GIS APPLICATION FOR LANSLIDE RISK MAPPING IN JAMBU DISTRICT, SEMARANG REGENCY, CENTRAL JAVA

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Abstract

This study aims to determine the vulnerability of landslides in Jambu District, Semarang Regency, Central Java by use GIS processes. The model of Puslittanak 2004 is used to calculate the level of landslide vulnerability by compiling some maps, which are land cover, soil type, land slope, rainfall, and geological formation. In the mapping process, each parameter has a score classification multiplied by the score of each parameter, then the multiplication result of the score and rating is added based on the suitability of its geographic location. The results indicate that the Jambu district has the potential for landslides from low to high levels. Based on the landslide prediction model, the dominant research area has a landslide vulnerability level with a moderate hazard class in 14 villages. On the other hand, the low hazard class landslide level includes ten villages, three villages high hazard level, and one village very high vulnerability level.

1. Introduction

Indonesia archipelago is located among three great geological plate which are Indo-Australia plate, Pacific Plate and Eurasia Plate. This cause some places in Indonesia are vulnerable to some natural disaster such as earthquakes, volcano eruption, tsunami, and landslide. According to the Undang-Undang (Indonesia Law) No.24/2007 [1], Disaster is an event or series of events that threatens and disrupts people's lives and livelihoods which are caused, either by natural factors and / or non-natural factors as well as human factors, resulting in human casualties, environmental damage, property loss, and psychological impacts.

Among the three kind of disaster which are geological disaster, Hydro-meteorological disaster and biological disaster, hydro-meteorological disaster caused the highest number of economic loses as well as human loses [2]. Hydrometeorological disaster is disaster events that occurred cause by an extreme climate and meteorological occurrences, such as landslides, tornadoes, hurricanes, floods, and droughts [3].

Landslide is one of the most vulnerable country to landslide. The composition of rock, morphological condition and rainfall pattern have a bis impact to cause landslide in the hilly area. The Directorate of Volcanology and Geological Disaster Mitigation (2005) [4] states that landslides can also be called land movements. It is defined as the mass of soil or a mixture of clay, gravel, sand and gravel as well as lumps and mud, which move along the slope or out of the slope due to the gravity of the earth. Wang et al. (2017) [5] stated that the occurrence of landslides is related to various factors such as precipitation, geology, distance from the fault, vegetation, and topography.

Jambu Subdistrict, Semarang Regency, is one of the areas in the province of Central Java, is included in the category of landslide-prone. Based on data from the Regional Disaster Management Agency (BPBD) of Semarang Regency, disasters that often occur in Semarang Regency are landslides, droughts, tornadoes, and floods. Every year, there is an increase in the number of disasters, especially landslides. In January

2020, there were more than six landslides in Jambu District, which caused a huge number of economic losses [6].

Various problems related to landslides in Jambu District are the background for the research group's research. The follow-up to this problem is to find solutions and appropriate steps to overcome and reduce the impact of landslides. One of the steps that can reduce the impact of landslides is to identify the characteristics of areas prone to landslides, through mapping of landslide-prone areas using GIS application. By mapping landslide-prone areas in Jambu District, the disaster's impact can be minimized, and preventive measures can be taken against areas with a high level of vulnerability. There are several research achievements regarding landslide hazard mapping. Rahman (2010) uses parameters of rainfall intensity, slope, geology, land use, soil permeability, soil texture, and soil depth in determining landslide susceptibility [7]. The purpose of this study was to map and describe the level of landslide risk in Jambu District, Semarang Regency based on the factors that influence the occurrence of landslides.

2. Research Method

Study Area

This research was conducted in February-March 2020. The research is located in Jambu District, Semarang Regency, Central Java. Administratively, Kambu Subdistrict is bordered by Ambarawa Subdistrict in the north, in the east with Bandungan and Banyubiru Districts, in the south with Temanggung Regency and in the west with Sumowono District. This area divided into ten villages, called: Bedono, Brongkol, Gemawang, Genting, Gondoriyo, Jambu, Kebondalem, Kelurahan, Kuwarasan and Rejosari as shown in Figure 1.

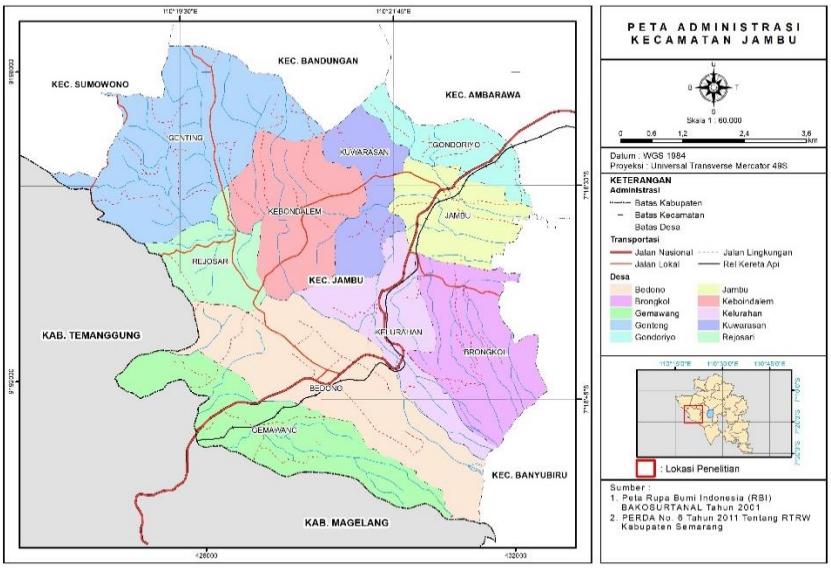

Figure 1. Administrative map of Jambu DIstrict

Methodology

This research uses GIS to map the landslide threat level, the landslide threat level, by marking and overlaying rock maps, soil type maps, land use maps, rainfall maps, and other data related to soil, land cover, rainfall and slope in Jambu District.

Landslide hazard map analysis is done after thematic maps of parameters, including rainfall maps, soil type maps, geological maps, slope maps of the area, and digital maps. Each type of map is classified based on the score and given a grade, and then the scores are grouped and analyzed. The mapping is done using ArcGIS software. In the mapping process, each parameter has a score classification multiplied by each parameter value according to the 2004 Puslittanak prediction model. Then the multiplication results of these scores and values are added based on the suitability of their geographic location. Puslittanak 2004 prediction model, the parameters used to determine the level of vulnerability are land cover, soil type, land slope, rainfall, and geological formation.

The model used to analyze the congestion vulnerability is an estimation model that refers to the 2004 research by Puslittanak with the formula [8]:

TOTAL SCORE : 0,3 FCH + 0,2 FBD + 0,2 FKL +0,2 FPL + 0,1 FJT

FCH	: Raifall Pattern
FBD	: Geological
FKL	: Slope
FPL	: Land Cover
FJT	: Soil

3. Finding and Discussion

The utilization of GIS in mapping the level of landslide hazard in Jambu District is related to mapping and spatial processing data, including rainfall data, rock types, soil types, slope, and land cover types. At which the research location, the most dominant factors in the occurrence of landslides, namely high rainfall, building rocks, and varying soil types. With the use of GIS in mapping landslide hazards, it can also use to determine low, medium, high, and very high hazards.

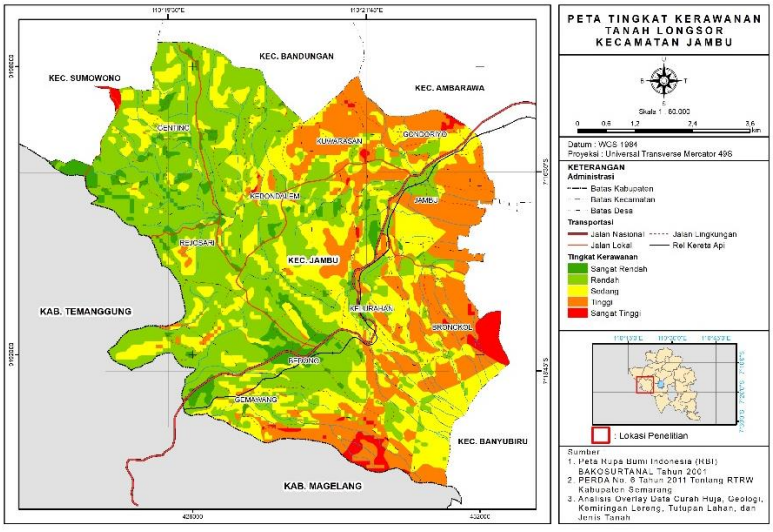

Figure 2. Landslide Risk Map of Jambu District

Figure 2 shows that the area with a very high-risk level for landslides was 122,74 hectares or 2,32% of the Jambu District area, then an area of 1.208,08 hectares showed a high-risk level or 22,83% from the Jambu District area. And an area of 1.476,46 Ha or 27,90% of the Jambu District area shows a

moderate risk, and 2.224,92 Ha or 42,04% area shows a low risk. while the remaining area of 260,19 Ha or 4,9% of the Jambu District is very low.

Estimating landslide-prone areas is carried out using an estimation model based on the research of Puslittanak in 2004. Based on this model, the parameters used to estimate landslide-prone areas include soil type, land cover, rock type, rainfall, and land slope.

Table 1. Classifications of Landslide Hazard

Interval Score (%)	Class Classification
2,40 – 2,49	Very Low
2,50 – 2,59	Low
2,60 – 2,69	Moderate
2,70 – 2,79	High
➢ 2,8	Very High

All parameters are classified based on scores then weighted according to their respective contributions, and then the data is processed. Based on the results of the analysis of 5 landslide hazard parameters using the Puslittanak 2004 landslide hazard prediction model, five criteria for landslide vulnerability were obtained, namely Very Low, Low, Moderate, High, and Very High. In the Landslide Hazard Estimation model sourced from Puslittanak in 2004, the rainfall factor received 30% weight, the rock type factor, land slope, and land cover type weighed 20, while the soil type factor weighted 10%. Based on the results of the total score and the parameters at the research location, the classification of hazard classes with the score intervals of each class is obtained, as listed in the table below.

Table 2. Village Hazard score

Village	Score	Level of Risk
Bedono	2,7	High
Brongkol	2,8	Very High
Gemawang	2,8	Very High
Genting	2,6	Moderate
Gondoriyo	2,9	Very High
Jambu	2,8	Very High
Kebondalem	2,6	Moderate
Kelurahan	2,7	High
Kuwarasan	2,7	High
Rejosari	2,4	Very Low

Table 2 and the landslide hazard map (Figure 2) in Jambu District, shows that the low landslide hazard level covers 10 villages, area has a landslide threat level with a very high hazard class covering four villages including Brongkol, Gemawang, Gondoriyo and Jambu. In addition, the high hazard class landslide level includes three villages which are Bedono, kelurahan and Kuwarasan, two villages moderate vulnerability level: Genting and Kebondalem, and one village very low vulnerability level which is Rejosari village.

Conclusion

The use of GIS in mapping landslide risk in Jambu District is carried out by processing spatial data using an estimation model based on the 2004 Puslittanak. It indicates that the Jambu District area has the potential for landslides from very low to very high levels. Based on the landslide prediction model, the dominant research area has a landslide threat level with a very high hazard class covering four villages. In addition, the high hazard class landslide level includes three villages, two villages moderate vulnerability level, and one village very low vulnerability level.

Acknowledgement

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