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THE TECTONIC REJUVENATION IN JENEBERANG WATERSHED, SOUTH SULAWESI

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Abstract

Jeneberang watershed is located in the southern part of Sulawesi’s south arm. It covers the regencies of Gowa, Takalar, Maros and the city of Makassar. Jeneberang River has caused acute floodings in the coastal plain of Makassar. The flood is not merely due to the water debit but mostly related to the large amount of transported materials. To protect the worsening of the flood a series of debris control or *sabo* dams were built along Jeneberang River. However, the dams are quickly filled with the materials due to the intensive erosion and slumping.

The present study aims to reveal the cause of land and rock movements at the upper part of Jeneberang watershed. The morphometric analysis using satellite imageries and the measurement of morphologic elements such as river gradient, bifurcation ratio, river density, high-low ratio of the valley, sinuosity indices and river offset were carried out. The results show that active tectonics intensively takes place in the upper part of Jeneberang watershed. The rock slumping recently occurred in Bawakaraeng was one of the evidences of the tectonic rejuvenation (*neotectonics*) in the southern part of Sulawesi’s south arm.

Keywords: flood, debris control, morphometric analysis, tectonic rejuvenation

Introduction

Sulawesi Island locates in a very active tectonic area. The odd shape of the island resembling K demonstrates the particular tectonic mechanism as among others put forward by Katili (1978) and Hamilton (1979). It was Klompé back in 1957 that first recognized the role of Sula spur acting as arrow’s spear that pushed the east arm of Sulawesi westward to form the present K-shape. Sukamto (1985) described the tectonics of south arm of Sulawesi Island. In this region, the tectonic activities predominantly took place in Tertiary time. Our investigation reveals further that the rejuvenation occurred in Quaternary.

The highly unstable earth’s crust of this area resulted in the intensive erosion and land movement. The materials filled Jeneberang River, which in turn caused severe flooding, particularly in Makassar‘s coastal plain. The disaster claims significant economic lost, because paddy fields and human settlements cover this area. Further, the capital city of Makassar locates also in the flood prone area. The government built the debris control or *sabo* dams along Jeneberang River. The eroded materials however, quickly filled the dams, resulted in the ineffectiveness of the dams.

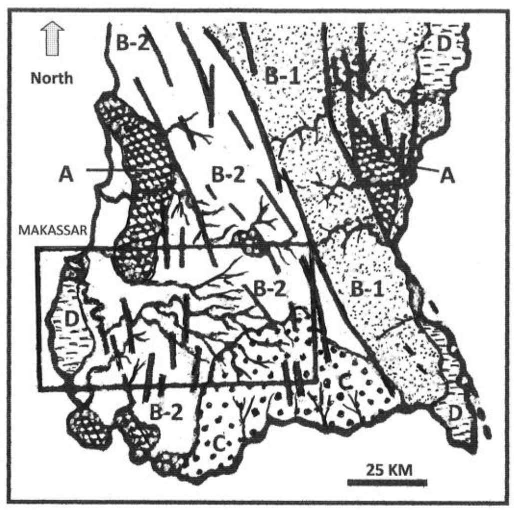

Figure 1: Map shows the investigated area (*square*) and the simplified geologic map. A, indicates Pre-Tertiary and Paleogene rocks, B-2, Middle to Upper Miocene volcanic products consisting of breccias, lava flows and volcano clastics, B-1 marine clastic sediments of Upper Miocene, C, Lower Quaternary Lompobatang volcanic products and D represents alluvial and coastal deposits. (Modified from Sukamto & Supriatna, 1982 and Berry & Grady, 1985)

The present study aims to contribute to the understanding of the cause of the erosion and land movement at the upper part of Jeneberang watershed. The investigated area covers the regencies of Gowa, Takalar, Maros and the City of Makassar in the south arm of Sulawesi Island. Geographically it extends from 119^{0}21’50”E to 120^{0}05’10’’E and 5^0 05’00’’S to 5^{0}28’00’’S (Figure 1).

Data and Method

The study applied the geomorphologic approach to reveal the tectonic activities in the area. The morphometric analysis includes the interpretation of processed satellite imageries, the field measurement of morphologic elements such as river gradient index, bifurcation ratio, river density, high-low valley ratio, sinuosity indices and the river offset. The analysis of the drainage and the fractures patterns provides the information on the direction of the tectonic compression of the area.

The fieldwork collected the information of ground truths to augment the analysis obtained from the satellite imagery. The river gradient compares the river's length and the river's bed elevation; the abrupt changes might indicate the boundary of different blocks. The bifurcation ratio measures the ratio between the numbers of rivers at particular order compared with numbers of the higher order. River density provides the information on the length of the river compared with the area of the watershed (km/km^2). Sinuosity indices show the dynamic of the vertical movement by comparing the width of river's bed and the valley's depth applying Keller & Pinter method (1996).

The Jeneberang watershed is divided into two regions, namely the upper and the lower Jeneberang. The upper watershed consists of Malino, Lengkese and Jenelata sub-watersheds. whereas the Lower Jeneberang sub-watershed represents lower Jeneberang. The measurements produced the following data (*Table 1*).

Table 1 Data of the morphometric measurements

Elements	**Jenebe-rang**	**Value (average)**	**Remarks**
Lineaments	Upper Lower	$N140^0E$ $N45^0E$ $N140^0E$ $N45^0E$	Similar direction of lineaments in Quaternary and Tertiary rocks
River gradient (SL)	Upper Lower	235.584 162.540	Break in slope at elev. +456 m
Bifurcation ratio (Rb)	Upper Lower	0.128 0.720	Showing the difference
River density (Dd)	Upper Lower	0.197 0.202	Showing slight difference
Width and depth (Vf)	Upper Lower	0,897 0.029	Showing contrast
Sinuosity indices (Smf)	Upper Lower	1.423 1.418	Similar
River offset	Upper Lower	9.714 1.418	Contrast

Result and Discussion

From the figures tabulated in Table 1, it is obvious that a dividing line exists between upper and lower Jeneberang watershed. The significant difference in the river gradient represents the topographic break at the elevation of approximately +450 m above sea level. The morphometric analysis supports the possible fault indicated by the abrupt topographic changes. The analysis of the lineaments pointed out the direction of faulting at $N140^0E$, which is in good agreement with the regional tectonic setting put forward by many earlier authors (Sukamto, 1985, Sukamto & Supriatna, 1982, Berry & Grady, 1987). The development of drainage pattern showing a significant difference between the upper and lower Jeneberang watershed supports the conclusion.

The sinuosity indices (Smf) reveal the tectonics that took place in the entirely Jeneberang watershed. However, the width and depth ratio (Vf) apparently indicates the higher rate in the upper watershed. The insignificant difference of the river density both in upper and lower watershed indicated that the tectonic activities involved the entirely watershed. The lithology seems to be insignificant in the development of the fractures that controlled the drainage pattern.

The rock units in the upper Jeneberang watershed compose of Lower Quaternary volcanic products of Lompobatang. The Upper Tertiary volcanic rocks consisting of breccias, volcano clastics and lava flows dominated the lithology in the lower Jeneberang watershed.

The value of various morphometric elements in the lithologic unit of Tertiary and Quaternary volcanic rocks concludes that the rejuvenation of tectonic activities occurred in Quaternary time. The contrast value of the river offset between the upper and lower Jeneberang watershed reveals the rate of activity, which is higher in the upper part. The tectonic movement might have triggered the recent Bawakaraeng landslides that slid down a huge amount of materials claiming significant number of casualties.

The recurrence of such natural disaster is quite apparent due to the continuing activity of the neotectonics. The materials deposited in Jeneberang River would definitively influence the performance of Bilibili dam. Taking into account the purpose of the dam in producing clean water for Makassar and generates electricity, the material control is very important. The construction of sabo dams at the upper Jeneberang River has contributed to the debris control of the area. Due to the rapid filling of the materials, however, the effective function of the facilities decline very quickly.

The earthquake in the rejuvenated tectonic setting of the area might easily trigger the landslides and the rock movements. It is therefore, the continuing monitoring of the micro-seismicity is strongly recommended.

Conclusions

1. The rejuvenation of tectonic activities takes place in the Jeneberang watershed, which locates in the southern part of south arm of Sulawesi Island;
2. The rate of neotectonic activities in the upper Jeneberang watershed is higher than that of the lower Jeneberang watershed;
3. The tectonic activity might have triggered the high intensity of rock and land movement at the upper Jeneberang watershed. The potential danger of such natural disaster is apparent;
4. The high rate of erosion and land movement due to the neotectonic activities resulted in a high deposition of materials in Jeneberang River. It might in turn, cause severe impact to various facilities constructed in this river;
5. The present study highly recommends the intensive and continuing monitoring of the micro-seismicity in this area as part of the natural disaster preparedness.

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