http://journal.uir.ac.id/index.php/JGEET

E-ISSN : 2541-5794
P-ISSN : 2503-216X

Journal of Geoscience,
Engineering, Environment, and Technology
Vol 8 No 4 2023

RESEARCH ARTICLE

Analysis of Disaster Vulnerability Areas in West Bandung Regency, West Java, Indonesia

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Received: Jul 15, 2022; Accepted: Nov 1, 2023.
DOI: 10.25299/jgeet.2023.8.4.10065

Abstract

Mineral resources, coal, and rock are one of the potentials possessed by Indonesia to be able to earn income from the mining sector. West Bandung Regency is one of the areas that have quite a lot of potential rock and mineral resources. The potential of this area is quite large, namely andesite rock, sand, limestone, and sandstone. Zeolite and others. On the other hand, the West Bandung area has a high potential and threat of being a disaster-prone. West Bandung Regency has the highest number of natural disasters occurring in the type of landslide disaster, which occurred 52 times in the period 2008-2016, or 68% of all disasters. Loss of economic value also occurs for mining material resources which are limited by the existence of a disaster zone. So it is necessary to carry out mitigation from the start to map disaster areas that have an impact on the distribution and existence of mining material resources. This study aims to identify and analyze the potential of rock resources in disaster-prone areas, so as to be able to prioritize conservation aspects for potential mining materials. The method used in this research is through literature study, mapping the potential of mining materials, mapping the potential of disaster-prone areas, processing of secondary data, and analysis using remote sensing. The results of this study are that the rocks in the West Bandung area are divided into groups of volcanic rocks, sedimentary rocks, and alluvial deposits. The volcanic rock group got a score of 3 because it was considered more prone to erosions than the sedimentary and alluvial rock groups which were scored 2 and 1. with a weighted level of disaster vulnerability. The zone of high disaster susceptibility is considered to have the highest probability of a disaster occurring. Therefore, in the final result, the overlap between the distribution of the potential for minerals and the zone of high disaster susceptibility results in a potential area for minerals that are relatively safe from disasters, both soil movement, and flooding. Potential mining resources in West Bandung Regency are Andesite basalt 1,860,412 ha (1.43%), Limestone 667.05 ha (0.50%), Sirtu 40,949.76 ha (31.35%%).

Keywords: Risk Mitigation, Disaster, Potential Loss, West Bandung, Geological Resources.

1. Introduction

Most areas of Indonesia are areas prone to land movement or landslides. Because, the tectonic position of the territory of Indonesia is flanked by three main plates of the world which are always active at speeds of 1 to 13 cm per year (A. Basofi, A. Fariza, and I. M. Kamal, 2019). Disaster prevention and recovery in Indonesia is one of the most important sectors. Indonesia as a disaster-prone country must certainly be able to carry out disaster management properly (Fitriani et al., 2021). Natural disasters have a negative impact on lives, economies, services, and the environment in the affected areas. The consequences are long-lasting and may have a negative impact on economic, social, and environmental conditions that cannot return to normal (Sesunan, 2014). Natural disasters will then result in various losses, both from human casualties to loss of property.

This economic loss and human casualties will then lead to a decline in thewelfare status of the affected community (Saefudin et al., 2021). So it is necessary to carry out mitigation to map disaster areas that have an impact on the distribution and existence of mining material resources, one of which has taken into account disaster aspects through a holistic research process. Another thing is the vulnerability aspect, where vulnerability is the tendency of elements exposed to hazards, such as people, livelihoods, or assets so that these elements can bear losses when exposed to hazard events (Lal et al., 2012).

West Bandung Regency (KBB) is one of the areas in West Java that has a high disaster vulnerability. The contours of the area which are dominated by highlands, hills, mountains, and cliffs, make this area of the Bandung Regency area hit by natural disasters every year, besides that West Bandung Regency is also traversed by a Lembang Fault which at any time can cause a fairly large earthquake (Ansori & Santoso, 2020). Comprehensive disaster mitigation efforts should start from a disaster risk study which will substantially rely on the initial step in the form of preparing a disaster database in the form of disaster maps.

In broad outline, the disaster map that should be the basis for developing a disaster mitigation strategy for a particular type of disaster is a disaster risk map which is a synthesis product from other disaster maps which include a hazard map, a vulnerability map and a capacity map. (capacity map) (Kebencanaan & Dan, 2017).

Geologically, West Bandung Regency is surrounded by various variations of formations and also stores variations in rock. The rocks composed in West Bandung Regency include Alluvial Rocks, Neogene Limestones, Oligo Limestones, Quaternary Volcanic Rocks, Neogene Volcanic Rocks, Rocks, Pilo Volcanic Rocks, Neogene Sedimentary Rocks, Pilo Sedimentary Rocks, Oglio Sedimentary Rocks, and Neogene Breakthrough Rock. West Bandung Regency is grouped into 4 (four) morphological units, namely plain morphology, sloping, hilly and mountainous morphology (Mulyadi, 2018).

This research is based on the frequent occurrence of disasters in the West Bandung Regency which have an impact on other sectors, one of which is the presence of andesite minerals, sand, limestone and others. This research has not been maximally carried out, especially the process of mapping the existence of potential mining resources which are reduced by the presence of disaster-prone zones has not been completely mapped. So there are technical weaknesses in this research that must be continued in other research scales. However, there are strengths in terms of data analysis and interpretation, which is quite a lot of disaster data that can be processed and combined with remote sensing analysis.

2. Geological Settings

The area of West Bandung Regency is composed of various types of rocks. West Bandung which is located in the Bandung Zone generally consists of relatively young volcanic and alluvial rocks and is interspersed with hills and ridges composed of Tertiary sedimentary rocks. This zone is bounded by a series of Quaternary volcanoes both to the north and south.

According to the Geological Map of Sheets Bandung (Geologi, 2006), Geological Maps of Sheets Cianjur (Java, 2021), and Geological Maps of Sheets Sindangbarang and Bandarwaru (Rahmanto et al., 2023) with a scale of 1:100,000, the northern area is generally composed of volcanic rocks that are lighter in size. which is thought to be related to ancient volcanic activity. In the eastern part, especially the Ngamprah, Cisarua, Parongpong, and Lembang areas, it consists of younger volcanic rocks and is directly related to the volcanism of Mount Tangkubanperahu. Some areas of Sessionkerta and Gununghalu are composed of young volcanic rocks originating from the volcanism of Mount Kendeng. Tertiary sedimentary rocks consisting of the Rajamandala Formation, Jatiluhur Formation, Citarum Formation, Cantayan Formation, and Cilanang Formation are scattered in some areas of Rongga, Saguling, Cipongkor, Cipatat, and Padalarang. Alluvial deposits are scattered around the streams leading to the Cirata Reservoir and the Saguling Reservoir. Breakthrough rocks in the form of andesite, hornblende andesite, and basalt break through the Tertiary rocks.

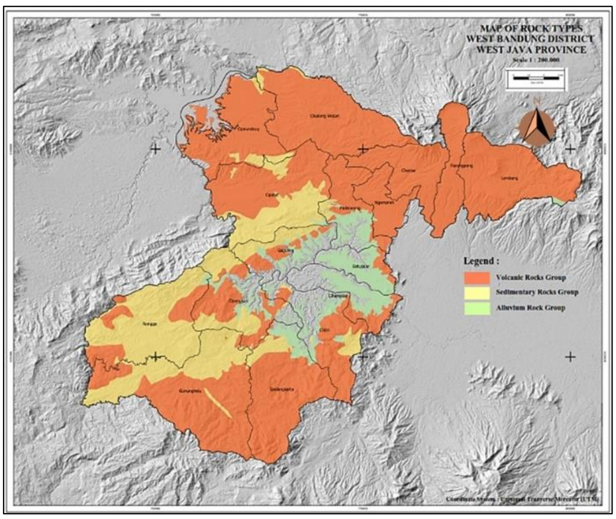

Fig 1. Map of Rock Types in the Study Area

Based on the mapping, it is known that the West Bandung area consists of three types of soil, namely latosol, andosol, and alluvial soil. Andosol soils are derived from weathering of volcanic rocks and igneous rocks, latosol soils are derived from weathering of sedimentary rocks, and alluvial soils are derived from weathering of alluvial deposits.

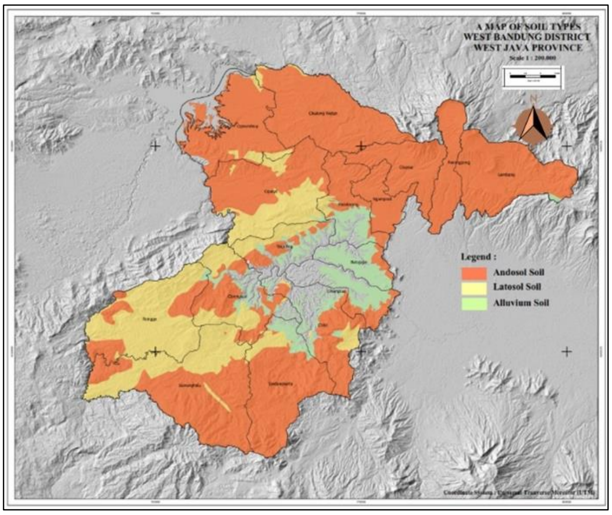

Fig. 2. Map of Soil Types in the Study Area

3. Regulation

Important things related to disaster management, including disaster mitigation, are policy aspects. Aspects of existing policies in West Bandung Regency regarding landslides. Regional Regulation of West Bandung Regency No. 2 of 2012 concerning the Regional Spatial Plan for West Bandung Regency 2009-2029;

a) Article 23 paragraph 5 discusses disaster evacuation routes and spaces including: development of disaster safe zones; the determination of the disaster evacuation route consists of: a landslide evacuation route in Cililin District via the Ciririp- Bangsaya-Buninagara road to the Cililin-Sindangkerta road to the disaster evacuation room at the Pendopo, Cililin District.
b) Article 30 paragraph 1 discusses areas prone to natural disasters in the form of landslide-prone areas consisting of: Lembang District; Parongpong District; Cikalongwetan District; Cipatat District; Cililin District; Cipongkor District; Sindangkerta District; Gununghalu District; and Rongga District.
c) In article 48 paragraph 2 there is an embodiment of protected areas including the following activities: maintaining protected forest areas and protected areas outside forest areas; maintain water catchment areas or areas that function hydrologically to ensure the availability of water resources; identification of protected forest areas; maintain and maintain protected forest areas; protection of water catchment areas; construction of infiltration ditches, infiltration wells, and infiltration lakes in water catchment areas that have been built; management of the area around the reservoir; management of the area there; protection of river border areas; construction of inspection roads along rivers in residential areas; protection of major rivers; protection of the area around the springs; protection of Nature Reserves; protection of Natural Tourism Parks; protection of the Grand Forest Park; identification and protection of landslide-prone areas; identification and protection of areas prone to volcanic eruptions; and protection of reservoirs, lakes, and rivers.
d) In article 58 paragraph 10 there are general provisions for zoning regulations for landslide-prone areas which are prepared by taking into account:
e) permitted activities include: permitted cultivation activities with technical requirements of technological engineering in accordance with the characteristics of the disaster other than in absolute protected areas; it is permitted that protection and preservation activities include the activities of planting

perennials and reforestation; and allowed to use unused land by planting plants that are able to bind and absorb water and are able to prevent erosion and landslides.

f) Activities that are directed to include: maintaining a safe area from disaster as an evacuation site; prepare evacuation routes in landslide-prone areas; control of cultivation activities located in areas prone to natural disasters; and development of information systems for early detection of landslides.

4. Material and Methods

The location covers the West Bandung Regency area, but technically for the survey location, it is only disaster locations that occur in 2021 and 2022 before May.

Based on the data, the area of West Bandung Regency is 1,305.77 KM², located between 60º 41' to 70º 19' south latitude and 107º 22' to 108º 05' east longitude. It has an average height of 110 m and a maximum of 2.2429 m above sea level. The slope of the area varies between 0 – 8%, 8 – 15% to above 45%.

West Bandung Regency covers 15 (fifteen) sub-districts consisting of: Padalarang, Cikalongwetan, Cililin, Parongpong, Cipatat, Cisarua, Batujajar, Ngamprah, Gununghalu, Cipongkor, Cipeundeuy, Lembang, Sindangkerta, Cihampelas and Rongga. In terms of land use in the West Bandung Regency area, land use for agricultural cultivation is the largest land use, namely 66,500,294 Ha, while the protected area is 50,150,928 Ha, non-agricultural cultivation is 12,159,151 Ha and others are 1,768. 654 Ha.

The methodology used in the research are;

1. Stages of Planning and Preparation
   a) The preparation stage is the initial stage to take an inventory of supporting data in research, including;
   b) Administrative data; territorial boundaries, land status and ownership, mining permits, and others.
   c) Topographic and geological data; data from topographic mapping, mapping of distribution and potential for geological disasters in the West Bandung Regency area.
   d) Other data, which includes spatial plans, geological disaster studies, etc.
2. Stages of Field Activities

This stage is the core activity of this research, while the data that is the target of this research include;

a) Environmental Aspect

Environmental aspects have 3 main components related to environmental impact issues to be considered in determining potential disaster zones.

b) Technical Aspects, including;

a) The area with the potential for geological disasters

b) Regional boundaries and frequency of disasters

Stages of Data Processing and Studio

This stage is the activity of taking inventory, calculating, processing and interpreting primary data and secondary data.

3. Stages of Analysis

There are two types of data used in this study, that is primary data and secondary data. The primary data is in the form of GNSS (Global Navigation Satellite System) measurement data at seven deformation monitoring points, while the secondary data used is Digital Elevation Model (DEM) to analyze the morphology of the research areThe software used to process GNSS data is using the compass solution software, which is the default software for GNSS from the ComNav brand, for 3 hours of observation. The time-lapse between epoch one and epoch two is 6 months (Studi et al., 2022).

4.1 Land Cover Analysis

This analysis uses satellite image data processing obtained from secondary data in ArcGIS using the Supervised Classification method. This method is used to classify images based on the spectral recognition (reflection value) obtained from the sample pixels (polygons that represent the sample area for each different type of land cover). The purposes of this investigation were to: (1) examine the level and characteristics of land use and land cover changes that occurred in the area between 2009 and 2019; (2) determine the impact of land use and land cover changes on the water overflow and infiltration capacity; and (3) produce flood risk maps for the Teunom sub-district (Sugianto et al., 2022).

4.2 Landslide Disaster Level Analysis

Research on the understanding of landslides in Indonesia has been widely practiced (Husna & Fauzi, 2019). The landslide disaster level analysis uses parameters including rainfall, geology, land cover, slope, and soil type. This analysis method uses an overlay analysis technique of each parameter needed in the analysis of landslide hazard. This analytical material is then processed using ArcGIS 10.2 software and produces data in the form of a landslide level map in West Bandung Regency. Landslides are natural disasters that harm humans and the economy both from natural events and human activities (Zamroni et al., 2020). Losses from landslides are often greater than other natural disasters such as windstorms, floods, and earthquakes (Hadmoko et al., 2017).

5. Result

Assessment of soil movement susceptibility can be carried out using the parameters of rainfall, rock type, slope, land use, and soil type based on the soil motion estimation model from Puslittanak (2004). The rainfall factor has a weight of 30%, rock type, 20%, slope 20%, land use 20%, while soil type 10%. Calculations are carried out to obtain the final value and division of the landslide hazard class. Spatial arrangement in western Bandung is still constrained by various disasters, one of which is landslide. Landslides cause some damaged locations in need of recovery. The type of landslide that often occurs is the slump; the causal factor is high rainfall and steep slopes. For spatial planning, a more detailed analysis of landslide areas is required. Further study is needed in areas stricken by disasters (Mulyadi, 2018). The evaluation spatially and temporally of historical landslides and consequences were based on the landslide database covering the period of 1981 – 2007 in the GIS environment (Hadmoko et al., 2017).

Based on the results of the calculation and division of interval classes, the following results were obtained.

Table 1. Distribution of soil movement susceptibility zones

Value Interval	Ground Movement Vulnerability Class
1,90 – 2,47	Very low
2,47 – 3,05	Low
3,05 – 3,62	Intermediate
3,62 – 4,20	Tall

The zone of very low ground movement susceptibility is generally around the edge of the Saguling Reservoir. Areas with a very low level of vulnerability are areas with gentle slopes and alluvial sedimentary rock types. This condition causes the slope to be in a relatively stable condition, thereby reducing the level of vulnerability to soil movement. Low ground movement susceptibility zones are generally located in areas with gently undulating morphology, such as the southern foothills of Mount Tangkubanperahu in Lembang and Parongpong, the southern part of Ngamprah and densely populated areas in Padalarang.

The zone of medium ground movement vulnerability is spread over almost the entire area of West Bandung Regency. Generally, this zone is found in areas with a slope of more than

15 percent. The condition of the slope causes the potential for ground motion to increase. In addition, the Andosol soil and volcanic rocks that underlie this zone have loose properties so they are prone to moving during certain conditions, such as heavy rains, earthquakes, and others.

Zones of high ground movement susceptibility are spread over almost the entire area of West Bandung Regency but only occupy a small part of the area of each sub-district. In the Cisarua, Parongpong, and Lembang areas, this zone is generally located on the slopes of Mount Tangkubanperahu with a slope of more than 45%. The high susceptibility zone in the south of Cililin and Cihamplas is closely related to the type of breakthrough rock in some areas which results in a morphology with a fairly steep slope.

In the southern part of Gununghalu and Sindangkerta, several areas are in the high vulnerability zone. The main cause is the type of soil and rock which are generally the product of Gunungkendeng volcanism. On the Landslide Hazard Map in West Bandug Regency published by the National Disaster Management Agency (BNPB), the area is included in the moderate danger zone.

5.1 Flood Vulnerability Zone

The preparation and determination of flood susceptibility zones is carried out in a systematic manner. Vulnerability zones are determined based on map sheets, administrative boundaries, and boundaries determined according to need. In making a flood hazard map for the West Bandung area, the administrative boundaries of the district are used as the boundaries of the area for which the analysis is carried out.

Flood mapping can be done by qualitative or quantitative methods. Each flood mapping method is closely related to the scale of the map and the purpose of making the map. Based on the wide scope of the investigation area and the scale that will be used in the final map, the flood susceptibility zone in the West Bandung area is carried out by utilizing the application of a geographic information system (GIS) which refers to SNI 8197:2015 concerning the Flood Prone Mapping Method.

Table 2. Values and Weights of River Flood Parameters According to SNI 8197:2015 (BSN, 2015)

Parameter	Classification	Value/Score	Weight	
Rainfall	≥ 200 mm	3	30%	
	50 – 200 mm	2		
	≤ 50 mm	1		
Land cover	Settlement	3	50%	70%
	Shrub / Farm	2		
	Rice fields / Forest	1		
Slope	0 – 2%	3	50%	
	2% - 4%	2		
	> 4%	1		

According to SNI 8197:2015 (BSN, 2015), flood disasters can be grouped into 4 categories, namely flash floods, coastal floods, river floods, and city floods. The classification of flood-prone areas is based on the landforms of the study area. Based on the condition of the landform, the mapping of flood susceptibility in the study area can be devoted to the type of river flood because morphologically it is located in hilly to mountainous areas with local alluvial plains.

The mapping method for river flood susceptibility is carried out by analyzing 3 parameters, namely climate parameters in the form of rainfall and land parameters in the form of land cover and slope. The weighting used is 30% for climate parameters and 70% for land parameters. The flood-prone class is divided based on the difference between the highest and lowest values divided by the desired interval class (4 classes).

5.2 Rainfall Analysis

The unavailability of the Meteorology, Climatology and Geophysics Agency (BMKG) weather station in West Bandung Regency makes it difficult to obtain rainfall data. Therefore, rainfall data is taken from the nearest weather station in Bandung City.

Based on climate data obtained from measurements at Bandung Station from 2009 to 2014, it is known that the average daily rainfall reaches 215.78 mm per day (Badan Pusat Statistik, 2016). Therefore, with reference to the weighting score above, the West Bandung Regency has a rainfall score of 3.

5.3 Land Cover Analysis

Areas Based on Indonesia's Digital Map of 1:50,000 Scale and 2019 Land Cover Map of the Ministry of Environment and Forestry, West Bandung region consists of 11 types of land cover, namely water bodies, shrubs, secondary dry land forests, plantation forests, settlements, plantations, mining, dry land agriculture, mixed dry land agriculture, rice fields, and open land. Based on the scores and weights in Table 2, the area of rice fields, forests, and water bodies has a score of 1, the area of shrubs, agriculture, plantations has a score of 2, and residential areas have a score of 3. Mining areas are considered flood-prone areas with a score of 3 because they consist of open land with large potential for water runoff.

5.4 Slope

The slope of the slope is one of the main factors that can trigger flooding. According to SNI 8197:2015, river flood-prone areas are generally located on alluvial plains. Alluvial plains generally have very low slopes that allow the flow of water to accumulate into floods.

Slope analysis was carried out using digital elevation model (DEM) data as a basis. The DEM data used is the National DEM or DEMNAS published by the Geospatial Information Agency (BIG). DEMNAS is built from several data sources including IFSAR data (5m resolution), TERRASAR-X (5m resolution) and ALOS PALSAR (11.25m resolution), by adding the stereo-plotting Masspoint data. The spatial resolution of DEMNAS is 0.27-arcsecond or about 8.1 meters, using the EGM2008 vertical datum (BIG, 2018). It is hoped that with better spatial resolution, the results of slope analysis and a more detailed assessment of ground motion susceptibility can be obtained.

Areas with slopes of less than 4% are generally concentrated around large watersheds. Areas with a slight slope are scattered around the flow of the Cidadap River which borders the Rongga area to the north and Gununghalu to the south and east and the Cijambu River which passes through the northern area of Rongga. Areas with small slopes are also scattered around the banks of the Cirata and Saguling reservoirs. In addition, there is also a plain area on the southern slopes of Mount Tangkubanperahu in the Lembang area.

5.5 Disaster Vulnerability Zone

After analyzing the assessment parameters and weighting the susceptibility to ground motion and flooding, the two maps were superimposed to obtain disaster hazard zones in the West Bandung Regency area. Earth movement and flooding each have a weight of 50%. The results of the weighting and calculations are then divided into 4 classes, namely very low, low, medium, and high disaster susceptibility zones.

The very low disaster susceptibility zone is generally located in high areas around the edge of the Saguling Reservoir. In this zone the vulnerability to ground movement is very low because the area is located above alluvium deposits which tend to be more stable. Its location which is not too close to the reservoir minimizes the possibility of being inundated when a flood disaster occurs.

The low vulnerability zone is in the highlands around the Saguling Reservoir and the hills in the Rongga, Gununghalu, Sindangkerta, and Cipatat areas. In this zone the level of vulnerability to ground movement is relatively low to medium, while the level of vulnerability to flooding is very low. This is due to the relatively wavy slope of the slopes so that it slightly increases the vulnerability of soil movements and minimizes flood vulnerability. Some areas with slightly gentle slopes on the southern slopes of Mount Tangkubanperahu are also in the low vulnerability zone.

The medium vulnerability zone is spread across all sub-districts in the West Bandung area. This zone generally has a medium to high level of landslide susceptibility and a low to medium level of flood susceptibility. Several densely populated areas in Ngamprah, Cisarua, Parongpong, and Lembang are in this zone. This causes a high risk of significant material losses when a disaster strikes.

High vulnerability zones are spread across all sub-districts in the West Bandung area. However, several areas such as Rongga, Cipatat, Saguling, Cipongkor, Cikalong Wetan, and Cipeundeuy have a fairly wide distribution of high vulnerability zones. Generally, high susceptibility zones have high ground movement susceptibility levels and low to high flood susceptibility levels. High vulnerability zones in the areas of Rongga, Cipatat, Saguling, Cipongkor, Cikalong Wetan, and Cipeundeuy are generally located in agricultural areas and rice fields. The arrival of disasters, both landslides and floods, will certainly cause significant material losses.

5.6 Mining Potential in Relation to Disaster Vulnerability

Disaster-prone areas, in addition to adversely affecting surface conditions, will have an impact on the amount of potential geological resources including mining commodities. This happens because, if the potential for more mining commodities is in disaster-prone areas, it will reduce the potential amount of the mining commodity itself.

Based on data obtained from One Map ESDM (Ministry of Energy and Mineral Resources, 2022), the main types of minerals produced from the West Bandung area are andesite-basalt, limestone, and sandstone. The existence of minerals in the West Bandung area is a stored potential that can be utilized for regional economic progress and community welfare. This potential can of course be optimized, especially by involving disaster mitigation in mining activities so that it can avoid disasters that may cause economic losses.

The potential of andesite and basalt is in the breakthrough rock formations of andesite and basalt types that break through Tertiary sedimentary rocks. Andesite and basalt can be found in Cipatat, Padalarang, Batujajar, Saguling, Cililin, Cihamplas, and Cipongkor areas. Limestone potential is in the Cipatat, Padalarang, and Rongga areas, and is in the Rajamandala Formation of the Limestone Member. The potential of limestone has been proven by the presence of several limestone quarries in the area. Potential sirtu in volcanic rock formations of Plio-Plistocene age in the areas of Rongga, Gununghalu, Sindangkerta, Cililin, Cihampelas, Batujajar, Cipongkor, Saguling, Padalarang, Ngamprah, Cipatat, Cipeundeuy, Cikalong Wetan, and Cisarua.

Estimates of the loss of economic value from the potential of minerals in the West Bandung area are carried out by analyzing the distribution of potential minerals and adjusting them to the level of disaster vulnerability as a result of the weighted results. The zone of high disaster susceptibility is considered to have the highest probability of a disaster occurring. Therefore, in the final result, the overlap between the distribution of the potential for minerals and the zone of high disaster susceptibility results in a potential area for minerals that are relatively safe from disasters, both soil movement and flooding.

Potential mining resources in West Bandung Regency are Andesite basalt 1,860,412 ha (1.43%), Limestone 667.05 ha (0.50%), Sirtu 40,949.76 ha (31.35%%).

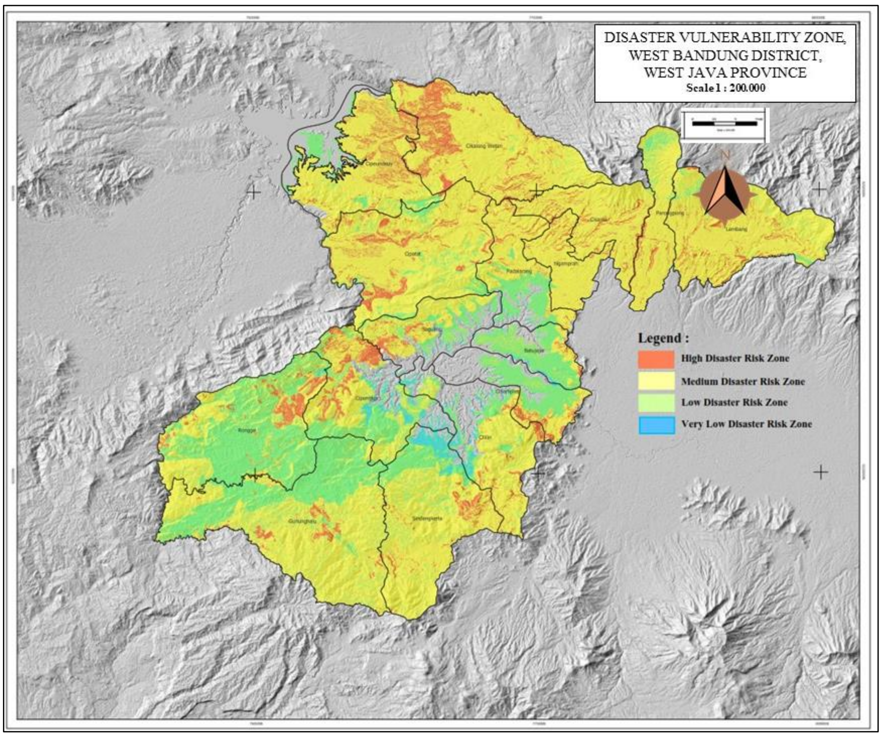

Fig. 3. Disaster Vulnerability Zone.

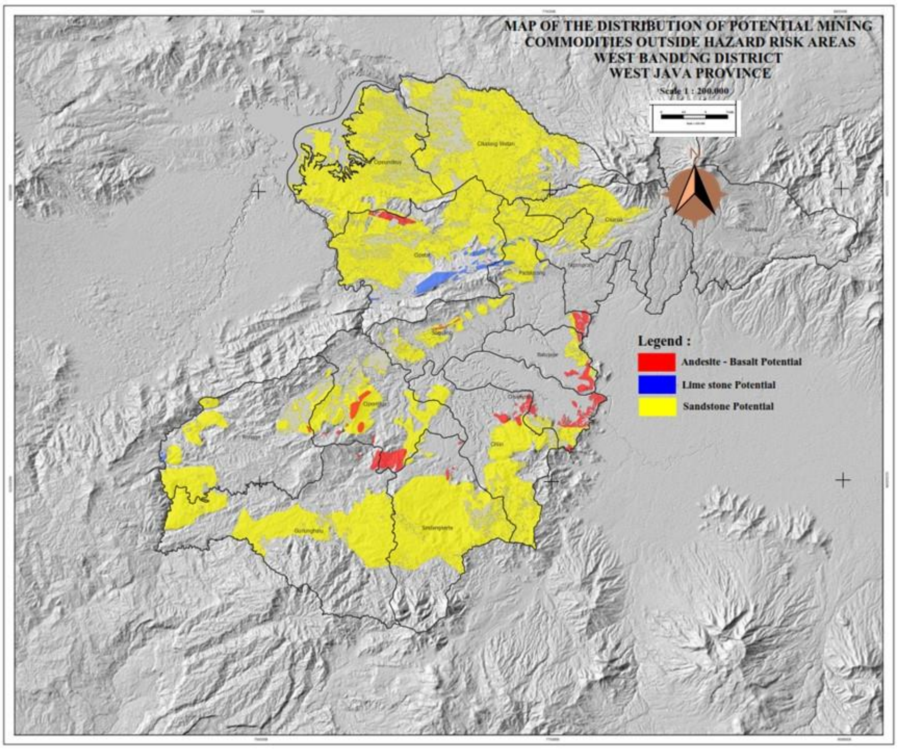

Fig. 4. Map of Potential Mining Commodities outside Disaster Prone Areas

6. Discussion

Natural disasters in relation to exposure and vulnerability all have corresponding economic costs and social costs; indeed, "if there were no costs they would not be classified as disasters in the first place". Natural hazards are naturally occurring events that became disastrous when they create large casualties and property losses, which impede social and economic development. Natural hazards occur globally and frequently. They threaten human society, natural systems, and major infrastructures (Cui et al., 2021). The economic impact of a disaster usually consists of direct (e.g. damage to infrastructure, crops, housing) and indirect (e.g. loss of revenue, unemployment, market destabilization) costs to the local economy (Parwanto & Oyama, 2014). Therefore, handling natural disasters during an emergency is not only the most important thing but there is a need forpreparedness efforts as early as possible so that the number of human victims and economic losses can be minimized as much as possible (Saefudin et al., 2021). It was determined that a total of 15,406 natural disasters occurred in the world between 1920 and 2020. Of natural disasters, 39.1% were hydrological (n = 6,025), 31.8% meteorological (n = 4,894), 11.2% geophysical (n = 1,732), 10.2% biological (n = 1,577), and 7.6% climatological (n =1,178) disasters (PALANBEK YAVAŞ et al., 2022). Some natural disasters cannot be controlled by humans such as earthquakes. Natural disasters that cannot be controlled by humans can then cause various damage and death (Labombang, 2011); (Saefudin et al., 2021). The need for preparation for disasters can reduce losses very large. This preparation can take the form of a series of activities and aims to be able to anticipate various existing problems so that the resolution of these problems can be solved effectively and efficiently (Saefudin et al., 2021). Disaster Mitigation and Disaster Preparedness are very difficult to distinguish. Measures of prevention / mitigation tend to be geared to major policy decisions at government level; also they are usually directed primarily from senior management levels (Marlyono & Nandi, 2018). Integrated activities between local government, the private sector and the international community are critical in reducing vulnerability to possible disasters (Stephan et al., 2017); (Marlyono & Nandi, 2018). Vulnerability is based on physical, economic, social and environmental losses caused by disasters. Catastrophe models use geographic information systems (GISs) to estimate the potential losses from specific natural disasters by simulating hypothetical physical characteristics of natural hazards, such as flood events, at a particular location (Botzen et al., 2019). Meanwhile, whether or not disaster is significant to economic value, there is a Neoclassical theory postulates that natural disasters do not have a significant impact on technological progress. Disasters can increase growth in the short term by shifting the economy from its normal growth path. On the other hand, endogenous growth models predict a negative impact of natural shocks on gross production and subsequently on economic growth (Panwar & Sen, 2019).

7. Conclusion

The results of identifying areas that have mineral resource potential by analyzing the distribution of mineral potential and adjusting it to the weight of the level of disaster vulnerability, where high disaster vulnerability zones are considered to have the highest probability of disaster. The influence of the distribution of disaster-prone areas has an impact on the distribution and amount of potential mining commodities, which is around ± 40% of the potential owned by West Bandung Regency. The distribution of mining commodities in West Bandung Regency is as follows Andesite basalt 1,860,412 ha (1.43%), Limestone 667.05 ha (0.50%), Sirtu 40,949.76 ha (31.35%).

Acknowledgements

We would like to thank the Institute for Research and Service, Bandung Islamic University which has funded this research, and we also thank the Regional Disaster Management Agency for West Bandung Regency, as well as other parties who assisted in this research, namely brothers Deni Mildani, and Narita.

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