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MAPPING SEISMIC VULNERABILITY INDEX (KG) FOR EARTHQUAKE SWARM ACTIVITY IN WESTERN HALMAHERA, INDONESIA

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ABSTRACT

This research was conducted to determine seismic vulnerability index based on microtremor analysis and make microzonation of seismic vulnerability index in West Halmahera district. The microzonation is expected to be used for regional development based on earthquake disaster mitigation. The swarm earthquake that occurred in West Halmahera regency, although not significant in terms of loss of life, greatly affected the stability and capacity of the region in terms of infrastructure development. Data acquisition at the research location obtained 56 point locations. Microtremor data were analyzed using the Horizontal to Vertical Spectral Ratio (HVSR) method to obtain frequency and amplification values that can be used to calculate the value of seismic vulnerability (Kg) from a region. The results obtained are the seismic vulnerability index (Kg) value in West Halmahera Regency is 0 cm/s^2 - 31341.52 cm/s^2. The highest Kg value is located in Jailolo sub-district at point D10 which is 10397.1 cm/s^2. This is closely related to the total amount of damage to buildings in Jailolo Subdistrict due to the earthquake in November 2015 to February 2016. Whereas for other Sub-districts classified as medium to low Kg values, it can be concluded that having a stable soil structure.

KEY WORDS: swarm, seismic vulnerability index, HVSR.

INTRODUCTION

An earthquake swarm is an earthquake phenomenon that has a small magnitude with a very high frequency of occurrence in a certain period of time, without a large earthquake. Where generally occurs in volcanic areas, faults, or in areas where stress concentration occurs (Mogi, 1963).

The characteristics and sources of causes of earthquake swarm are often unknown. For megathrust subduction areas, swarm earthquakes tend to occur and occur between earthquake fault areas - large earthquakes and occur in areas with low interstitial strain accumulation (Holtkamp and Brudzinki, 2014). Tectonic earthquake swarms often coincide with aseismic slip and sometimes precede damaging earthquakes (Passarelli, et. all., 2018).

West Halmahera is located on the west coast of Halmahera island. There are 4 volcanoes, where there are 3 volcanoes that are active until now along the coast of Halmahera from south to north. Active volcanoes are Gamkonora Mountain, Mother Mountain and Tobaru Mountain. While Mount Jailolo is still being investigated until now its activities have been inactive for a long time.

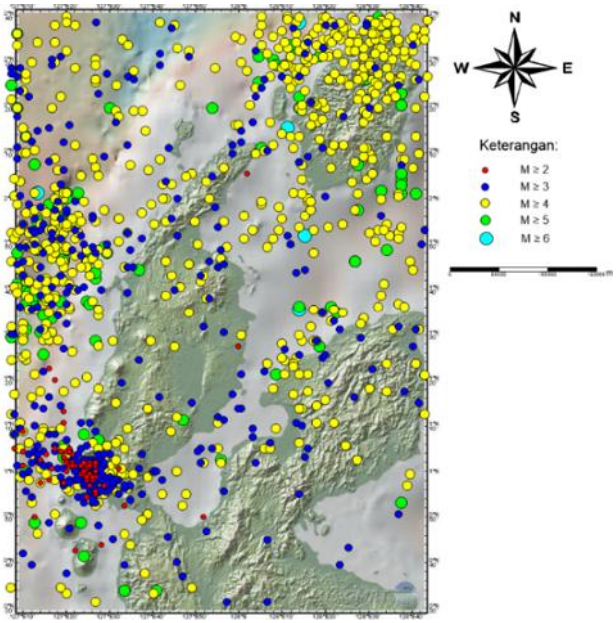

Fig.1 The epicenter of eartquake swarm based on some earthquake catalogs 1910-2018 at West Halmahera

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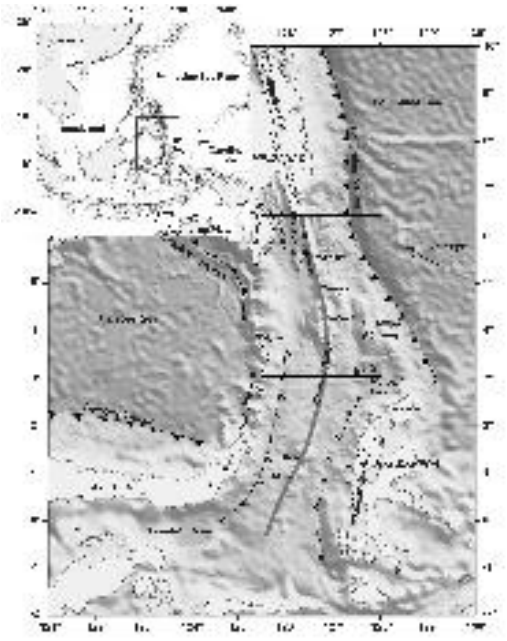

Fig.2 Simple regional tectonic in the Maluku sea area (Widiwijayanti et al., 2003)

The swarm earthquake that occurred throughout the end of November 2015 to February 2016 with the largest magnitude of about > 4.8 M centered on the jailolo mountain. Although there were no fatalities, structural damage such as damaged houses were also significant.

Swarm earthquake relocation in Jailolo area, West Halmahera conducted by Putri. Y.T., et al., 2016 found that some of the swarm earthquakes that occurred were concentrated at a depth of less than 20 km and probably were caused by volcanic activity.

In addition (Passarelli, et.all., 2018) also revealed the results of his analysis that the swarm earthquake that occurred in 2015-2016 in jailolo also had the possibility of coming from magmatic activity. The analysis is based on observations duration, extent, speed of the hypocenter migration, source mechanisms of the earthquake, Non-DC tensile component of the MTs inferred for the largest events of the swarm, appearance and orientation of opening cracks at the surface, hypothesis reconciles the occurrence of four large normal faulting events within the regional strike-slip tectonic regime of West Halmahera. However, further research is still needed to find out the causes and characteristics of the earthquake swarm.

Seismic vulnerability index (Kg) is an index that describes the level of vulnerability of the surface soil layer to deformation during an earthquake (Daryono, 2011). The microzonation of seismic hazard by using the HVSR method is to connect the frequency and amplification values to be able to analyze seismic vulnerabilities in an area. Where seismic vulnerability index (Kg) parameters can reflect local effects and can be used as indicators in determining weak points, especially in slope areas (Warnana, Soemitra, and Utama, 2011).

The purpose of this study was to determine the seismic susceptibility index and create a seismic susceptibility microzonation index in West Halmahera Regency. The microzonation is expected to be used for infrastructure development and regional spatial planning and as a reference for earthquake disaster mitigation.

THE MAIN BODY OF PAPER

The equipment and materials used in this measurement are a set of TDS-303, GPS, UPS, laptop data acquisition seismometer tools, DATAPRO software for microtremor data acquisition, and ArcGis and Surfer software for mapping.

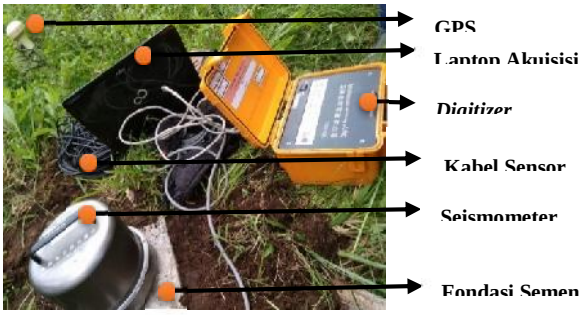

Fig. 3 A set of TDS-303 type Seismometers

Data acquisition at the study location with a location point of 56 points to obtain primary data in the form of the dominant period period of the land using the mikrotremor method. The mikrotremor method is a measurement based on surface wave recording used to determine the characteristics of surface sedimentary layers in a region. The results obtained from mikrotremor observation are frequency and amplification values that can be used to calculate the value of seismic vulnerability (Kg) from a region.

Data processing to produce seismic vulnerability index (Kg) value with the HVSR method from Nakamura (2000) was assisted by the HVSRModel in the MATLAB program. Data processing was carried out to obtain a horizontal to vertical (H/V) spectrum ratio of all types of vibration signals recorded in the field. After processing the data, the frequency and dominant periods are obtained. The frequency and dominant period values are used as a reference to get the seismic vulnerability index (Kg) value.

RESULT AND DISCUSSION

The results obtained from this study are the seismic susceptibility index (Kg) and seismic susceptibility index (Kg) microzonation maps in West Halmahera District. Seismic vulnerability index (Kg) analysis is the result of a further analysis of the Dominant Period value analysis. The results of the analysis at 56 measurement points in the study area resulted in Seismic Vulnerability values (Kg) varying from 0 to 31341.52. The results of the seismic susceptibility index (Kg) microzonation in West Halmahera are shown in Fig. 4

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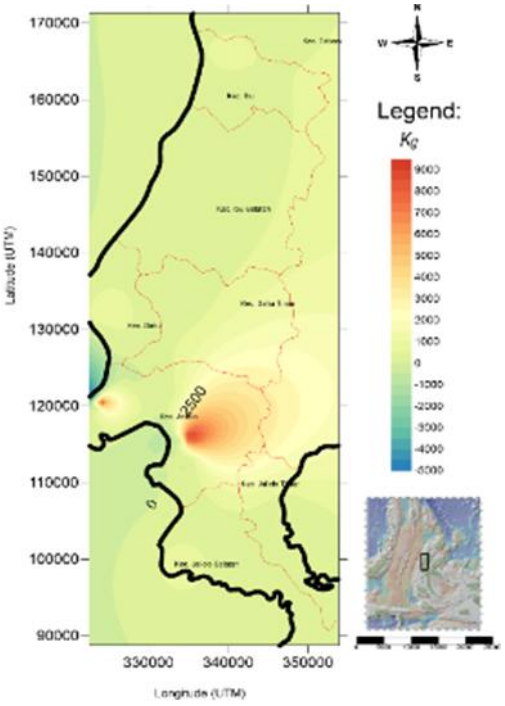

Figure 4. Microzonation of vulnerability seismic index at West Halmahera

The Kg value is used to detect weak zones (unconsolidated sediment) or areas or regions that have the potential to cause damage and fractures in the event of an earthquake. The higher the Kg value, the area is an area that has a higher level of building damage due to earthquakes. On the contrary, if the Kg value is lower then the area is an area that has a lower level of soil structure stability against building damage due to earthquakes.

In the microzonation map, Kg shows that the highest Kg value is in the Jailolo Subdistrict with a value of 10397.1 cm / s2 at point D10. This is closely related to the total amount of damage to buildings in Jailolo Subdistrict due to the earthquake in November 2015 to February 2016. Whereas for other Sub-districts classified as moderate to low Kg values, it can be concluded that having a stable soil structure.

CONCLUSIONS

Based on the research that has been done, it can be concluded that:

1. The seismic vulnerability index (Kg) value in West Halmahera Regency is 0 cm/s^2 up to 31341.52 cm/s^2.
2. The highest Kg value is located in Jailolo sub-district at point D10 which is 10397.1 cm/s^2.
3. Other sub-districts are classified as medium to low Kg, which can be concluded that having a stable soil structure.

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