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The Innovation Breakthrough in Digital and Disruptive Era
ABSTRACT

The Manado-Tomohon line is one of the main transportation routes connecting Manado City as the capital city of North Sulawesi Province with several regencies and cities such as Minahasa, Mitra, Tomohon City, and Bolsel Regency. The Manado-Tomohon route in terms of economic activity is quite high because there are motels, fruit, and snack trade routes, as well as residential areas. From the geological aspect, it is covered with less compact material and has a rough topography and high rainfall, where these physical factors are very influential on changes in landform/geomorphology on the Manado-Tomohon road track. Seeing this, it is very important to study and map the geomorphological condition of the Manado-Tomohon road track. The purpose of this research is to prepare a geomorphological map/landform and examine the geomorphological aspect/landform of the Manado-Tomohon road track.

Keywords: Study, Geomorphological Aspect, Geomorphological Map

1. INTRODUCTION

It is important to conduct a study on changes in the shape of the earth's surface because it is closely related to the life of living things, especially the humans who inhabit them.

The Manado-Tomohon route is one of the landforms in North Sulawesi that has an important function for the people of North Sulawesi because it is the main transportation route connecting Manado City as the Capital of North Sulawesi Province with several regencies and cities such as Minahasa, Mitra, Tomohon City, and Bolsel Regency. The Manado-Tomohon route in terms of economic activity is quite high because there are motels, restaurants, fruit trade routes, and light snacks typical of North Sulawesi, namely dodol cakes which can be populated by residents who tend to increase. Based on the land use direction map of the Directorate of Environmental Geology 1997, this route is classified in category B, namely its use is directed to only local agriculture which is directed to rural growth by taking into account morphological conditions and does not occupy disaster-prone areas. However, the reality is that there are residential residents who are on a fairly steep slope so they are prone to landslides, even based on data on landslide events in 2014 there were landslide events that caused people's houses to be buried by landslides and took human lives.

Geologically, based on a geological map with a Manado sheet system with a scale of 1:250,000 [1], the Manado-Tomohon route is covered by young volcanic rocks consisting of lava, lapilli, bombs, and abau which are classified as unconsolidated rocks or rocks that have not been compacted so that they are prone to landslides. On the other hand, based on the map of the earth from the Manado sheet (1991) issued by Bakosurtanal on a scale of 1: 50,000, The Manado-Tomohon route generally has a rough topography, which can be seen from the high level of contour density which reflects the steepness of the slopes which of course supports the occurrence of landslides that can interfere with the smooth activities of residents on the Manado-Tomohon route. Of course, smooth transportation is related to the function of the Manado-Tomohon road as the main transportation route connecting Manado City and several City Regencies in North Sulawesi.

The strategic and high level of economic activity of the population on the Manado-Tomohon road shows how important it is to study the physical condition of the landforms on the Manado-Tomohon road which includes morphological aspects, and morphological
This research uses a geomorphological approach to achieve the research objectives, which are related to the study of landforms on the Manado-Tomohon road track in order to produce landform maps or geomorphological maps, carried out in the following manner or stages, procurement of materials in the form of maps and images or photos, analysis of maps and interpretation of photos or images to produce a temporary geomorphological/landform. Thus the research methods include:

The Pre-Field Stage is the interpretation of maps and aerial photographs to prepare a temporary landform map

The Field Work phase is carried out by observing the research area by referring to the landform/geomorphology map as well as identifying and observing all geomorphological processes that occur at the research location.

The Post-Field Stage is to revise the map of the landform/geomorphology of the research area based on the results of observations of the landforms and geomorphological processes, in this case, the processes that occur due to the work of exogenous workers, then describe the condition of the landforms on the Manado – Tomohon road track, then compile a research report.

3. RESULTS AND DISCUSSION

Landform of Research Area. In accordance with the objectives of this study, namely to produce geomorphological maps and describe geomorphological conditions, this discussion will describe four geomorphological aspects which include morphological and morphometric aspects, morphological aspects, morphochronological aspects, and morphoassociation aspects as well as geomorphological maps of the research area shown in Figure 2.

3.1. Morphrographic and Morphometric Aspects of the Research Area

The morphographic aspect is to describe the landform qualitatively. The morphological aspects of the research area are depicted through geomorphological maps as well as slope maps, which are related to topographical conditions where the landforms of the research area consist of 3 classifications, namely the upper slopes of volcanoes with geomorphological mapping symbols V2, the middle slope of the volcano is denuded with the mapping symbol V3 and the lower slope of the volcano with the mapping symbol V4. The morphology of the research area from flat to steep is volcanic material.

The landforms V2, V3, and V4 refer to the formations of volcanic origin. By reference [3] this landform is related to various phenomena of magma movement that rises to the earth's surface. This landform is more based on the material or the
constituent rocks, namely volcanic rocks of various types. In the research area, the constituent rocks are volcanic rocks resulting from the active eruption of the Lokon volcano. Volcanic landform material is a pyroclastic material consisting of various sizes ranging from ash, dust, sand, lapilli, bombs, and lumps. Sizes from ash to lumps were found in the study area.

In addition to V2, V3, and V4 landforms, the research area also found the results of exogenous processes caused by physical land conditions such as material, and topographical conditions and triggered by human activities and rainfall, namely landslides with the type of landslide, creep, and landslide. Landslides in the study area every year in the rainy season landslides occur even in 2014 along with flash floods in Manado City. This research area also experienced serious landslides which resulted in the interruption of the Manado-Tomohon transportation route and several City Districts in North Sulawesi even for a long time the transportation route was diverted through other roads.

3.2. Aspects of morphometry

According to Ricci in reference [2], explaining the morphometric aspect emphasizes the size of the morphology and at least there are three things to pay attention to, namely relief, slope including its profile and channel characteristics. Regarding the relief, the research area is classified as smooth to rough because based on the topography, it is flat to steep. In terms of slope, based on the slope map, the slope conditions of the study area are classified into 4 categories, namely 0-8% with flat topography, >8-15% with a sloping topography, >15-25% with rather steep topography and >25% with steep topography. Regarding the character of the channel based on the results of the observation of the channel characteristics, there are valleys with the shape of the letters V and U.

3.3. Aspects of Morphogenesis

The aspect of morphogenesis refers to the origin of the landform and its development. Based on geomorphological forces, land formation is divided into denudational landforms from fluvial, marine, eolian, glacial, solutional, volcanic, and tectonic processes [3]. Based on this classification, the morphological aspect in the research area is included in the landform from the volcanic process, namely the material comes from the activity/eruption of Lokon Volcano whose material includes ash, dust, bomb lapilli, and bongka. In addition, there is also the formation of a denudational process, which is indicated by the presence of three types of landslides in the research area, namely landslides, landslides, and creeps.

3.4. Aspects of Morphochronology

Morphochronology refers to the sequence of landforms that exist on the earth's surface as a result of geomorphological processes. The order of landforms is classified into young, mature, and old stages of landforms [7]. But this classification in nature is difficult to distinguish clearly between stages in which clearly only the old stage is characterized, namely if the landform has been eroded almost flush with sea level so that in this study the basis is not staged but the process of weathering, soil formation, and erosion and sedimentation which in terms of soil geomorphology is a very advanced level of weathering. Referring to the concept of the level of weathering, the research area in terms of morphochronology is an area with mild to very advanced weathering levels because from the weathering of rock material, there is a material that has become soil. Meanwhile, light weathering can be seen from the presence of rock blocks in the study area and moderate weathering is seen in bomb-sized rocks [8].

3.5. Aspect of Morphoassociation

The morphoassociation aspect refers to the relationship between one landform and another in the spatial arrangement or distribution on the earth's surface.

Landform formation on the surface of the earth is determined by various factors including rock topography, the climate in this case rainfall, temperature and humidity, vegetation, organisms, and time [10]. The aspect of morphoassociation in the research area cannot be separated from the factors that have been mentioned, because the research area has a flat to steep topography, the constituent rocks are young volcanic rocks whose characteristics are unconsolidated rocks which are less compact due to their loose nature, also the study area has high rainfall so that in the Schmidt and Fergusson classification the climate is wet which is also related to temperature and humidity [11], then the condition of the vegetation in the research area from the density level varies because based on the land use map there are dry fields, mixed forests, and similar forests, and organism factors related to humans with human activities in the research area apart from being a settlement, there are also economic activities such as motels, fruit selling activities, restaurants, and light snacks.

Which of course all have an impact on the morphoassociation. Based on the geomorphological map of the landforms in the study area, namely V1, V2, and V3 which although genetically derived from volcanic activity [13], but by the presence of other factors related to the process of changing the landform, it shows a difference with a characteristic that is for V3 and V4 belonging to a landform that has undergone a denudation process where this landform has undergone a process of erosion and mass/material movement in the form of a landslide with the type of landslide, sedimentation and crawling which of course in a low
place this material will experience sedimentation [14]. The process of this mass movement occurs not only because of the slope but also related to the materials that make up the research area, namely ash, dust, sand, lapilli, bombs and bongka as well as topographic conditions from flat to steep, different land use and land cover, time of day, human activities and rainfall where the last two are the triggering factors. Thus the morphoassociation aspect in the research area occurs and is determined by land physical factors, rainfall, human activities, and also time [15].

Figure 1. Geomorphological Map/Landform of the Manado-Tomohon Road track

4. CONCLUSION

Based on the results of the research and discussion, it can be concluded that the morphological aspects which include morphography and morphometry, morphogenesis aspects, morphochronological aspects, and morpho-association aspects on the Manado-Tomohon road track are closely related to the process of changing landforms. Land use in the research area is very important to pay attention to the suitability of its designation in order to minimize changes in landforms caused by geomorphological processes.

REFERENCES


