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Investigation Volcanic Land Form and Mapping Landslide Hazard Potential at Mount Talang

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Abstract

The survey geomorphology, it is the one apart of applied geomorphology. In case has done investigation character of geomorphological landscape of Mount Talang and mapping of landslide hazard potential. In this research has used some method, the first field observation and sampling for geomorphology character study were conducted. Second the mapping landslide hazard used method the MAFF Japan where integrating physical field data and spatial data using geographic information system. The results of this study where found some volcanic morphology, volcanic cones, upper slopes, middle slope, lower slopes, foot slope, and volcanic plain. The landslide hazard, where involving sources of observation and sampling for the study of geomorphological characters. From the research has found the landslide hazard in four zone, zone (I) land stable and low hazard potential large 9 ha, zone (II) land enough stable and middle hazard potential large 12.295 ha, zone (III) land less stable and high hazard potential large 1.118 ha, and Zone (IV) land unstable and highest hazard potential 0.1 ha. The typical of geomorphology, morphometry, and land use it has really influence to landslide potential to landslide hazard.

Keywords: Land form, Volcanic, Landslide

Introduction

Mount Talang is also called Mount Soelasih is an active volcano type A strato or layered means volcano built by lava and pyroclastic rebound. This volcano is a complex of volcanoes consisting of cone Mount Batino and cone of Mount Jantan growing in the middle zone Semangko, the Fault is active. The history of Talang volcano activity has a relatively long period, with the shortest interval of 2 years and the longest 40 years. The eruption is magmatic, which is generally accompanied by black smoke soaring. After the eruption of 1883, volcanic activity of this volcano is only an increase in activities not followed by a large eruption. This mountain is a type of Strato volcano, is one of the active volcanoes in West Sumatra, and one of its crater becomes a lake called Lake Talang. Mount Talang has erupted many times since 1833 until 2007. Landforms formed by volcanic processes such as craters, volcanic cones, lava flows, or volcanic foot plains are witnesses of geomorphological processes occurring in past. Therefore, the study of volcanic geomorphology is very useful for disaster studies especially to understand the character of volcano and mitigation planning in order to suppress the bad impact of the eruption, to potential landslide disaster caused (Oktorie, 2017). In this case the identification and mapping of volcanic forms is essential in geomorphology studies, so it is the utilization of geospatial technology (Hermon, 2014; Hermon, 2017).

Landslide or so-called ground movement is a geological event that occurs due to the movement of rock or soil period with various types and types such as the fall of rocks or large clumps of soil. In general, landslide events are caused by two factors, namely the driving factors and trigger factors. Examples of disasters that have occurred in Mount Talang namely Landslide, precisely occurred in Aia Batumbuak, Mount Talang Solok that occurred on the strip, November 14, 2016 that caused 1 person died and 1 person was scratched because buried landslide material. The disaster had happened before in September precisely in Rawang Lubuk Selasih, Nagari Batang Barus which also claimed lives. This research is aimed to study geomorphology of mountain gutters and mapping of landslide hazard level. This research was conducted in Mount Talang of West Sumatera. Purpose in the research to investigate investigation volcanic land form, and mapping landslide hazard potential at mount Talang (Hermon, 2012; Hermon, 2014).

Method

The study geomorphology, in this case use two process, the first we create the geomorphology map, and second its doing survey use GPS and observation the exciting geomorphology. The technical for data analysis landslide, we use ENVI and ArcGIS, where we use remote sensing software to interpretation the SPOT6 imagery data, to create land cover map use method image interpretation OBIA (object base image analysis), and then we use GIS technology to combination the primary data from the survey, and geospatial data such as land system map, geology map, topography, SRTM Imagery,

Table 1. Data for analysis

Data	Sources
Topography	Inageoportal Indoensia BIG Geospatial Agency
SRTM	http://usgs.gov
SPOT 6	LAPPAN,
Land system map	Ministry of Agricultural
Geology map	http://humas.pvmbg Geology Agency

For the complete technical analyst data will explain down here:

1. Primary Survey Geomorphology

   Before doing primary survey, in this step, we create the geomorphology map integrating the geology, slope, lithology, land cover map, and generating to be geomorphology map use the principle of (Hermon, 2014) to classification geomorphology. To take information from the real condition about the geomorphology, and type, and many data that will be taken.

2. Image Interpretation

   In this case, where this is used for to interpretation to create land cover sing the OBIA object-based on image analysis, and slope map use slope analysis. In this case, where this is used for interpretation to create land cover sing the OBIA object-based on image analysis, and slope map used slope analysis. To mapping functional ecology and land cover type, use the OBIA technic. OBIA approach is tied in with high spatial resolution situations. In an image, such a situation may occur if the pixels are significantly smaller than the objects under consideratio. Called these groups “object candidates,” which must be recognized by further processing steps and must be transformed into meaningful objects. It is well known that semantically significant regions are found in an image at different spatial scales of analysis (Qhao, 2011).

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The selection of object-based classification is based on the consideration that this method is capable of generating segments and classes in the form of polygons (not generalizable results) that can be edited based on a field check. The object-based on classification process includes two steps, namely (a) object-based on segmentation, and (b) object-based on classification. In the meantime, object-based on classification results are further processed through correction of field data to become a properly considered reference map (Danoedoro, 2015). The techniques Interpretation in the object base image analyst (OBIA) model and high image data in land cover mappings, of course, improve the quality of results. By specifying the dominant object that is recognized as the object character representing as the sample (Hanif and Nofrizal, 2017).

3. Landslide Mapping

In this case, to create the map landslide potential, use the method by MAFF-Japan. Where using the combination of geospatial data:

Table 2. Criteria analysis Landslide Hazard MAFF-Japan

No	Criteria	Score	No	Criteria	Score
1	**Rain Fall (P)**		**4**	**Geology (G)**	
	<2.500	4.5		Alluvium	1
	2.000 – 2.500	4.0		Pleistocene, material of sedimentation	2
	2.500 – 3.000	3.5		Pliocene, material of sedimentation	4
	3.000 – 3.500	3.0		Plesitocene, sedimentation of volcano	2
	3.500 – 4.000	2.5		Miocene, karst	3
	4.000 – 4.500	2.0		Material young volcano	1
	4.500 – 5.000	1.5		Material old volcano	3
	>5000	1		Miocene Volcano	3
2	**Land Use (LU)**		**5**	**Soil Type (ST)**	
	Residential, golf area, garden, Industrial, Industrial Estate, cemetery area	3		Histosols	5
				Ferralsols	3
				Gleysols	5
	Farming area	4		Vertisols	5
	Cultivate area	2		Acrisols	5
	Plantation	2		Lithosols	3
	Grass, Underbrush	3		Podzols	2
	Fishpond	4		Andosols	3
	Peat land	4		Regosols	2
	Lake	4		Grumosols	5
	Forest	4	**6**	**Land form (LF)**	
	Land critical	1		Zone of Marine low land	5
3	**Slope % (S)**			Zone of low land	5
	0-2	5		Zone of high land	3
	>2 – 15	4		Zone of hills, at an slope <15%	4
	15 – 40	3		Zone of hills, at an slope 15%-40%	3
	>40	1		Zone of hills >40%	2
				Zone of mountain <15%	3
				Zone of mountain 15%-40%	2
				Zone of mountain >40%	1

Sources: Hermon (2009)

The formula to calculation final score of landslide

$$TBL= P+3.(LU)+2.(S)+2.(ST)+G+LF$$

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Table 3. Interval Landslide Hazard Zone (MAFF-Japan)

Zone	Interval	Land character	Hazard classification
I	>22.3725	Land stable	Low
II	>17.25 – 22.375	Land enough stable	Middle
III	>12.125 – 17.25	Land less stable	High
IV	≤12.125	Land un stables	Highest

Sources: Hermon (2014)

The analysis process is done with GIS device consist of four step, (1) overlay spatial data (2) attribute editing and scoring stage (3) tabulate analysis (4) spatial representation.

Results and Discussion

Geomorphology

The type of land form, in this study was conducted in two processes, first making geomorphology map in the scale of 1: 60.000. Which is obtained in some form is done then checking the field. The results of the primary survey of geomorphological studies found several types of data forms in the area of mountain Talang is quite varied, existing landscapes, processes and forming materials, more details as follows:

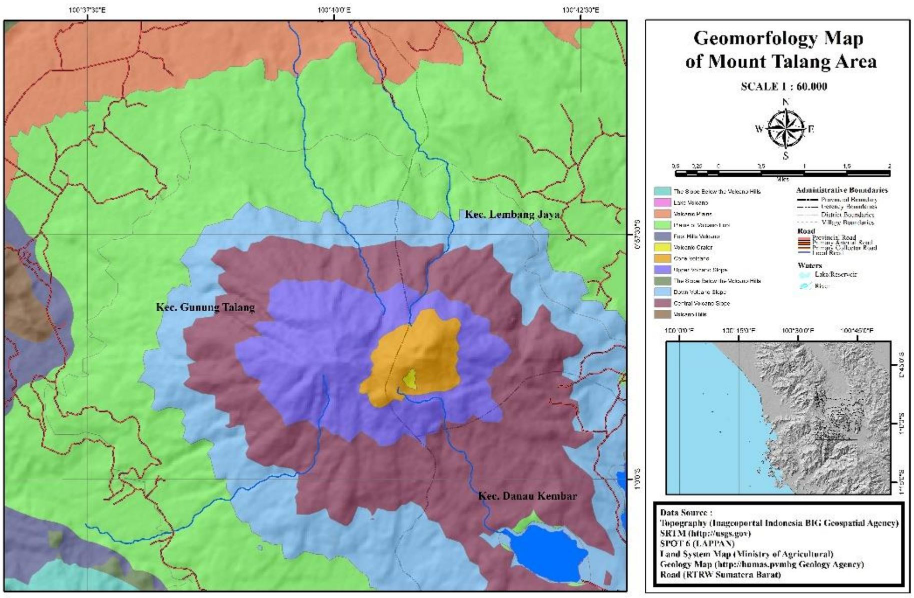

Figure 1. Geomorphology map

The result of a survey on Mount Talang, on the summit of the Mountain we found the volcano caldron, the area have young material of eruption. Center of caldron we found the stone, dust, cliff, mineral sulfur and smoke result of the eruption. The unit of this form is formed due to collapse in the event of the volcanic eruption or occurs due to some material at the top of the volcano participate transported at the time of the eruption. Generally has a steep crater slope.

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(a) **(b)**

Figure 2. (a) Crater volcano caldron (b) Volcanic Cone

In the volcanic cone, has findi steep slope conditions by under conditions of footprint burning vegetation resulting from volcanic eruption. This condition indicates the existence of eruption material supply in the area around the volcano cone. In a note, this mountain once erupted in 1833, 2005, and last in 2007. Until this paper published, Mount Talang still releases volcanic materials such as sulfur gas (S).

Formation of land is the top of volcanic due to volcanic eruption. The steep slopes until very steep, geomorphological process is erosion and landslide. The dominant type of igneous igneous rock that has the characteristics of coarse texture due to freezing that occurred drastically (Hermon, 2014). In the vicinity of Mount Talang, there are several water sources located on the slopes of Mount Talang. We get some sulfur solid materials located in the water source area which is quite close to the crater of the mountain. The pH level of this solid element is worth 4. This causes that water at a water source close to the crater of the crater is very dangerous to eat. Moved westward from the mountain as far as 250 m, the slopes of the mountain began to land, and overgrown with vegetation is relatively fertile. With this type of vegetation tundra cover this land. There is a clear source of water on this slope that flows towards the east. With a pH value of 6, making this one source of water as a place of climbers Mount Talang take drinking water supplies.

Volcanic top slope found the depth of the soil layer that reaches a depth of approximately 40 cm. in this section many rock material outcrops, in the form of chunks of lumps, until the pebbles on the surface of the soil. Although the top of this mountain is released by the process resulting from the freezing process of mountain liquid, the peak is still overgrown by fairly dense vegetation. This is caused by the soil compiler Mount Talang, among others, is the type of soil andosol, regosol, litosol. However, due to passive mountain activity, the environment in this region has temperatures that are quite hot and makes the plants less fertile.

The upperslope of the Mount Talang, in is part of a volcano that has a steep slope to very steep. In the tropics generally on the upperslope of volcanic, the characterized by the presence of moss vegetation, and other vegetation. On this volcanic have good groundwater, and sometimes spring (spring). At the edge of the central slope of Mount Talang found the conditions of cover vegetation covering a fairly dense and diverse. Some locations experience degredation from logging activities. The condition of this landscape has a steep slope. Middle slope is part of volcano that has a steeply sloping color until it is steep. Vegetation that grows diverse, because this area is a fertile area because of deposits of material deposited in this section. Have good quality, and local people appear belt source water (spring belt). The geological structure of this region to the peak area is the structure of young rocks. This is because at the top of the mountain is an area consisting of new geological materials, formed by mountain magma eruption, and still not experiencing weathering, and long enough erosion.

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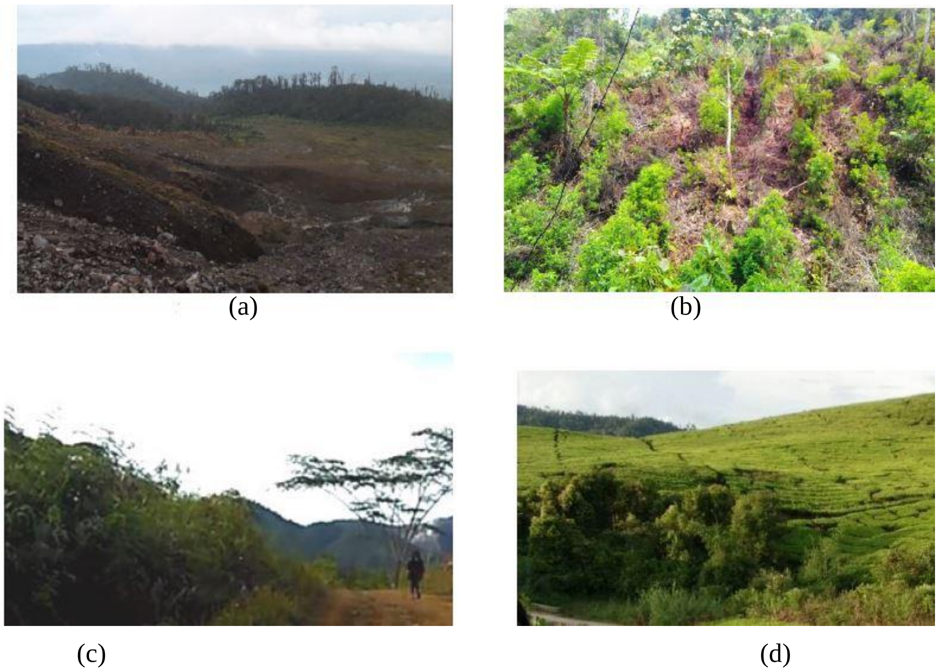

Figure 3. (a) Upperslop of Mount (b) Middleslope (c) Lowerslope (d) Footslope

The lower slope of Mount Talang, conditions of slope it has found in the conditions of surface where it land development of human activity of land for timber forest trees. Part of volcanic form that has sloping up to steep slopes. Generally in this unit of land has good groundwater and vegetation that grows diverse because these land units generally have fertile soil. Where viewed from the vegetation pattern, the lower slope has a type of vegetation grasses such as bamboo (bambusa vulgaris) that grow around this area. Bamboo of this type has a spread in Java, Sumatra, Kalimantan, and Maluku. The geological structure of this region is the old basalt.

At the case study on the foot slope we found good soil conditions, with several streams of water from springs. The unit of this landform has the characteristic of sloping slope to sloping, good groundwater quality. Generally the soil in this unit of land is fertile due to pyroclastic material deposits from volcanoes. Land use in units of this form is diverse. With relatively rudimentary soil properties, less sloping land, and good irrigation, this region has become a place of economic empowerment of Mount Talang communities, with its uses such as tea plantations, fields, and horticulture. In fact, with the empowerment of land around Mount Talang this, making it as one of the largest income for the Province of West Sumatra (Hermon, 2018a).

From spatial data integration to Map Representation of hazard index from result of final score calculation of method by MAFF Japan to mapping of landslide hazard at gutter mountain location, found level of landslide hazard that is Low, Medium, High. Judging from the color gradient of the legend from the green color is the area of low landslide level and then rose to yellow is the last red area high hazard zone.

From the map above we can understand, the level of landslide hazard in the mountain area consists of low, medium, high. Using MAFF Japan's calculation method of analysis comprises calculation of scores from Geology, Land Form Geomorphology, Land system, Land System, Land Use, Rain Fall, Slope. The data in Overlay using Arcgis 10.2 and then calculated then produce the landslide vulnerability data in gradation with color differentiation of landslide vulnerability level. In terms of data entry, we see from the calculated scores studied from the slope of the slope and the constituent rocks which will be the material form of the geomorphology of the area plus the exogenous factors of weathering and the pressure of nature which will be added by rainfall data. Some of the data became a reference for making landslide vulnerability maps.

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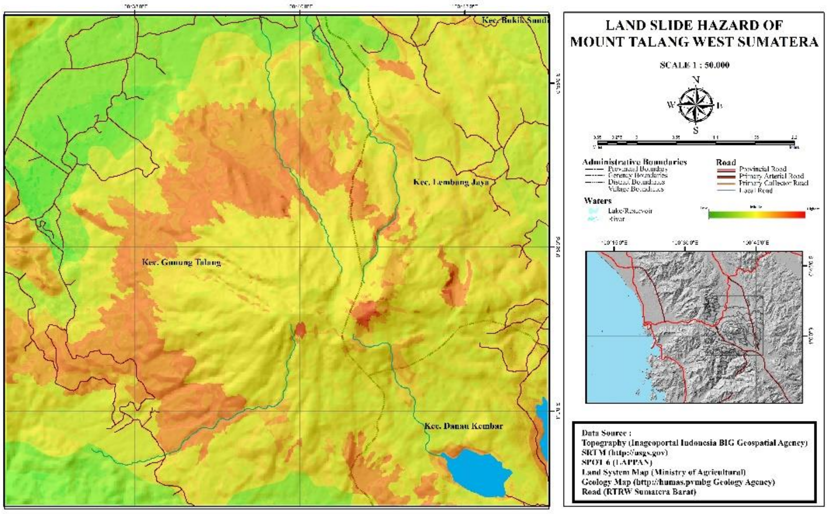

Figure 4. Landslide Hazard MAP

The map can be used in a location that will become vulnerable to landslides, we can see the area of the housing zone and the road which we can analyze his future in suppressing the intensity of the landslide so we can do anticipatory action when the rainy season began to come because at that time more moving land plus some buffer areas that have been lost due to clearing. For this analysis, the area of Gunung Talang subdistrict has a high landslide potential and wide area coverage because the precise area is located at the foot of the mountain where the area becomes a high level of landslide hazard (Hermon, 2018b).

Table 4. Calculation area of Landslide Hazard

Zone	Land character	Hazard classification	Larges (Ha)
I	Land stable	Low	9
II	Land enough stable	Middle	12295
III	Land less stable	High	1118
IV	Land un stables	Highest	0.1

Sources: Data analysis

The results of the scorecard score with the MAFF Japan regional method covered in 4 classes but after the calculated level of danger to be 3 that is Low, Middle, High. Calculated using ArcGIS 10.2 with Calculate Geometry tools considering the position of Universal Transverse Mercator (UTM) Zone 47S coordinate position. So can the area covered by the level of danger.

Characteristics of the land to determine the level of danger the higher the stable level of a land the smaller the level of landslide hazard and vice versa. The area of analysis with the level of medium-sized landslide haze became the most widespread of its coverage area, followed by high hazard level which touched the number of 1118 hectares, and the last low danger area with 9-hectare area. Form the spatial data has found the character of geomorphology, morphometric, and land use it was indicator has really influence to landslide potential on Mount Talang.

Conclusion

The condition of the mountain area which is located behind the hill is in the semangko fault and part of the hill mountains. Geomorphology formation had seen from the geological structure of mountain areas Talang that much influenced volcanic system. The landscape formed in the area of depression makes the pattern of slope in every part of the hills, the insulating plant is in the middle of a high-density level but increasingly upwards begin to decrease the density is dominated by moss. The composition of the soil is composed of andosol, regosol, and litosol structures resulting from the volcanic activity of the gutters. In the region of the foot of the mountain is dominated by horticultural plants that flourish. Potential of hazard landslides that have been divided into 3 zones low, medium, high and is the result of calculation by MAFF Japan. This result will had class by four zone or location with each hazard classification level. So this research is very important in analyzing the vulnerability of the area as an example of a road in the danger zone we can anticipate the disaster before the disaster occurs. Crop buffer becomes the key in every slope that potentially becomes avalanche if it decreases and no longer refuses hills hence the level of the landslide will be higher influence of some indicator (geomorphology, morphometric and land use).

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