Determination of Seismic Vulnerability Index and Sediment Thickness Using the HVSR Method in Mamuju, Tapalang, and Malunda districts

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Abstract: Research was carried out on determination of the Seismic vulnerability index and sediment thickness using theHVSR method in Mamuju, Tapalang and Malunda districts from June 30 to July 1 2021. This research aims to determinethe thickness of the sediment layer at the research site and determine the value of seismic vulnerability index. This researchuses microtremor data analyzed by HVSR, this method was processed in geopsy software and considered effective in determining the characteristics of the soil layer. The HVSR method produces natural frequency parameters (f_0) and amplification (A_0) which are presented in the form of a H/V curve so that this method can estimate the seismic vulnerability index *(Kg)*. The H/V data was then used as an input on the analysis of the ellipticity curve to obtain the value of the sediment layer thickness (*h*). The results from this reasearch indicate that the value of (h) in the study area ranges from 14 m to 100 m. The (*h*) value is in Mamuju District at points (M01, M03, M04), Tapalang (T02, T03, T04, T05), and Malunda (ML02, and ML03) so that the sedimentary rock is very thick that it is vulnerable to earthquake shocks. The value of the seismic vulnerability index (Kg) at the research site ranges from 0.1 to 15.25. Kg values tend tobe in valley areas and areas close to the coast, if viewed from the geological map, the area was an alluvium formation andcoastal deposits so vulnerable to potential earthquakes.

Keywords: HVSR method, Seismic vulnerability index, sediment thickness,

1. INTRODUCTION

West Sulawesi, especially in Mamuju and Malunda districts, is an area that was prone to earthquake, this is due to the presence of an active fault that runs along the Mamuju to Majene area. . West Sulawesi has experienced at least an earthquake that occurred in 1820, 1976, 1969, 1984 and on January 15, 2021 There was an earthquake that resulted in many casualties and damage to buildings (Dedy dkk, 2021). To determine the level of earthquake vulnerability using microtremor data which was further processed using the Horizontal Vertical Spectral To Rasio (HVSR) method, the analysis resulted in the thickness of the sediment layer and seismic vulnerability index in the study area, which can be used for planning and development reference.

2. MATERIAL AND METHODS

This research was conducted in the districts of Mamuju, Tapalang, and Malunda with a total of 14 measurement points of which 5 points are in the Mamuju district, 5 points are in the Tapalang district and 4 points are in the malunda district This study uses a set of Digital Portable Seismographs type TDL 303-S with a recording duration of 30 to 45 minutes for each measurement point. get the natural frequency value and amplification value. The values (f_0) and (A_0) obtained can then be used to determine the value of seismic vulnerability (*Kg*), the value of the seismic vulnerability index (*Kg*) at each research point is obtained from the square of the amplification factor divided by the dominant frequency value. To determine the value sediment thickness (*h*) a processing is carried out using the ellipticity curve method, by analyzing the H/V curve using Dinver on the Geopsy sub-Sesarray software by entering input parameters including P wave speed (Vp), Poisson ratio (σ), S wave velocity (Vs).), and density (ρ). then classified with the Soil Classification table Based on the Natural Frequency Value of Microtremor

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Table 1. Kanai and Omote - Nakajima Land Classifications (Arifin et all, 2014).

Land Classification		Period (T) (second)	Explanation	Characteristic
Kanai	Omote - Nakajima			
Type I		0.05–0.15	Tertiary or older rocks.	Hard
Type II	Type A	0.10–0.25	Alluvial rocks, with a thickness of 5m. Consists of*sandy-gravel,sandy hard clay*, *loam*, etc.	medium
Type III	Type B	0.25–0.40	Alluvial rocks, with thickness >5m. Consists of*sandy-gravel hard clay, loam,* etc.	Soft
Type IV	Type C	>0.40	Alluvial material, which is formed from sedimentation of deltas, topsoils, mud, etc.	Very Soft

TABLE 1. Kanai-Classification of soil types (Arifin et all,2014)

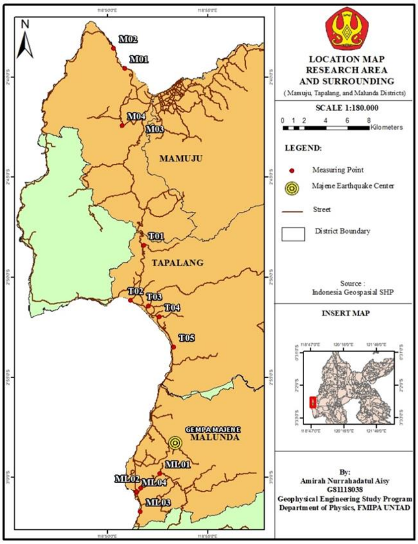

FIGURE 1. Research sites

3. RESULTS AND DISCUSSION

Seismic Vulnerability Index (*Kg*) describes the level of vulnerability of an area during an earthquake. The value of the seismic vulnerability index (*Kg*) at each research point is obtained from the square of the amplification factor divided by the dominant frequency value which is then made a map that we can see on the map image of the location of the study area. classification of seismic vulnerability index into three zones, High zone if the seismic vulnerability index is greater than 6, Medium zone if it falls between 3 and 6, and Small zone if it is less than 3 (Refrizon, 2013).

The research area has a seismic vulnerability index in (*Kg*) map. shows the research area that has a low seismic vulnerability index (*Kg*) value, namely at points M01, M02 M03, T01, T05, ML01 ML02, ML03 with values ranging from 0.01 to 2.73 and The seismic vulnerability index which is currently at points M04, T02, and ML04 with a value range of 5.53 to 5.85 tends to be east and south. with values 7.07 and 15.25 tend to be westward.

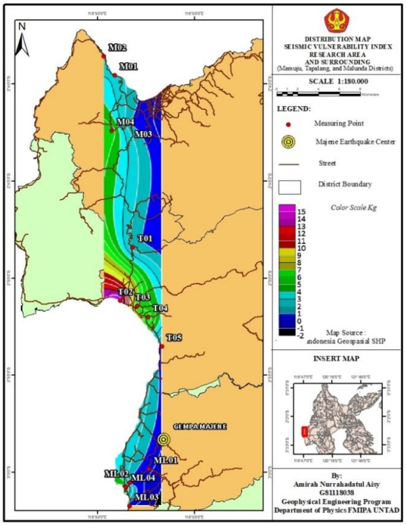

FIGURE 2. Map of seismic vulnerability index (Kg) of the study area

High (*Kg*) values tend to be in valley areas and coastal areas, if viewed from the geological map, these areas are alluvium formations and coastal deposits. (*Kg*) values tend to be low in the hills area. This is in accordance with the value of the seismic vulnerability index obtained in research conducted by Nakamura (2000 and 2008) and Gurler, et al., (2000). Classification of soil types, the results obtained through the HVSR method are still general. This is because the results of processing with the HVSR method can only know the characteristics of the soil type and the thickness of the sediment layer (Patimah, 2017).

In figure (3) the thickness of the sediment layer in the study area ranges from 14 m to 100 m, see Classification of soil table. The thinnest layer is located at points M01, ML01 and ML04 tends to the south and the thickest is at points M02, M03, M04, T01, T02, T03, T04, T05, ML02, and ML03 tends to the north. The thickness of the sediment layer (*h*) in the study area follows the geological conditions of the area, if it is correlated with the natural frequency value, the research area in Mamuju district has a thick sediment category indicated by alluvial sedimentary rocks more than >5 m while Tapalang and Malunda districts have sediment thickness with medium category with alluvial rock indication less then <5m. Sediment thickness map shows that the closer to the north, the higher the thickness of the sediment so that it is more susceptible to potential earthquakes.

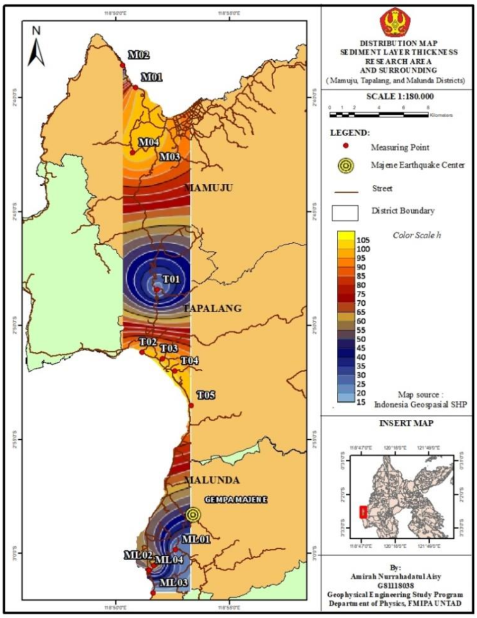

FIGURE 3. Map of the thickness of the sediment layer *(h)* of the study area

4. CONCLUSION

1. The seismic vulnerability index (Kg) values at the research site range from 0.1 to 15.25. High Kg values tend to be in valley areas and those near the coast. When considering the geological map, these areas consist of alluvial formations and coastal deposits, making them susceptible to earthquake potential.
2. The thickness of sediment layers (h) in the research area varies between 14 m and 100 m. The Mamuju District and Tapalang District tend to have relatively high values and substantial sediment thickness, indicating a high earthquake potential in these areas of Mamuju and Tapalang Districts.

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