



Analysis of Landslide Hazards Area Using Geographic Information System in Gayo Lues District

Sukrizal¹; Eldina Fatimah²; Nizamuddin³

¹ Disaster Science Postgraduate Program, Syiah Kuala University, Banda Aceh, Indonesia

² Civil Engineering, Faculty of Engineering, Syiah Kuala University, Banda Aceh, Indonesia

³ Informatics Engineering, FMIPA, Syiah Kuala University, Banda Aceh, Indonesia

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Abstract

Given the landslide hazards in Gayo Lues Regency are scattered in all sub-districts with various characteristics that influence them, and various parameters that make the vulnerability of landslides increasingly high, and have an impact on the socio-economic and spatial pattern of the district. The research objective is to identify and map the characteristics of landslides, the level of vulnerability. The data of this study are primary and secondary data at the landslide point. The results showed that the dominant type of landslide occurred was the flow of ragged material, rotation and translation with a cause analysis in the form of trigger factors and controllers and the occurrence of landslide repetition in several areas with the result of identifying the characteristics of the threat of landslides.

Keywords: Vulnerability; Geographic Information System

1. Introduction

In mountainous regions of northeast Algeria mountainous regions of northeast Algeriathe, controlling factors of landslides, a temporal distribution of 603 recognized landslides (1981–2011) is compared with the monthly precipitation variation, indicating a strong correlation between precipitation and landslide occurrence (Hadji, et.al., 2013).

Landslides are one of the natural disasters that often hit the wet tropics. The damage caused by mass movements is not only direct damage such as damage to public facilities, agricultural land, or human casualties, but also indirect damage that paralyzes development activities and economic activities in the disaster area and its surroundings (Hardiyatmo, 2006). Considering the natural disaster of the Gayo Lues Regency landslide which was followed by a decline in rock material, wood mixed with mud which had an impact on the area below the mountain or hill. Based on BNPB analysis data that uses 2 (two) parameters of potential landslide hazards, landslide hazard areas in Gayo Lues have been identified with an area of 489,279 ha or 88% of the regency's total area of 554,991 ha and high category landslide hazard classes (BNPB, 2015).

The authors' initial observations in one area that experienced repeated landslides in the Pining District area, the occurrence of landslides upstream of the river channel returned to landslides after the earthquake centered in Pantan Weather, Gayo Lues in May 2017. In addition to being influenced by these trigger factors, landslides occur more often because they are caused by contributing factors to landslides, including land use or land cover, rock types, and are also influenced by Karnawati (2005) rainfall parameters throughout the year.

2. Area Descriptions, Methods and Material Studied

This research was conducted in Gayo Lues district, Aceh Province, Indonesia. This research was conducted with consideration of the author's initial observations and was supported by changes in the 2013 Spatial Planning data plan for Gayo Lues district. The data was used to identify secondary characteristics of landslides. analysis to create a map of the level of vulnerability of landslides in the Gayo Lues region by using a landslide vulnerability analysis. Data on vulnerability analysis of landslides are presented in the form categories of landslide vulnerability (Paimin, et al., 2009).

Table 1. Categories of Landslide Vulnerability

| No | Weighted Score | Category |
|----|----------------|-----------------|
| 1 | >4.3 | Very vulnerable |
| 2 | 3.5 – 4.3 | prone |
| 3 | 2.6 – 3.4 | rather prone |
| 4 | 1.7 – 2.5 | Little Prone |
| 5 | < 1.7 | Not prone |

Source: Paimin, et al. (2009)

3. Results and Discussion

Gayo Lues Landslide Hazard Level

Analysis and mapping in view of the existence of the level of vulnerability of landslides in Gayo Lues Regency was carried out during 2018, with reference to the use of several parameters that are often used in identifying the level of vulnerability of landslides in an area.

Results and Analysis of Rainfall Parameter

Rain is one of the trigger factors for landslides, rain has certain rainfall and takes place at a certain period, so that poured water can seep into the soil and push the land to landslide. Determination of research decisions is 4 regions (Aceh Tengah, Gayo Lues, Aceh Tenggara, Aceh Selatan), rainfall data collection uses the inverse distance weighted method by considering the preferred interpolation value in the next close sample. So that the area is seen in the Rainfall Map of Gayo Lues Regency, with broad categories of categories as shown in Figure 1 below.

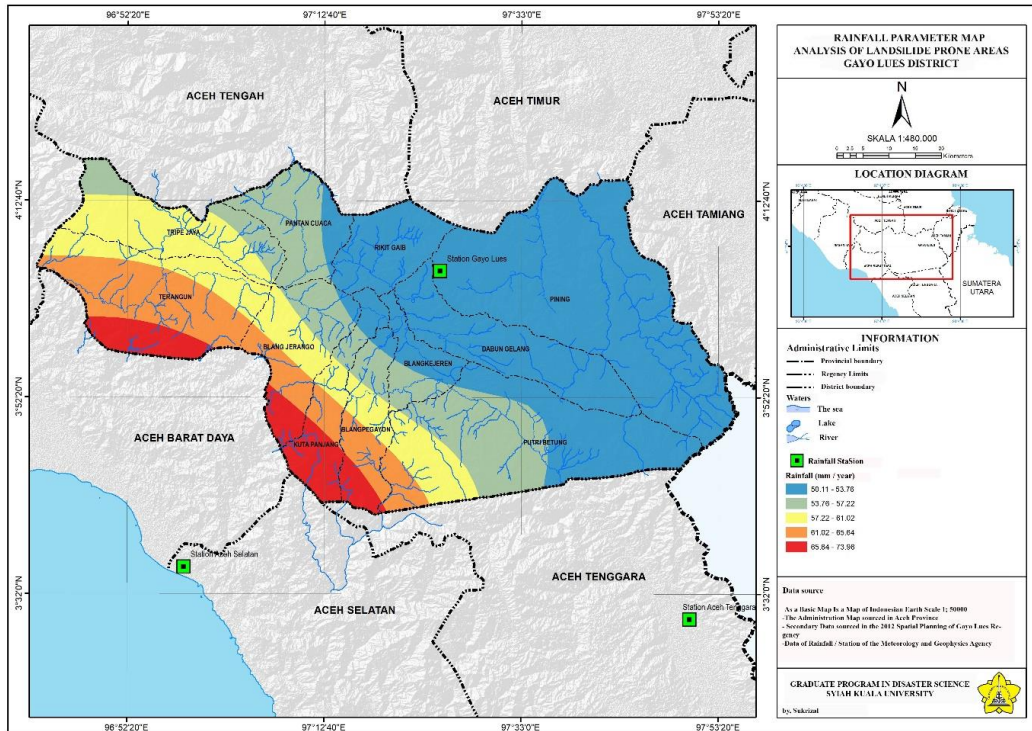


Figure 1. Rainfall Map (Meteorology Climatology and Geophysics Council, 2018)

Gayo Lues Regency only has 1 rainfall station located and managed by the Gayo Lues Agriculture Office. To get accurate data on rainfall, researchers involved three rainfall stations adjacent to the study area including, rainfall data in the districts of South Aceh, Southeast Aceh, or Central Aceh.

Table 2. Interpolation Rainfall Scores

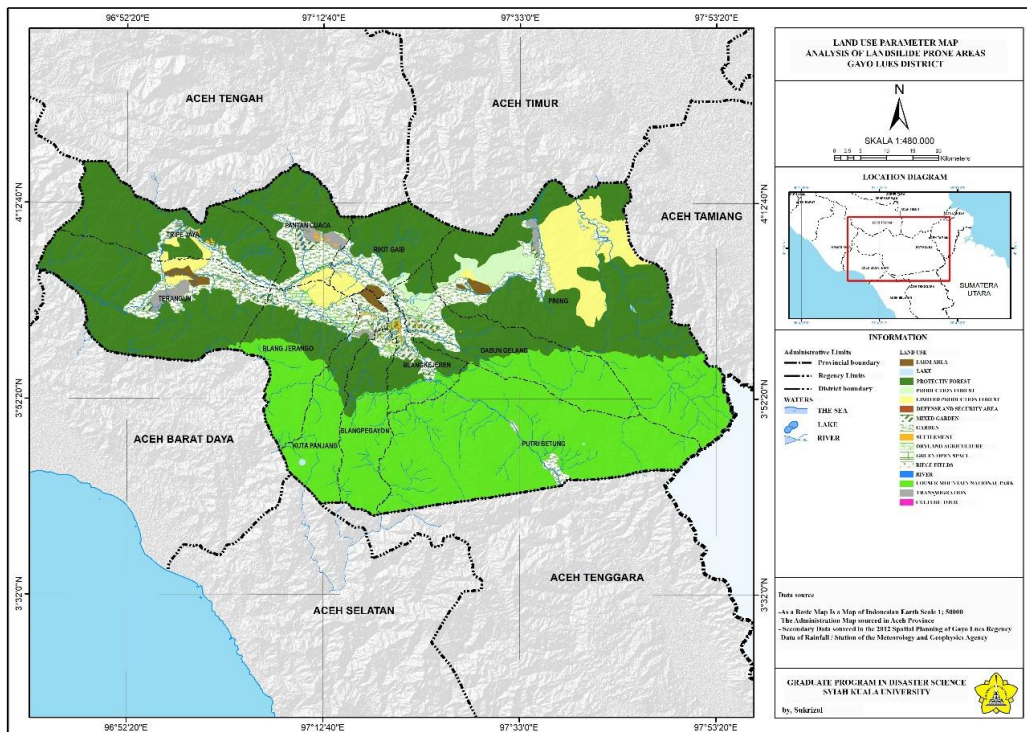
| No | Rainfall (mm) | Category | Kelas Curah |
|----|---------------|------------|-------------|
| 1 | 50.11-53.76 | Rather low | Dry |
| 2 | 53.76-57.22 | Rather low | little dry |
| 3 | 57.22-61.02 | Rather low | Rather wet |
| 4 | 61.02-65.64 | Rather low | Wet |
| 5 | 65.64-73.96 | Rather low | Wet |

Based on Table 2 above, it is explained that, based on the scoring and weighting that has been carried out, there are Gayo Lues, Southeast Aceh, South Aceh and Central Aceh stations for the past 9 years. Distribution of rainfall is known with a range of categories of 50-73 mm and the level of vulnerability is rather low, this is because the amount of rainfall data can be very limited and the number of rainfall stations is still small and new.

Results and Analysis of Land Use Parameters

Many factors related to humans in the field of land use. In land use, humans tend to use the land excessively which can cause unwanted physical symptoms. These symptoms are bad for humans, such as the decline in productivity of agricultural land due to accelerated erosion, landslides, floods and others. In other words, these bad physical symptoms will eventually cause social symptoms.

In 2015 the Gayo Lues regional government allowed the sap tusam company to set up a factory in processing production forests in Rikit Gaib Subdistrict with the area of exploitation of all tusam trees in Gayo Lues, this led to a return to increased vulnerability to landslides in the area. In the map below, we can see the existence of land use in Gayo Lues based on the 2012 RTRW, but this has increased over time because of the increasing economic and plantation needs of the community.

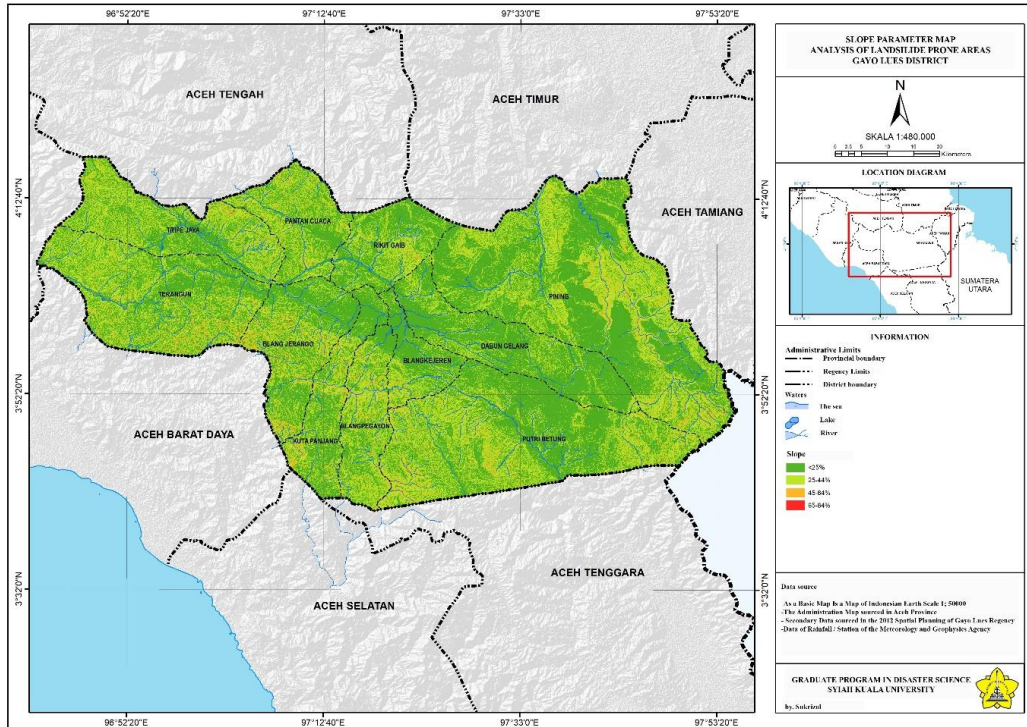


Map Figure 2: Land Use (Data Analysis, 2018)

Based on the analysis of vulnerability level parameters, in the land use parameter that the high category reaches a total area of more than 12055 thousand hectares which is dominated by settlements, rice fields, transmigration and cultural tourism, with the highest area in the Terangon sub-district of 2386.98 hectares. In the rather high category which is dominated by rivers and lakes with the highest area in the Pining sub-district reaching 503.16 hectares. The moderate category is dominated by the land use of the hamka area and green open space with the highest area of 1412.49 hectares in Terangon District and the lowest area of 0.51 hectares in Blang Jerango sub-district. In the low category which is dominated by land use in the form of protected forests and mountain lauser national parks so that this area becomes the largest area in Gayo Lues Regency in its land use with the highest area of 97892.69 located in Putri Betung District, Gayo Lues Regency.

Results and Analysis of Slope Parameters

The degree and length of the slope are elements that influence the occurrence of landslides. The higher the degree of slope it will provide a higher hazard of landslides, so the highest weight value is given. Scoring and slope classification can be divided into five classes (Paimin, 2009), the results of the research presented in figures.



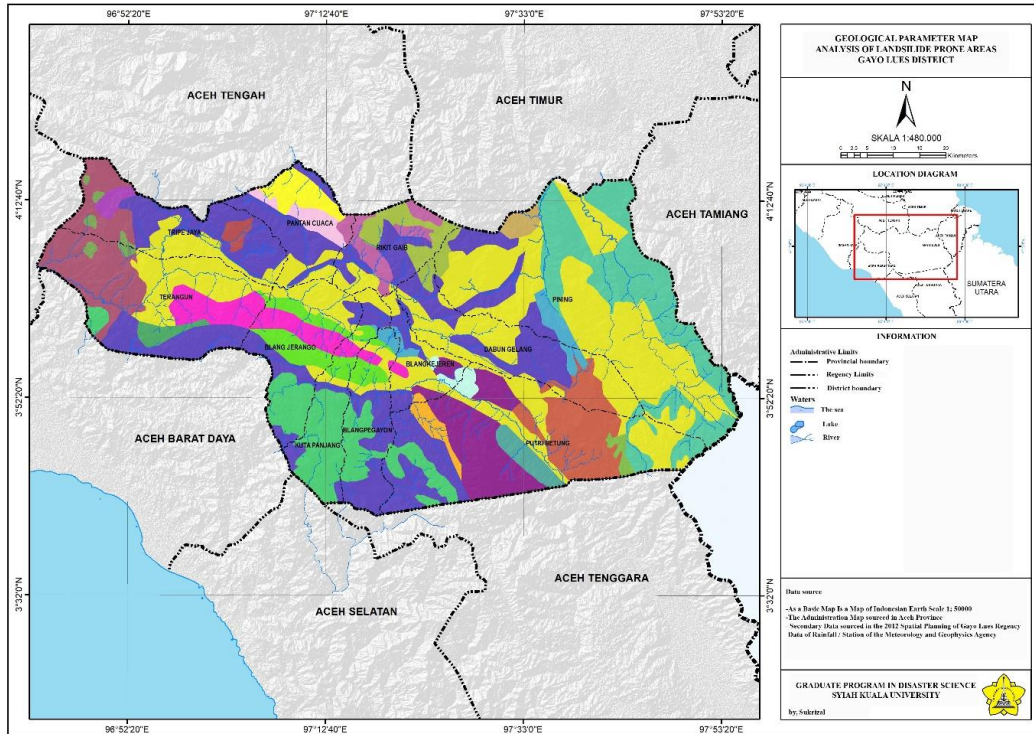
Map image 3: Slope (Data Processing, 2018)

Based on the analysis of information to see its existence in supporting the risk of landslide vulnerability including 127.106 hectares or about 0.02% of the Gayo Lues region is at a rather high slope level located in Blang Jerango sub-district, in the medium category with an area of 21079.48 Ha or 3.84%, 208892.52 Ha or 38.07% are in the rather low category, and 318594.39 Ha or 58.06% in the low category. However, the low category in this parameter shows that the dominant Gayo Lues region is steep and bumpy.

Results of Analysis of Geological Parameters and Faults

Rock structure and mineralogical composition are one of the factors that cause landslides. In the Gayo Lues mountain region, rock types are dominated by sedimentary material, where these rocks are in the form of clay, calcareous clay and calcareous rocks which have a water-resistant property so that in saturated conditions water can function as a gliding field during landslides.

This study uses secondary data from the local government by analyzing the geological structure and the existence of faults in Gayo Lues Regency, with the results of data processing as follows map image 4:



Map Image 4: Geology (Data Processing, 2018)

Based on the analysis, it is explained that the Gayo Lues region is in the high category in the geological percentage score of 35.94% (201108.73 Ha) which is dominated by sedimentary rocks, with the largest area of Pining sub-district reaching 53029.97 Ha. In the medium category which is dominated by Granite hills with a percentage of 7.52% and an area of 42105.40 Ha and spread in several districts. In the low category which is dominated by alluvial land and limestone with a percentage of 32.92% and an area reaching 184231.64 Ha and is free in all sub-districts with the highest area found in the sub-district of 68622.58 Ha, this indicates that the region experienced a history of high landslides with the appearance of phenomena fan shape in the alluvial region caused by the flow of landslides in the door of the river channel which is currently a residential area.

The existence of faults in each sub-district in Gayo Lues Regency is based on data from BAPEDA and PUPR in the local area, combining these scores due to the presence and absence of faults in the area is weighted between scores 1 and 5 only and difficult to process spatially but can be determined and added with the percentage of geology, the presence of faults in each sub-district can be seen based on the picture of the Geological Map and the existence of the fault below.

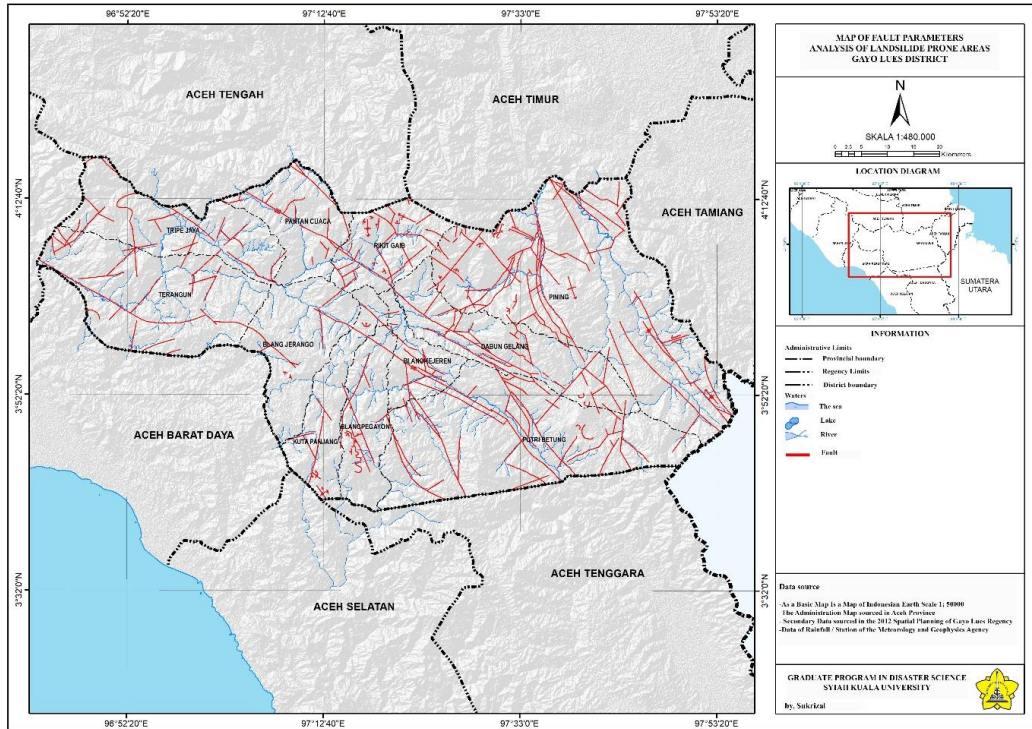


Image Map 5: Fault (Data Processing, 2018)

Infrastructure and settlement are parameters used to increase the vulnerability of the area by looking at the existence of landslides at the research point, so that the parameter category shows vulnerability in the landslide point of the research area, such as Pantan Cuaca, Putri Betung, Teripe Jaya, Pining and other sub-districts as in Figure 6:

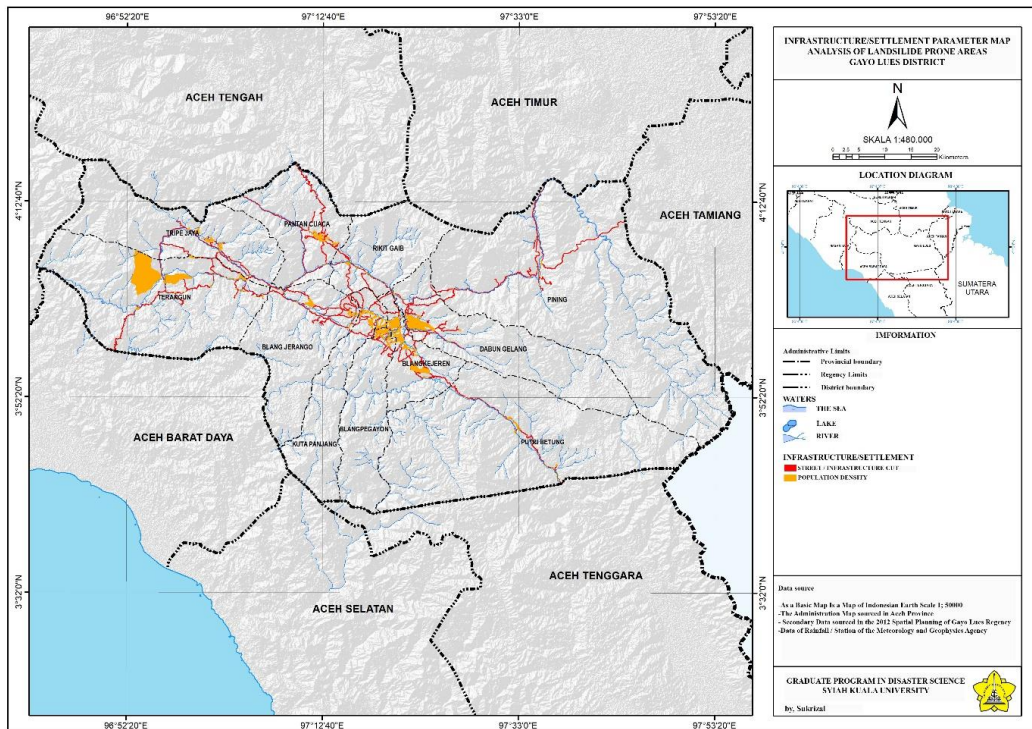


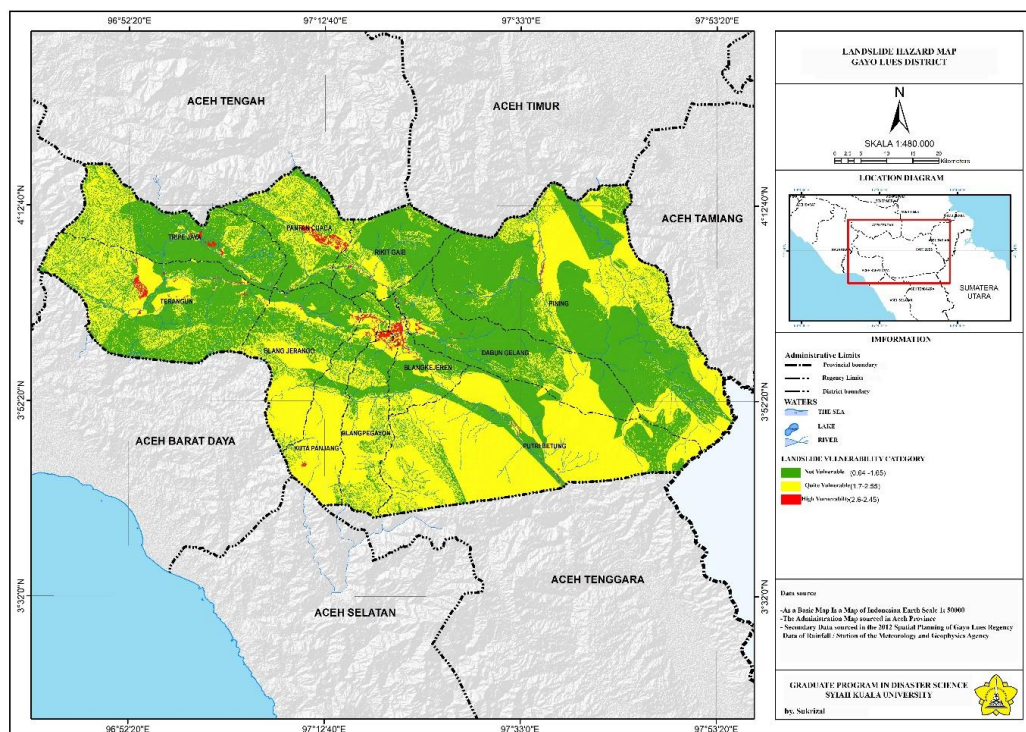
Figure 6: Infrastructure / Exploitation (Data, 2018)

Based on the picture, it is explained that almost all sub-districts in Gayo Lues have infrastructure and residential areas around the study area of landslides, so this parameter makes the high category in each sub-district with a percentage of 1.41% (7801.74 Ha) based on the spatial area and infrastructure.

In the medium category with a total area of vulnerability, reaching 0.12% or 673.71 Ha with the widest area, namely Pining sub-district 98.41 Ha and the smallest area in this category is Blang Pegayon sub-district covering 23.21 Ha with the classification of roads and other infrastructure. For the low category which is the widest area in this category which reaches 98.47% or 546515.61 ha of the entire area of Gayo Lues Regency, this category indicates that the area does not have much infrastructure or settlements. To see the results of the mapping that has been done, it can be seen that some regions have population densities in the landslide area.

Analysis of Landslide Prone Areas

To get the results of the data in analyzing the level of avalanche vulnerability used classification, category and suspension, including scoring natural parameters of rainfall, land slope, the presence of faults and geology by 60% and the management parameters including land use and infrastructure / settlements of 40%. After all the above parameters were obtained in this study using mapping modeling, the results of scoring and data striking above overlay union to obtain the results of the level of vulnerability of direct land in Gayo Lues Regency in Figures.



Map Figure 7: Avalanche Analysis of Data Landslides, 2018

Based on the analysis and processing of the data above, it shows that a number of sub-districts in Gayo Lues have vulnerability, the category is prone to landslides of around 0.48% or 2666 Ha, with the largest area being in Pantan Weather District reaching 555.14 Ha and the lowest area with 53.16 Ha in Rikit District Invisibility. Likewise in the category of slightly prone to landslides with the highest percentage reaching 45.21% or around 250892.46 Ha, with the highest activity and area in the District of Putri Betung with an area of 77609.65 Ha, this is because the area is a mountain lauser national park.

Prone to being covered with an area of 301432.36 ha or 54.31% of the total area of Gayo Lues which is the area of the Lauser forest ecosystem.

Conclusion

The results showed that the dominant type of landslide occurred was the flow of ragged material, rotation and translation with a cause analysis in the form of trigger factors and controllers and the occurrence of landslide repetition in several areas with the result of identifying the characteristics of the threat of landslides.

The results showed that there were 22 landslide points in Gayo Lues that had various characteristics that affected them. The intended factor is; exogenous and endogenous with a duration of 3 hours up to more than 24 hours, identified symptoms of springs drying up, muddy and muddy flow, repetition of landslides more than 2 times until there are landslide activities to date. Types of landslides include Translation, Rotation and Flow of Granules, with the cause being dominated by poor land use, as well as threatened components including settlement, agriculture, physical assets, and some cultural and historical sites.

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