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Landslides Intensity on River Morphology of Jeneberang Watershed after Collapse of Caldera Wall at Mt. Bawakaraeng

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Abstract: Disruption of morphological stability Jeneberang watershed, especially for river morphology of Jeneberang after disaster events continue to a negative impact on the quality, quantity and continuity of water volume in Jeneberang watershed as a result of increasing landslides activity and increasing debris flow into the river channel. This study aimed to analyze the vulnerability of river morphology and increasing of the landslides intensity area after the collapse of caldera wall at the Mt. Bawakaraeng. The method used is rosette diagram with stereonet 8 application, plotting the point of landslides location, estimate the direction of lineament (structural geology) with Davis and Reynolds method based on; observations of the regional structure pattern map, geological map and geomorphological analysis. Landslides observation data after the collapse of caldera wall at the Mt. Bawakareang showed the the active landslides pattern following the pattern of lineament (fault) that have occurred since the Pliocene-Pleistocene (5-1 m year ago). Tectonic processes that occur in the Jeneberang watershed can be classified into five stages, starting from the stage of the tectonic in Pliocene-Pleistocene, a period of equilibrium in the Pleistocene-Resen and a disruption of the equilibrium part II at the Recent time (collapse of caldera wall at Mt. Bawakaraeng) and increasing of landslides intensity after the great landslides of Mt. Bawakaraeng in faulting area that have developed as river morphology.

Key words: Fault, jeneberang landslides, watershed, caldera of Mt. Bawakaraeng

INTRODUCTION

Natural disasters such as landslides, floods and flash floods can be triggered by two factors, namely external and internal factors. External factor such as high intensity of annual rain fall, landuse change and road construction. Internal factor include soil characteristics and processes that formed the geological structure in the past and present have been deforming rocks. Landslides are naturally as geologic process that commonly lead to various types of failure to landscapes, inhabitant and constructions as well (Tangestani, 2009).

The interaction of external and internal factors affecting the stability of the region in both the micro and macro scale. Likewise, the caldera-wall of Mount Bawakaraeng collapsed on March 26, 2004 which is located around of Mt, Sarobaiya (2560 masl) and Mt.Sarongan (2514 masl) both of them are located in the northern of Mt. Bawakaraeng (2830 masl). Mt. Bawakaraeng is located just east of the headwaters of the Jeneberang River. Landslides followed debris flow occurred in Bawakaraeng caldera which produces landslide volume of about 232 million m^3 (Hall, 2012). Environmental effects caused by landslides include the alteration of agriculture, changes to natural ecosystems, changes in river morphology due to landslide dams and other effects such as sedimentation and flooding (Highland and Sun, 2013). Tsuchiya *et al.* (2009) research concluded that the main cause of landslide is still udentified but they assumed a rise ground in the caldera wall may have been the major trigger. Meanwhile, Solle find out lithology condition, heavy rainfall dan steep slope are main cause of landslide at Mt. Bawakaraeng caldera.

Disruption of morphological stability of Jeneberang basin, especially river morphology of Jeneberang after disaster events continue to pose a negative impact on the quality, quantity and continuity of water volume due to increasing mass flow of debris into the river channel. This study aimed to analyze the vulnerability of river morphology and the intensity landslide area after the collapse of the caldera wall of Mt. Bawakaraeng.

MATERIALS AND METHODS

Study site and methods

Study site: Jeneberang watershed is belongs to Gowa region, South Sulawesi Province of Indonesia. It is

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situated between latitute 5°26’ 56”-5°08’12” N and longitude 119°22'26”- 119°56”31” S. and elevation ascended from 106 to 2830 m about sea level and total area 345 km^2. The land use of Jeneberang watershed consist of settlement or villages, dry land agriculture, paddy field along river bank and forest in mounthain area. The annual rainfall in this region is showing to small toward in area with low elevation (2000-2500 mm), meanwhile in area with high elevation (>3500 mm). The Jeneberang river flows originally at the foot slope of Mt. Bawakaraeng, about 2500 m above sea level and runs east through between two flat terrain insite the caldera. On the other hand, out site caldera, the large scale of terrace composed of debris deposits.

Tools and materials used in this study is a geological map of 1: 250,000, 10.2 GIS software, such earth map 1: 50,000 and GPS. The method used is a method diagram of a rosette with application stereonet 8, plotting the location of the point of landslides, estimate the direction of straightness (structural geology) based on the method (Davis and Reynolds, 1996) from observations of the regional structure pattern maps, map geological and geomorphological analysis of the surface.

RESULTS AND DISCUSSION

Landslide on the river morphology since March 26, 2004 up to now intense occured, this is evidenced by many points of the landslide site in the form of shallow landslides on river morphology and Jeneberang basin morphology (Fig. 1).

Shallow landslides intense incident occurs (Fig. 2) has added a mass of sediment entering the river channel and can impove the flow of debris, especially in the rainy season. Addition of debris mass can lower the quality and quantity of water in the Jeneberang watershed (Fig. 3).

Landslides triggered by heavy rainfall average annual Jeneberang basin, ie 2668-3000 mm $year^{-1}$ and the slope factor topography. Observation landslides after the collapse of the caldera wall Mt. Bawakaraeng shows the pattern of landslide spread in the Jeneberang watershed follow the pattern of spread of fault that have occurred since the Pliocene-Pleistocene epoch (5-1 m years ago). There are two shift directions of strike slip fault that developed in the study area, namely; Northeast-Southwest and Northwest-Southeast with the main direction of the relative sharpness of North-South. According to Davis and Reynolds (1996), the main shift directions has greatest force among other sharpness. Among the main sharpness are two strike slip fault that is likely to form the smallest angle 60-75° (Fig. 4). This resembles the model of the geological structures in the Jeneberang watershed (Fig. 5). Tectonic processes that occur in the watershed Jeneberang can be classified into five stages, namely:

- Phase 1; tectonic process occurs in Pliocene-Pleistocene epoch that makes rock that has formed undergo folding, joint and fracture. Structures that occur will deform throughout the body of rocks
- Phase 2; rocks were deformed get back the equilibrium point and can maintain the form that has been generated from the first process. This goes from the Pleistocene epoch to Resen
- Stage 3; rock impaired balance due to internal processes (wave propagation of tectonic activity in the surrounding area) and external process; derived from intensive rainfall, land use change and the growing need for space due to population growth. The result is a mass movement of rock and soil through fields of deformation (stocky and fracture), resulting in great landslide, collapse of the caldera wall Mt. Bawakaraeng

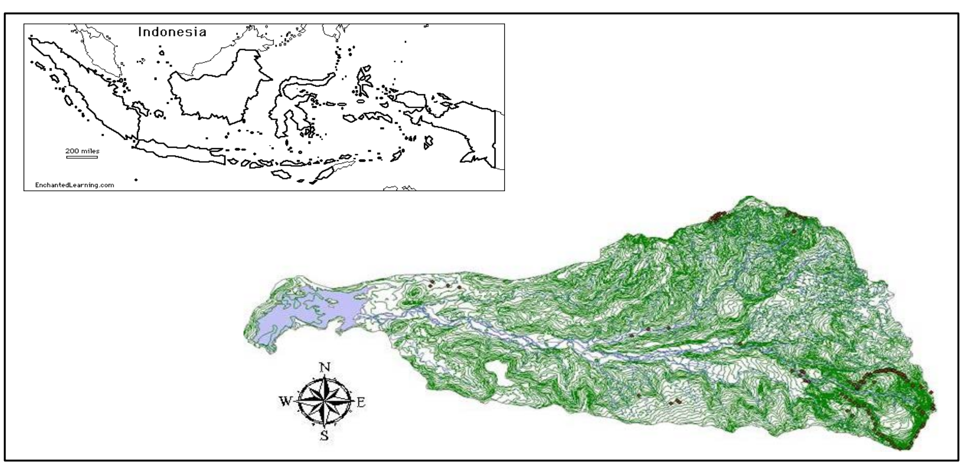

Fig. 1: Map of location landslide point in 2004-2013 as indicated by the black dots

Fig. 2: Landslide on the morphology of the river and the region on a variety of topographic slope

Fig. 3: Silty water along jeneberang river (A and B)

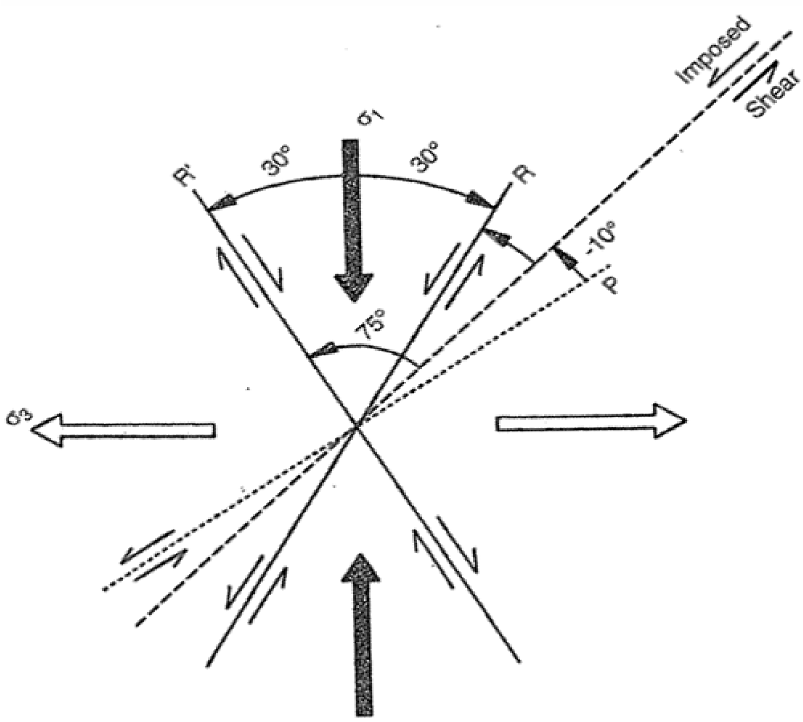

Fig. 4: Metode of Davis and Reynolds (1996) establishment of strike slip fault and the its direction, resembles the geological structure model Jeneberang Watershed

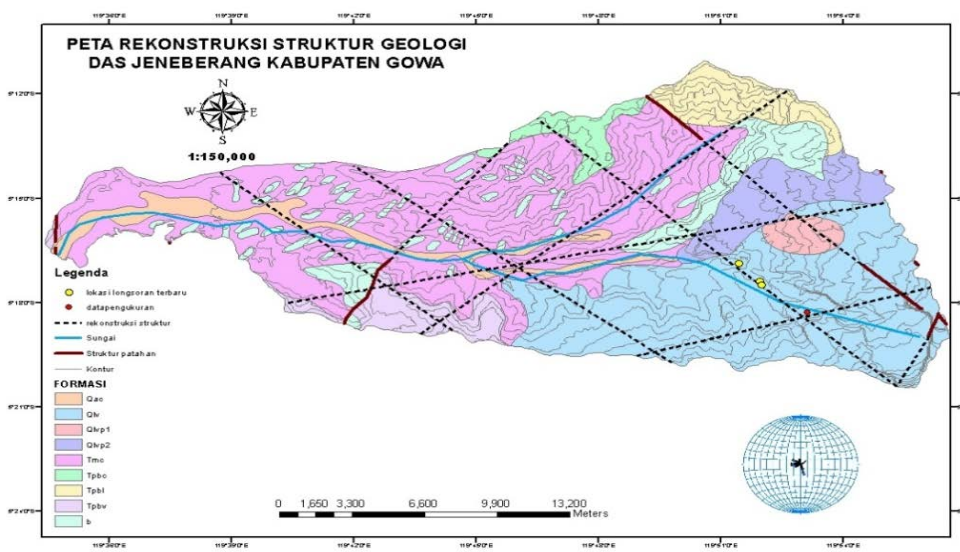

Fig. 5: Map of the reconstruction of the geological structure patterns that lead to the increased intensity of the landslide on the watershed Jeneberang

- Phase 4; the collapse of the caldera wall (partial loss of mass of rock that had been united) can bring down the entire shear strength of rocks both large scale and small scale, so the region becomes impaired balance and avalanche activity is increased, especially in the area of the along fault line, which generally becomes morphological development river
- Phase 5; landslide will continue to occur (takes a long t ime) until a new equilibrium occurs

CONCLUSION

Landslides occurred in Jeneberang watershed due to parent rock has undergone imbalance caused by external processes such as intensive rainfall, land use change. The result is a mass movement of rock and soil through fields of deformation (stocky and fracture), resulting in great landslide, collapse of the caldera wall G. Bawakaraeng. This reduces the shear strength of the rock around the well on a large scale or small scale, so the region becomes impaired balance and avalanche activity is increased especially in river morphology.

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