iJET EXPLORE International Journal of Engineering & Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-3444

International Journal of Engineering and Technology Volume 3 No. 10, October, 2013

The Influence of Seismic Activity in South Sulawesi Area to the Geomorphology of Jeneberang Watershed

Muhammad Altin Massinai[1], Adjat Sudradjat [2] Lantu[1]
[1]Department of Geophysics, Hasanuddin University, Makassar 90245 Indonesia
[2]Department of Geology, Padjadjaran University, Bandung 40122 Indonesia

ABSTRACT

Seismicity is one of the parameters of tectonic activity in a region. Jeneberang watershed in South Sulawesi is the clean water source for the cities of Makassar and Sungguminasa. seismic activity of Jeneberang watershed in the southern part of South Sulawesi arm seemed dominated by shallow earthquakes (depth less than 60 kilometers) and medium-sized earthquakes (depths between 60-300 kilometers). Distribution of earthquakes with intermediate depth look at coordinates 119,15^o - 120,15^o E and 4,8^o - 5,5^o S. Earthquakes that occur on land with a shallow depth due to the faults activity in the South Arm of Sulawesi. The position of the source of the earthquake at a depth of 500 km - 800 km is at coordinates 119,55^o - 120,15^o E and 5,0^o - 5,4^o S. This position is located on the southern arm of Sulawesi mainland. This earthquake is associated with a *trench* the *sea floor spreading* in the Makassar Strait and the Gulf of Bone. The trenchs on subduction zone to characterize the lithosphere. Seismisitas activity shows a subduction zone of the sea floor *spreading* in the Makassar Strait and the Gulf of Bone. Seismisitas activity indicates two zones of sea-floor spreading which makes the southern arm of Sulawesi have compression (compression). It also indicates the southern Sulawesi geomorphology including the Jeneberang watershed is significantly influenced by active tectonics.

Keywords: *seismic activity, Jeneberang watershed, geomorphology.*

1. INTRODUCTION

Sulawesi Island consists of four arms namely North, East, Southeast Arm and South Arm. The four arms of Sulawesi are united in a form of K (Katili,1989). The condition of tectonic in South Arm of Sulawesi strongly influences seismic activity and ground motion in the South Sulawesi (Massinai et al, 2006). Jeneberang depression which belongs to Jeneberang Basin area is the product of tectonic activity in South Arm of Sulawesi. The Tectonic activity also raises several active faults. The Faults spreading along the South Arm of Sulawesi is an exciting geological landmark and a clear geomorphological expression of the tectonic activity in the Jeneberang Basin area. These are normal faults that occur when Lompobattang Volcano is still active. This active fault will vibrate when it moves causing the cliffs of Mount of Bawakaraeng along Jeneberang River upstream unstable causing ground movement. As a consequence, the occured ground motion forms denudated landscapes around the Lengkese sub watershed of Jeneberang Watershed (Massinai, 2010).

According to Hamilton (1989), there are some faults causing earthquake activity, namely:

[1] Palu-Koro Fault, stretching from Palu to southern of southeast through northern South Sulawesi cutting Matano fault to the south of Bone Gulf to Banda Sea;
[2] Saddang Fault, spreading from the coast of Mamuju cutting diagonally across the central part of South Sulawesi, the southern part, Bulukumba the Eastern of Selayar island;
[3] Walenae Fault, spreading from north to south of South Sulawesi peninsula as the Walenae depression;
[4] The trenches, the southern Makassar and Bone deep sea;
[5] Some subs of the fault, both on the land and sea.

Geological structure of South Sulawesi consists of the main faults and the minor ones seen along from north-south and some from south- west to south east. Structure Map of southern Sulawesi is edited from Berry and Grady (1987) can be seen in Figure 1.

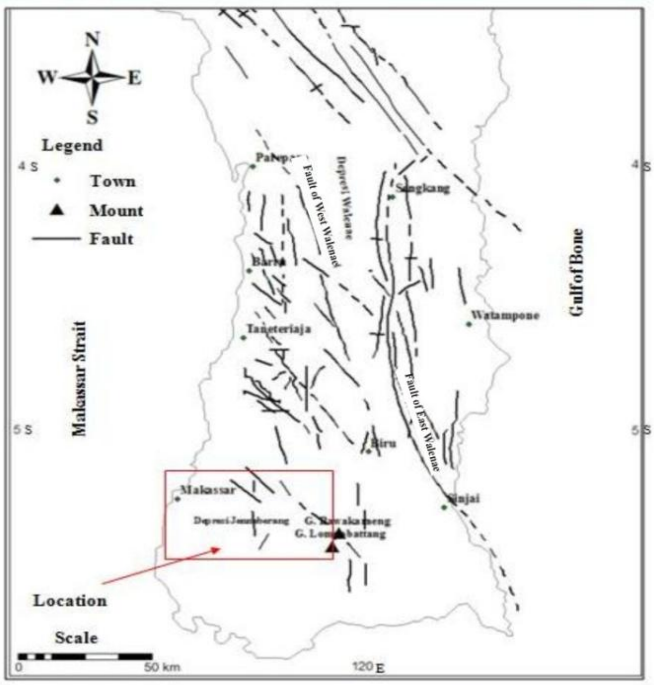

Figure 1 The structure Map of southern Sulawesi shows the main fault system (Berry and Grady, 1987).

From the map of earthquake epicentre distribution, the highest activity in the northern part of South Sulawesi is likely influenced by the Palu-Koro fault. The central part of South Sulawesi is influenced by Matano fault, while in the South is affected by the fault activity of Saddang Walenae (Lantu et al, 2006).

The activeness of Sadang and walenae faults are influenced by other activities in South Sulawesi, including:

[1] the Expansion of the seabed around the Makassar Strait moving eastward pushing both faults;
[2] the Proliferation of Bone Gulf seabed moving westward pressing Saddang and Walenae faults.

From the description of tectonic phenomena above, it can be identified that the zone of Walenae fault is distressed or depressed zone. (van Leeuwen, 1981). Thus there is a tendency that the regional seismic activity around the area of Walenae fault will increase. Mount of Bawakaraeng located upstream of the Jeneberang river around Walenae fault is affected by the activity of this fault. This is the effect of tectonic affecting instability of Jeneberang basin.

The morphology of the eastern South Sulawesi such as in Sinjai and Bantaeng in this study is the expression of the steepness of the spreading zone of Bone gulf seabed . Sudradjat(1982) assumes that the expression of steepness in the Bone Gulf seabed is a continuation from the Palu valley morphological expression and probably to the Selayar island with the total distance of 750 Kms. The steepness of Bone gulf seabed is associated with regional slope along the median line due to the crash between East of Mandala and West of Mandala, Sulawesi.

The morphology of western area is hilly and rough, while in the east is smooth. Morphology in eastern is generated from Miocene volcanic klastika rocks. The morphology in western is generated from Miocene volcanic rocks and Pliocene klastika with a height of less than 50 meters above sea level and almost a plain. The Hills stretching to the west are in the form of basalt embankments. Morphological unit in the eastern part is made up of Baturappe-Cindako volcanic rock units and Lompobattang volcanic rock formations.

The landscape existing around Mount of Bawakaraeng may indicate the existence of geological structure. The rough topography which suddenly becomes smooth with clear boundaries and nearly straight make it possible to the existence of faults on the boundaries of both morphologies. The geology of South Sulawesi is a bit complicated and complex, since it is part of the geology of Sulawesi region which has such a complicated and complex geological conditions as well. This situation is caused by the island of Sulawesi which is basically a combination of two series of orogen, namely Asiatic Island Arc and Sunda Mountain System. On the other hand, it is also the effect of the meeting of three plates, namely Eurasian, Indian-Australian and Pacific (Katili 1978).

2. DATA AND METHODOLOGY

The location of research is Jeneberang basin and the surrounding located in the southwest peninsula of the southern Sulawesi. The Jeneberang basin consists of 5 subwatersheds, namely Tallo, Malino, Lengkese, Jenelata and Jenebarang Hilir and the surrounding area. Geographically, Jeneberang watershed is located at 119^{o} 21’ 50’’ East Longitude – 120^{o}05’10’’ East Longitude and 05^{o}05’00’’ LS – 05^{o}28’00’’ South Lattitude.

Jeneberang watershed administratively belongs to Maros, Gowa,Takalar regencies, and the city of Makassar. Figure 2 shows a map of the study sites located in the southwest of South Sulawesi province.

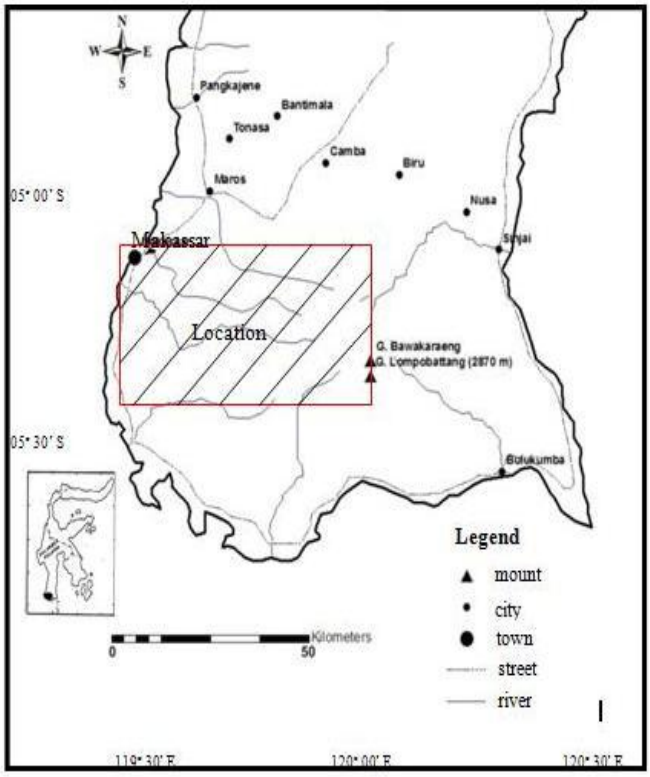

Figure 2 :The Location of the study area in the southwestern basin Jeneberang, South Sulawesi

This study uses seismology data (earthquake data) occurred in the southern region of Sulawesi in the period from 1985 up to 2011. The parameters used are P wave polarization, the name and number of stations recording the earthquake, the depth and latitude and longitude coordinates.

The P wave polarization data are secondary data with compression and dilatation signals . The data are collected from the earthquake observation network SEISCOMP 3 at regional Earthquake Center BMKG Region IV Makassar.
The method used is the P wave impulse method to determine the first motion of the P wave in the form of compression or dilatation. The more stations detected the better the results will be obtained.

3. ANALYSIS OF SEISMICITY

Seismicity is one of the parameters of tectonic activity in a region. In the southern part of central Sulawesi, earthquake has shallow, medium and deep depth caused by the process of sea-bed spreading in the Makassar Strait and the Bone Gulf.

The activity of Jeneberang Watershed area seems to be dominated by shallow earthquakes (depth less than 60 Kms) and medium earthquakes (depths between 60-300 kilometers). Earthquakes are caused by high sea-floor spreading activity in Makassar Strait and Bone Gulf. The distribution of earthquakes with medium depth is seen at the coordinates 119,15^o to 120,15^o East Longitude and 4,8^o to 5,5^o South Lattitude. Earthquakes that occur on land with shallow depth is due to the faults' activity in the area of South Arm of Sulawesi.

Tectonic activity in this area shows the position of the earthquake center at a depth of 500 Kms up to 800 Kms located at coordinates 119,55^o to 120,15^o East Longitude and 5,0^o s/d 5,4^o South Lattitude. This position is located in the South Arm of Sulawesi. This deep earthquake is associated with a trough in the ocean floor in Makassar Strait and Gulf of Bone. This area is a subduction zone (subduction), centered in Makassar Strait during the Tertiary (Katili, 1978). Seismicity activity indicates the subduction zone in Makassar Strait and Bone Gulf seabed.This shows two sea-floor spreading zones leading the South Arm of Sulawesi becomes compressed. This also indicates that the geomorphology in southern Sulawesi can be classified into Jeneberang basin area which is influenced by tectonic activity. Figure (3) shows the cross section of an east - west at 119.15 up to 120.35 East longitude with subduction zone pattern centered in Makassar Strait and Gulf of Bone.

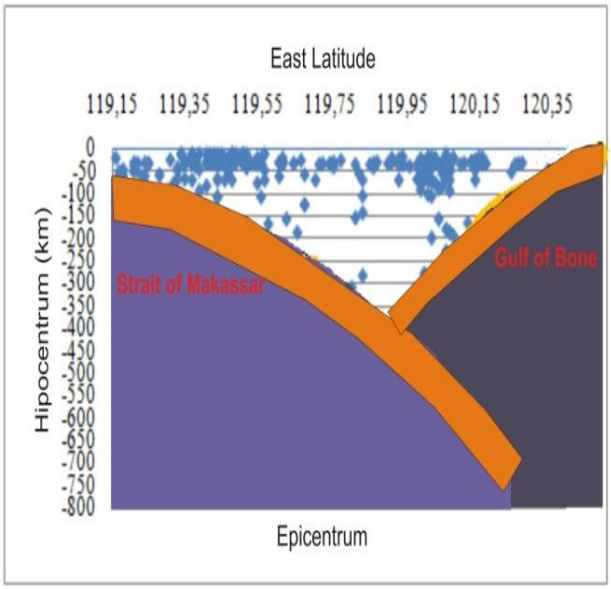

Figure 3 West-East cross-section seismicity activities with subduction zone pattern in Jenebarang watershed

Seismicity Activities occurring in Jeneberang watershed and its surrounding have magnitude below 5.0 richter scale. At time range from 1985 to 2009, the earthquake with a magnitude of 4-5 richter scale occurs only 7 times, while others below 4 richter scale. These Micro vibrations affect the denudated morphology in Mount of Bawakaraeng Valley. Figure (4) shows the position of the earthquake epicenter in Jeneberang watershed and its surrounding.

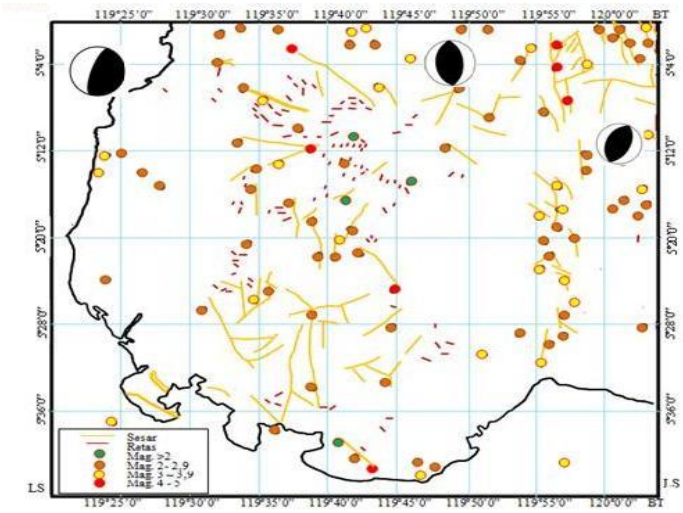

Figure 4 The earthquake epicenter position in Jeneberang watershed and its surrounding.

The distribution of focal mechanisms in the figure shows that the increasing fault heading to southwest-northeast. In shallow earthquake activity, when the magnitude is large (M> 6.0), it is considered dangerous and may cause damage. The distribution of earthquake with medium depth appears to be concentrated in the northern Jeneberang watershed. This earthquake is considered not so dangerous due to its hypocenter which is relatively deep and its influence on the surface is not too significant.

Generally, the depth of the earthquake epicenter is not more than 100Kms, since earthquake occurs only to Regas rock (brittle) and Regas lithosphere with 100 km thickness However, there is an earthquake centered at a depth of 700Kms. This very deep earthquake is not related to the mid- ocean ridge or transform fault, but with the troughs on the ocean floor. The troughs characterize the places where the lithosphere subduct to the sheath. The position in three dimension of the earthquake hypocenter in Jeneberang watershed and its surrounding are shown in Figure 5.

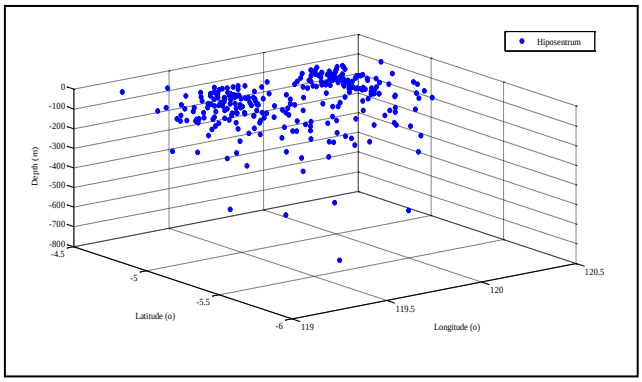

Figure 5 The earthquake hypocenter position in three dimension of Jeneberang watershed and its surrounding

The Earthquake in distribution center tends to be weak, irregular depth, less than 100 Kms and generally less than 20 Kms. This shows lithosphere on a thin expansion and the ductile asthenosphere should be closed to the surface. The seismotectonic, regionally, controls the cracks and will affect toward either the thickness or the tenuity of the continent getting cracked. In this thin continent, mantle mate-

rial rises to form horst just like what happens in the center of South Arm of Sulawesi.

During–Neogene period, the highlands of South Sulawesi Stopped moving eastward For being restrained by Buton microcontinent and Banggai-Sula collision and the central part of Sulawesi, including South Sulawesi was elevated.

The movement of tectonic as the expansion of Makassar Strait occurred at the end of the Pliocene era. The Expansion to the east caused subduction and formation of Lompobattang Mount. In the Pleistocene period, the subduction in Makassar Strait began to subside and the source of magma in Mount of Lompobattang stopped, and during the Pleistocene age, Jeneberang watershed was initially formed. In Pleistocene time in the southeastern part of South Arm of Sulawesi, the movement to open the Bone Gulf hit Mount of Lompobattang allowing Mount of Sapaya formed. Mount of Sapaya in the south and Mount of Lompobattang in the east as the depression boundary of Jeneberang where Jeneberang watershed is.

4. CONCLUSION

The seismicity pattern in southern part of Sulawesi forms subduction pattern in the opposite direction to the east from the subduction center in Makassar Strait and to the west from the subduction center in the Gulf of Bone.

The seismicity activity in Jeneberang watershed has an average magnitude of about 4-5 magnitude ranging from 0 - 800Kms in depth.

The movement of tectonic identified-with the seismic data makes this area unstable resulting in the formation of denudated geomorphology in jeneberang-watershed.

ACKNOWLEDGEMENT

The authors are grateful to Prof. Adjat Sudradjat, Prof. Febri Hirnawan, Dr. Ildrem Syafri, for supporting this research. They also would like to thank Prof. Idrus Paturusi on behalf of University of Hasanuddin, for financial support for the presentation of this paper.

REFERENCES

[1] Anonymous, 2000. *Focal Mechanism Data*, 1976-2000. Harvard CMT Catalog. Seattle: Incorporated Research Institutions for Seismology –IRIS.

[2] Berry, R.F. and Grady, A.E., 1997. *Mesoscopic structures produced by Plio-Pleistocene wrench faulting in South-Sulawesi, Indonesia*. Jour. Struct. Geol. ,Vol. 9, 1997, 563-571.

[3] Burbank, D.W., and Anderson, R.S., 2001 *Tectonic Geomorphology*. Blackwell Science, Inc. Massachusetts, 2001, 274 p.

[4] Darman, Herman dan Hasan Sidi, 2000. *An outline of The Geology Of Indonesia* Indonesian Assosiation of Geologist, 2000, 192 p.

[5] Hall, Robert, 2002. *Cenozoic Geological and Plate Tectonic Evolution of SE Asia and The SW Pacific : Computer-Based Reconstructions, Model and Animation*, Journal of Asian Earth Sciences. Pergamon.

[6] Hamilton, Warren, 1989. *Convergent-Plate Tectonics Viewed From The Indonesian Region* . Geol. Indon., Jakarta, Vol. 12, No.1, 1989, 35 – 88.

[7] Katili, J. A. 1989. *Evolution of the Southeast Asian Arc Complex*. Geol. Indon., Jakarta, Vol. 12, No. 1, 1989, 113 – 143.

[8] Lantu., Miranda., Suko Prayitno Adi, 2006. *Analysis of Eathquake Activity of Southwest Sulawesi*, Journal of Fusi, Vol.10, No.3, 2006, 186-191.

[9] Massinai, Muh. Altin**.,** Syamsuddin., Maharani, 2010. *Model of Vertical Resistivity Distribution of Rock Layers in Jeneberang watershed***.** International Journal Of Basic & Applied Sciences, Vol. 10, No.6, 2010, 151 - 161.

[10] Massinai, Muhammad Altin, 2012. *The Role of Morphotectonics in Controlling the Geomorphology of Lengkese-Jenelata Watershed, South Sulawesi*, Indonesian Journal of Applied Sciences (IJAS), Vol.2 No.1, 2012, 6 – 9.

[11] Massinai, Muhammad Altin, 2012. *The Contribution of Tectonics to Build the Geomorphology of Jeneberang Watershed Region of South Sulawesi*. Thesis Geology Engineering, Padjadjaran University, Indonesia.

[12] Sukamto, Rab dan Supriatna, 1995. *Geological Map of Ujungpandang, Benteng and Sinjai sheet*, Geological Research and Development Centre, Bandung, Indonesia.

[13] Van Leeuwen, Th. M., 1981. *The Geology of Southwest Sulawesi With Special Reference To The Biru Area*. Dalam. Barber,A.J & Wiryosujono, S. (Editor) The Geology And Tectonics Of Eastern Indonesia (Pergamon Press, Oxford, 277 – 304.