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Original Article

Mapping Hydrometeorological Disaster Hazards of Landslides as an Effort to Build Regional Resilience in Banten Province

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ABSTRACT
Hydrometeorological disasters are disasters caused by atmospheric dynamics related to water, air, and the earth's surface. The use of spatial data for disaster hazard mapping has not been widely carried out in various regions of Indonesia, especially for specific disasters such as hydrometeorological disasters, including floods, landslides, and droughts. The purpose of this study is to map the hydrometeorological disaster hazards in the form of landslides in Banten. Based on the bibliometric analysis that has been carried out, no research was found that focused on mapping the hydrometeorological disaster hazards of landslides in the Banten Province area. The research method used is spatial analysis using the ArcGIS application and AHP for mapping landslide hazards in Banten Province. The parameters used include slope maps, precipitation, distance to faults, soil types, geology, drainage density, slope direction, and NDVI vegetation density. The results of the analysis show that the area with a high level of danger is the largest, with a coverage of 1929.99 km^2, the area with a moderate level of danger is 10007.36 km^2, and the area with a low level of danger is the smallest, at 128.13 km^2. The preparation of a landslide hydrometeorological disaster hazard map is one of the components that can increase the regional resilience index in Banten.

KEYWORDS
Mapping; Hydrometeorology; Landslide; Resilience; Banten

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INTRODUCTION

Indonesia is located in the Pacific Ring of Fire, where three tectonic plates converge: the Eurasian Plate, the Indo-Australian Plate, and the Pacific Plate. This geological setting makes Indonesia highly susceptible to natural disasters. Furthermore, Indonesia is one of the largest archipelagic nations in the world, comprising over 17,000 islands, and is situated between two major oceans, the Pacific and the Indian Oceans. These factors make Indonesia highly vulnerable to hydrometeorological disasters and directly expose the country to the impacts of global climate change. Indonesia ranks third among 192 countries worldwide in terms of disaster risk.

The overall trend of disaster events in Indonesia has been increasing, particularly over the past five years.

According to the 2021 Disaster Information Data (DIBI) report from the National Disaster Management Agency (BNPB), disaster occurrences significantly rose from 1,703 events in 2015 to 5,003 in 2020, with hydrometeorological disasters dominating each year. Landslides, in particular, have become a major natural risk in many countries, including Indonesia (Hadmoko et al., 2010). One of the regions in Indonesia with a high susceptibility to hydrometeorological disasters is Banten Province. Between 2009 and 2019, Banten experienced 581 disaster events, of which 563 were hydrometeorological disasters. The high frequency of disasters in Banten has resulted in significant vulnerability. Banten is the fourth most populous province in Indonesia, with a population of 12.47 million people, including 1.63 million individuals considered vulnerable.

Hydrometeorological disasters, including floods, landslides, and droughts, pose a significant threat to Banten Province due to its geographic location, which is prone to climate change and extreme weather phenomena. Landslides, in particular, can significantly alter the economic conditions of a region (Ruslanjari & Dewi, 2019). The region's resilience to these disasters largely depends on a deep understanding of the distribution and intensity of hazards in each area. Hazard mapping is a crucial step in identifying vulnerable zones and formulating effective mitigation strategies. Through comprehensive, data-driven mapping, local governments can optimize disaster mitigation efforts and response plans, as well as enhance community preparedness for potential threats. This study aims to create a hydrometeorological disaster hazard map, specifically for landslides in Banten Province, as a foundation for strengthening regional resilience in a sustainable manner.

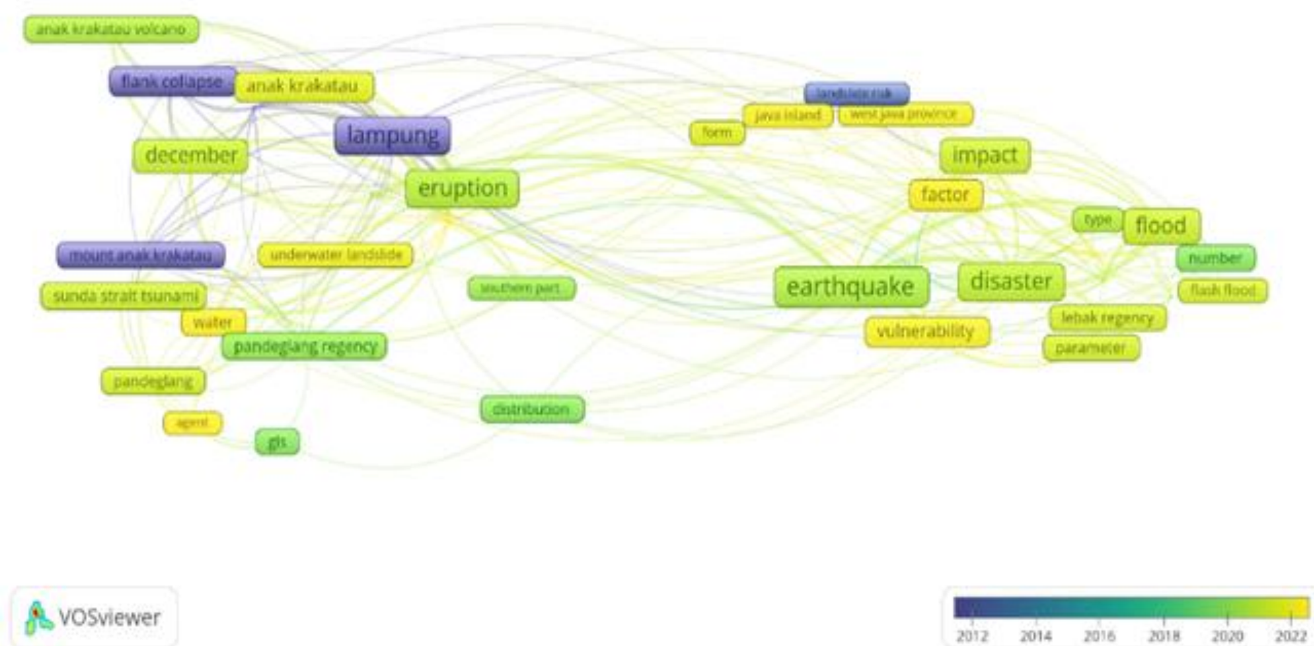

Figure 1. Bibliometric Analysis of Google Scholar Articles on the Trends in Landslide Disaster Research in Banten

Based on an initial bibliometric analysis of Google Scholar articles on disaster research and landslide hazard mapping in Banten Province, no comprehensive studies on landslide disasters were found. The only research conducted on landslides dates back to 2012, whereas landslides are a dynamic disaster type, with increasing intensity. Most disaster-related studies in Banten have focused on earthquakes and tsunamis, particularly those caused by the Anak Krakatau volcanic activity. The scope of disaster studies has mainly been limited to earthquake, tsunami, and flood hazards in the Pandeglang and Lebak regions. No landslide hazard mapping research covering Banten Province as a whole has been found. This gap presents an opportunity for new research. Thus, the author is motivated to conduct a study titled “Mapping Hydrometeorological Landslide Disaster Hazards as a Strategy to Build Regional Resilience in Banten Province.”

METHOD

This study is a descriptive quantitative research with a Geographic Information System (GIS) approach.

The spatial model approach facilitates the depiction and processing of data in a large-area region (Dedy et al., 2023). This approach involves processes of data collection, processing, analysis, classification, and field surveys (ground check) to produce accurate maps and analyses. The hazard map produced is a landslide hazard map with parameter maps that have been previously compiled, including; slope map, precipitation, distance to fault, land use, soil type, geology, drainage density, slope aspect, and vegetation density (NDVI). The hazard parameter maps will undergo overlay analysis and scoring to produce a new map, which is the landslide hazard map of Banten Province. The area calculation is performed using square kilometers as the unit of measurement. This study is conducted in Banten Province, which consists of four regencies and four administrative cities, namely: Lebak Regency, Pandeglang Regency, Serang Regency, Tangerang Regency, Cilegon City, Serang City, Tangerang City, and South Tangerang City. The variables and parameters used in the landslide hazard mapping are presented in Table 1 below.

Table 1. Variables and Parameters of Landslide Hazard Map

Variable	Parameter
Landslide Disaster	Slope
	Precipitation
	Distance to Fault
	Land Use
	Soil Type
	Geology
	Drainage Density
	Slope Aspect
	Vegetation Density (NDVI)

RESULTS AND DISCUSSION

General Overview of the Research Area

Banten Province is located on the westernmost part of Java Island, with geographical coordinates between 5º7'50" - 7º1'11" South Latitude and 105º1'11" - 106º7'12" East Longitude. According to the Ministry of Home Affairs Decree No. 100.1-1-6117 of 2022, the area of Banten Province is 9,352.77 km^2. This province borders DKI Jakarta and West Java Province to the east, the Java Sea to the north, the Indian Ocean to the south, and the Sunda Strait to the west. Administratively, Banten Province consists of 4 cities and 4 regencies, covering 154 districts and 1,273 villages. The climate in this region is influenced by the monsoon winds as well as the La Niña and El Niño phenomena. During the rainy season (November-March), the west winds from the Indian Ocean and winds from Asia passing through the South China Sea dominate the weather. In contrast, during the dry season (June-August), the winds contribute to drought, particularly in the northern coastal areas of Banten.

Landslide Hazard Parameter Map

1. Slope Map

Areas with high annual precipitation are generally found on the southern side of Banten Province, including Pandeglang and Lebak Regencies. These areas are characterized by highlands in the form of mountain ranges and Mount Salak, which reaches an elevation of 2,211 meters above sea level. They serve as a catchment area, with annual precipitation intensities ranging from 3,500 to 4,000 mm per year. According to Table 3, the highest precipitation distribution in Banten Province is between 3,500 and 4,000 mm/year, covering an area of 3,835.27 km^2, primarily in the southern regions, especially in Lebak and Pandeglang. Moderate precipitation, with intensities of 2,500 to 3,500 mm/year, is spread across most of the central and northern regions, while the lowest precipitation, between 2,000 and 2,500 mm/year, is found in the northern and northeastern areas. Precipitation is a major triggering factor for landslides in humid tropical climates (Noviyanto et al., 2020). Landslides are typically caused by an increase in water content and water pressure within the soil pores, which can reduce the shear strength of the soil.

Table 2. Area Size According to Slope Steepness

Slope	Area (Km^2)	Percentage
<8	4195,33	44,86
8 - 15	2256,13	24,12
15 - 25	1451,97	15,52
25 - 45	1110,87	11,88
> 45	338,46	3,62
Total	**9352,77**	**100**

Source: Research results, 2024

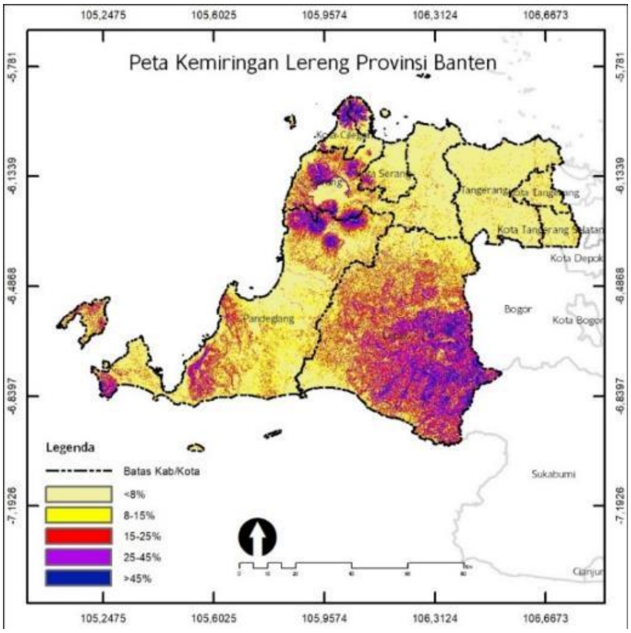

Figure 2. Slope map

2. Precipitation Map

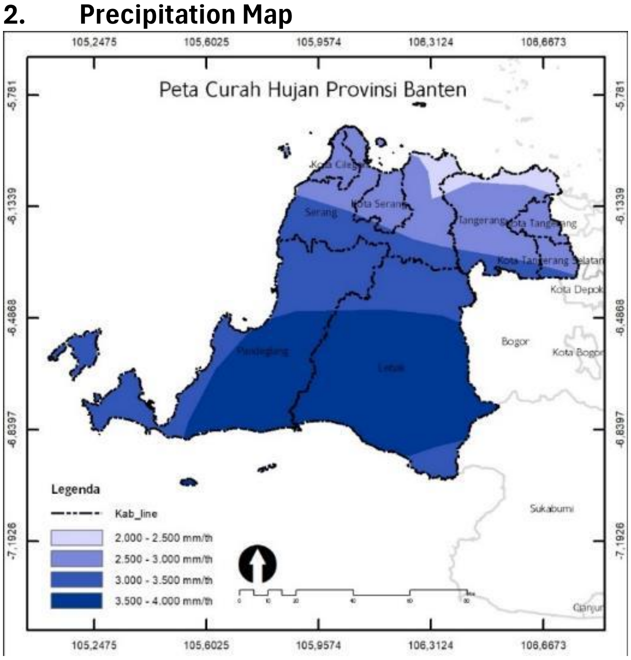

Figure 3. Precipitation Map

Regions with high annual precipitation are generally found on the southern side of Banten Province, which includes Pandeglang and Lebak Regencies. These areas are characterized by highland regions, including mountain ranges and Mount Salak with an elevation of 2,211 meters above sea level, and serve as a catchment area with an annual precipitation intensity of 3,500 – 4,000 mm/year. According to Table 3, the distribution of precipitation in Banten Province is highest in the range of 3,500 - 4,000 mm/year, covering an area of 3,835.27 km^2, predominantly in the southern region, especially in Lebak and Pandeglang Regencies. Moderate precipitation, with an intensity of 2,500 - 3,500 mm/year, is spread across much of the central and northern regions, while the lowest precipitation, with an intensity of 2,000 - 2,500 mm/year, is found in the northern and northeastern regions. Precipitation is a major trigger for landslides in humid tropical climates (Noviyanto et al., 2020). Landslides are usually caused by an increase in water content and water pressure in the soil pores, which can reduce the soil's shear strength.

Table 3. Area Size According to Annual Precipitation Intensity

Precipitation (mm/year)	Area (Km^2)	Percentage
2.000 - 2.500	323,92	3,46
2.500 - 3.000	2113,82	22,60
3.000 - 3.500	3079,76	32,93
3.500 - 4.000	3835,27	41,01
Total	**9352,77**	**100**

Source: Research results, 2024

3. Fault Distance Map

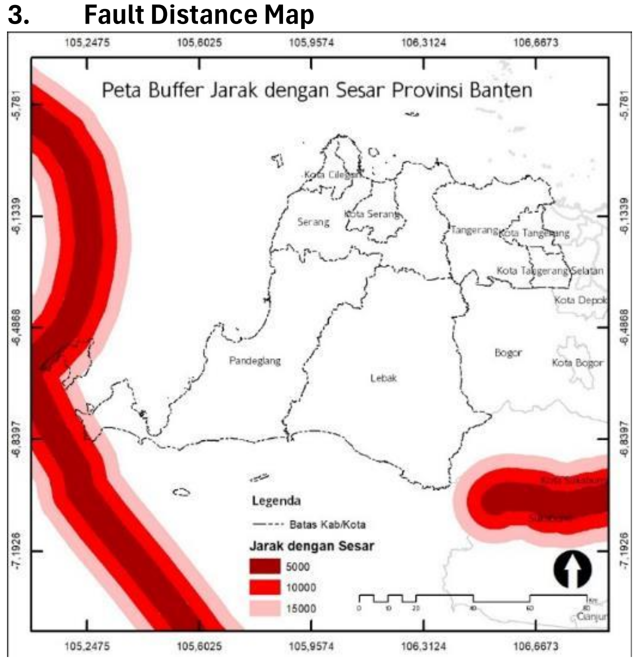

Figure 4. Fault Distance Buffer Map

Based on Figure 4, the area within a 5000-meter radius from the fault line (fault zone) is indicated by a dark red color. This zone is very close to the fault and is highly vulnerable to tectonic activities such as earthquakes. The medium red color (10,000 meters) represents areas within a 10,000-meter radius from the fault, which are marked with a medium red color. The tectonic risk in this zone is still high, but slightly lower compared to the dark red zone. The light pink color (15,000 meters) marks areas within a 15,000-meter radius from the fault.

4. Land Use Map

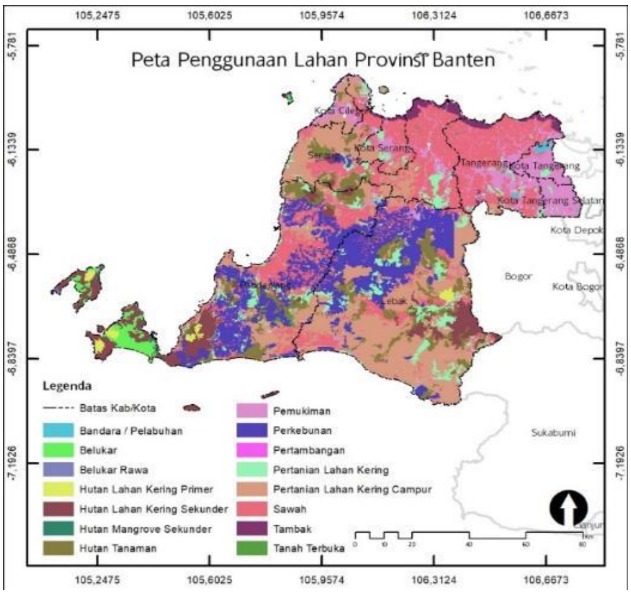

Figure 5. Land Use Map

Land use changes occur due to the need to meet the growing population demands (Miswar et al., 2021). In several areas of Indonesia, land conversion is a common phenomenon in regional development. Land use plays a crucial role in determining the parameters for landslide occurrences (Darmawan et al., 2022). The land use map of Banten Province shows various types of land uses across the region. Based on Figure 5 and Table 4, it is evident that residential areas cover 927.07 km^2 or 9.91% of Banten Province, spread across the northern and eastern regions, including metropolitan areas like Tangerang City, South Tangerang City, and their surroundings. High residential density can increase disaster threats, such as fires, floods, and landslides. The development pattern concentrated in most of the coastal areas leads to a high disaster risk (Alfi et al., 2020).

The plantation area, which spans 1583.34 km^2 or 16.93%, is widely spread in the central and southern regions of Banten. Monoculture can reduce biodiversity and increase vulnerability to pest and disease attacks. The dryland agricultural area, covering 575.55 km^2 or 6.15%, and the mixed dryland agricultural area, covering 2260.84 km^2, dominate the central part of the province. Dryland farming is vulnerable to droughts and climate change. Rice field areas, covering 2241.08 km^2, are spread across the central and western parts of Banten Province. These areas are vulnerable to both floods and droughts, and poor water management can lead to crop damage.

Table 4. Area by Land Use

Land Use	Area (Km²)	Percentage (%)
Airport/Seaport	28.06	0.3
Shrubland	164.02	1.75
Swamp Shrubland	11.63	0.12
Primary Dryland Forest	79.37	0.85
Secondary Dryland Forest	529.65	5.66
Secondary Mangrove Forest	31.37	0.34
Plantation Forest	713.55	7.63
Residential Area	927.07	9.91
Plantation	1583.34	16.93
Mining	10.17	0.11
Dryland Agriculture	575.55	6.15
Mixed Dryland Agriculture	2260.84	24.17
Rice Fields	2241.08	23.96
Fishponds	157.96	1.69
Open Land	39.13	0.42
Total	**9352.77**	**100**

Source: Research results, 2024

5. Soil Type Map

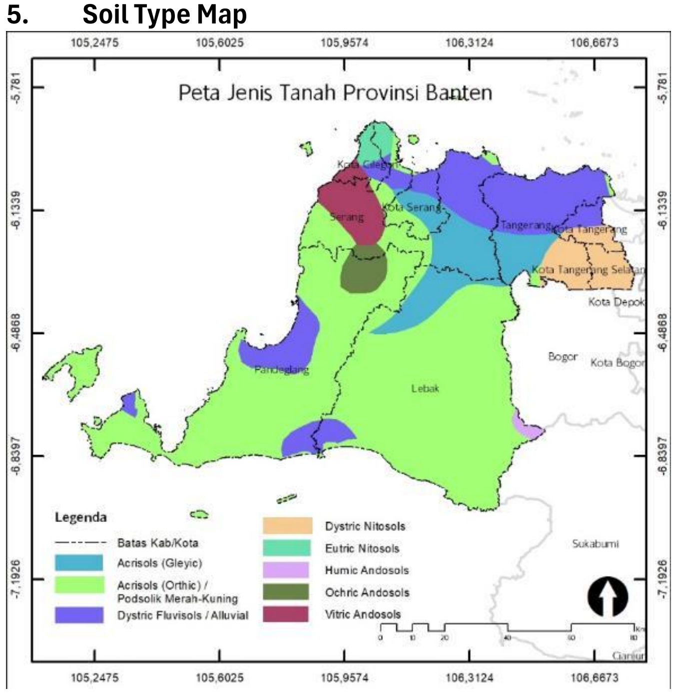

Figure 6. Soil Type Map

The Acrisols (Gleyic, Orthic) or Podzolic soils are found in the central and southern parts of this province, typically in areas with high rainfall. Acrisols/Podzolic soils can support agriculture but require good management because they tend to be less fertile. The Red-Kunin Podzolic soils are commonly found in the Lebak area, often occurring in tropical and humid climates. Dystric Fluvisols/Alluvial soils are found along the coastline and near major rivers, and these soils are usually fertile and suitable for agriculture. Dystric Nitosols/Latosols, Eutric Nitosols/Latosols, Humic Andosols, Ochric Andosols, and Vitric Andosols are various soil types spread across different parts of the province, with Andosols typically associated with volcanic activity, which provides high organic content.

Table 5. Area by Soil Type

DOMSOI	Soil Type by FAO/UENESCO (1974)	Soil Types of the National Soil Classification System	Area (Km^2)	Percentage (%)
Ne	Eutric Nitosol	Latosol	140,24	1,50
Jd	Dystric Fluvisols	Aluvial	1163,53	12,44
Tv	Victric Andosols	Andosol	364,30	3,90
Ao	Orthic Acrisols	Podsolik	1079,43	11,54
Ag	Gleyic Acrisols	Podsolik	980,65	10,49
Nd	Distric Nitosols	Latosol	488,37	5,22
To	Ochric Andosols	Andosol	212,35	2,27
Ao	Orthic Acrisols	Podsolik	2925,62	31,28
Jd	Dystric Fluvisols	Aluvial	291,30	3,11
Ao	Orthic Acrisols	Podsolik	1308,41	13,99
Ao	Orthic Acrisols	Podsolik	94,08	1,01
Jd	Dystric Fluvisols	Aluvial	50,68	0,54
Th	Humic Andosols	Andosol	63,39	0,68
Jd	Dystric Fluvisols	Aluvial	190,43	2,04
	Total		**9352,77**	**100**

Source: Research results, 2024

Alluvial soils (Dystric Fluvisols), which are found in coastal areas and near large rivers, are prone to flooding due to their ability to retain large amounts of water. Areas around the city of Serang and northern cities (such as Tangerang City and South Tangerang City) are likely to have a higher flood risk due to the presence of alluvial soils. Regions with Acrisols or Red-Yellow Podsolic soils, particularly in areas with undulating or hilly topography, such as in Lebak Regency, are more vulnerable to landslides, especially during the rainy season. The presence of Andosols (Humic, Ochric, Vitric) indicates past volcanic activity. These areas may still have risks associated with volcanic activity if nearby volcanoes (such as Mount Krakatau) become active again. Regions with Acrisols and Red-Yellow Podsolic soils require proper land management techniques to prevent erosion and improve soil fertility, especially in areas with high rainfall.

5. Geological Map

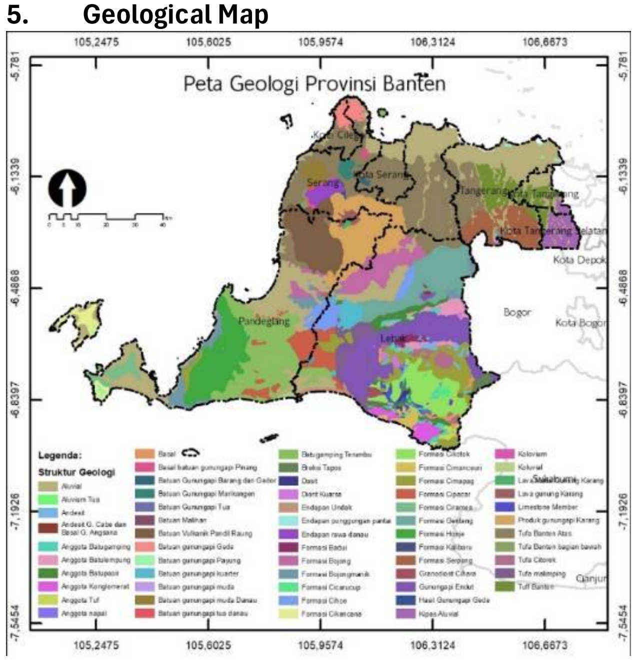

Figure 7. Geological Map

Based on Figure 7, it can be observed that the geological structures of Alluvium and Terrace Deposits are predominantly distributed in lowland areas, particularly in the northern regions such as Tangerang City, South Tangerang City, and Serang City. These areas are generally flat and represent river deposition zones. Volcanic Geological Formations, such as young and old volcanic rocks, are located in the central and southern parts of Banten, especially in Lebak and Pandeglang Regencies. Sedimentary Formations, such as the Bojongmanik Formation and the Cimapag Formation, are found in the central and southern regions of Banten. Complex Formations, including the Bayah Complex and Jampang Complex in the southern region, consist of older and structurally complex rock types.

From a topographic perspective, the mountains and hills dominated by volcanic rocks in the southern and central regions indicate steep mountainous and hilly terrain. The Lowlands and Coastal Areas, located in the northern and parts of the southwestern regions, exhibit lowland and coastal topography characterized by alluvial deposits.

7. Drainage Density Map

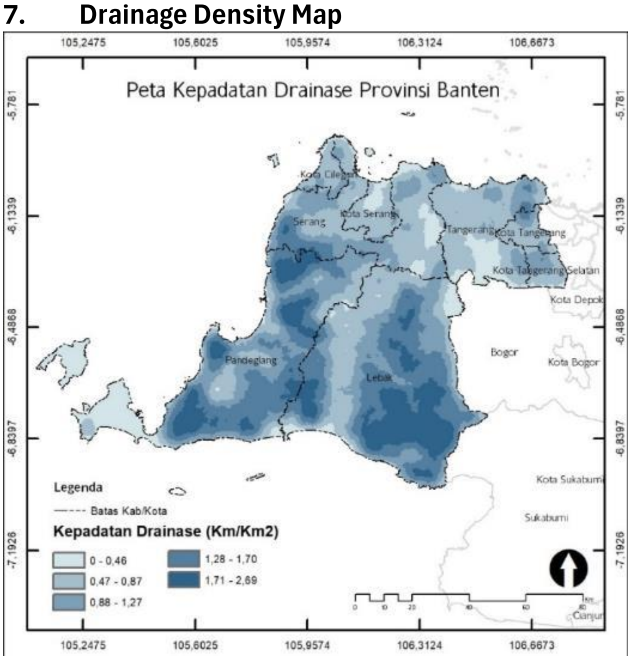

Figure 8. Drainage Density Map

The map presented in Figure 8 illustrates the drainage density of Banten Province, measured in units of km/km^2. Drainage density serves as an important indicator in hydrological and hydrometeorological disaster analysis, providing insights into surface water flow potential and the likelihood of flooding or other hydrometeorological events. The drainage density in Banten Province is classified into five categories: very sparse (<0.46 km/km^2), sparse (0.47–0.87 km/km^2), moderate (0.88–1.27 km/km^2), good density (1.28–1.70 km/km^2), and very good density (>1.71 km/km^2). Areas with very good drainage density tend to have numerous rivers and tributaries, while moderate to good drainage density is typically found in regions comprising a mix of lowlands and hilly areas. In contrast, very sparse to sparse drainage density is generally located in lowland regions or areas with low rainfall intensity.

8. Slope Aspect Map

The slope aspect map of Banten Province was generated through the extraction of DEMNAS data from 2019, provided by the Geospatial Information Agency (BIG). The DEMNAS data utilized has a resolution of 8.1 meters, covering 39 NLP 50K grid tiles, which corresponds to the mapped area of Banten Province. The satellite sensor employed is TerraSAR-X, an active sensor that produces cloud-free imagery. Slope aspect indicates the intensity of sunlight exposure received by the soil and the organisms present on it. In tropical regions, sunlight is a crucial environmental factor in soil pedogenesis, the process of soil formation and development. The slope aspects across Banten Province are visualized in Figure 9.

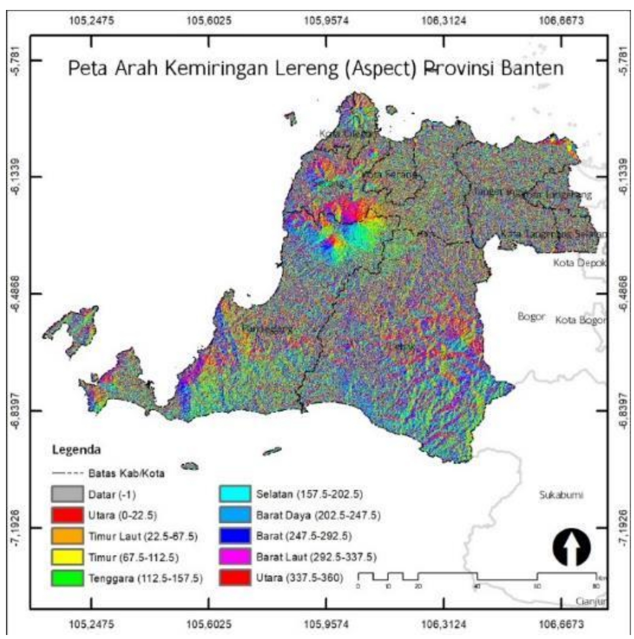

Figure 9. Slope Aspect Map

Based on Figure 9 and Table 6, the largest slope aspect area is oriented toward the north (337.51°–360°), covering 1,004.54 km^2 (10.74% of the total area). Conversely, the smallest slope aspect area is oriented toward the northeast (22.51°–67.5°), covering 905.69 km^2

(9.68% of the total area). On average, the distribution of slope aspect areas for each direction is approximately 10% of the total area. The distribution is relatively even, with minimal percentage differences across the various slope aspects.

Table 6. Slope Aspect Distribution in Banten Province

Aspect	Area (km²)	Percentage (%)
Flat (-1)	919.68	9.83
North (0–22.5)	914.98	9.78
Northeast (22.51–67.5)	905.69	9.68
East (67.51–112.5)	915.05	9.78
Southeast (112.51–157.5)	935.62	10
South (157.51–202.5)	927.22	9.91
Southwest (202.51–247.5)	941.2	10.06
West (247.51–292.5)	933.83	9.98
Northwest (292.51–337.5)	954.97	10.21
North (337.51–360)	1004.54	10.74
Total	**9352.77**	**100**

9. Vegetation Density Map (NDVI)

The NDVI (Normalized Difference Vegetation Index) was calculated using the combination of band 4 (RED) and band 5 (NIR) from satellite imagery, utilizing the formula:

$$\mathrm{NDVI} = \frac{(\mathrm{NIR}-\mathrm{RED})}{(\mathrm{NIR}+\mathrm{RED})}$$

Where:

- **NIR** represents the near-infrared radiation from the pixel.
- **RED** represents the red light radiation from the pixel.

The NDVI map illustrates the distribution of vegetation, providing essential insights into the ecological and geographical conditions of Banten Province. NDVI also serves as a critical parameter for disaster threat mapping. As shown in Figure 10 and Table 7, the vegetation distribution in Banten Province is categorized as follows:

- **Dense Vegetation (29.64%)** and **Moderately Dense Vegetation (24.97%)**: These areas are primarily located in mountainous and forested regions, such as Ujung Kulon National Park in southwestern Banten.
- **Sparse Vegetation (18.62%)**: This includes agricultural lands, plantation areas, or degraded secondary forests.
- **Non-Vegetation (15.74%)**: Urban areas, road infrastructure, and industrial zones, especially around major cities such as Serang, Tangerang, and Cilegon.
- **Cloud and Water (11.02%)**: This category includes water bodies like Tasikardi Lake, Ciujung River, and extensive coastal areas.

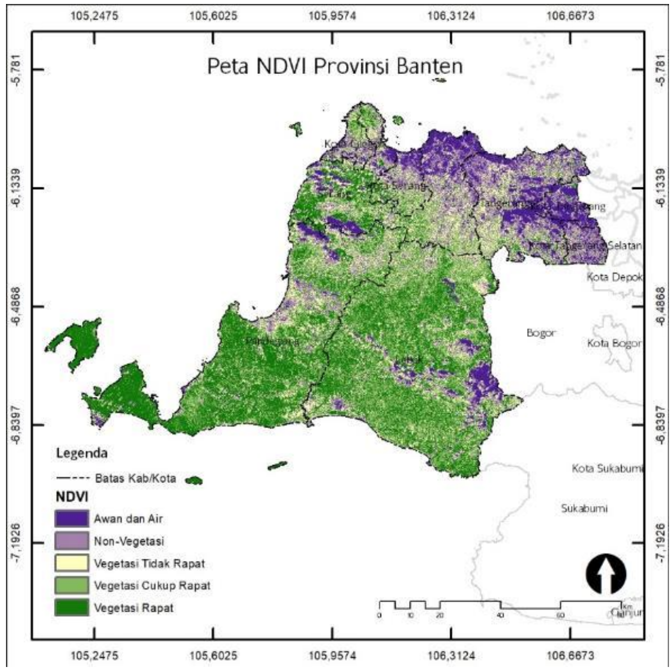

Figure 10. NDVI Map

Table 7. Area Distribution by Vegetation Index (NDVI)

NDVI Category	Area (km²)	Percentage (%)
Cloud and Water	1,030.55	11.02
Non-Vegetation	1,472.49	15.74
Sparse Vegetation	1,741.91	18.62
Moderately Dense Vegetation	2,335.48	24.97
Dense Vegetation	2,772.34	29.64
Total	**9,352.77**	**100**

This distribution highlights the ecological diversity of Banten Province, with a significant proportion of dense and moderately dense vegetation concentrated in forested and mountainous regions, and urbanization reflected in the non-vegetation category.

Landslide Hazard Map of Banten Province

The mapping of landslide hazard zones in Banten Province employs the Multi-Criteria Decision Making (MCDM) method. This method involves analyzing inter-criteria relationships among landslide-controlling parameters to produce a zonation map of landslide hazards. Specifically, the Analytical Hierarchy Process (AHP) is used for parameter weighting, which determines the influence (intensity of importance) of each landslide-controlling parameter on the potential for landslide disasters.

The results of the weighting and scoring for each parameter are summarized in Table 8, which outlines the key parameters, weights, classes, and scores used in the landslide hazard analysis.

Table 8. Parameters, weights, classes, and scores of the Landslide Hazard Map

Parameter	Weight	Class	Score
Slope	0,273	<8%	0,122
		8-15%	0,141
		15-25%	0,178
		25-45%	0,22
		>45%	0,339
Percipitation (mm/yr)	0,207	<1000	0,074
		<2000	0,13
		2000 - 2500	0,192
		2500 - 3000	0,281
		>3000	0,323
Fault distance	0,055	Buffer >10000 M	0,3
		Buffer 0-5000 M	0,369
		Buffer 5000-10000 M	0,331
Land use	0,079	Forest/Dense Vegetation and Water Bodies	0,091
		Mixed Gardens/Bushland	0,097
		Plantations and Irrigated Rice Fields	0,152
		Industrial and Residential Areas	0,277
		Vacant Lands	0,383
Soil	0,056	Latosol	0,198
		Aluvial	0,221
		Podsolik	0,276
		Andosol	0,305
Geoligical	0,08	Basalt, Diabase, Andesite, Dacite	0,25
		Alluvial, Cinambo, Deposits (coastal, river)	0,35
		Banten Tuff, Gunung Karang Lava, Volcanic Products	0,4
Drainage Density (Km^2/Km)	0,201	0-1,24	0,057
		1,24-2,49	0,082
		2,49-3,73	0,253
		3,73-4,97	0,29
		>4,97	0,318
Slope Aspect	0,01	North	0,134
		Southeast and Northeast	0,174
		East and West	0,198

Parameter	Weight	Class	Score
		Southwest, Northwest	0,23
		South	0,264
Vegetation Density (NDVI)	0,039	Cloud and Water	0,035
		Dense Vegetation	0,048
		Moderately Dense Vegetation	0,183
		Sparse Vegetation	0,221
		Non-Vegetation	0,513

Source: Aminudin et al. (2023); BNPB (2019); Rahma & Mardiatno (2018); Rahmawati (2024).

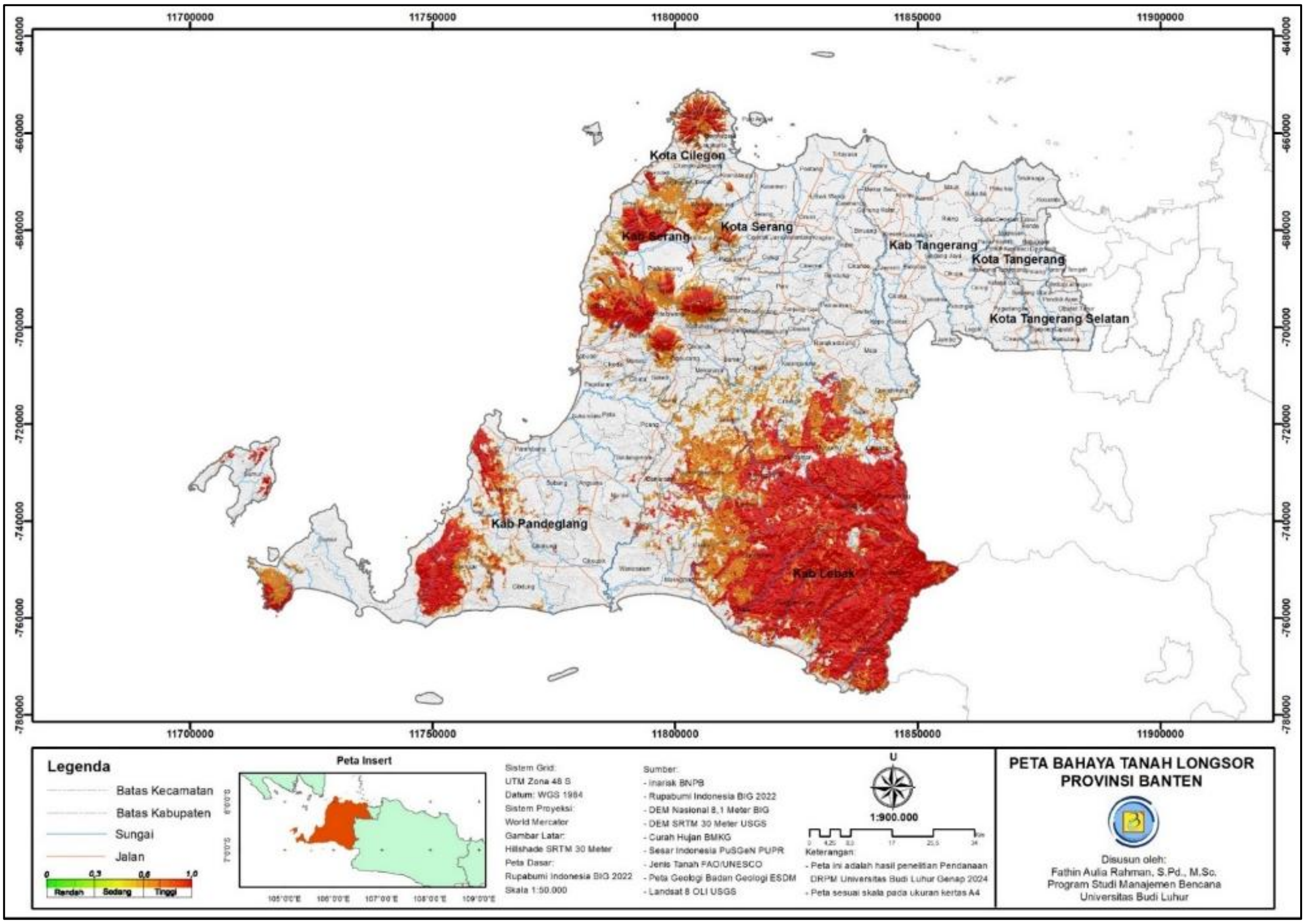

Figure 11. Landslide Hazard Map Results using AHP for Banten Province

The results of spatial data processing using ArcGIS are shown in Table 9, which allow for the identification of landslide hazards as follows:

1. **High hazard level**: Areas with a high landslide hazard are colored red and cover the largest area, 1929.99 km^2.
2. **Moderate hazard level**: Areas with a moderate hazard level, covering 1007.36 km^2, are colored orange.
3. **Low hazard level**: Areas with a low hazard level, covering 128.13 km^2, are colored yellow.

The priority for disaster risk management focuses on the high-risk areas for mitigation actions, evacuation, and landslide control infrastructure development. Mountainous and hilly areas, particularly in the southern and central parts of the province, are more susceptible to landslides. Soil conditions, vegetation, and rainfall also influence the landslide hazard. Topographic data can be used to predict landslide-prone areas. Increasing capacity and awareness in areas with moderate and low hazards can help reduce potential impacts.

Table 9. Landslide Hazard Area by Category

Landslide Hazard Level	Area (Km^2)
Low	128.13
Moderate	1007.36
High	1929.99
Total	**3065.48**

From a spatial distribution perspectiv e, the highest landslide hazard concentration is in the southern and central regions, particularly in Lebak Regency, Pandeglang Regency, and parts of Serang Regency. The northern areas, such as Tangerang City and its surroundings, tend to have a lower hazard. Identifying critical infrastructure such as roads, bridges, and public facilities located in high-risk areas is also important. The use of spatial data for emergency response planning and evacuation plans should be more effective. Uncontrolled land development in slope and hill areas increases landslide hazards. Land-use policies that consider landslide risks need to be implemented, including reforestation and erosion control.

From an economic aspect, high-risk areas have significant potential for economic losses, particularly related to infrastructure and property damage. A cost-benefit analysis for landslide mitigation investments, such as terracing, slope reinforcement, and drainage systems, should be carried out. Regarding asset protection, identifying economic assets located in high-risk areas and developing protection strategies, including insurance, are essential. Promoting investment in landslide-resistant infrastructure to reduce future economic losses is vital.

Social capital is also an essential component in a comprehensive and inclusive landslide hazard study, which includes attention to vulnerable groups such as the elderly, babies and toddlers, people with disabilities, the poor, children, pregnant and breastfeeding women, as well as rural communities living on slopes. These groups require special attention. Educational programs and emergency response training should be conducted to improve community preparedness for landslide hazards.

Hydrometeorological Landslide Hazard Map as an Effort to Build Regional Resilience in Banten Province

The definition of regional resilience, derived from the concept of national resilience, refers to the dynamic condition of a region that encompasses all integrated aspects of life, with strength and perseverance that enable the development of power to face threats and obstacles (Soemarsono et al., 2001). In the context of disaster management, the level of regional resilience is used to determine the capacity index, so the calculation of regional resilience can be carried out alongside the creation of disaster hazard maps (Bachtiar et al., 2021). The assessment of regional resilience is measured using the Regional Resilience Index (IKD) issued by the National Disaster Management Agency (BNPB). IKD is a series of instruments to measure the capacity of regions under the assumption that the region has fixed disaster hazards and vulnerabilities. According to Ruslanjari et al. (2020), the level of resilience can also be assessed through analysis in the social, economic, physical, and environmental aspects.

The preparation of hydrometeorological landslide hazard maps is one of the components that can improve the regional resilience index. Hazard maps are included in the Pre-Disaster Framework and are mandated by the BPBD/OPD (Regional Disaster Management Agency) in the Pre-Disaster phase as stipulated in Mandate Number 6: Creation of Disaster Hazard Maps. Hazard maps are used as a reference for spatial planning policies, including in the preparation of RTRW (Regional Spatial Plan), RDTR (Detailed Spatial Plan), and considerations in preparing RPJM (Medium-Term Development Plan). Hazard map preparation is generally carried out by the regency/city governments or provinces as part of the KRB (Disaster Risk Study) documents prepared by the BPBD of the regency/city and province. The preparation of hydrometeorological landslide hazard maps in Banten Province plays an important role in building regional resilience (Rahman, Achadi, 2024).

Recommendations based on the landslide hazard map as an effort to build regional resilience in Banten Province:

1. Infrastructure Strengthening: Development and improvement of landslide mitigation infrastructure such as terracing, slope reinforcement, and drainage systems.
2. Land Management: Implementing sustainable land use policies to reduce the risk of landslides.
3. Improved Preparedness: Educational programs and training for the community on landslide risks and mitigation measures.
4. Cross-Sector Cooperation: Collaboration between the government, private sector, and communities in landslide risk reduction efforts.

CONCLUSION

Through the application of the Multi-Criteria Decision Making (MCDM) method, particularly the Analytical Hierarchy Process (AHP), this study examines controlling parameters for landslides, such as slope gradient, rainfall, distance from fault lines, and land use. The result is that the visualization of landslide hazard maps can identify areas with high, medium, and low hazard levels, each requiring different priorities for handling and mitigation. This research also emphasizes the need for infrastructure strengthening, sustainable land management, improved community preparedness, and cross-sector cooperation in efforts to reduce landslide risk.

The hydrometeorological landslide hazard maps created serve as an essential component in enhancing the regional resilience index and are used as a reference in spatial planning policies and regional development planning. Through this approach, it is hoped that Banten Province can build better resilience against landslide threats and their negative impacts. Moreover, a holistic approach encompassing social, economic, and environmental aspects is crucial for landslide mitigation efforts. By identifying vulnerable groups, such as the elderly, children, and low-income communities living in high-risk areas, this study recommends educational programs and emergency response training to increase community preparedness. Strengthening social capital and promoting investment in landslide-resistant infrastructure are also key focuses to reduce potential economic losses in the future.

Overall, this comprehensive approach aims to build more inclusive and sustainable regional resilience, ensuring that all layers of society are prepared to face landslide threats in Banten Province.

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