Landslide Mapping And Community Social Economic Vulnerability Analysis In Landslide Prone Areas In Purworejo Regency

Wiwik Prihatin[*1], Suryanto[2], Tetuko Rawidyo Putro [3]

[1]*Master of Economic and Development Programme, Faculty Economic and Business, Universitas Sebelas Maret, Surakarta, 57126, Indonesia*

[2]*Faculty of Economic and Business, Sebelas Maret University, Surakarta, 57126, Indonesia, https://orcid.org/0000-0002-3763-9639*

[3]*Faculty of Economic and Business, Sebelas Maret University, Surakarta, 57126, Indonesia, https://orcid.org/0000-0002-3922-0460*

[1]*wiwikprihatin.mesp@student.uns.ac.id,* [2]*suryanto_feb@staffuns.ac.id,* [3]*tetuko03@gmail.com*

Abstract

Based on the Central Java Province Spatial Planning document for 2009-2029, Purworejo Regency is one of the areas prone to landslides and is quite dangerous. The total number of landslide disasters in Purworejo Regency reached 64 incidents and caused heavy casualties and material losses. The purpose of this study is to map the distribution zone and the level of landslide-prone, to find out the level of social-economic vulnerability, the level of risk of loss in Purworejo Regency, and in areas that have low, medium, and high hazard classes. This study uses secondary data and quantitative descriptive analysis methods by scoring and weighting parameters that refer to the BNPB Disaster Risk Assessment Guideline No.2 of 2012. The results showed that the landslide- prone zoning in the Purworejo Regency was divided into four classes of vulnerability, namely very low, low, medium, and high. Purworejo Regency's economic and social vulnerability index shows the same vulnerability, so the risk of loss due to disaster is very large. The results of the economic vulnerability index in all sub-districts are moderate and the social vulnerability index is high in Purworejo and Kutoarjo subdistricts, while Bruno sub-district is classified as medium Based on the risk matrix, it is known that the level of risk of loss in Kutoarjo district in the economic aspect is low and the social risk is moderate. Purworejo district has a moderate economic risk and high social risk. Bruno sub-district has the same high economic and social risks, so the losses are greater than other sub- districts. Efforts that can be made to reduce the risk of loss due to landslides are to protect important areas by making landslide retaining buildings and relocation are highly recommended for areas that are in very vulnerable areas.

Keywords: Landslides; GIS; Hazard; Economic and Social Vulnerability.

INTRODUCTION

Purworejo Regency is a regency in Central Java Province located between 109^0 47' 28"- 110^0 8' 20" east longitude and 7° 32' – 7° 54" southern part consisting of 40% of the plains area and 60% of the mountainous area. The position geographically makes Purworejo Regency vulnerable to natural disasters, especially landslides. Based on the Spatial Plan of Central Java Province in 2009-2029, Purworejo Regency is designated as one of the landslide-prone areas and quite dangerous.

Landslide disasters in Purworejo Regency occur when the rainy season arrives with high intensity and length. The location of landslides is usually on steep slopes without anchoring and hilly

areas. According to data from BPBD Purworejo Regency, the first landslide disaster occurred in 2000, which hit three sub- districts namely Bagelan, Kaligesing, and Purworejo. There are as many as 64 landslides until 2020 that hit Purworejo Regency has caused heavy fatalities and material losses, such as damage to people's homes, public facilities, farmland, roads, and other things.

To find out the zoning prone to landslides and the magnitude of the level of risk in the economic and social aspects caused by disasters, there is a need for analysis and mapping of landslide-prone areas that can provide an overview of the condition of the existing area based on the factors that cause it to occur. Rainfall, slope, land cover, and soil type are used as parameters that are given a value or score which is then multiplied by the weight value of each parameter that influences the occurrence of landslide disasters. All these parameters are overlayed using spatial analysis based on Geographic Information System (GIS) and conducted a score of vulnerability so that a zoning map of Purworejo Regency landslide-prone areas is obtained. Furthermore, to find out the magnitude of the risk posed, a vulnerability analysis is carried out. Vulnerability analysis is assessed in the form of economic and social vulnerabilities in Purworejo Regency and areas that have low, moderate, and high levels of landslide vulnerability. If the landslide disaster occurs in the economic and social conditions of vulnerable communities, it causes major losses on vulnerable areas in Purworejo Regency.

Various studies have also been conducted including efforts to review the spread of landslide-prone areas in Purworejo Regency by Rahman in 2010 and Sutarno in 2012. The study revealed that the problem of landslides caused by a precipitous topography to very steep followed by very high rainfall with potentially landslide-prone areas spread in the north and east then it is necessary to provide a settlement relocation area, without measuring the level of vulnerability that will be accepted by the community and the research has long been done so it is feared that dynamic land-use changes and other factors in

the present day. It can further aggravate avalanches. While research on landslide disaster mitigation strategies in Purworejo Regency has been conducted by Putri and Khaerani in 2017 which revealed the mitigation of landslide disasters of the Regional Disaster Management Agency (BPBD) Purworejo Regency has not been maximal, in practice no landslide emergency plan document is used as a reference as well as low public knowledge of landslide mitigation efforts. Therefore, specifically, research on mapping the latest landslides and measuring the level of the social and economic vulnerability of the community to landslide disasters in Purworejo Regency has not been found. This is because the research conducted in Purworejo Regency only partially looked at landslide vulnerability and has not analyzed the socio-economic vulnerability of the community. So that with the efforts to reduce disaster risk based on a social and economic vulnerability in this study are expected to help reduce the risk of landslide disasters and become one of the sources of public knowledge.

In the end, landslide disaster mapping and socio-economic vulnerability analysis in Purworejo Regency is intended to provide information to the community such as formulating appropriate mitigation strategies to reduce the impact or risk of disasters and reference for spatial planning of Purworejo Regency in conducting regional development.

LITERATURE REVIEW

Community welfare
According to Brudeseth (2015), explaining that well-being is a quality-of-life satisfaction that aims to measure the position of community members in establishing a balance of life including, among others, material well-being, community welfare, emotional well-being, and security. Well-being cannot be achieved or work well if one aspect of life balance is problematic. People who are in disaster-prone areas make life balance can be disrupted or not run normally because the impact of disasters causes various losses to people's lives and livelihoods in the

form of fatalities, material or psychological impacts.

Economic development

Economic development can be defined as any activity carried out by a region to develop economic activities and the standard of living of its people. "The success of economic development is not solely influenced by the choice of economic model and development model it applies, but also influenced by the presence of characteristics typical in each region or country that can affect the success of economic development" (Taryono, 2015). Areas that have characteristics prone to disasters will make economic development experience obstacles. Disasters always have a bad impact on short-term macroeconomic observations related to declining production. In developing countries, the decline in output after disasters is much greater than that of developed countries (Noy, 2007).

Economic and social vulnerability

Vulnerability is defined as the lack of community capacity in dealing with the impact of a disaster. Economic vulnerability is defined as the economic capability of a society largely determining the level of vulnerability to the threat of danger. In general, poor communities or areas are more vulnerable to danger, because they do not have adequate financial ability to make disaster prevention or mitigation efforts (BNPB, 2008).

Social vulnerability is a social condition of society that also affects the level of vulnerability to the threat of danger. In terms of education, lack of knowledge about the risks of danger and disaster will increase the level of vulnerability, as well as low levels of public health also result in susceptibility to danger. Disaster-prone communities are a group of people who need help because of the circumstances they have included the elderly, people with disabilities, children, and pregnant women (BNPB, 2008).

Landslide disaster

Definition of disaster according to spatial planning guidelines (2007) is an event that threatens and disrupts people's lives caused by natural factors, non-natural factors, and human factors resulting in fatalities, environmental damage, property losses, and psychological impacts.

According to Suripin (2002), landslides are a form of erosion in which the transport or movement of the land period occurs at some time in a relatively large volume. In Indonesia landslide events often occur, especially in steep places. Common causes of landslides according to The Minister of Public Works Regulation No.22/PRT/M of 2007 on Guidelines for Spatial Arrangement of Landslide Prone Areas based on natural factors, namely soil type, topography, land cover, and rainfall.

Landslides can be a threat if they pose a risk of loss. Threats can be identified through the creation of a threat map that refers to the disaster threat index of the National Disaster Management Agency (BNPB) Regulation No. 02 of 2012 on General Guidelines for Disaster Risk Assessment. The threat map will show the hazard level zoning of one type of disaster threat at any given time, depending on the vulnerability and capacity of that area, which can lead to disaster.

Geographic Information System (GIS)

Geographic Information System (GIS) helps utilize spatial analysis that produces a map that contains various information such as the potential for ground movement and all aspects. This can certainly be used by the local government to the community as an early warning in the mitigation of the pre-disaster stage of landslides.

METHODOLOGY

The research approach in this report uses quantitative descriptive methods that aim to reveal a phenomenon of natural circumstances to see landslide-prone zoning in Purworejo Regency which is then seen the level of landslide hazard with the score and weighting of landslide parameters (rainfall, soil type, land use, marbles) which will be overlayed spatially with Geographic Information System (GIS) after it is

known that the distribution of landslide-prone zones with the level of danger in Purworejo Regency the next stage is to analyze the level of vulnerability and risk of losses of vulnerable areas in the face of landslide disasters using the index of economic vulnerability and social vulnerability following the Regulation of the Head of the National Disaster Management Agency (BNPB) Number 02 of 2012 on General Guidelines for Disaster Risk Assessment by taking three sub- districts that have landslide vulnerability classes. Low, medium, and high.

Landslide susceptibility level

The analysis is to be used using a raster- based Geographic Information System (GIS), consisting of three stages, namely the determination of parameters or variables, determination of scores, and overlays for weighting. Determination for landslide-prone zoning maps is done by reviewing various similar literature that has been done before, then setting four parameters, namely marbles, soil type, rainfall, land cover. The scoring for each variable depends on its effect on landslide hazard with the lowest score of 1 and highest 5.

Table 1. Landslide susceptibility parameters

No.	Parameter	Variable	Weight (%)	Score
1.	Rainfall	<2000 (Low)	25	1
		2000-2500 (Medium)		2
		2500-3000 (Fairly Wet)		3
		3000-3500 (Wet)		4
		>3500 (Very Wet)		5
2.	Type of Land	Alluvial (Insensitive)	15	1
		Latosol (Somewhat Sensitive)		2
		Podsolic (Sensitive)		3
		Regosol (Very Sensitive)		4
3.	Slope	0-8 (Flat)	35	1
		8-15 (Ramps)		2
		15-25 (Somewhat Steep)		3
		25-40 (Steep)		4
		>40 (Very Steep)		5
4.	Land Use	Forest	25	1
		Garden		2
		Shrubs, Settlements, Ponds, Swamps		3
		Farmland		4
		Paddy		5

Source: Analysis results, 2020.

The result of this overlay will be a new parameter where the combination of several maps will form a wedge that can be used as a parameter of landslide potential. To determine the value of the new parameter, a mathematical equation is needed by combining the scoring and

weighting that has been done before. The equation is:

$X = W_i \times X_i$ Information:

X = Value of vulnerability W_i = Weight for i-parameter

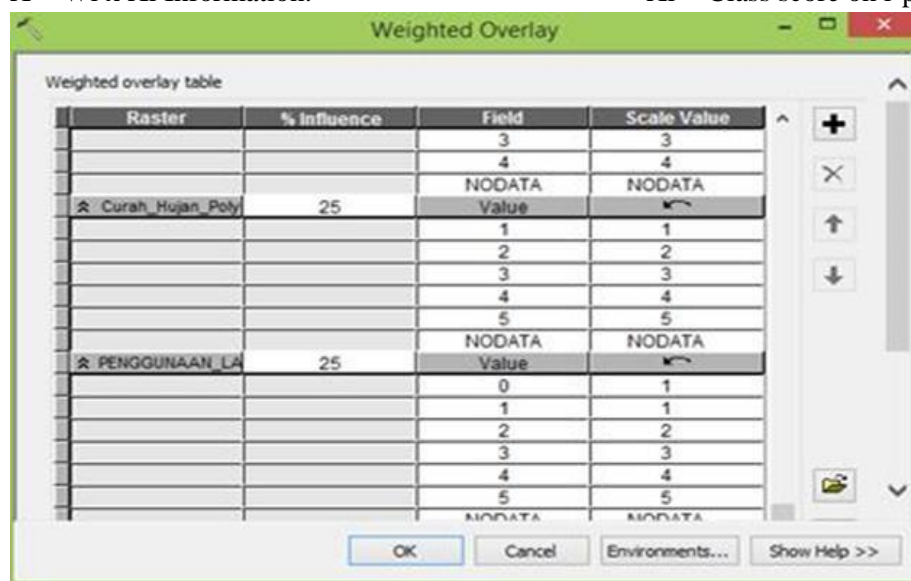X_i = Class score on i-parameter

Figure 1. The results of the equation can determine the value of vulnerability on the new map. The new map in raster form is then converted into a polygon to represent spatial features that have an area. In this new map, the score value is determined based on where the region with a high landslide potential will have a high value shown in the gride code column in GIS.

Table 2. Classification of landslide susceptibility

Landslide susceptibility class	Score
Very low	1
Low	2
Medium	3
High	4

Source: National Geological Agency-ESDM, 2020.

Vulnerability

The vulnerability analysis carried out is a vulnerability in economic and social aspects calculated based on the general guidelines of BNPB disaster risk assessment number 2 of 2012, with the method of scoring and weighting. The results of the calculation of the score and weighting of the vulnerability aspect can be classified the vulnerability index class into three classes, namely low, medium, and high vulnerability.

Table 3. Classification of vulnerability index classes

Vulnerability class	Value	Weight	Score
Low	1		0,00-0,33
Medium	2	100%	0,34-0,66
High	3		0,67-1,00

Source: National Disaster Management Agency (BNPB), 2012.

PARAMETERS OF ECONOMIC VULNERABILITY

Economic vulnerability in its analysis uses two parameters namely PDRB and productive land area (rice fields, gardens, agriculture, and others) converted into rupiah. Productive land parameters are obtained from Purworejo Regency data in numbers or portals of one data. The PDRB parameters used are based on prevailing prices, obtained from data from the Purworejo District Statistics Agency. This parameter is used to see the ability of economic resources of a region in creating added value at a

certain period, so that if the PDRB value is high then its economic resources are also high aka abundant and economic losses due to disasters are also large.

Table 4. Components of landslide disaster economic vulnerability index

Parameter	Weight (%)	Class			Score
		Low	Medium	High	
Productive land	60	<50 million	50-200 million	>200 million	max class/value
PDRB	40	<100 million	100-300 million	>300 million	class
economic vulnerability: (0.6 x productive land score) + (0.4 x PDRB score)					

Source: National Disaster Management Agency (BNPB), 2012.

Social Vulnerability Parameters

The social vulnerability of the population to landslide disasters uses two parameters namely population density and vulnerable groups (gender ratio, age group ratio, disability ratio, poverty ratio). These parameters are determined based on the ability of the population in the face of disasters. The sex ratio is the ratio of the male population to women in landslide- prone areas. The male population is considered to have a greater capacity and responsiveness than women in the event of a disaster. Poverty is the number of poor people in landslide-prone areas, the poor have low financial capabilities in the event of a disaster. Disabled people are the number of people with disabilities from various criteria such as blind, deaf, double disability, and others. The age group that includes vulnerable is the age group of 0-14 years and >65 years or non-productive age who have low ability capacity in the event of a disaster.

Table 5. Component of landslide disaster social vulnerability index

Parameter	Weight (%)	Class			Score
		low	medium	high	
population density	60	<500 soul/km²	500-100 soul/km²	>1000 soul/km²	class/ max grade class
the ratio of vulnerable groups (gender, poverty, disabled people, age group)	40	<20%	20-40%	>40%	

$$Kerentanan\ Sosial : \left(0{,}6 \times \frac{\log\left(\frac{Skor\ kepadatan\ penduduk}{0{,}01}\right)}{\log\left(\frac{100}{0{,}01}\right)}\right) + 0{,}4 \times Skor\ Rasio\ Kel.\ Rentan$$

Source: National Disaster Management Agency (BNPB), 2012.

LEVEL OF RISK OF ECONOMIC AND SOCIAL VULNERABILITY

Meeting from the disaster threat level to the level of vulnerability of the community will be able to position the community and the area concerned at different levels of risk. Classification of the level of risk of loss of landslide-prone areas can be seen from the level of threat and social-economic vulnerability through the risk matrix.

Figure 2. Risk Matrix

RESULTS

Spatial Analysis of landslide-prone Zoning

This analysis uses a raster-based Geographic Information System (GIS), consisting of three stages namely the determination of parameters or variables, determination of scores, and overlay for weighting. Determination for landslide-prone zoning maps is done by reviewing various similar literature that has been done before, then setting four parameters, namely marbles, soil type, rainfall, land cover.

TOPOGRAPHY

Topography or slope conditions in Purworejo Regency can be divided into five categories, namely slope of 0-8% (flat) covering the southern and central parts of Purworejo Regency; the slope of 8-15% (low) covers parts of Kemiri, Bruno, Bener, Loano, Bagelan, Kaligesing, Pituruh; the slope of 15-25%

(medium) covering the northern and eastern parts of Purworejo Regency; the slope of 25-40% (height) covering a small part of Bruno, Kemiri, Gebang, Kaligesing, Bener; The slope of >40% (steep) covers parts of Kemiri, Pituruh, and Bruno districts.

Lithology

Lithology or soil type in Purworejo Regency has alluvial soil type, Latosol, Podsolik, Regosol with different levels of vulnerability to landslides. Alluvial soil types dominate most of the central and southern regions of Purworejo Regency. The land of Latosol is found in the northern and eastern regions of Purworejo Regency. The land is located in some areas of Pituruh subdistrict, Gebang, Kemiri. Tanah Regosol is located in parts of the southern end of Gerabag, Ngombol, Purwodadi, Bagelan, and northern Districts Gebang, Bener, Loano, Purworejo.

CLIMATOLOGY

Purworejo Regency has a wet tropical climate with an average temperature between 19 °C-28°C, and air humidity between 70%-90%. Rainfall with a dry class of 2,000-2,500 dominates the southern subdistrict region while rainfall with a fairly wet class of 2,500-3000 dominates the northern subdistrict of Purworejo Regency.

Land Use

Land use in Purworejo Regency is divided into rice fields and non-rice fields. Rice fields have an area of 29,732 ha planted with rice with the type of irrigation rice fields and rain fields. For non-rice fields have an area of 73,749 ha in which there are forests, agriculture, plantations, built and unweakened land, and others.
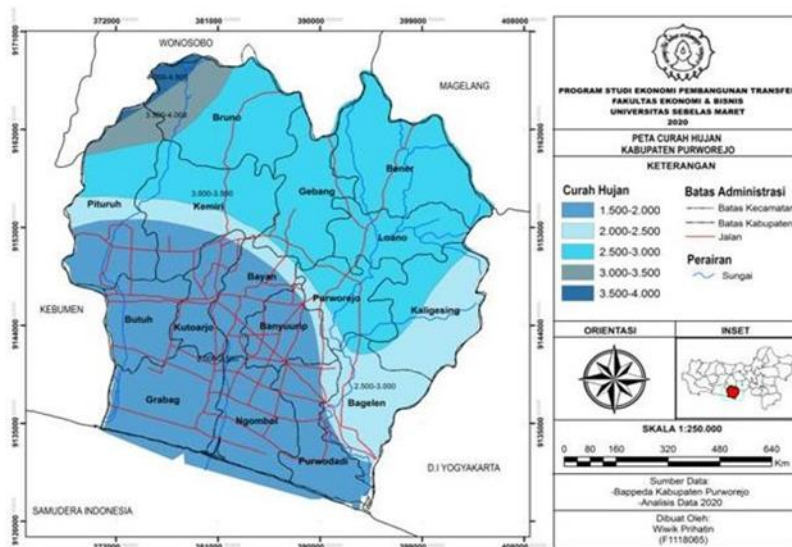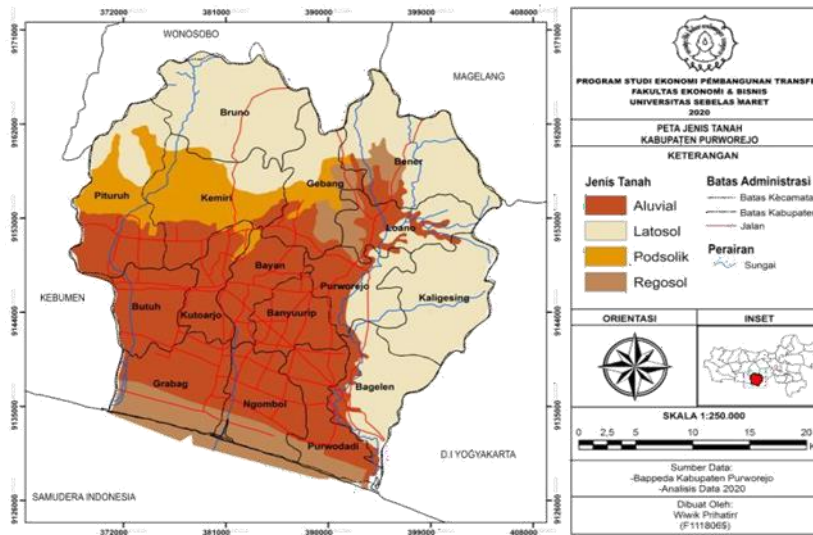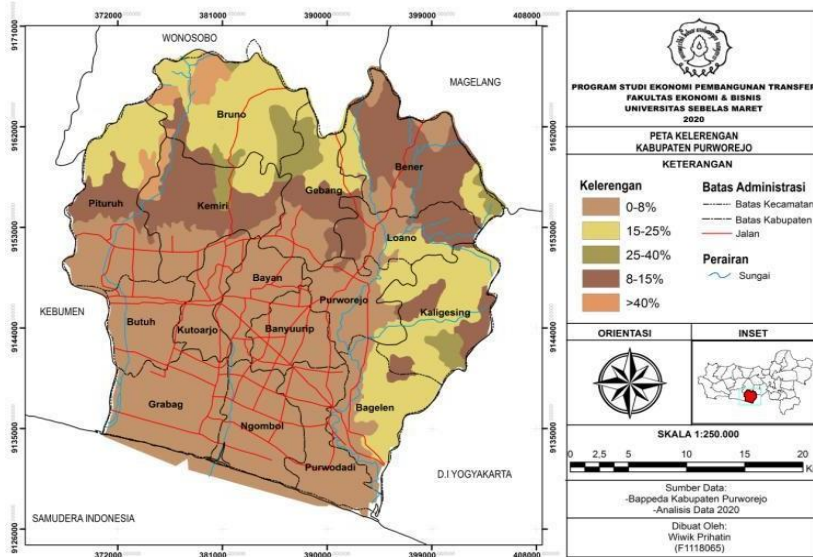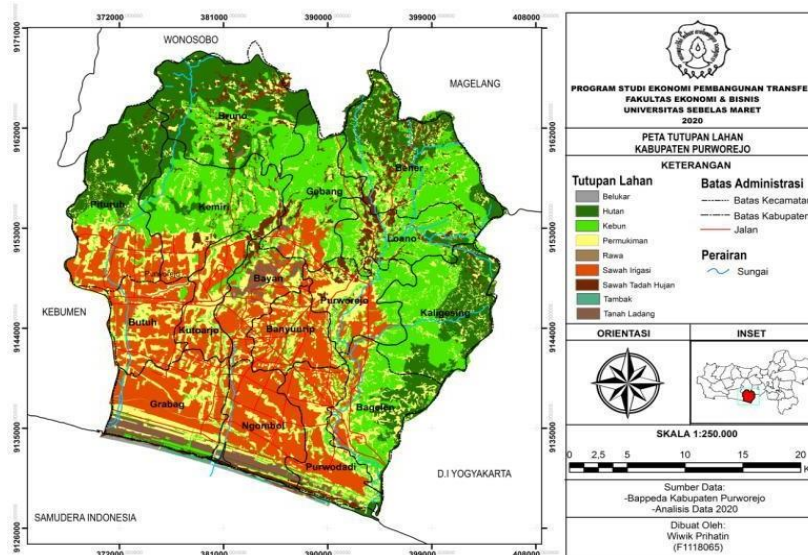
Figure 3. Map of the Physical Condition of Purworejo Regency

LANDSLIDE VULNERABILITY

Spatial data processing from Geographic Information System (GIS) produces landslide-prone zoning maps of Purworejo Regency which is divided into four classes, namely very low, low, medium, and high. Very low landslide vulnerability is an area that has a very low level of vulnerability to land movement or rarely land movement, both old ground movement, and new land movement, except in areas not wide on river cliffs. The area of landslide-prone area is very low, namely ± 27.13828 km² or 2,713.82 ha in Purworejo Regency. Very low zones are dominated by flat marbles (0-8%) and partial ramps (8-15%), low and moderate-intensity rainfall of about <2000- 2500 mm/year, alluvial soil types that have landslide insensitive properties, and land cover of many forests and gardens, the rest of which are others. This class zone is widely found in the southern and central parts of Purworejo Regency which includes most districts Grabag, Ngombol, Banyuurip, Bayan, Kutoarjo, and a small part in Bagelen, Purworejo, Need, Pituruh, Kemiri, and mostly in Purwodadi District.

Low landslide vulnerability is an area where the level of vulnerability of soil movement is relatively low, rarely occurs ground movement if there are no problems on the slope and if there is old ground movement, the slope will be effective again. The area of low landslide-prone area is ± 751.5306 km² or 75,153.05 ha in Purworejo Regency. Most low avalanche vulnerability class zones are in flat marbles (0-8%) and a small percentage of sloping marbles, somewhat steep (8-25%). The types of soil that dominate are alluvial and latosol. The average rainfall is in the low, moderate, and a quite wet class of <2000- 3000 mm / year. Land cover is widely used for settlements or built-up land and plantations. This class zone is spread throughout the districts in Purworejo Regency, namely Grabag, Ngombol, Banyuurip, Bayan, Kutoarjo, Bagelen, Purworejo, Butuh, Pituruh, Kemiri, Purwodadi, Kaligesing, Bruno, Gebang, Loano, Bener. Of the entire region, this zone is mostly in the lowlands, namely the south and east directions of Purworejo Regency.
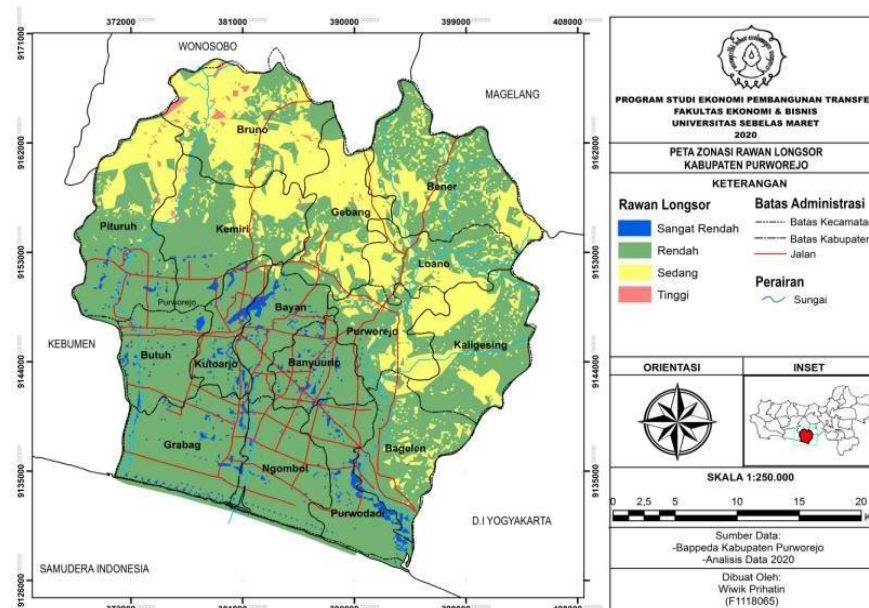
Figure 4. Zoning Prone to Landslide Purworejo District

Landslide vulnerability has a level of middle-class land movement, there can be land movement especially in areas bordering river valleys, fault scarps, road cliffs, and if slopes are disturbed. The slope range of slopes ranging from flat (0-8%) to very steep (<40%), averages in marble classes three and four. Rainfall levels are mostly quite wet class which is 2500-3000 mm / year. The type of soil is mostly Latosol which is somewhat sensitive to landslides. The land cover that dominates is the settlement while the gardens and rice fields are half. Moderate or middle-class landslide vulnerability zones are located in the northern and eastern parts of Purworejo Regency, namely in Pituruh, Kemiri, Bruno, Gebang, Loano, Bener, Bagelen, Kaligesing, Purworejo. For Bruno and Gebang districts dominated by moderate and medium-class landslide-prone because the area is in the steep hills that are also planted with rain-dreaded rice fields. While Bayan District is only a small part that is at the top of the border of Kemiri subdistrict. High landslide vulnerability has a high level of vulnerability to be exposed to soil movement, often soil movement due to long high-intensity rainfall and soil movement both old and new actively moving so that this area is very dangerous to occupy. Slopes range from ramps (8- 15%) to very steep (>40%) dominated by rather steep slopes (15-25%). The average

rainfall intensity is classified as a fairly wet and wet class of 2500-3500 mm / year. The condition of mostly latosol soil types and land cover such as green vegetation whose roots bind to the soil and absorb water is generally very little because settlements or land are built and rain-soaked rice fields control most of the area. High landslide-prone class zones are located in Pituruh, Gebang, Bruno, and Kemiri districts. Bruno subdistrict has the highest landslide-prone area compared to other sub-districts, this is because Bruno subdistrict is a highland area in the form of the South Serayu mountains with an altitude of 200-900 meters above sea level and factors supporting the parameters of the cause of high landslides as well. Some studies and cases of landslides that have occurred in Purworejo Regency generally report that high and long intensity rainfall and steep slopes make landslide disasters occur.

VULNERABILITY ANALYSIS

This economic and social vulnerability was carried out after creating a map of landslide-prone disasters that resulted in very low, low, moderate, and high threat levels at the subdistrict level in Purworejo Regency. Only three of the sixteen subdistricts of landslide-prone areas low, medium, and high threat levels were taken for vulnerability analysis, namely in Kutoarjo

District (low), Purworejo (Medium), Bruno (High).

ECONOMIC AND SOCIAL VULNERABILITY OF PURWOREJO REGENCY

Productive land in Purworejo Regency is divided into two, namely rice fields and non-rice fields. The area of rice fields in Purworejo Regency is 52,613 ha with the amount of rice production weighing 336,837 tons while the area of non-rice fields is 37,245.31 ha with the amount of product produced weighing 117,801.8 tons so that the total area of productive land is 89,858.31 ha. If the area of all productive land is converted into rupiah to Rp 2,976,355,803.- which belongs to the high class (>200 million). The PDRB parameter used is based on prevailing prices, Purworejo Regency in 2019 has a PDRB of Rp 18,672,840.-, according to the economic vulnerability index classified into the low class (<100 million).

For social vulnerability used population density parameters which are the result of a population of 718,316 people divided by an area of 1,034 km², Purworejo Regency has a population density of 694 people / km² with a moderate index class category. In addition to population, density parameters are also used vulnerable group parameters. The sex ratio is the ratio of the male population to women in landslide- prone areas, the result obtained by 97 people means that for every 100 female population there are 97 male residents. The poor population of Purworejo Regency is as many as 80,692 people or 11.29%. The number of disabled people in Purworejo Regency is 2,459. The number of age groups in Purworejo Regency is 251,819 people or 35%. The total percentage of vulnerable groups of Purworejo Regency is 47%, including the high class (>40%) or vulnerable to landslides.

Table 6. Purworejo district social and economic vulnerability index

No.	Vulnerability	Parameter	Weight (%)	Class	Value	Scoring	Index
1.	economics	land Productive	60	high	3	1,00	0,73
		PDRB	40	low	1	0,33	
2.	social	Density inhabitant	60	medium	2	0,66	0,79
		Ratio group vulnerable	40	high	3	1,00	

The level of vulnerability of economic and social aspects of Purworejo Regency is classified as high class. Landslide-prone areas that have high economic and social value will cause losses or risks received high both in the short and long term, so it is very vulnerable if exposed to disasters. The economic and social vulnerability of Purworejo Regency resulted in the same high

level of vulnerability with a value approaching 1.00. The vulnerability level is entered into a gis attribute table that is overlayed with the previous disaster threat level. The results can be seen in Map 7. The risk of loss due to economic and social vulnerability depends on the threat level of each region.
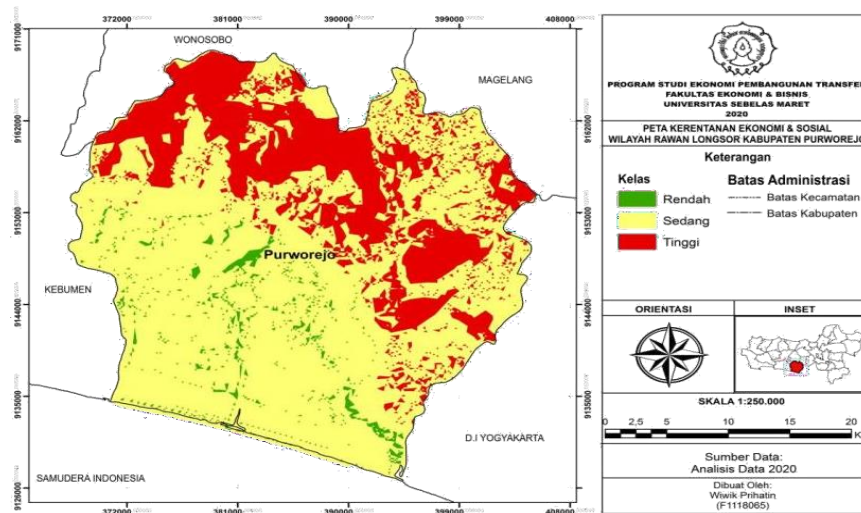
Figure 5. The Resulting Overlay of Threats and Socioeconomic Vulnerabilities of Purworejo Districts

Economic and Social Vulnerability of Landslide Disasters in Low, Medium, and High Threat Level Zones (Kutoarjo Subdistrict, Purworejo, Bruno)

PDRB in Purworejo district has the highest amount, which is Rp 3,133,339.95. Kutoarjo district is second at Rp 1,175,545.64. While Bruno subdistrict has the lowest Gross Regional Domestic Product of Rp 472,303.62. Based on the economic vulnerability index, the PDRB of the three sub-districts belongs to the low class (<100 million). The level of land productivity according to the type of production and the highest land area is owned by Bruno subdistrict. The lowest land productivity is in Purworejo subdistrict. If converted into rupiah, Kutoarjo district has a higher productive land value of Rp 168,602,592.8 compared to Bruno district Rp 144,326,223, because of the amount of rice field production is greater, then Purworejo district in the last order has productive land of Rp 119,840,472. All sub-districts are included in the index of middle or medium class economic vulnerability (50-200 million)

Table 7. The productive land area of landslide-prone areas in Purworejo district

No.	Land Productive	Kutoarjo District		Purworejo District		Bruno District	
		Sum Production (Ton)	Broad Land (Ha)	Sum Production (Ton)	Broad Land (Ha)	Sum Production (Ton)	Broad Land (Ha)
1.	Rice Fields	21.517	3.851	14.566	1.839	12.785	1.476
2.	Land Is Not Paddy	2.304,43	1.044,73	3062,2	648,6	12.667,32	3.158,53
	Total	23.821,43	4.895,73	17.628,2	2.487,6	25.452,32	4.634,53

Source: Purworejo Regency in Numbers, BPS, 2020.

Landslide-prone areas that have the most populous population are Purworejo district with 1,624 people / km², followed by Kutoarjo district with 1,598 people / km² and Bruno district with 412.21 people / km². Based on the population index exposed, the population density of

Kutoarjo and Purworejo districts belongs to the high index class (>1000 people / km²), and Bruno district is included in the low index class (<500 people / km²). Kutoarjo district has a percentage of vulnerable groups of 53% meaning it belongs to the highly vulnerable group (>40%). Purworejo subdistrict has a percentage of vulnerable groups of 23% classified as moderate (20- 40%). While Bruno subdistrict which is in the high landslide-prone class has a highly vulnerable group of 55% or more than 40%.

Table 8. Vulnerable groups of landslide-prone areas in Purworejo district

No.	District	Number of Vulnerable Groups (souls)				Total	Percentage
		Kind Gender	Poverty	Person Disabled	Age Group		
1.	Kutoarjo	98	5.985	157	25.789	32.029	53%
2.	Purworejo	96	6.270	130	13.011	19.507	23%
3.	Bruno	99	8.149	117	16.306	24.671	55%

The results of the scoring and weighting of economic vulnerability in all three sub-districts showed the same level of economic vulnerability, the namely medium class with a score of 0.52. The vulnerability component with the highest index values in all three sub-districts is social vulnerability versus economic vulnerability.

Table 9. Index of the social and economic vulnerability of landslide-prone areas in Purworejo district

No.	District	Vulnerability	Parameter	Weight (%)	Class	Value	Scoring	Index
1.	Kutoarjo	Economics	Productive Land	60	Medium	2	0,66	0,52
			PDRB	40	Low	1	0,33	
		Social	Population Density	60	High	3	1,00	1,00
			Vulnerable Group Ratio	40	High	3	1,00	
2.	Purworejo	Economics	Productive Land	60	Medium	2	0,66	0,52
			PDRB	40	Low	1	0,33	
		Social	Population Density	60	High	3	1,00	0,86
			Vulnerable Group Ratio	40	Medium	2	0,66	
3.	Bruno	Economics	Productive Land	60	Medium	2	0,66	0,52
			PDRB	40	Low	1	0,33	
		Social	Population Density	60	Low	1	0,33	0,59

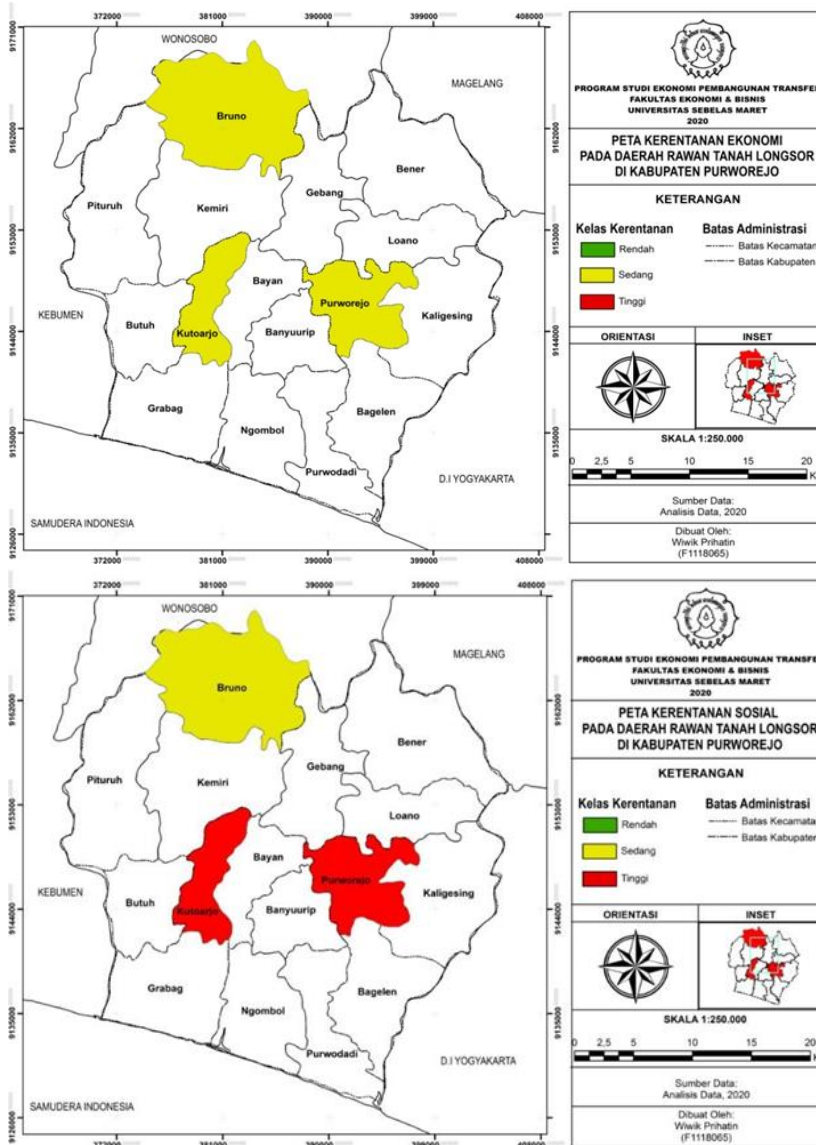|			Vulnerable Group Ratio	40	High	3	1,00	

Figure 8. Map of Economic and Social Disasters In landslide-prone Areas in Purworejo Regency

Once the threat and vulnerability level are obtained, it can be concluded that the meeting of the disaster threat level with the level of vulnerability of the community, will be able to position the community and the area concerned at different levels of risk. The high level of risk of loss of Kutoarjo subdistrict, Purworejo, Bruno can be seen from the level of threat and social-economic vulnerability through the risk matrix.
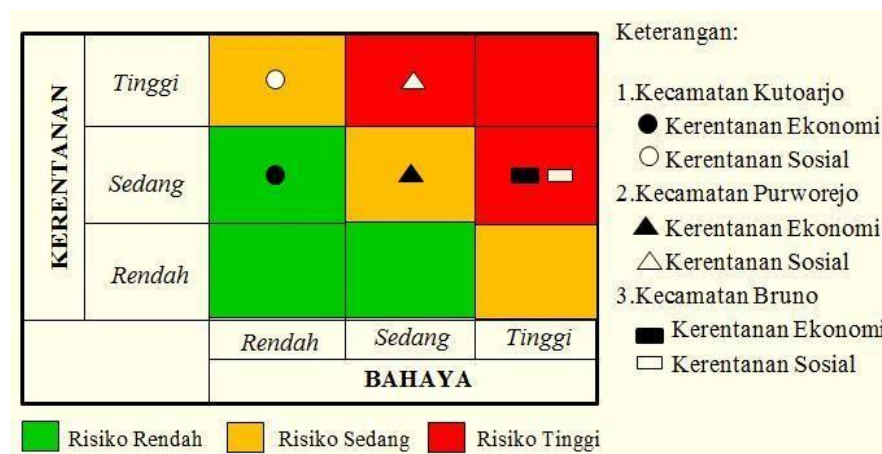
Figure 4. Risk Matrix of Social Economic Threat and Vulnerability Levels in Purworejo Regency

The risk matrix in Kutoarjo District shows that the risk of losses caused by the economy is low and social is moderate, meaning that economic activities can still run and socially can be prevented through strengthening the role in vulnerable groups to be ready for disaster when it comes. Purworejo subdistrict is seen from the risk matrix has moderate economic risks and high social risks, in this situation, Purworejo subdistrict as an economic center and activities must be protected by the creation of landslide-bearing buildings along the important area and reduce the density of its population so that in the event of a disaster does not complicate the evacuation process. Bruno subdistrict has high economic and social risks, so the losses are estimated to be very large compared to other sub-districts.

CONCLUSIONS

Landslide-prone zoning in Purworejo Regency is divided into four classes of vulnerability, namely very low, low, medium or medium, and high. Areas that have a very low-grade landslide-prone zoning area of ± 27.13828 km² or 2.54% spread across eleven sub-districts namely Grabag, Ngombol, Banyuurip, Bayan, Kutoarjo, Bagelen, Purworejo, Need, Pituruh, Kemiri, Purwodadi subdistrict. Landslide prone area with the largest percentage is in the low class of 70.34% or ± 751.5306 km² spread throughout the subdistrict in Purworejo Regency.

\For areas that have moderate or medium class landslide-prone zoning covering an area of ± 284.0557 km² or 26.58%. While the lowest area is in high-grade landslide- prone zoning covering an area of ± 5.606724 km² or 0.52% of the total area prone to landslides spread across four districts that are side by side or bordering Pituruh, Gebang, Bruno, and Kemiri.

Areas of landslide-prone class are areas whose characteristics have flat marbles to ramps, alluvial soil types, low rainfall intensity, and land cover in the form of forests and gardens. The low landslide- prone area has the characteristics of flat marbles to somewhat steep, alluvial, and latosol soil types, rainfall intensity is quite wet, and the cover of settlements, gardens, and ponds. Areas of a moderate or medium landslide-prone class have the characteristics of steep marbles, types of latosols to regosol soil, land cover is used for most settlements. Gardens, and rice paddies. While the high landslide-prone class area has the characteristics of marbles rather steep to very steep, the type of soil latosol to regosol, the intensity of wet rainfall, and the widest land use in the form of rain-soaked rice fields, there are also forests, gardens, and settlements.

The results of the economic and social vulnerability index in Purworejo Regency showed the same high vulnerability with a value close to 1.00. If the disaster-hit Purworejo Regency causes the risk of disaster losses received is very large. Economic vulnerability in all three sub-districts based on the parameters of productive land is relatively moderate and based on GDP is relatively low. Social vulnerability based on population density parameters in Kutoarjo and Purworejo districts is relatively

high while Bruno district has a low population density and on the parameters of vulnerable groups, Kutoarjo and Bruno districts are classified as high compared to Purworejo subdistrict whose vulnerability is classified as moderate. The results of the economic vulnerability index in all sub-districts including moderate, namely 0.52, and the social vulnerability index including high

are in Purworejo Subdistrict (0.86) and Kutoarjo subdistrict (1.00) while Bruno district is included moderately (0.59).Based on the risk matrix, the relationship between the disaster threat level and the level of social-economic vulnerability in Kutoarjo subdistrict is known that the level of loss or risk caused by landslides in the economic aspect is low and for social risk is classified as moderate. Purworejo subdistrict has moderate economic risks and high social risks in the event of a landslide disaster. While Bruno subdistrict has the same high economic and social risk, the losses are estimated to be greater than other sub-districts.

Social vulnerability in all calculations shows greater value than economic vulnerability, which is following the provisions of the National Disaster Management Agency which assesses the main factors causing high vulnerability can occur. The dense population and the large number of vulnerable groups who settle in landslide-prone areas will cause large and significant loss of life. The safety of one's life or life is more important than all aspects. Not to mention post-disaster will certainly create psychological trauma for anyone affected by the loss of the disaster.

The government is expected to make appropriate and clear policies or regulations regarding land use so that land transfer does not occur and always support the program of activities carried out by agencies that deal with disasters and communities, both from funding aspects and other aspects.

For the community is to access all important information related to disasters and be open. If you want to build settlements must be by the spatial plan of the area that has been set and not in areas that are prone to high landslides and

must have drainage channels that have been good well as green open space.

Do not do illegal tree felling activities and must do tree growers or plants that have strong roots binding the soil in disaster- prone areas, especially areas with steep slopes. Community commitment and participation must be strong in every stage of the program so that the target of success of disaster mitigation efforts can be more easily achieved.

To the Regional Disaster Management Agency (BPBD) which is to expand the scope of disaster management and take full responsibility for all tasks owned and obliged to carry it out and notification of information about disasters such as socialization, counseling, and simulation to the community through various media must be done thoroughly and integrated.

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