

Risk Analysis of Disasters in Pringsewu Regency, Lampung Province, Indonesia

Armijon^{1,*}, Anggun Tridawati¹, Fajriyanto¹, Erlan Sumanjaya¹, Ida Susanti²

¹ Department of Geodesy and Geomatics Engineering, Faculty of Engineering Universitas Lampung, Lampung 35141, Indonesia;

² Regional Development Planning Agency "BAPPEDA Lampung Province", Bandar Lampung, Lampung 35119, Indonesia;

* email: armijon@eng.unila.ac.id (Korepondensi)

Abstract

Natural disasters are a serious global issue as they can cause environmental damage, poverty, and even loss of life. Pringsewu is a regency in Lampung Province, Indonesia, that is highly vulnerable to floods, landslides, earthquakes, extreme weather, and forest fire disasters. Therefore, a disaster risk assessment is needed to support disaster mitigation efforts. This study aims to analyze the disaster risk in Pringsewu Regency and is conducted by the Head of the National Disaster Management Agency Regulation Number 02 of 2012 concerning General Guidelines for Disaster Risk Assessment. The research findings indicate that flood, landslide, earthquake, extreme weather, and forest fire disasters, based on their level of threat, vulnerability, and capacity, are classified as moderate.

Introduction

Disasters are events that threaten the lives of communities and can be divided into two types, namely natural disasters and non-natural disasters (Ramli, 2010). Non-natural disasters include technological failures, modernization, and disease outbreaks, while natural disasters include floods, landslides, earthquakes, and tsunamis (Wiaro, 2017).

Natural disasters are a serious issue in the world as they can cause environmental damage, poverty, and even loss of life (Oktari et al., 2022). One country threatened by natural disasters is Indonesia. Indonesia is highly vulnerable to natural disasters, both geographically, demographically, sociologically, and historically (Surtiari et al., 2017; Wardyaningrum, 2014). This is due to the convergence of three tectonic plates, namely the Pacific Plate, Eurasian Plate, and Indo-Australian Plate (Pramono et al., 2020; Emaliyawati et al., 2016; Larue et al., 2016).

According to the National Disaster Management Agency (BNPB), from 2005 to 2019, more than 78% of the disasters that occurred in Indonesia were hydro-meteorological disasters, such as landslides (Zamroni, Kurniati, and Prasetya, 2020), earthquakes (Winarno, 2011), tsunamis (McKeon and Masyrafah, 2016; Hamzah, Puspito, and Imamura, 2000), storms (Tjasyono and Kx, 1985), tornadoes (Darmawan et al., 2020), volcanic eruptions (Verstappen, 1994), and floods (Pratama and Sumitra, 2020). From 2000 to 2015, the number of deaths due to disasters in Indonesia increased by around 17 times compared to the period from 1986 to 1999 (Dartanto, 2022), and in 2019, natural disasters in Indonesia caused economic losses amounting to 80 trillion Indonesian Rupiah (BNPB, 2019).

In Indonesia, many provinces are at risk of disasters, and one of them is Lampung. Based on a survey conducted by BNPB, Lampung is a highly vulnerable province to disasters, mainly due to three risk factors: Gunung Anak Krakatau (Anak Krakatau Volcano), Sesar Sunda (Sunda Fault), and Sesar Semangko (Semangko Fault) (BNPB, 2021). This complexity makes Lampung a disaster-prone province, including the district of Pringsewu.

Urban Land Use Plan Kabupaten Pringsewu mentions the presence of five types of disasters that threaten the area, namely floods, extreme weather, earthquakes, landslides, and forest fires, particularly in the protected forest areas. According to the Historical Disaster Records obtained from the Regional Disaster Management Agency (BPBD), the most frequent disaster that occurred in Kabupaten Pringsewu from 2015 to 2022 was whirlwinds. Whirlwinds are characterized by strong winds and are usually triggered by high annual rainfall in the Pringsewu region.

Based on the incident, a risk analysis study is needed for flood, landslide, earthquake, extreme weather, and forest fire disasters in Pringsewu Regency, by the Head of the National Disaster Management Agency Regulation Number 02 of 2012 concerning General Guidelines for Disaster Risk Assessment. One of the actions that can be taken is the development of a disaster mitigation document (Sugito in Mudin et al., 2015). The aim is to update the supporting data for disaster mitigation in the Pringsewu Regency area and implement effective disaster risk mitigation efforts to reduce economic losses and casualties

Method

The assessment of disaster risk maps is obtained through the integration of hazard maps, vulnerability maps, and capacity maps. These maps are derived from various indices calculated based on their own data and calculation methods. The calculation methods and data required to calculate the various indices will differ for each type of threat. The mapping method can be seen in Figure 1.

The mapping of disaster risks is obtained through the calculation of the likelihood of disaster events and the consideration of social, economic, physical, environmental, institutional, early warning, education, and mitigation components. Each of these components serves as the basis for generating hazard indices, population exposure indices, loss indices, and capacity indices, which are determining factors in the creation of disaster risk maps and associated risk levels. In principle, disaster risk maps and the Disaster Risk Profile document are derived from the same assessment sources, with differences in the outcomes obtained.

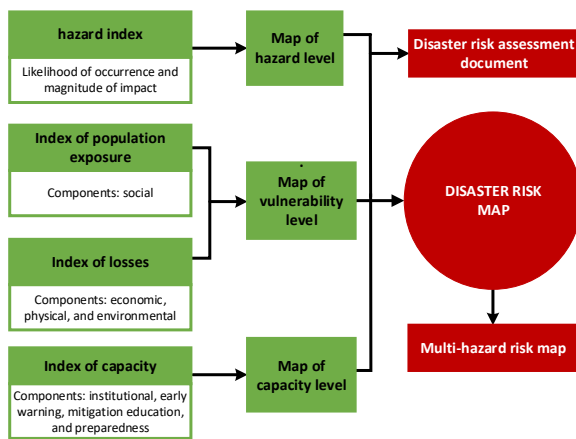


Figure 1. Research methodology.

Disaster risk maps are obtained through the integration of hazard maps, vulnerability maps, and capacity maps. Meanwhile, the KRB Document includes the levels of hazard, vulnerability, and capacity to determine the level of disaster risk. Disaster risk maps and the KRB Document are the expected outcomes of the disaster risk assessment in the district. The summary of the assessment results extends to the sub-district level in Pringsewu District. The sub-districts include Adiluwih, Ambarawa, Banyumas, Gading Rejo, Pagelaran, Pagelaran Utara, Pardasuka, Pringsewu, and Sukoharjo.

The basic formulation for disaster risk analysis according to the Head of BNPB Regulation Number 4 of 2008 is as follows:

$$R = Hazard \times \frac{Vulnerability}{Capacity}$$

Explanation:

R: Disaster Risk
H: Hazard
V : Vulnerability
C : Capacity

Analysis

The level of disaster risk is calculated by considering the vulnerability and resilience levels using the assistance of GIS (Geographic Information System) technology. In Pringsewu District, the risk of natural disasters is calculated based on the types of disasters such as floods, landslides, earthquakes, extreme weather, and forest fires.

A. Disaster Risk Assessment Index

1. Hazard

The assessment of the hazard index covers all potential disasters in Pringsewu Regency. Each disaster is evaluated based on different parameters. The determination of these parameters refers to general guidelines for disaster risk assessment and other reference guidelines available in relevant national ministries/institutions. These parameters as a whole can determine the extensive potential hazards in disaster-prone areas.

- a. Floods
The assessment of the flood hazard index is determined by the following parameters: distance from rivers map, soil type map, topography map, land cover map, slope map, and rainfall map.
- b. Extreme Weather
The parameters used to determine the hazard index for extreme weather are land cover maps, slope maps, and rainfall maps.
- c. Earthquakes
The assessment of the earthquake hazard index is determined by the following parameters: distance from fault map, slope map, and rock type map.
- d. Landslides
The assessment of the landslide hazard index is determined by the following parameters: distance from fault map, slope map, and rock type map.
- e. Forest Fires
The assessment of the forest fire hazard index is determined by the following parameters: soil type map, rainfall map, and forest type map.

The results of the hazard level assessment for all types of potential disasters in Pringsewu Regency can be seen in the following table:

Table 1. Hazard Level Table in Pringsewu Regency

No	Hazard Type	Hazard Level
1	Flood	Moderate
2	Landslide	Low

3	Earthquake	Low
4	Extreme Weather	Moderate
5	Forest and Land Fire	High

The table above provides information about the overall hazard level of potential disasters in Pringsewu Regency. The hazard levels vary for each type of disaster, namely low, moderate, and high. The low hazard level applies to earthquake and landslide potential, while the high hazard level applies to forest and land fire potential. The determination of the hazard level is based on the maximum hazard index value for each potential disaster.

2. Vulnerability

The assessment of vulnerability to flood, extreme weather, earthquake, landslide, and forest fire is obtained through the exposure index of the population and vulnerable community groups to these disasters. Meanwhile, the losses caused by floods, extreme weather, earthquake, landslide, and forest fire are categorized into two types: monetary losses (physical and economic) and losses in terms of environmental damage. Similar to the population exposure index, the loss index is also evaluated for each disaster by presenting data from all potentially affected districts.

Overall, disaster vulnerability is at a high level for the 4 types of potential disasters in Pringsewu Regency. The results of vulnerability analysis for each potential disaster in Pringsewu Regency can be seen in the following table:

Table 2: Disaster vulnerability levels in Pringsewu Regency

No	Hazard Type	Class			
		Population Exposure	Financial Loss (Rupiah)	Environmental Damage	Vulnerability Level
1	Flood	High	High	Low	High
2	Landslide	High	High	High	High
3	Earthquake	High	High	-	High
4	Extreme Weather	High	High	Low	High
5	Forest and Land Fire	Low	Low	Low	Low

The table above provides information on the overall disaster vulnerability levels for each type of disaster. There are vulnerability levels determined based on population exposure, financial losses, environmental damage, and overall vulnerability level.

3. Capacity

The assessment of regional capacity follows the Regulation of the Head of the National Disaster Management Agency Number 03 of 2012 concerning the Guidelines for the Assessment of Regional Capacity in Disaster Management. The regulation states that the Capacity Index is calculated based on indicators within the Hyogo Framework for Actions (Hyogo-HFA). The HFA, agreed upon by more than 160 countries worldwide, consists of 5 priority programs for disaster risk reduction. The achievement of these disaster risk reduction priorities is measured by 22 achievement indicators.

The recapitulation of the overall capacity levels for all types of disasters in Pringsewu District can be seen in the following table:

Table 3: Disaster capacity levels in Pringsewu District.

No	Disaster Type	Class		
		Regional Resilience	Readiness	Capacity Level
1	Flood	Low	Medium	Medium
2	Landslide	Low	Medium	Medium
3	Earthquake	Low	Medium	Medium
4	Extreme Weather	Low	Medium	Medium
5	Forest and Land Fire	Low	Medium	Medium

Based on the above table, the overall capacity level for each disaster in Pringsewu District is medium. Therefore, an improvement in the capacity of the government and the community is needed for all disasters in Pringsewu District.

B. Risk Level Assessment

From the combination of hazard level, vulnerability, and capacity, the disaster risk level in Pringsewu Regency can be determined. The risk level for the 5 types of hazards in Pringsewu Regency has a moderate risk potential. This provides an overview for the Pringsewu Regency Government and related parties to develop efforts for disaster risk reduction to support disaster management in Pringsewu Regency.

Table 4. Disaster risk levels in Pringsewu Regency.

No	Hazard Type	Class			
		Hazard	Vulnerability	Capacity	Risk
1	Flood	Medium	High	Medium	Medium
2	Landslide	Low	High	Medium	Medium
3	Earthquake	Low	High	Medium	Medium
4	Extreme Weather	Medium	High	Medium	Medium
5	Forest and Land Fire	High	Low	Medium	Medium

a. Flood Risk

The flood risk in Pringsewu Regency is highest in the Pardasuka District, which is presented in more detail in the following picture:

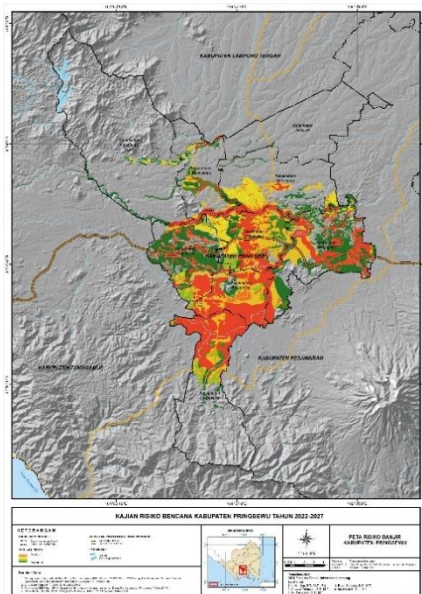


Figure 2. Flood disaster risk level in Pringsewu Regency

b. Landslide Risk

The landslide risk in Pringsewu Regency is highest in the North Pagelaran District, which is presented in more detail in the following picture.

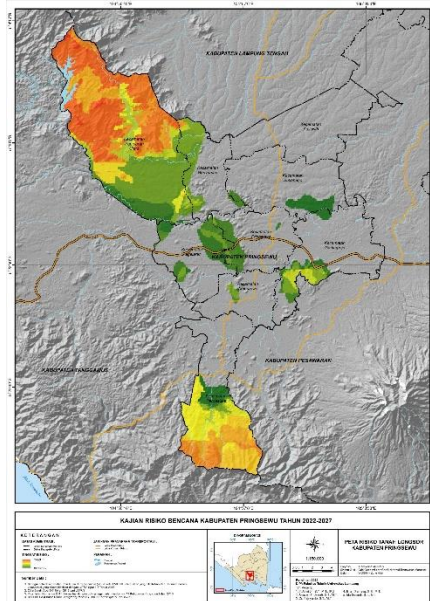


Figure 3. Landslide disaster risk level in Pringsewu Regency

c. Earthquake Risk

The earthquake risk in Pringsewu Regency is highest in the southern part of the Pardasuka District, which is presented in more detail in the following picture.

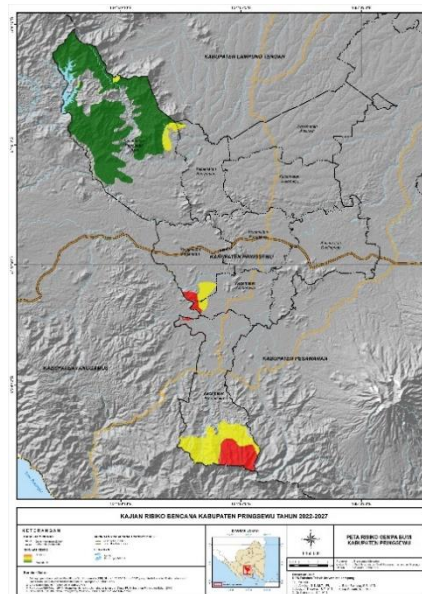


Figure 4. Earthquake disaster risk level in Pringsewu Regency

d. Extreme Weather Risk

The extreme weather risk in Pringsewu Regency is highest in the Pardasuka, Ambarawa, Pagelaran, Pringsewu, and Gadingrejo Districts, which are presented in more detail in the following picture.

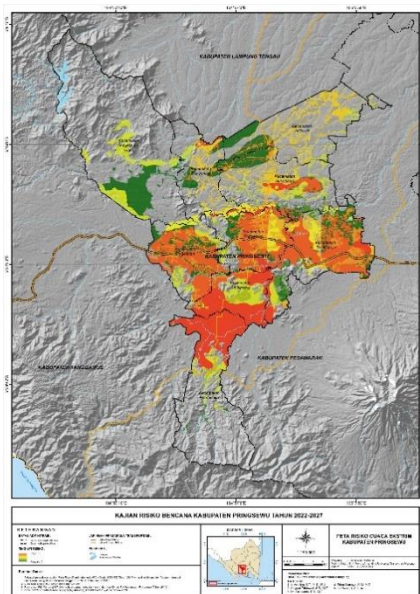


Figure 5. Extreme weather disaster risk level in Pringsewu Regency

e. Forest and Land Fire Risk

The risk of forest and land fires in Pringsewu Regency are highest in the North Pagelaran District, which is presented in more detail in the following picture:

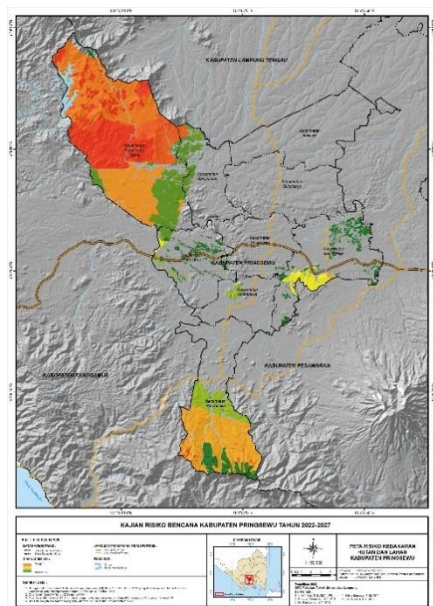


Figure 6. Forest fire disaster risk level in Pringsewu Regency

Conclusion

From the combination of hazard levels, vulnerability, and capacity, the level of disaster risk in Pringsewu Regency was determined. The research findings indicate that floods, landslides, earthquakes, extreme weather, and forest fires are categorized as moderate risks. These findings can serve as a guide in formulating disaster mitigation efforts to reduce the risk in Pringsewu Regency.

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Conflicts of Interest: The authors whose names are listed immediately below certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers’ bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements) or nonfinancial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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