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Flood Risk Assessment of Residential Areas for Disaster Mitigation: A Geospatial-based Approach in Gorontalo Regency, Gorontalo Province

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ABSTRACT

Rapid population growth in Gorontalo Regency, Gorontalo Province, has increased demand for residential land, despite the region's high vulnerability to flooding driven by intense rainfall and land use change. This study aims to map the spatial distribution of flood risk and propose mitigation strategies for flood-prone residential areas. Spatial analysis using scoring and overlay techniques was applied to parameters including rainfall, soil texture, slope, elevation, and land use. Results indicate that 39.22% of the area (84,654.70 ha) has low vulnerability, 51.52% (111,218.94 ha) moderate, and 9.26% (19,998.45 ha) high. High-risk zones are concentrated in low-lying districts such as Limboto, West Limboto, Telaga, Telaga Biru, and Dungaliyo, particularly within the Limboto and Paguyaman watersheds. Recommended mitigation measures include reforestation, limiting land conversion, enforcing risk-based spatial planning, developing flood-control infrastructure, and strengthening community awareness. These findings support sustainable, disaster-aware spatial planning and improved flood risk management.

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1. INTRODUCTION

Demographic changes and land use dynamics have become major challenges in regional planning, especially in areas prone to natural disasters such as flooding. Gorontalo Regency, located in Gorontalo Province, is one of the regions experiencing rapid population growth. According to data from the Central Statistics Agency (BPS, 2024), the population of Gorontalo Regency exceeds 418,000 people, with the highest population density in administrative centers such as Limboto and Telaga districts. This growth demands an increase in the need for residential land, but unfortunately, many of the developed areas are in flood-prone zones. This situation is exacerbated by high annual rainfall and changes in land use patterns, which have reduced the environment's capacity to absorb runoff water.

This phenomenon is not unique to Gorontalo Regency. According to (Becker et al., 2021), changes in land use in coastal and lowland areas globally contribute significantly to increased flood risk, particularly due to the loss of vegetation cover and increased impervious surfaces (Becker et al., 2021). In the local context, research by (Djiko et al., 2022) shows that the Paguyaman River Basin (DAS) in Gorontalo Regency has experienced significant forest cover degradation due to illegal logging and mining activities, leading to increased peak flow and surface runoff (Djiko et al., 2022). This directly impacts the high frequency of floods in downstream areas, including residential areas. Data from Wahana Lingkungan Hidup Indonesia (2024) also indicates that Gorontalo is currently in a state of ecological emergency, partly due to the destruction of water catchment areas and the conversion of forests into agricultural land. Historical data show that flooding has had a significant impact on the community. The October 2021 flood submerged 179 houses and affected around 5,600 people in the sub-districts of Telaga Biru, Limboto, and Limboto Barat (Ibrahim, 2021). A similar incident occurred again in 2024 in Dungaliyo District, with 237 houses submerged to a depth of 30 – 90 cm, affecting more than 1,100 people (Becker et al., 2021; Irajifar et al., 2016; Sahu et al., 2021). This reality underscores the need for residential land management that not only meets housing needs but also considers environmental safety aspects based on existing disaster risks.

One strategic approach to addressing this challenge is the evaluation of residential land suitability based on geospatial data (Becker et al., 2021; Irajifar et al., 2016; Sahu et al., 2021). This approach enables comprehensive analysis that considers various physical, social, and environmental factors to determine the suitability of land use. Geospatial data, which includes information on topography, hydrology, soil types, and land use patterns, can provide an accurate spatial representation of the characteristics of the area to be evaluated (Saaty, 2008; Agrawal, 2025). Additionally, geospatial technology supports data-driven decision-making processes, particularly in formulating more effective and targeted flood disaster mitigation strategies. From a spatial planning perspective, a disaster risk-based approach is becoming mainstream in Indonesia. (Litasari et al., 2022; Rumambi, 2023) state that the allocation of residential land use should explicitly integrate disaster risk (Litasari et al., 2022). This is in line with the direction of Presidential Regulation of the Republic of Indonesia Number 60 of 2021 concerning the Rescue of National Priority Lakes, in which Lake Limboto, as part of the main hydrological system in Gorontalo, is designated as a national priority area that must be restored due to its vital function in regulating water management in the region.

Geospatial technologies such as Geographic Information Systems (GIS) have proven effective in assessing land suitability for various uses, particularly residential areas (Samad and Morshed, 2016). Through spatial analysis, this technology enables the identification of disaster-prone zones and provides scientific information that can strengthen the policy-

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making process in regional planning. For example, research conducted by (Wirawan et al., 2021) shows that post-disaster land cover assessment can serve as a guide in designing regional development that aligns with existing spatial risk patterns (Wirawan et al., 2021). Recent studies have integrated geomorphological approaches with geospatial technology to assess flood risks. Studies by (Dahlia et al., 2018; 2020) demonstrate the use of SRTM DEM and Landsat imagery in mapping flood vulnerability in Jakarta. Parameters such as elevation, slope gradient, and landform are used to assess spatial vulnerability. The research findings indicate that the majority of northern Jakarta falls into the high-risk category (Dahlia et al., 2018; Dahlia and Fadiarman, 2020).

Research by (Setiawan et al., 2020) in Samarinda focused on a holistic analysis of the causes of flooding, covering natural factors (high rainfall, topography, and Mahakam tides) and human factors (population growth, land use change, drainage, and waste management). They identified three types of flooding: runoff, local, and caused by the Mahakam River tide (Setiawan et al., 2020). Similar studies have been conducted in various regions using a geospatial approach, including Banda Aceh (Rusdi et al., 2015), Ambon Bay Baguala (Rakuasa et al., 2022), and Cianjur Regency (Tanjung et al., 2022). The approaches used generally involve weighting and scoring methods to produce flood vulnerability maps useful for mitigation planning. For example, (Rusdi et al., 2015) used soil permeability, topography, and geological parameters to generate land suitability maps in accordance with FAO standards. Meanwhile, research in Cianjur emphasizes the importance of integrating spatial planning and disaster risk data to identify suitable land for residential development (Tanjung et al., 2022).

However, research gaps remain in many studies on flood mitigation, particularly in the integration of geospatial information with spatial and social dimensions. Most previous studies, such as those by (Rakuasa et al.,2022), have focused only on mapping flood vulnerability using one or two physical parameters, such as rainfall or slope gradient. However, recent studies such as those conducted by (Kuswardhana et al., 2023) suggest the importance of a multi-criteria approach that combines various parameters such as soil texture, elevation, and land use type to obtain a more comprehensive risk picture (Kuswardhana et al., 2023). Research by (Dahlia et al., 2018) also highlights the importance of exposure maps developed by overlaying vulnerability and land use maps. The results show that settlements are the most at-risk due to their large area and vulnerable locations.

This study aims to fill this gap by developing a spatial approach based on scoring and overlay using five main parameters, namely rainfall, soil texture, slope, elevation, and land use, in mapping flood risk in Gorontalo Regency. This study produced a flood vulnerability map as a basis for adaptive spatial planning and an exposure map of existing residential areas. The results of this study provide concrete recommendations to local governments and the wider community on safe, sustainable, and disaster risk reduction-based residential land management.

2. METHODS

2.1 Location

This research was conducted in Gorontalo Regency, Gorontalo Province. Geographically, the research location is bordered by North Gorontalo Regency to the North, Bone Bolango Regency and Gorontalo City to the East, Boalemo Regency to the West, and Tomini Gulf to the South. The astronomical location of the research is located at 0 ° 30'- 0 ° 54' LU and 122 ° 07' - 123 ° 44' East **(Figure 1)**. Gorontalo Regency has an area of 2,143.48 km2, consisting of 19 Districts, 14 urban villages, and 191 villages.

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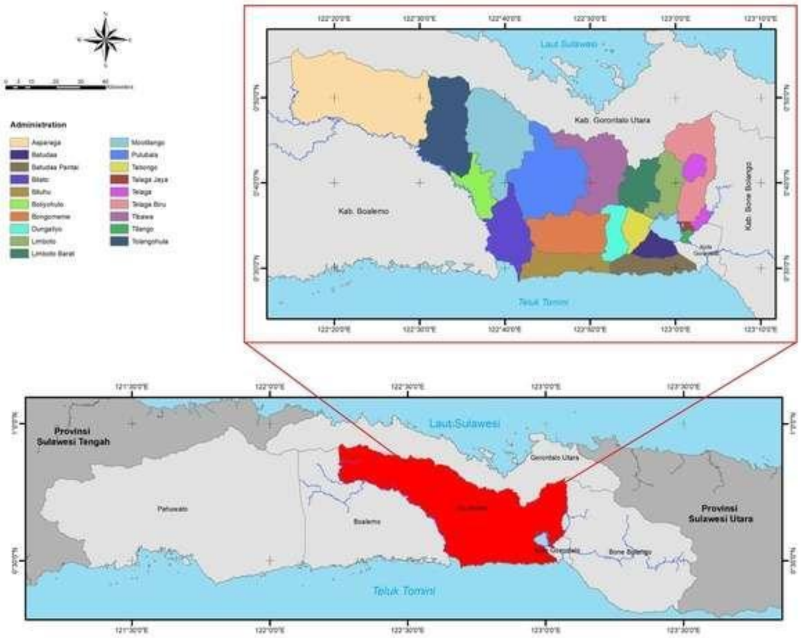

Figure 1. Research location map

2.2 Research Variables

The research variables were the various factors that influence flood vulnerability. Based on this, the variables used in this study were rainfall, soil type, slope, elevation, and land use.

2.3 Data Types and Sources

The data used in this study consisted of secondary and primary data. Secondary data was obtained through a review of literature and documents from relevant institutions. Details of the secondary data used in this study are presented in Table 1. Primary data were derived from expert judgment in the form of parameter scores and weights. These data were subsequently analyzed using the Borda Count method to determine the relative importance ranking of each parameter.

Table 1. Types of Secondary Data and their sources

No.	Data Type		Data Source
1	Gorontalo Regency Settlement Map	Identifying the distribution and boundaries of residential areas as flood risk analysis areas.	PUPR Gorontalo District
2	District Administration Map	Delimitation of administrative boundaries as a basis for mapping and spatial analysis.	PUPR Gorontalo District
3	Rainfall	Using rainfall intensity and distribution as key parameters in flood potential analysis.	BMKG - Gorontalo Province
4	DEM (*Digital Elevation Model*) image	Analyzing the altitude and slope that affect flood vulnerability.	Geospatial Information Agency (BIG) https://tanahair.indonesia.go.id/
5	Map of soil type	Identifying soil characteristics that affect infiltration and surface	PUPR Gorontalo District

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No.	Data Type		Data Source
		runoff.	
6	Land use map	Identify types of land use that affect flood vulnerability levels.	Ministry of Environment and Forestry of the Republic of Indonesia.

Source: Research

2.4 Data Analysis Technique

The data analysis used spatial analysis with scoring and overlay techniques (Erfani et al., 2023; Kusumo and Nursari, 2016; Muzaki et al., 2022). This approach enables the integration of multi-source data, including remote sensing data and field survey results. The product of this analysis is a comprehensive flood vulnerability map that supports decision-making for various stakeholders. The parameters considered in this study included land use, rainfall, slope, soil texture, and elevation. Each parameter represents key environmental characteristics influencing flood susceptibility. Before flood vulnerability assessment, elevation and slope analyses were conducted using Digital Elevation Model (DEM) data (Dahlia et al., 2018; Dahlia and Fadiarman, 2020). Slope derivation and reclassification analyses were performed to generate the relevant variables required in this study. Afterwards, each parameter was classified into several categories representing the characteristics of the study area. A scoring system was applied to represent the relative influence of each parameter class on flood occurrence. Scores ranged from 1 to 5, with 1 indicating the lowest influence and 5 indicating the highest influence. For instance, the slope parameter was divided into five classes. Slopes ranging from 0 – 8% were classified as flat areas and assigned the highest score (5) due to their low runoff capacity and high potential for water accumulation. Slopes exceeding 40% were classified as very steep areas and assigned the lowest score (1) because of their high runoff capacity, which reduces flood susceptibility. The overall research framework is presented in **Figure 2**.

The weights on each parameter were determined using an expert judgment approach (Kusumo and Nursari, 2016). A total of nine experts participated as respondents and were selected using purposive sampling based on their academic expertise and relevance to the research domain. The experts represented multidisciplinary scientific backgrounds, including environmental science, hydrology, regional and urban planning, and geography, ensure a comprehensive and balanced evaluation. The experts participated in a structured assessment procedure in which they independently ranked each parameter according to its relative importance in influencing flood vulnerability. The ranking results from all experts were aggregated using the Borda Count method, a rank-based multi-criteria decision-making technique that integrates multiple expert preferences across defined criteria (Mukadi, 2023; Zou and Qiu, 2017). This method enhances the reliability and objectivity of the weighting process by consolidating diverse expert perspectives into a single composite ranking. The final parameter weights were obtained by normalizing score: dividing each parameter's total score by the cumulative score of all parameters to generate relative weights. The normalization results indicated that land use had the highest weight (30%), followed by rainfall (25%), slope (20%), soil texture (15%), and elevation (10%). Higher weights indicate parameters with greater

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influence on flood vulnerability, whereas lower weights represent relatively smaller contributions. These weighting results were subsequently integrated into the spatial overlay analysis to produce the flood vulnerability assessment. The criteria, scoring scheme, and parameter weights used in this study are presented in **Tables 2-6**.

Table 2. Land Use Criteria, Scores, and Weights

No.	Land Use Type	Score	Weight
1.	Forest	1	
2	Plantation	2	
3.	Shrubs, bushes, reeds	3	30
4.	Dry land farming, Farmland/Fields, Settlement	4	
5	Rice fields, swamps, open land	5	

Source: Analysis Result

Table 3. Rainfall Criteria, Scores and Weights

No.	Rainfall (mm/year)	Score	Weight
1.	<1500	1	
2.	1501 - 2000	2	
3.	2001 - 2500	3	25
4.	2501 - 3000	4	
5.	>3000	5	

Source: Analysis Result

Table 4. Slope Criteria, Scores, and Weights

No.	Slope (%)	Score	Weight
1.	0 – 8	1	
2.	8 – 15	2	
3.	15 – 25	3	20
4.	25 – 40	4	
5.	>40	5	

Source: Analysis Result

Table 5. Soil texture criteria, scores and weights

No.	Soil Type	Score	Weight
1.	Alluvial, Glei, Planosol, Gray Hydromorph, Laterite Groundwater	1	
2.	Latosol	2	
3.	Brown Forest Soil, Non-Calcic, Brown Mediterranean	3	15
4	Andosol, Laterite, Grumosol, Podsol, Podzolic	4	
5	Regosol, Lithosol, Organosol, Renzina	5	

Source: Analysis Result

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Table 6. Score and Weight Criteria of the Altitude of the place

No.	Height of Place	Score	Weight
1	0 – 20 meters above sea level	1	
2	21 - 50 meters above sea level	2	
3	51 - 100 meters above sea level	3	10
4	101 - 300 meters above sea level	4	
5	>300 meters above sea level	5	

Source: Analysis Result

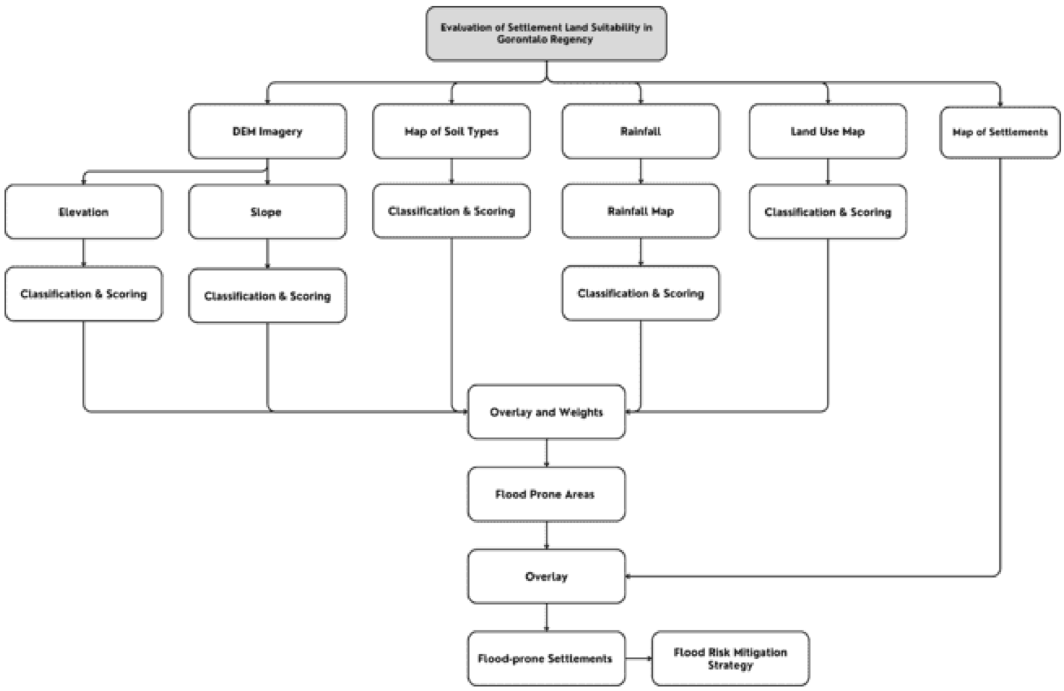

Figure 2. Research framework

3. RESULTS AND DISCUSSION

3.1 Overview of the Research Location

Gorontalo Regency, located in Gorontalo Province, has an area of approximately 2,189.08 km². The region consists of 19 districts with 205 villages and sub-villages. Gorontalo Regency has a tropical climate with two main seasons: rainy season and dry season. The topography varies from lowlands to hills. Based on 2020 census data, the population of Gorontalo Regency reached 393,107 people, which is estimated to increase to 418,244 people in 2023 (BPS, 2024). Population density tends to be concentrated in urban areas such as Limboto and Telaga, with an average population density of around 191 people/km². The majority of the population is Muslim, with cultural diversity influenced by Gorontalo customs. Gorontalo Regency's leading sectors include agriculture, fisheries, and livestock. The main commodities are corn, rice, coconut, and cocoa. Small to medium industries also contribute to the economy, such as the processing of agricultural products and local handicrafts. The gross regional domestic product (GRDP) of Gorontalo Regency shows a steady increase, especially from the primary sector. Gorontalo Regency has various educational facilities ranging from primary to tertiary levels. In the health sector, there are several health centers and hospitals that serve the health needs of the community.

Settlements in Gorontalo Regency are divided into urban and rural areas. Urban settlements located in Limboto and Telaga Districts have denser settlement characteristics, with infrastructure such as paved roads, clean water facilities, and almost 100% access to electricity. This area is growing rapidly as it is the center of government and economy. Most rural settlements still use scattered settlement patterns. Traditional Gorontalo houses can be found in this region with typical wooden architecture. Inadequate road access and sanitation infrastructure in some remote villages are challenges that need to be improved. Based on BPS data, around 85% of households in Gorontalo Regency have access to clean water, and 75% of households have proper sanitation facilities (BPS, 2024).

3.2 Spatial Distribution of Flood Disaster Risk

The results of the analysis of flood-prone areas in Gorontalo Regency showed three classes of flood vulnerability, namely low, moderate, and high levels of vulnerability **(Table 7)**. This vulnerability level is the result of data analysis and overlay of 5 (five) parameters that affect flood vulnerability **(Figure 3)**. The spatial distribution of flood vulnerability levels in Gorontalo Regency was obtained **(Figure 4)** from the results of the analysis using the scoring and overlay method. The area of flood-prone areas with a low vulnerability level is 84,654.70 hectares, areas with a moderate vulnerability level are 111,218.94 hectares, and areas with a high vulnerability level are 19,998.45 hectares **(Table 7)**. In percentage terms, more than 51% (percent) of Gorontalo Regency is dominated by areas with moderate flood vulnerability. Meanwhile, areas with high level of vulnerability are less than 10% (percent) of the total area of Gorontalo Regency. Based on the location of the distribution of flood vulnerability levels in Gorontalo Regency, low flood vulnerability levels are located in areas with altitudes above an average of 100 meters to > 300 meters above sea level, with slopes above 15% to > 40%. The type of land use in this area is mostly forests and plantations. Areas with a moderate level of vulnerability are scattered in the central part of Gorontalo Regency, which is an area with an altitude ranging from 50 meters to 300 meters above sea level, with a slope ranging from 8%-25%. The type of land use in this area is dominated by plantations, agriculture, fields, and forests. The high vulnerability area is spread in an area with an altitude of 0-20 meters above sea level with a slope of 0-8%. For land use, this area is dominated by rice fields, both technical irrigation and rainfed rice fields, and the rest are swamps.

Table. 7 Area of flood-prone areas

No.	Criteria	Area (Ha)	Percentage (%)
1	Low Level	84.654,70	39,22
2	Moderate Level	111.218,94	51,52
3	High Level	19.998,45	9,26
	Total Area	**215.872,09**	**100**

Source: Analysis Result

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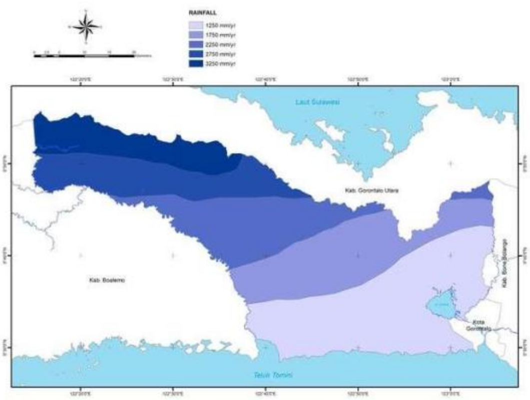

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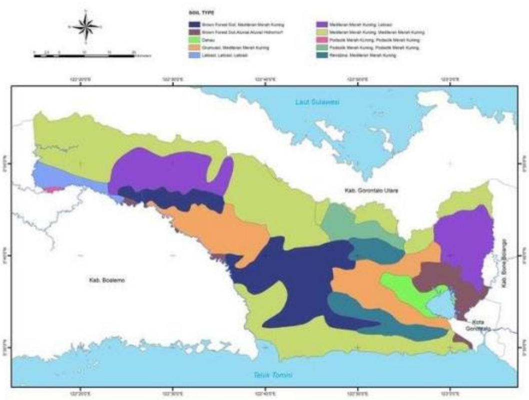

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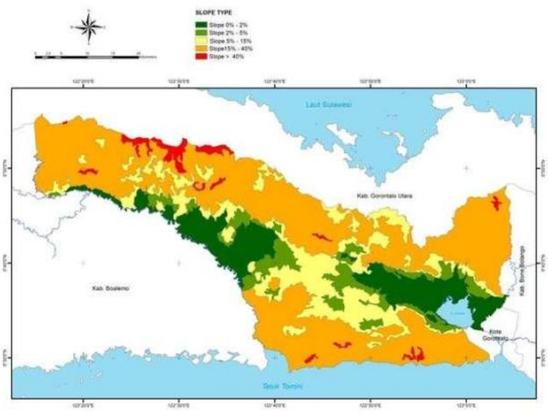

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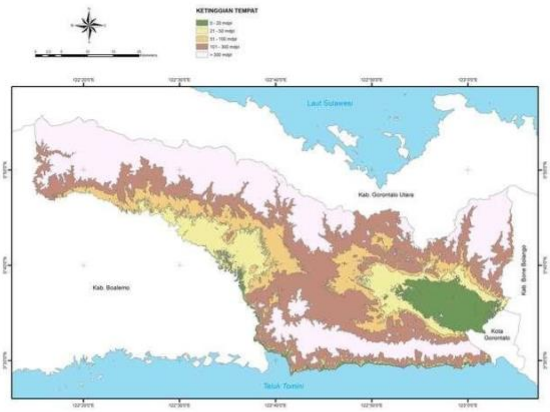

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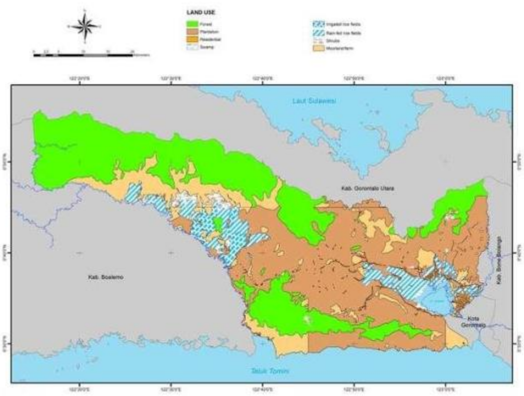

(e)

Figure 3. Spatial distribution of each parameters affecting flood vulnerability. Note: (a) rainfall, (b) soil type, (c) slope, (d) elevation, and (e) land use.

From a spatial point of view, areas with a high level of vulnerability are divided into two flood areas. The first is the Limboto Flood Area, which is the catchment area of the Limboto watershed with Limboto Lake as its estuary. The Limboto watershed is a part of the Limboto River Basin (Kepmen PU, 2010). Administratively, areas with high vulnerability are located in Tibawa District, West Limboto District, Dungaliyo District, Tabongo District, Limboto District, Telaga District, Batudaa District, Telaga District, Telaga Jaya District, Telaga Biru District, and Tilango District. The analysis results revealed that the Limboto watershed has a radial shape with a centripetal radial river flow pattern flowing towards Lake Limboto as an estuary. Under these conditions, lowland areas with a slope of 0 - 8% become the place for rainwater to

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accumulate, making it very vulnerable to the risk of flooding before entering the river to flow into Lake Limboto. Based on the Decree of the Minister of Forestry (2009), the Limboto watershed is categorized as a critical watershed and is prioritized for treatment. The Limboto watershed area is currently experiencing disruption of the hydrological cycle, which causes 3 problems: (1) during the rainy season, it will cause flooding; (2) during the summer, it will experience drought; (3) pollution problems (Kodoatie, 2010 in Ayuba, 2019). Presidential Decree No. 60 of 2021 was issued concerning the Rescue of National Priority Lakes, with the main point in this regulation being to accelerate damage control, maintain, recover, and restore the condition and function of lakes (Perpres, 2021).

The second is the Paguyaman Flood Area, which is the catchment area of the Paguyaman watershed with the Paguyaman River as its estuary. Administratively, areas that have a high level of vulnerability are located in Asparaga District, Tolanguhula District, Mootilango District, and Boliyohuto District. The Paguyaman watershed is a part of the Paguyaman River Basin. The condition of the forest in the upper Paguyaman watershed has been damaged and continues to decline due to illegal logging, shifting cultivation, and unlicensed gold mining, causing flooding to occur often during the rainy season. Data from BPDAS Bone Bolango shows that critical to highly critical land in the Paguyaman Watershed covers 43,550 hectares, while the moderately critical and potentially critical categories amount to 241,862 hectares spread across several regions (Kepmen PU, 2014). As a result of rampant forest clearing activities, research was conducted by Djiko et al in 2022 to compare the peak discharge between the Hydrograph in 2008 with a forest area of 78.10% and in 2019 with a forest area of 77.47%. The research showed that the peak discharge in 2019 was higher than that in 2008. This result is in line with the infiltration in 2008, which is higher compared to 2019, and the surface runoff in 2019 is higher than in 2008 (Djiko et al., 2022). The potential increase in peak discharge will continue to grow in the coming years, accompanied by land development in the Paguyaman watershed. Therefore, the frequency of flooding in the lower Paguyaman River (Gorontalo Regency and Boalemo Regency) will continue to increase.

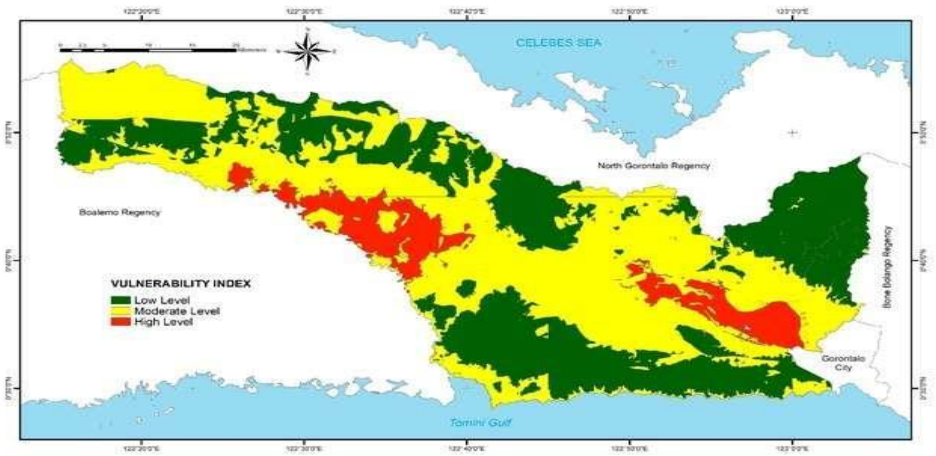

Figure 4. Spatial distribution of flood vulnerability Index in Gorontalo Regency - Gorontalo province *Source: Analysis Result*

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3.3 Residential Areas at Risk of Flooding

In the Gorontalo Regency spatial plan for 2012-2032, the residential area consists of urban settlements and rural settlements. The area of urban settlements is 10,204.57 Ha, and the area of rural settlements is 6,635.47 Ha. Thus, the total area of residential areas in Gorontalo Regency is 16,840.04 Ha. The overlay analysis on residential areas at risk of flooding recorded 320.34 Ha of residential areas have a low level of vulnerability, 14,137.09 Ha of residential areas have a moderate level of risk, and 2,336.79 Ha of residential areas have a high level of risk **(Table 8)**. The area with the highest potential to be affected by flood disasters is the Limboto Flood Area, which is due to the higher population level when compared to the Paguyaman Flood Area **(Figure 5)**.

Based on the results of ground checks and recordings of flood events that occurred in the Gorontalo Regency area on July 7-16, 2024 (Hanapi, 2024; Yopan Latif, 2024; Apris Nawu, 2025), the flood events occurred in areas with moderate to high levels of vulnerability. Meanwhile, flood events that occurred in residential areas of Limboto District, Tabongo District, Batudaa District, Telaga Jaya District, and Tilango District are located in areas with moderate to high vulnerability levels. The worst flooding was experienced by the community of Tabumela Village in Tilango District, Gorontalo Regency **(Figure 6)**. In terms of spatial flood vulnerability, this area is categorized as having a high level of vulnerability.

Table 8. Residential areas at risk of flooding

No.	Criteria	Area (Ha)
1	Low Level	320,34
2	Moderate Level	14.137,09
3	High Level	2.336,79
	Total Area	**16.794,10**

Source: Analysis Result

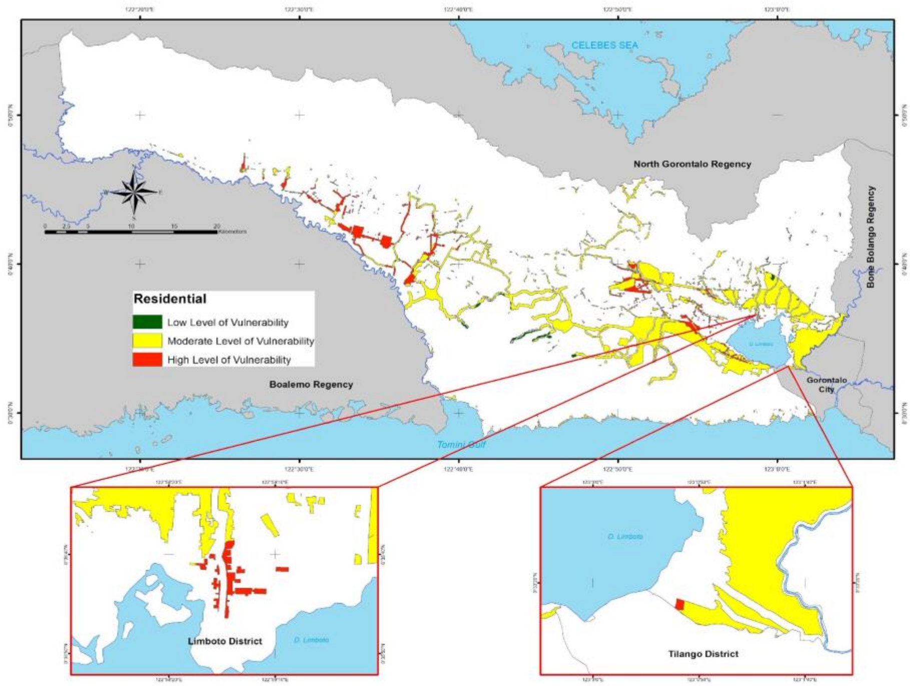

Figure 5. Map of the distribution of flood-risk residential in Gorontalo Regency
Source: Analysis Result

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Figure 6. Drone photo of Tabumela Village settlement area during a flood event in Gorontalo Regency. This area is categorized as High Vulnerability. The drone photo was taken on July 14, 2024. Location Coordinates: 0° 33' 16.56" LU and 123°1' 2.32" East

3.4 Flood Disaster Mitigation Strategies

Flood disaster mitigation strategies can be carried out with several activities involving various components consisting of government elements, private institutions, and the community in general. The following are strategies that can be carried out as flood disaster mitigation efforts in residential areas:

1 The government, in every policy, ensures that land use decisions are based on disaster risk assessments, to achieve effective and efficient spatial planning (Litasari et al., 2022; Lusiana and Widiyarta, 2021; Rędzińska and Piotrkowska, 2020);
2 Improve monitoring and prosecution of illegal clearing of forest areas;
3 Reduce land conversion from forest to plantation or agriculture;
4 Conduct reforestation efforts in areas or areas that have been declared critical;
5 Involve the community in the planning process so that citizens gain insight into the risks and vulnerabilities of a disaster (Margarena et al., 2023);
6 Development of residential infrastructure, such as drainage channels and other flood control structures, such as canals, as an effort to control surface flow (run off)
7 Develop and implement Green Infrastructure, such as hybrid buildings that are resilient to flood risk for high flood risk residential areas. (Andersson et al., 2022; Araaf Tauhid, 2019);
8 Incorporate disaster mitigation education into the school curriculum so that there is early awareness and attentiveness of students in dealing with natural disasters (Ayub et al., 2022);
9 Involve local community participation in disaster risk management efforts, such as in the Disaster Resilient Village Program;

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10 Explore and integrate local wisdom values into effective disaster mitigation strategies to achieve community resilience (Bakri et al., 2020).

4. CONCLUSIONS

The conclusion from this research is that the spatial distribution of flood-prone areas in Gorontalo Regency is almost evenly distributed. With an area of 60.78% falling into the category of flood-prone areas with moderate to high levels of vulnerability, while the remaining 39.22% fall into the category of low levels of vulnerability. In terms of area, 84,654.70 hectares are categorized as low vulnerability, 111,218.94 hectares as moderate vulnerability, and 19,998.45 hectares as high vulnerability. Areas with a potential moderate level of flood vulnerability are spread across almost all Districts in Gorontalo Regency. Areas with high flood vulnerability are spread across Tibawa District, West Limboto District, Dungaliyo District, Tabongo District, Limboto District, Telaga District, Batudaa District, Telaga District, Telaga Jaya District, Telaga Biru District, Tilango District, Asparaga District, Tolanguhula District, Mootilango District, and Boliyohuto District. Out of all those districts, that potentially affected residential area is 16,473.76 Ha, consisting of 14,137.09 Ha with a moderate level of vulnerability and 2,336.79 Ha with a high level of vulnerability to flooding. Disaster mitigation strategies are crucial to be implemented in residential areas. This study formulated several recommendations of flood disaster mitigations strategies, namely: (1) through the Government's efforts in reforming land use policy to ensure that land use decisions are based on disaster risk assessments so as to achieve effective and efficient spatial planning; (2) improve monitoring and prosecution of illegal clearing of forest areas; (3) reduce land conversion from forest to plantation or agriculture; (4) conduct reforestation efforts in areas or areas that have been declared critical; (5) involve the community in the planning process so that citizens gain insight into the risks and vulnerabilities of a disaster; (6) development of residential infrastructure such as drainage channels and other flood control structures like canals, as an effort to control run-off; (7) Develop and implement Green Infrastructure such as hybrid buildings that are resilient to flood risk for high flood risk residential areas (8) incorporate disaster mitigation education into the school curriculum so that there is awareness and attentiveness of students in dealing with natural disasters; (9) involve local community participation in disaster risk management efforts, such as in the Disaster Resilient Village Program; (10) explore and integrate local wisdom values into effective disaster mitigation strategies to achieve community resilience.

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