Approach for Flood Susceptibility Assessment and Residential Zoning in Pallangga, Indonesia

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ABSTRACT

Flood susceptibility assessment is essential for supporting land-use control and mitigation-oriented spatial planning in rapidly developing downstream areas. This study aimed to assess flood susceptibility in the Pallangga District, Gowa Regency, Indonesia, using a simplified GIS-based approach and evaluate its implications for residential zoning in the Regional Spatial Plan (RTRW). Four parameters were used: built-up land density, distance from the river, relative elevation, and slope. Built-up land density was derived from Sentinel-2 L2A imagery using the spectral index rule-based classification approach, whereas relative elevation and slope were generated from DEMNAS data. Each parameter was scored and weighted based on expert judgment and then integrated using the weighted overlay method. The flood susceptibility index was classified into low-, moderate-, and high-risk classes using the natural breaks method and generalized using the minimum mapping unit approach. The results showed that moderate flood susceptibility dominated the Pallangga District, covering 2965.0 ha (53.0 %) of the total area, followed by low susceptibility at 1442.5 ha (25.7 %) and high susceptibility at 1191.5 ha (21.3 %). High-risk areas were mainly concentrated in the northern part of the district, where low relative elevation, flat slopes, river proximity, and higher built-up land density interact spatially. Overlay analysis with RTRW residential zoning indicated that 736.3 ha (38.5 %) of the planned residential areas were located within high-flood-susceptibility zones. These findings highlight the need to integrate flood susceptibility information into residential zoning evaluations, land-use control, and local flood mitigation planning.

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1. INTRODUCTION

Flooding remains one of the most frequent and destructive natural hazards worldwide, causing significant impacts on human settlements, infrastructure, economic activities, and environmental sustainability. Increasing urban development and changes in land use and land cover have altered natural hydrological processes, resulting in higher surface runoff and increased flood susceptibility. The expansion of built-up areas reduces infiltration capacity and limits natural rainwater storage, thereby accelerating runoff generation and increasing the likelihood of flooding (Feng et al., 2021). Therefore, flood susceptibility assessment is essential for disaster risk reduction and spatial planning, particularly through the use of geographic information systems (GIS), remote sensing, and spatial analysis techniques that integrate environmental and anthropogenic parameters

(Rakuasa et al., 2022; Irawan et al., 2024; Islam et al., 2025; Rahmanita & Idarwati, 2025). The Pallangga District in Gowa Regency, South Sulawesi, is an area where such an assessment is highly important because it functions as a buffer zone for Makassar City and the administrative center of Gowa Regency, leading to continuous population growth and increasing development pressure. Population statistics show substantial growth between 2018 and 2024, indicating greater pressure on land resources and built-up area expansion (BPS, 2019; BPS, 2025). Moreover, most parts of the Pallangga District are located in the downstream section of the Jeneberang Watershed, where water accumulation from upstream areas, combined with predominantly flat terrain, slows runoff movement and increases the likelihood of water ponding and flooding (Sabila et al., 2023; Tentua et al., 2018; Ma'rufah et al., 2024). These conditions highlight the need for a spatially explicit flood susceptibility assessment to support flood mitigation and sustainable regional development.

The increasing pressure of urban development in the Pallangga District raises concerns regarding the potential escalation of flood-related problems, as the conversion of agricultural and open land into residential and commercial uses reduces infiltration areas and increases surface runoff during rainfall events (Feng et al., 2021; Jauhari et al., 2024). At the same time, the district's downstream watershed position and flat topography create favorable conditions for water accumulation, particularly near river channels and in low-lying areas. These conditions indicate that flood susceptibility in the Pallangga District is influenced by the interaction of physical and anthropogenic factors, necessitating a spatial assessment to identify areas with different susceptibility levels. One widely adopted approach is the development of flood susceptibility maps through the integration of multiple spatial parameters, including topography, hydrological proximity, and land-use characteristics, within a geographic information system (GIS) environment. Such mapping enables decision-makers to identify flood-prone areas and integrate the results into land-use planning, infrastructure development, disaster mitigation strategies, and risk-informed land management (Rakuasa et al., 2022; Irawan et al., 2024). Therefore, spatial analysis provides an effective and accessible solution for supporting flood management, particularly in regions with limited detailed hydrological data.

Numerous studies have employed GIS-based approaches to assess flood susceptibility by integrating multiple environmental and physio-socio parameters, such as elevation, slope, land use, rainfall, drainage density, soil characteristics, and distance from river networks. These parameters are commonly combined using weighted overlay techniques, multicriteria decision analysis, or statistical and machine-learning approaches to generate flood susceptibility maps (Tentua et al., 2018; Rakuasa et al., 2022). Among these variables, topographic characteristics play an important role because slope influences surface runoff movement and accumulation, whereas elevation determines the relative position of an area within the landscape. Areas with gentle slopes tend to experience slower runoff movement and greater water ponding, thereby increasing flood susceptibility (Tentua et al., 2018; Ma'rufah et al., 2024). In addition, locations near rivers often have higher susceptibility owing to the potential for overflow during periods of elevated discharge (Rifandi et al., 2024). Recent studies have also emphasized the importance of land-use characteristics, as urban expansion and increasing built-up land density reduce infiltration and increase runoff volumes (Feng et al., 2021; Shrestha et al., 2021; Sugianto et al., 2022; Amalia & Benardi, 2026). Therefore, the integration of built-up land characteristics, topographic conditions, and river proximity provides a practical framework for evaluating flood susceptibility, particularly in rapidly developing peri-urban areas.

Although previous studies have successfully applied various methods for flood susceptibility assessment, most still rely on a relatively large number of parameters and often use absolute elevation above sea level as the main topographic indicator (Tentua et al., 2018; Rakuasa et al., 2022; Artikanur et al., 2023; Irawan et al., 2024). While the use of many variables may improve analytical comprehensiveness, it also increases data requirements and limits applicability in areas with incomplete spatial datasets. Therefore, simplified flood susceptibility assessment methods using readily available spatial data are still needed. In addition, absolute elevation may not always adequately represent flood susceptibility in downstream areas with relatively flat topography because it does not clearly describe the local position of an area relative to nearby river systems. In such environments, relative elevation may provide a more meaningful representation of flood susceptibility related to river overflow processes. Another limitation is the limited integration between flood susceptibility assessments and official spatial planning instruments, particularly in evaluating the compatibility between flood-prone areas and land-use allocations. This is important because inappropriate land allocation in flood-prone zones can increase future exposure to flood hazards. Thus, studies are needed that not only assess flood susceptibility but also examine its implications for residential zoning and spatial planning policies.

This study assessed flood susceptibility in the Pallangga District, Gowa Regency, using four spatial parameters: built-up land density, distance from the river, relative elevation, and slope, and evaluated its spatial relationship with residential zoning designated in the RTRW. This analysis provides a preliminary spatial assessment to support land-use management and disaster mitigation in rapidly developing areas with limited data availability. The novelty of this study lies in the incorporation of relative elevation as a topographic parameter in a predominantly flat downstream watershed environment, as it represents the position of a location relative to river reference elevation and may better reflect flooding tendencies associated with river overflow than absolute elevation. In addition, this study links flood susceptibility mapping with RTRW residential zoning, thereby connecting physical flood-prone conditions with spatial planning considerations. The scope of this study is limited to a simplified GIS-based assessment using four spatial parameters; rainfall intensity, drainage density, soil characteristics, and hydraulic conditions were not included. Therefore, the results should be interpreted as a preliminary susceptibility assessment to support planning and decision-making rather than as a comprehensive flood hazard or flood risk analysis.

2. METHOD

2.1. Research Location, Tools, and Materials

This study was conducted in Pallangga District, Gowa Regency, South Sulawesi Province, Indonesia. Geographically, the study area is located between 5°11'20.40"–5°17'49.20" S and 119°25'19.99"–119°31'26.92" E. Pallangga District consists of 16 administrative units, comprising 12 villages and 4 urban villages. The location of the study area is presented in Figure 1.

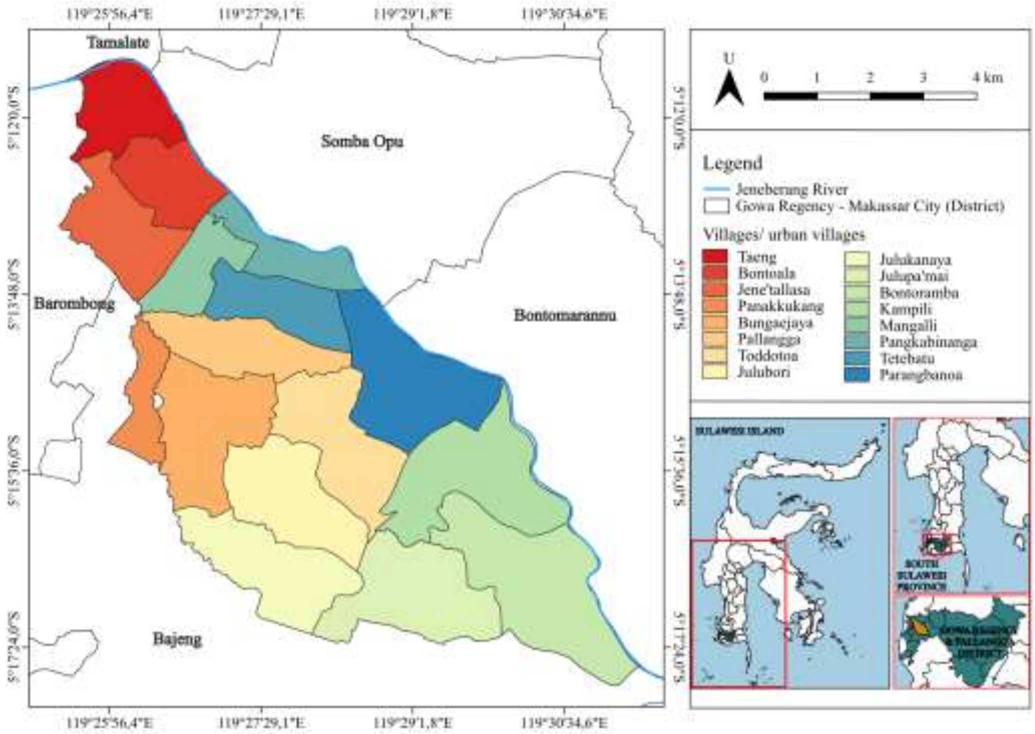

Figure 1. Map of the research location.

The tools used in this study included an Acer Z476 laptop, QGIS 3.34.4 for spatial data processing and analysis, and Microsoft Office for data tabulation and manuscript preparation. The spatial data used in this study consisted of administrative boundaries, built-up land density, river networks, relative elevation, slope, and the RTRW of the Gowa Regency. The details of the research materials are listed in Table 1.

Table 1. Research materials

Vector Data	Data Source
Administrative boundaries of Pallangga District at the village/urban village level	Ina-Geoportal
Built-up land density	Sentinel-2 L2A imagery in 2024 (Copernicus)
River networks	Ina-Geoportal
Relative elevation	DEMNAS
Slope	DEMNAS
Regional Spatial Plan (RTRW) of Gowa Regency	Ministry of Agrarian Affairs and Spatial Planning/National Land Agency of South Sulawesi

2.2. Flood Susceptibility Analysis

Flood susceptibility in the Pallangga District was analyzed using four spatial parameters: built-up land density, distance from the river, relative elevation, and slope. These parameters represent land use pressure, proximity to river overflow sources, and local topographic conditions. Built-up land density was derived from built-up land cover extracted from 2024 Sentinel-2 L2A imagery using the spectral index rule-based classification (SIRBC) approach, which produced an overall accuracy of 88.6%.

Built-up land density was calculated by comparing the built-up land area with the total administrative area of each village or urban village. Distance from the river was generated using a buffer analysis of the river network. Relative elevation was derived from the DEMNAS by calculating the elevation difference between land surfaces and the reference elevation of the Jeneberang River. Slope was also derived from the DEMNAS and classified according to slope categories relevant to flood susceptibility.

Each parameter was classified and assigned a score based on its influence on flood susceptibility. The scoring system used values of 1, 2, and 3, where higher scores indicated a greater contribution to flood susceptibility. Parameter weights were determined through expert judgment involving five experts from disaster management agencies, regional planning institutions, and academia. The weighted overlay method was then used to calculate the flood susceptibility index using Equation (1).

$$S = \sum_{i=1}^{n} (s_i \times w_i) \quad (1)$$

where S is the final score or flood susceptibility index, s_i is the score of the ith parameter, w_i is the weight of the ith parameter, and n is the number of parameters.

The resulting index was classified into three flood susceptibility classes (low, moderate, and high) using the Natural Breaks (Jenks) method in QGIS. This classification method groups similar values into the same class while maximizing differences among classes. To improve map readability and adjust the output to the RTRW scale of 1:50000, the flood susceptibility map was generalized using the minimum mapping unit (MMU) approach with a threshold of 22500 m^2 or 2.25 ha.

2.3. Parameters

The first parameter was built-up land density, which represents the proportion of built-up land within each administrative unit. A higher built-up land density was assigned a higher score because built-up surfaces reduce infiltration capacity and increase surface runoff. The second parameter was distance from the river, which was classified into river, 25 m, 50 m, and >50 m zones. Areas closer to the river were considered more susceptible to flooding because of their higher exposure to potential river overflows.

The third parameter was relative elevation. Areas with relative elevation values ≤0 m were considered more susceptible because they are located at the same level as, or lower than, the reference elevation of the Jeneberang River. Areas with relative elevation values >0 m were considered less susceptible. The fourth parameter was slope, classified into 0–3%, 3–8%, and 8–15%. Flatter areas were assigned higher scores because low slopes reduce runoff velocity and increase the possibility of water accumulation.

The scores, weights, and weighted scores for each flood susceptibility parameter are listed in Table 2.

Table 2. Weighting of flood susceptibility parameters

No	Parameter	Class	Score	Weight	Weighted Score
1	Built-up land density	22.1%–44.7%	3	2.2	6.6
		7%–22.1%	2	2.2	4.4
		2.8%–7%	1	2.2	2.2
2	Distance from the river	River	3	2.2	6.6
		25 m	3	2.2	6.6
		50 m	2	2.2	4.4
		>50 m	1	2.2	2.2
3	Relative elevation	≤0 m	2	4.0	8.0
		>0 m	1	4.0	4.0
4	Slope	0%–3%	3	1.6	4.8
		3%–8%	2	1.6	3.2
		8%–15%	1	1.6	1.6

2.4. Comparison of Flood Susceptibility with the RTRW

A comparison between flood susceptibility and the RTRW was conducted by overlaying the flood susceptibility map with residential zoning data from the RTRW of Gowa Regency. The analysis focused only on residential areas because these zones are designated for settlement and related commercial development, making them directly associated with potential community exposure to flooding.

Overlay results were used to calculate the area and percentage of residential zones located within low, moderate, and high flood susceptibility classes. This analysis provides information on the spatial compatibility between planned residential development and flood susceptibility conditions in the Pallangga District. The resulting map is presented in Figure 7 in the Results and Discussion section.

2.5. Statistical Analysis

The analysis used descriptive spatial statistics. Area calculations were conducted for each parameter class, flood susceptibility class, and residential zoning category based on flood susceptibility level. The results were expressed in hectares and percentages to describe the spatial distribution of flood susceptibility and its relationship with residential zoning in the RTRW.

This study was designed as a simplified GIS-based preliminary assessment. Therefore, rainfall intensity, drainage density, soil characteristics, hydraulic modeling, formal validation, and sensitivity analysis were not included in the analysis. The results should consequently be interpreted as an initial spatial assessment to support land-use planning and flood mitigation considerations in the Pallangga District.

3. RESULTS AND DISCUSSION

3.1. Flood Susceptibility Parameters

The built-up land density in the Pallangga District ranged from 2.8% to 44.7%, indicating substantial variations in the intensity of land development among villages and urban villages. Based on the Natural Breaks classification, built-up land density was divided into three classes: 2.8%–7%, 7%–22.1%, and 22.1%–44.7% (Table 3). The low-density class (2.8%–7%) occupied the largest proportion of the study area, covering 3662.3 ha, or 65.4% of the total area. The moderate- and high-density classes covered 16.6% and 18.0% of the study area, respectively.

Table 3. Built-up land density

Class	Area (ha)	Area (%)
2.8%–7%	3662.3	65.4
7%–22.1%	926.6	16.6
22.1%–44.7%	1010.1	18.0
Total	5599.0	100.0

The spatial distribution shown in Figure 2 indicates that low built-up density dominates most parts of the Pallangga District, whereas areas with moderate to high built-up density are concentrated in locations experiencing more intensive urban development. This pattern suggests that although non built-up land remains dominant, urban expansion has begun to create localized concentrations of impervious surfaces that may influence hydrological processes and runoff generation.

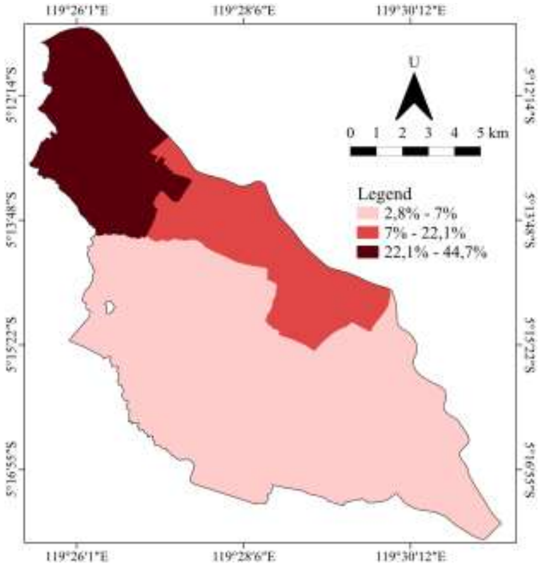

Figure 2. Map of the built-up land density.

The observed distribution of built-up land density reflects the ongoing urbanization process in the Pallangga District as a peri-urban area influenced by the growth of Makassar City and the administrative center of Gowa Regency. Similar findings have been reported by Feng et al. (2021), who demonstrated that increasing urbanization significantly alters hydrological responses through the expansion of impervious surfaces. Shrestha et al. (2021) and Sugianto et al. (2022) reported that land-use conversion from vegetated or agricultural areas to built-up land reduces infiltration capacity and increases surface runoff.

Compared with studies that utilize detailed land-use classifications, the use of built-up land density in this study provides a simplified yet effective representation of urban development intensity. This approach offers practical advantages in data-limited environments because it requires fewer input variables while still capturing the influence of land-use change on flood susceptibility.

The dominance of low-density areas suggests that substantial portions of the Pallangga District retain opportunities to maintain infiltration functions. However, the existence of concentrated high-density areas indicates locations where future urban expansion may increase flood susceptibility if not accompanied by adequate drainage and stormwater management. From a planning perspective, monitoring built-up land density is important because it directly affects runoff generation and may exacerbate flooding when combined with unfavorable topographic conditions.

The distance from the river was analyzed using river buffers classified into river, 25 m, 50 m, and >50 m zones. The results indicate that the majority of the study area is located more than 50 m from the river, covering 4873.3 ha or 87.0% of the total area (Table 4). Areas located within 25 m and 50 m of the river account for only 5.2% and 4.9%, respectively, whereas the river channel itself occupies 2.9% of the study area.

Table 4. Distance from the river

Class	Area (ha)	Area (%)
River	161.4	2.9
25 m	288.4	5.2
50 m	275.9	4.9
>50 m	4873.3	87.0
Total	5599.0	100.0

The spatial distribution illustrated in Figure 3 shows that areas close to the river are concentrated along the main river corridors, whereas most districts are relatively distant from river channels. This pattern indicates that direct exposure to river overflow is spatially limited but potentially significant in areas immediately adjacent to river networks.

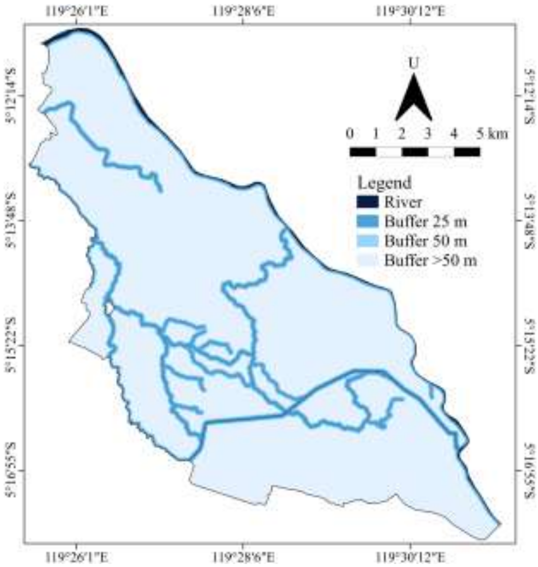

Figure 3. Map of the distance from the river.

The distance from the river is widely recognized as an important variable in flood susceptibility analysis because areas closer to river channels are more likely to be affected by overflow during high-discharge events. Flood-prone areas are generally concentrated near river systems (Rifandi et al., 2024). The findings of this study support this concept by identifying limited but strategically important areas located close to rivers. Unlike studies that use complex hydrological parameters, such as drainage density and river discharge, this study applies a simple proximity-based approach. Although simplified, this method effectively identifies locations with potentially higher exposure to river overflows and can be implemented using readily available spatial data.

The predominance of areas located more than 50 m from rivers suggests that river proximity alone cannot fully explain flood susceptibility in the Pallangga District. This finding highlights the importance of considering other control factors, such as built-up land density and topographic characteristics. Therefore, flood susceptibility in the study area is likely to result from the interaction of multiple spatial variables rather than river proximity alone, reinforcing the importance of an integrated assessment approach.

Relative elevation was classified into two categories: ≤0 m and >0 m, relative to the reference elevation of the Jeneberang River. The analysis revealed that 4305.5 ha (76.9 %) of the study area fell within the ≤0 m class, whereas only 23.1% was located above the reference elevation (Table 5).

Table 5. Relative elevation

Class	Ar9%ha)	Area (%)
≤0 m	4305.5	76.9
>0 m	1293.5	23.1
Total	5599.0	100.0

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As shown in Figure 4, areas with a relative elevation of ≤0 m dominate most parts of the Pallangga District. This indicates that a substantial proportion of the district is situated at an elevation equal to or lower than the reference river elevation, thereby increasing the potential for inundation during river-overflow events.

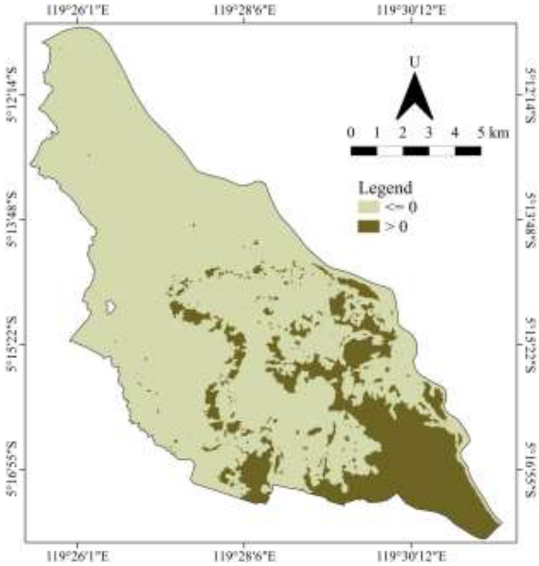

Figure 4. Map of the relative elevation.

Most flood susceptibility studies rely on absolute elevation to represent topographic influences (Chen et al., 2013; Tentua et al., 2018; Rakuasa et al., 2022; Irawan et al., 2024). However, in relatively flat downstream environments, absolute elevation may not adequately reflect the local topographic relationship between land surfaces and river systems. The use of relative elevation in this study provides an alternative perspective by emphasizing local elevation differences relative to the river reference elevation. This approach offers a practical advantage for low-gradient landscapes, where subtle elevation differences can significantly influence flood behavior. Consequently, relative elevation may better represent potential inundation pathways and water accumulation processes than absolute elevation alone in downstream watershed environments.

The dominance of the ≤0 m class suggests that topographic position relative to the river is a critical factor controlling flood susceptibility in the Pallangga District. This finding complements previous results on built-up land density and river proximity by demonstrating that topographic constraints create conditions favorable for water accumulation. The importance of relative elevation is further reflected in its highest parameter weight, indicating its substantial contribution to the flood susceptibility index. In addition, slope analysis shows that the Pallangga District is predominantly characterized by flat terrain, with the 0%–3% slope class occupying 4099.0 ha or 73.2% of the study area, while the 3%–8% and 8%–15% classes account for 22.3% and 4.5%, respectively (Table 6).

Table 6. Slope

Class	Area (ha)	Area (%)
0%–3%	4099.0	73.2
3%–8%	1248.7	22.3
8%–15%	251.3	4.5
Total	5599.0	100.0

The distribution pattern shown in Figure 5 confirms the predominance of flat slopes throughout the district. Such topographic conditions generally promote slower runoff movement and increase the potential for water ponding during rainfall events.

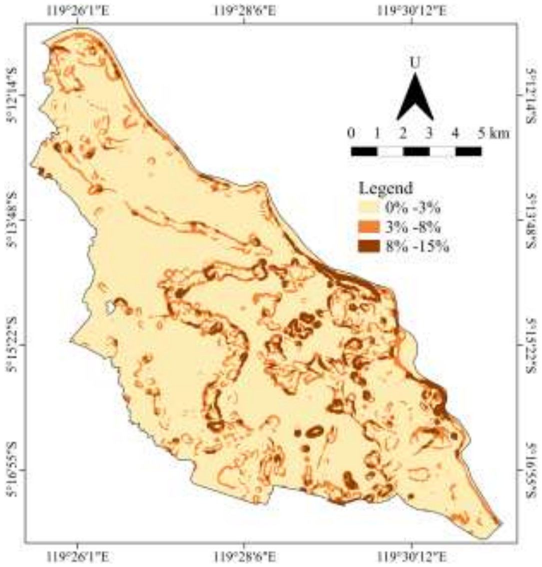

Figure 5. Map of the slope.

Flat terrain is closely associated with higher flood susceptibility because gentle slopes reduce runoff velocity and promote water accumulation. This condition is consistent with previous studies on flood-prone areas (Tentua et al., 2018; Ma'rufah et al., 2024). Most of the Pallangga District is dominated by the flattest slope category. Although slope received the lowest parameter weight, its broad distribution strengthens the influence of low relative elevation and built-up land density, thereby contributing to runoff accumulation, prolonged inundation, and the overall spatial pattern of flood susceptibility in the study area.

3.2. Flood Susceptibility

The weighting results indicated that relative elevation received the highest weight (4.0), followed by built-up land density and distance from the river (2.2 each), whereas slope received the lowest weight (1.6) (Table 2). Consequently, relative elevation was the most significant contributor to the flood susceptibility index.

Based on the weighted overlay analysis, flood susceptibility in the Pallangga District was classified into low, moderate, and high classes (Table 7). Moderate flood susceptibility dominated the study area, covering 2965.0 ha, or 53.0% of the total area. Low susceptibility covered 25.7%, while high susceptibility occupied 21.3%.

Table 7. Flood susceptibility

Class	Area (ha)	Area (%)
Low	1442.5	25.7
Moderate	2965.0	53.0
High	1191.5	21.3
Total	5599.0	100.0

Spatially, Figure 6 shows that areas with high flood susceptibility are concentrated mainly in the northern part of the district, particularly in Taeng, Bontoala, Jene'tallasa Villages, and Mangalli Urban village. In contrast, moderate susceptibility dominates the central region, while low susceptibility is more prevalent in the southern area.

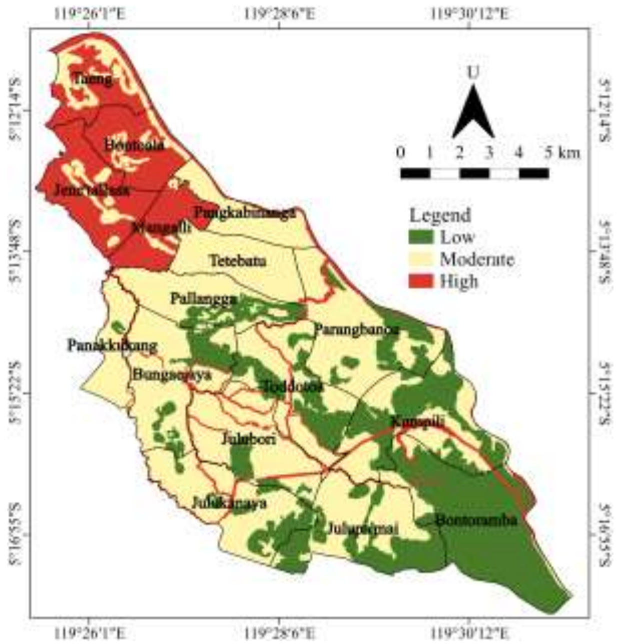

Figure 6. Map of the flood susceptibility.

The spatial pattern identified in this study is generally consistent with flood susceptibility assessments reported in previous studies, wherein low-lying areas with flat slopes and increasing urban development tend to exhibit higher susceptibility (Tentua et al., 2018; Irawan et al., 2024). The concentration of high susceptibility in the northern part of the district is likely associated with the combined effects of high built-up land density, proximity to river systems, low relative elevation, and flat terrain.

Furthermore, a comparison with historical flood occurrence data (Table 9) indicates that several areas classified as highly susceptible, including the Taeng and Bontoala Villages and the Mangalli Urban village, experienced flood events in recent years. Although formal validation was not conducted, this correspondence provides preliminary support for the reliability of the susceptibility map.

The flood susceptibility pattern generally supports the hypothesis that areas characterized by high built-up land density, short distance from rivers, low relative elevation, and gentle slopes tend to exhibit greater flood susceptibility. The findings also demonstrate the importance of relative elevation in representing flood-related topographic conditions in downstream watershed environments. From a practical perspective, the resulting map provides a useful basis for identifying priority areas for flood mitigation, land-use control, and future development planning. Moreover, the consistency between susceptibility patterns and historical flood occurrences suggests that the simplified parameter approach can serve as an effective preliminary assessment tool in areas with limited data availability.

Table 8. Flooding incidents in Pallangga District in recent years

Year	Village/urban village	Type of Disaster
2019	Pangkabinanga	Flash Flood
	Tetebatu	
	Mangalli	
	Panakkukang	
	Kampili	
	Taeng	
2020	Panakkukang	Flood
2021	Panakkukang	Flood
2024	Mangalli	Flood

Source: Gowa Regency Regional Disaster Management Agency, 2024

3.3. Comparison of Flood Susceptibility with the Regional Spatial Plan

Overlay analysis between flood susceptibility and residential zoning in the RTRW revealed that 736.3 ha or 38.5% of residential areas were located within the high flood susceptibility zone (Table 9). Residential areas within the moderate- and low-susceptibility zones accounted for 32.2% and 29.3% of the total, respectively.

Table 9. Area of residential areas in the RTRW according to flood susceptibility

Residential Areas According to Susceptibility	Area (ha)	Area (%)
Residential Areas - Low Flood Susceptibility	560.4	29.3
Residential Areas - Moderate Flood Susceptibility	617.6	32.2
Residential Areas - High Flood Susceptibility	736.3	38.5
Total	1914.3	100.0

As shown in Figure 7, residential areas with high flood susceptibility are concentrated primarily in the northern part of the Pallangga District, whereas residential areas with lower susceptibility are generally distributed across the central and southern regions.

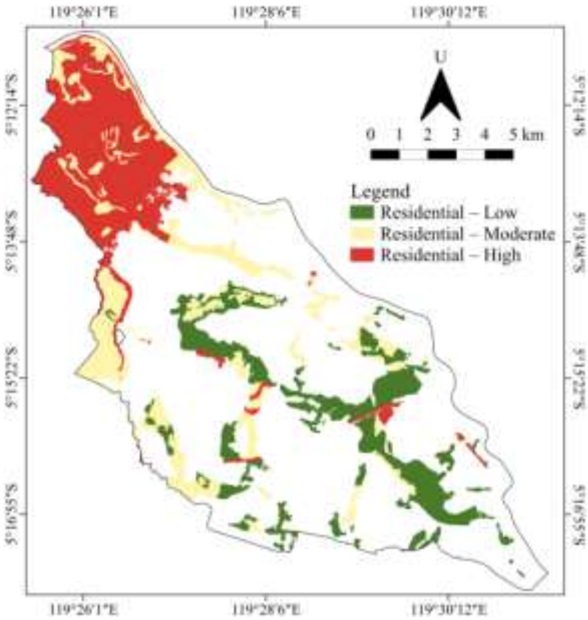

Figure 7. Map of the residential areas in the RTRW according to flood susceptibility.

The concentration of residential zoning in highly susceptible areas indicates a potential mismatch between planned land use and environmental constraints. Similar concerns have been highlighted in the spatial planning literature, noting that development in hazard-prone areas increases future exposure and vulnerability. The findings suggest that flood susceptibility information should be incorporated more explicitly into land-use planning and zoning evaluations.

The integration of flood susceptibility analysis with the RTRW demonstrates the practical value of spatial hazard assessment for planning purposes. The large proportion of residential zoning located within highly susceptible areas highlights the need for stronger land-use controls, flood mitigation measures, and risk-informed planning strategies. These findings are consistent with the flood susceptibility patterns discussed previously, in which high susceptibility areas are associated with low relative elevation, flat slopes, river proximity, and increasing built-up land density. Therefore, incorporating flood susceptibility considerations into future spatial planning revisions can help reduce flood exposure and improve the long-term sustainability of urban development in the Pallangga District.

4. CONCLUSIONS

This study demonstrates that flood susceptibility in the Pallangga District is mainly distributed in the moderate class, covering 53.0% of the total area, followed by the low class at 25.7% and the high class at 21.3%. High flood susceptibility is concentrated in the northern part of the district, particularly in areas characterized by low relative elevation, flat slopes, proximity to river networks, and higher built-up land density. Among the parameters used, relative elevation showed the strongest contribution to the susceptibility index, indicating its relevance for representing local topographic conditions in flat downstream watershed areas.

A comparison with residential zoning in the RTRW shows that 38.5% of planned residential areas are located within high flood susceptibility zones. This finding indicates a potential mismatch between spatial planning allocations and flood susceptibility conditions. Therefore, flood susceptibility information should be considered in land-use control, residential development planning, and mitigation-oriented spatial policies. Although this study uses a simplified GIS-based approach and does not include rainfall, drainage density, soil type, hydraulic modeling, formal validation, or sensitivity analysis, the results provide a practical preliminary framework for identifying flood-prone areas and supporting spatial planning decisions in the Pallangga District.

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