Journal of Experimental and Applied Physics
Journal Homepage: jeap.ppj.unp.ac.id
Vol. 1, No. 3, December 2023.
ISSN (Print): 2988-0378 ISSN (Online): 2987-9256

Microzonation Analysis of Soil Vulnerability Index of Sumani Region As Part of The Sumatra Fault System Using Microtremor

Lingga Ayunda Pradipta[1], Syafriani[1,*], Hamdi[1], Letmi Dwiridal[1]

[1] *Department of Physics, Universitas Negeri Padang, Padang 25131, Indonesia*

Article History
Received : December, 23th 2023
Revised : December, 30th 2023
Accepted : December, 31th 2023
Published : December, 31th 2023

DOI:
https://doi.org/10.24036/jeap.v1i3.30

Corresponding Author
*Author Name: Syafriani
Email: syafri@fmipa.unp.ac.id

Abstract: West Sumatra is a province located on the west coast of the island of Sumatra in the middle which has four active fault segments. Nagari Sumani is part of the Sumani Segment line, which makes Nagari Sumani very vulnerable to earthquakes. Efforts are needed too . reduce the impact of the earthquake in Nagari Sumani. This study aims to determine the value of soil vulnerability index (Kg) and soil vulnerability index microzonation (Kg) in Nagari Sumani, specifically Jorong Pinjangek and Jorong Guci, in the area of the Sumani Segment route. The microtremor method of measuring this microtremor can determine the dominant frequency value (f0), amplification factor (A0), and soil susceptibility index value (Kg). Microtremor data was used to obtain the H/V curve at each point of data collection using Geopsy software. Seismic vulnerability index microzonation is carried out using software Surfers 13. The results of this study indicate that the seismic vulnerability index in Nagari Sumani ranges from 3.65 x 10^{-6} s^2/cm to 99.51 x 10^{-6} s^2/cm which has low, medium, to high categories. The results of microzonation of low soil susceptibility index (Kg) are at points 1,2,7, and 8 with a value range of 3.65 x 10^{-6} s^2/cm to 41.02 x 10^{-6} s^2/cm, the medium category is in points 3 and 5 with a value range of 50.02 x 10^{-6} s^2/cm to 54.23 x 10^{-6} s^2/cm, while the high category is at points 4 and 6 with a value range of 63.32 x 10-6 s^2/cm to 99.51 x 10^{-6} s^2/cm .

Keywords: Seismic Vulnerability Index, Microtremor, HVSR, Sumani.

1. Introduction

West Sumatra is one of the areas where the intensity of earthquakes is very high. The source of the earthquake in the West Sumatra region does not only come from the meeting of tectonic plates, but is also caused by the Sumatran fault system and the Mentawai fault system. Of all these earthquake sources, it will cause the West Sumatra region to become an earthquake-prone

How to cite:
L. A. Pradipta, Syafriani, Hamdi, L. Dwiridal, 2023, Microzonation Analysis of Soil Vulnerability Index of Sumani Region As Part of The Sumatra Fault System Using Microtremor, *Journal of Experimental and Applied Physics,* Vol.1, No.3, page 25-39. https://doi.org/10.24036/jeap.v1i3.30

area, West Sumatra is a province located on the west coast of the island of Sumatra in the middle which has four active fault segments. This segment is one of the parts of the Sumatran fault zone, including the Sumpur Segment, Sianok Segment, Sumani Segment, and Difficult Segment.

Microtremor is a weak vibration of the ground caused by natural or man-made disturbances, such as wind, ocean waves, traffic, and industrial machinery (Motame et al., 2007). Microtremor data using the HVSR (Horizontal to Vertical Spectral Ratio) method can be used to determine the amplification value and seismic vulnerability index that describes the dynamic characteristics of the soil [1]. The HVSR analysis method was developed to calculate the ratio of the Fourier spectrum of the horizontal component of the microtremor signal to its vertical component [1].

One method that can be used to describe subsurface conditions is through microtremor measurements. Microtremor measurement produces dominant frequency parameters and amplification factors, as well as derivatives of these parameters, namely seismic susceptibility index [14]. Seismic vulnerability index (Kg) is an index that describes the level of vulnerability of the surface soil layer to deformation during an earthquake. This Kg value can be used to predict areas that are damaged by earthquakes.

In the Sumani area, there are new settlements that are still under construction in the last few years and there is a large number of people in the study area, it is necessary to conduct research on the soil vulnerability index in the Sumani area to determine the level of vulnerability of the area's soil to earthquake disasters. considering that the Sumani area is an area located on the Sumatran Fault in the Sumani Segment. Soil vulnerability index can be determined by the Microtremor method to estimate the soil vulnerability index from the Sumani Segment. The microtremor method compares the spectrum ratio of the horizontal component of the microtremor signal to its vertical component.

Amplification is an earthquake wave propagating from the bedrock to the ground surface. The earthquake amplification factor is an earthquake acceleration factor that occurs on the ground surface due to specific soil types [13].

A fault is a fracture in rock that moves parallel to its plane. In general, it is not known how much movement occurs next to the fault and which blocks move and which part is stationary, so the term relative shift is used to classify faults, because it is not known which blocks move relative to the other side. The shift on one side through the fault plane makes one block relatively up, down, and horizontal to the other [2]. Microtremor data is very useful for: (1) predicting the thickness of sediment layers qualitatively (2) compiling period maps dominant (3) compiling a map of amplification factors (4) compiling a seismic susceptibility index map. (Kg).

Microtremor is ground vibration with microtremor amplitude caused by natural or human factors. Microtremor is based on Rayleigh waves showing that the peak period of the microtremor H/V ratio provides the basis of the S wave period [15].

The data from the microtremor measurements in the field is ground vibration data in a function of time. Microtremor utilizes the noise ratio around ground vibrations from human and natural activities on the horizontal and vertical components to describe subsurface structure [16].

Microtremor microzonation is a process of dividing the area based on certain parameters with the characteristics considered, among others; ground vibration, amplification factor, and dominant period. The results of this microzonation indicate that when there is strong ground shaking, high damage is possible in areas with high seismic susceptibility. The information contained in the disaster map of a particular area cannot be used as a reference for evaluating other areas, because each region has its disaster map according to the characteristics of the soil and rocks [3].

Natural frequency (f0) is a frequency value that often appears so that it is recognized as the frequency value of the rock layers of the area so that the frequency value can indicate the type and characteristics of the rock. The natural frequency value from HVSR processing represents the natural frequency found in the area. This states that in the event of an earthquake or disturbance in the form of vibrations that have the same frequency as the natural frequency, resonance will occur which results in the amplification of seismic waves in the area.

Table 1. Soil Classification Based on the Dominant Frequency Value of Microtremor by Kanai [4]

Soil Classification Type	Soil Classification Kind	Dominant Frequency (Hz)	Classification Kanai	Description
Type IV	Kind I	6,667 – 20	Tertiary or older rocks. Consists of hard sandy rocks, gravel, and other.	The thickness of the surface sediment is very thin, dominated by hard rock
	Kind II	4 – 10	Alluvial rock, with a thickness of 5 meters. Consists of sandy, gravel, sandy hard clay, loam, and others.	The thickness of the surface sediment is in the medium category of 5-10 meters.
Type III	Kind III	2,5 – 4	Alluvial rock, with a thickness of >5 meters. Consists of sandy gravel, sandy hard clay, loam, and others.	The thickness of the surface sediment is in the thick category, around 10-30 meters.
Type II Type I	Kind IV	< 2,5	Alluvial rock, is formed from deltaic sedimentation, topsoil, and mud with a depth of 30 meters or more.	Surface sediment thickness very thick.

The amplification factor (A0) of an earthquake is the ratio of the maximum acceleration of an earthquake at the ground surface to the bedrock. The frequency and amplitude content of earthquake waves that propagate from bedrock to the earth's surface will change as they pass through soil deposits. This process can produce a large acceleration of the structure and cause severe damage, especially when the seismic wave frequency is the same as the resonance frequency of the man-made structure.

Table 2. Classification of amplification factor values [5]

Zone	Classification	Amplification Factor Value	Color in Mapping
1	Low	> 3	Green
2	Medium	3 – 6	Blue
3	High	6 – 9	Yellow
4	Very High	≥ 9	Red

Soil vulnerability index (Kg) is an index that shows the level of vulnerability of the soil surface layer of an area to soil deformation during an earthquake [6]. Areas that have a low soil vulnerability index have little potential for damage during an earthquake. Meanwhile, areas that have a high soil vulnerability index have a high potential for damage during an earthquake. Building damage caused by an earthquake occurs when the earthquake force exceeds the strain limit of a building. This causes changes in the base position and collapse in buildings that have low structural stability. Consider the soil vulnerability and the value of the strain shift (γ) in the soil layer during an earthquake [12] . The seismic susceptibility index is defined for strain conditions on a scale of 10^{-6} (cm/s^2) [7].

Table 3. Classification of soil vulnerability index values [8]

Zone	Soil Vulnerability Index (Kg)
Low	< 3
Medium	3 – 6
High	> 6

The value of the dominant period is the time required for the wave to propagate through the sediment layer or experience one reflection from the reflecting plane to the surface. The value of the dominant period can indicate the character of the rock layers in the area.

2. Materials and Method

This microtremor data collection activity was carried out in early March, to review the data collection points before conducting the study. In April, the research sites were reviewed based on suggestions and input from the examiners for the research sites. In June, direct microtremor data collection was carried out on the Sumatra Fault line, in the Sumani Segment, in Jorong Pinjangek and Jorong Guci, Nagari Sumani, X Koto Singkarak District, Solok Regency, West Sumatra, with 8 data collection points, with the distance between the points. 300 m – 500 m, with measurements at one point, carried out for 40 minutes.

The tools used in this research are hardware and software. Hardware is the equipment used during microtremor signal measurement in the field (1)Hardware used as follows:1)Sysmatrack-M.AE 2)Seismograph 3D-M.AE 3)Connecting cable between sysmatrack-M.AE and the Seismic Sensor Surface-M.AE 4) Compass 5)GPS 6)Laptop (2)Software used as follows:1)Geopsy software is used for HVSR analysis 2)Google Earth to find out the location of data collection points in the research area and site survey to find out field conditions 3) Microsoft Excel 2007 is used to calculate the value of soil vulnerability (Kg) 4) Surfer 13 is used to create modeling contours. The dominant frequency data and the amplification factor are used to determine the value of the seismic vulnerability index [11]. The Kg value is the most accessible vulnerability index to identify from the point of the measurement location.

The results of the microtremor measurement are in the form of raw ground vibration data as a function of time. Noiseless wave research was carried out using Geopsy software by cutting high-noise waves. The data was processed using Geopsy software to analyze HVSR. This data was analyzed at the Geophysics Laboratory, Faculty of Mathematics and Natural Sciences, Padang State University.

The next stage is processing soil velocity data from the microtremor survey using Geopsy software with the output of the dominant frequency value (f0) and amplification factor (A0). A soil vulnerability index for Sumani area using Google Earth software.

$$Kg = \frac{A0^2}{f0} \quad (1)$$

Kg is the seismic vulnerability index value, A0 is the amplification value, and f0 is the dominant frequency value (Hz). The HVSR method compares the vertical signal component with the horizontal signal component obtained from microtremor signal measurements [17].

The natural frequency value from HVSR processing represents the natural frequency found in the area. This states that in the event of an earthquake or disturbance in the form of vibrations that have the same frequency as the natural frequency, resonance will occur which results in amplification of seismic waves in the area. The value of the natural frequency (f0) of an area according to Mucciarelli and Gallipoli (2001) is supported by several factors, namely the thickness of the weathered layer and the average subsurface velocity (Vs), so it can be written as: (2) where f0 is the natural frequency, Vs is the average value of the shear wave velocity at a depth of up to 30 meters from the surface, and H is the thickness of the weathered layer.

Earthquake wave amplification can occur when the wave propagates to the ground surface where the natural frequency (f0) of the soil has a frequency value that is almost the same or the same as the frequency of the incoming earthquake. Amplification is an event that strengthens a wave when it passes through a certain medium. The ratio between the characteristics of the horizontal signal to the vertical signal is directly proportional to the gain of the wave as it passes through a medium.

The amplification factor (A0) of an earthquake is the ratio of the maximum acceleration of an earthquake at the ground surface to the bedrock. The frequency and amplitude content of earthquake waves that propagate from bedrock to the earth's surface will change as they pass through soil deposits. This process can produce a large acceleration of the structure and cause severe damage, especially when the seismic wave frequency is the same as the resonance frequency of the man-made structure.

According to [1], the value of the amplification factor of a place can be known from the peak height of the HVSR amplitude spectrum as a result of microtremor measurements at that location. Several studies have found a correlation between the peaks of the H/V spectrum with the distribution of structural damage due to earthquakes and the intensity of ground shaking due to the earthquake and intensity of ground shaking during an earthquake which is significantly influenced by geological conditions and local soil conditions. Soft sedimentary rock is known to amplify ground motion during earthquakes and therefore the average damage caused is more severe than that of hard layers [1].

3. Results and Discussion

The number of distribution points taken from the two jorongs in Nagari Sumani is not the same. At Jorong Pinjangek 3 data collection points were taken, and at Jorong jar 5 data retrieval points were taken, with a maximum distance of 500 m between points. The overall location can be seen in Figure 1

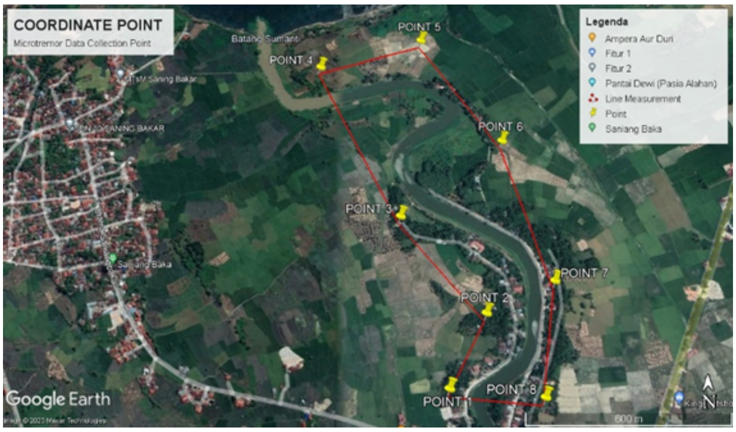

Figure 1. Map of the location and distribution points of the research area

In a study conducted from March to June, the results of this study were presented in the form of a contour map of the dominant frequency, amplification factor, and soil vulnerability index as a result of HVSR analysis of microtremor measurement data in Nagari Sumani, X Koto Singkarak District, Solok Regency. . There are three components in the microtremor data, namely the horizontal component N-S (North-South), the horizontal component E-W (East-West), and the vertical component (Up-Down). The recording data format is in the form of trace (*.trc) which is then stored in minimised format (*.MSD). Measurements were made using a microtremor set consisting of a Sysmatrack MAE Seismograph, an S3S Sensor, and a laptop used for microtremor data analysis. like in Figure 2


Figure 2. Measurement with Microtremor

Data collection in the field is shown in Figure 2. Figure 2 is the use of a microtremor device when collecting research data at the research site. Microtremor data were analyzed using Geopsy software by cutting and windowing for signal selection without noise. Figure 3 shows an example of microtremor data from measurements in the field.

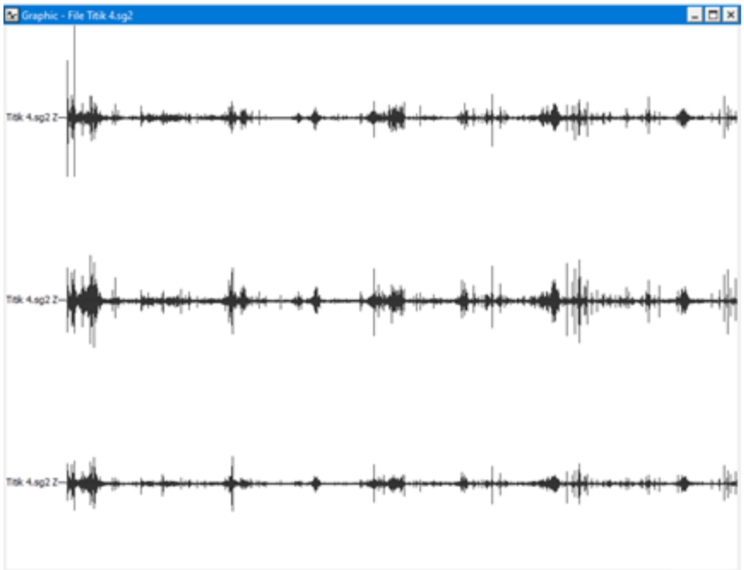

Figure 3. Microtremor data at point 1 before cutting

Based on Figure 3 shows one example of microtremor data from measurements in the field at point 1 before cutting the signal and windowing in the geopsy application. Then the H/V of each component is averaged and the average H/V curve is obtained. Figure 4 shows an example of microtremor data in data 4 which has been cut data and windowing in geopsy software.

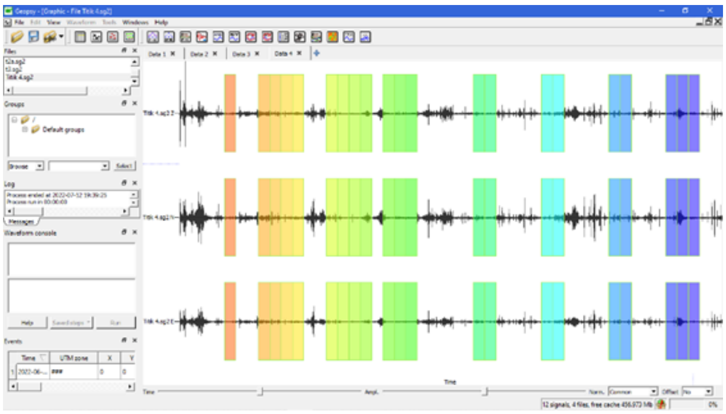

Figure 4. Microtremor data on 4 . data

Based on Figure 4 shows an example of microtremor data in data 4 which has been cut and windowed on the part where there is noise, so the data used is only the part with little or no noise. Figure 5 shows an example of the HVSR curve in data 4 which has been cut data in the geopsy software.

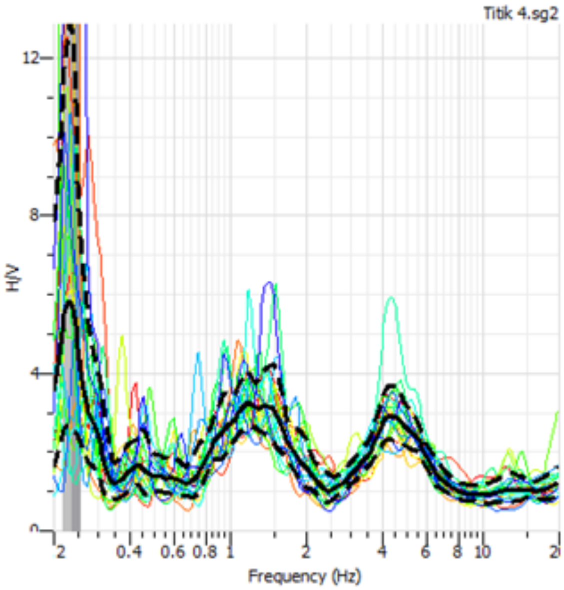

Figure 5. HVSR curve on 4 microtremor . data

Based on Figure 5 shows the results of the HVSR curve that has been cut, it can be seen that there is a change in the curve after cutting noise in the data, which on the curve before cutting, a lot of noise is generated. The horizontal component data is divided by the vertical component in the frequency domain so that the H/V value is obtained for each window. Then, the H/V value of each component for all windows is averaged so that the average H/V curve is obtained.

Based on the results of the analysis, it is known that the dominant frequency value obtained from the data processing is classified into soil type III and type III with a dominant frequency range of 2.5 Hz which is composed of alluvial rock with a thickness of > 5 meters. Consisting of sandy gravel, sandy hard clay, loam, and others, the thickness of the surface sediment falls into the thick category, around 10-30 meters. The following results of data analysis of dominant frequency values at each measurement point can be seen in Table 4.

Table 4. Results of Data Analysis of Dominant Frequency Values (f0)

Point	Longitude X (m)	Latitude Y (m)	Dominant Frequency (f0)	Category
4	100.586659	-0.700561	0.233094	
3	100.588888	-0.705281	0.244404	
5	100.589722	-0.699728	0.245549	
6	100.591942	-0.703065	0.248915	Low
2	100.591108	-0.708067	0.254344	
1	100.589995	-0.710002	0.254444	
7	100.593049	-0.707224	0.262732	
8	100.592493	-0.710281	1.64267	High

Table 4 is the result of data analysis of the dominant frequency value, so we get varying values for microtremor measurements in the study area which can be seen in Figure 6. Figure 6 shows the results of the analysis of the H/V curve for the dominant frequency value.

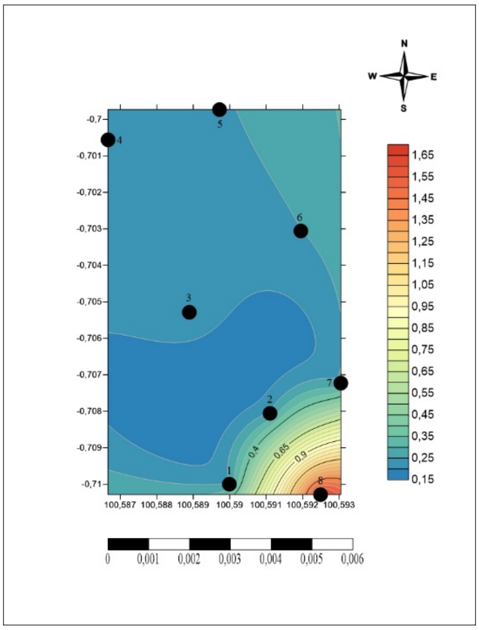

Figure 6. Map of the dominant frequency distribution of Nagari Sumani

Based on Figure 6 shows the results of the H/V curve for the dominant frequency value in Nagari Sumani, the results of the analysis of the H/V curve obtained that the dominant frequency varied from the microtremor measurement data, namely 0.15 Hz to 1.65 Hz. Based on the results of data analysis, it can be seen that the value of the amplification factor obtained from the results of data processing is classified in the low to high-level category with a small amplification value range of 5. The following results of data analysis of the amplification value at each measurement point can be seen in Table 5.

Table 5. Results of Data Analysis of Amplification Factor Values (A0)

Point	Longitude X (m)	Latitude Y (m)	Amplification Factor (A0)	Category
8	100.592493	-0.710281	2.45017	Low
2	100.591108	-0.708067	2.72544	
1	100.589995	-0.710002	3.04033	
7	100.593049	-0.707224	3.28296	
3	100.588888	-0.705281	3.49675	Medium
5	100.589722	-0.699728	3.64932	
4	100.586659	-0.700561	4.9185	High
6	100.591942	-0.703065	4.97027	

Table 5 is the result of the data analysis of the amplification factor values, so various values are obtained in the microtremor measurements in the study area which can be seen in Figure 7. Figure 7 shows the results of the analysis of the H/V curve for the amplification factor value.

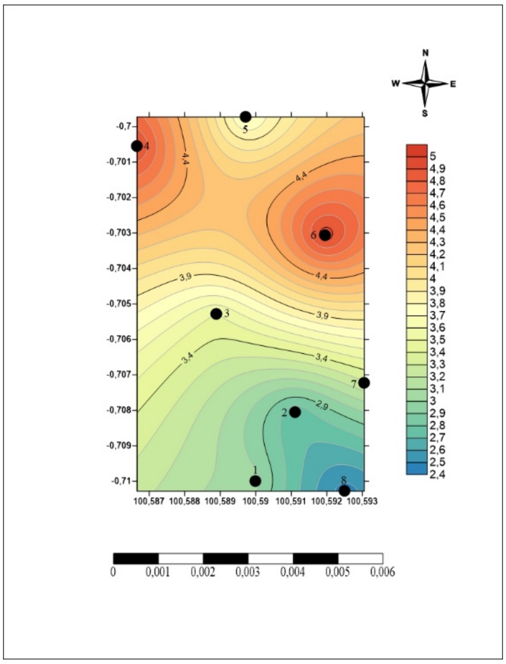

Figure 7. Map of the distribution of amplification factors in Nagari Sumani

Based on Figure 7 shows the results of the H/V curve for the value of the amplification factor in Nagari Sumani, the results of the analysis of the H/V curve obtained amplification factors that vary from the microtremor measurement data, namely 2.45017 to 4.97027. Furthermore, from the dominant frequency value (f0) and the amplification factor value (A0), the soil vulnerability index value (Kg) can be obtained using the formula in equation 1. Based on the calculation results, it can be seen that the soil vulnerability index value obtained from the data processing is classified in the low to high-level category. The following results of the calculation of the soil vulnerability index data at each measurement point can be seen in Table 6.

Table 6. Results of Data Analysis of Soil Vulnerability Index Value (Kg)

Point	Longitude X (m)	Latitude Y (m)	Soil Vulnerability Index (Kg)	Category
8	100.592493	-0.710281	3.654619022	Low
2	100.591108	-0.708067	29.20463307	
1	100.589995	-0.710002	36.32864799	
7	100.593049	-0.707224	41.02213039	
3	100.588888	-0.705281	50.0288889	Medium
5	100.589722	-0.699728	54.23575931	
6	100.591942	-0.703065	63.32701474	High
4	100.586659	-0.700561	99.51558759	

Table 6 is the result of the calculation of the data on the value of the soil susceptibility index, so various values are obtained for the microtremor measurements in the study area which can be seen in Figure 8. Figure 8 shows the results of the analysis of the H/V curve for the value of the amplification factor.

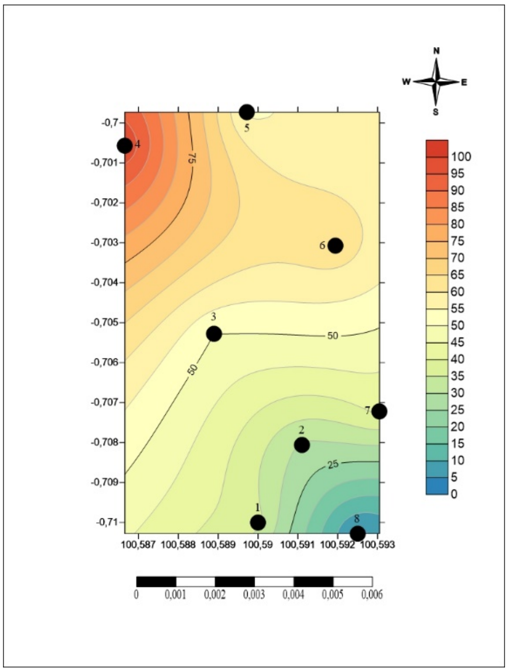

Figure 8. Distribution Map of Soil Vulnerability Index of Nagari Sumani

Based on Figure 8 shows the results of the H/V curve for the value of the soil vulnerability index in Nagari Sumani, the results of the analysis of the H/V curve obtained that the soil susceptibility index values varied from the microtremor measurement data, ranging from 3.654619022 to 99.51558759. Furthermore, for microzonation mapping, the contour map that has been created in the Surfer 13 software earlier, is then exported to the google earth application. Figure 9 shows a microzonation map of the distribution of amplification factor values on Google Earth.

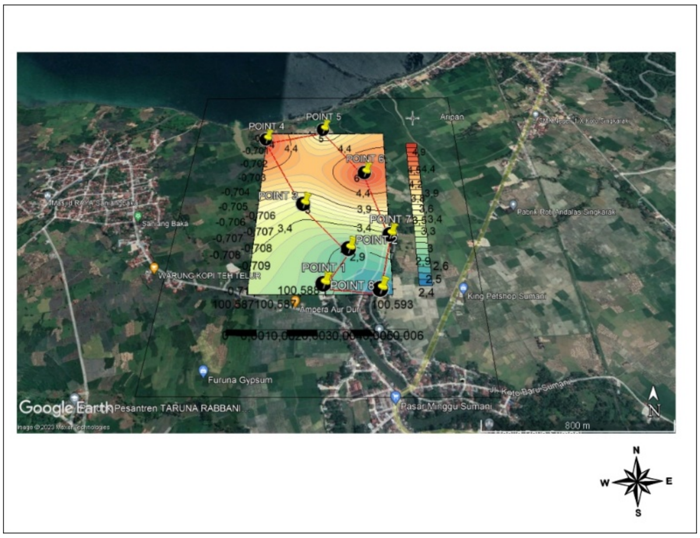

Figure 9. Microzonation Map Distribution of Amplification Factor Values in Nagari Sumani

Based on Figure 9, the results of the microzonation of the distribution of amplification factor values are found to be in zone 2 with a moderate classification. Figure 10 shows a microzonation map of the distribution of dominant frequency values on Google Earth.

Figure 10. Microzonation Map Distribution of Dominant Frequency Values of Nagari Sumani

Based on Figure 10, the results of the microzonation of the distribution of dominant frequency values in the measurement area are obtained, composed of alluvial rock with a thickness of >5 meters.

Figure 11 shows a microzonation map of the distribution of soil susceptibility index values on the Google Earth software which was previously contoured in the Surfer 13 software**.**

Figure 11. Microzonation Map Distribution of Soil Vulnerability Index Values of Nagari Sumani

Based on Figure 11, the results of the microzonation of the distribution of soil vulnerability index values in the measurement area are included in the medium to the high zone.

The results obtained from this study are the value of the soil vulnerability index in the Sumani area as part of the Sumatran Fault system and its microzonation. In this study, microtremor data processing uses the HVSR method which produces a H/V curve. [9] argues that the H/V curve is formed from secondary waves, but the large Rayleigh wave effect can affect the shape of the H/V curve so it is a noise that must be removed. The H/V curve produces the dominant frequency (f0) and amplification factor (A0) which are used in the calculation of the soil susceptibility index (Kg). The values of dominant frequency (f0), amplification factor (A0), and soil susceptibility index (Kg) were visualized by microzonation. This is done to determine the distribution of the level of vulnerability of an area in the event of an earthquake in the Sumatran Fault line.

In Figure 6 it can be seen that the results of the H/V curve analysis obtained the dominant frequency (f0) which varied from the microtremor measurement data, namely 0.15 Hz to 1.65 Hz, by connecting the dominant frequency value with table 1. Soil classification according to Kanai and Omete- Nakajima, most of the Nagari Sumani area, especially Jorong Pinjangek and Jorong Guci are composed of alluvial rock with a thickness of >5 meters. Consists of sandy gravel, sandy hard clay, loam, and others. Included in type III and type III with the thickness of the surface sediment into the thick category, about 10-30 meters.

River alluvial rock (Qal) consists of gravel, sand, clay, and silt which are river deposits that are deposited along river basins or the coast. The dominant frequency value (f0) of an area is supported by several factors, namely the thickness of the weathered layer and the average subsurface velocity (Vs)).which uses the HVSR method for mapping the earthquake microzonation in the Solok area, it reflects the presence of very thick surface sediments and indicates that the area is at risk of severe earthquake damage.[10]

Figure 7 can be seen from the results of the H/V curve analysis that the amplification factor value (A0) varies from the microtremor measurement data, which ranges from 2.4 to 5, by connecting the amplification factor value with table 3. classification of the amplification factor value, then most of the Nagari area Sumani especially Jorong Pinjangek and Jorong Guci belong to zone 2 with moderate classification. Regions that have a high amplification factor value tend to have a large potential for resonance in that area, and vice versa, if an area that has a low amplification factor value tends to have a small potential for resonance in that area.

Distribution of damage to building structures due to earthquakes and intensity of ground shaking due to earthquakes and intensity of ground shaking during earthquakes are significantly influenced by geological conditions and local soil conditions. Soft sedimentary rock is known to amplify ground motion during earthquakes and therefore the average damage caused is more severe than that of hard layers [1]. which uses the HVSR method for mapping the earthquake microzonation in the Solok area, the Sumani area has a fairly high amplification and is vulnerable to damage from the impact of an earthquake. This zone is not recommended for development facilities[10]

Figure 8 can be seen from the calculation results, the soil vulnerability index value of Nagari Sumani ranges from 3.65 to 99.51 by connecting the value of the soil vulnerability index with table 2. Soil vulnerability index classification, then the soil vulnerability index value is obtained in Nagari Sumani, especially Jorong Pinjangek and Jorong Guci belong to the medium to the high zone. Points 1,2,7, and 8 are dominated by green, so they have low risk, while points 3 and 4 are dominated by blue, so they have moderate risk. Points 3 and 5 are dominated by blue so they have a moderate risk, while points 4 and 6 are dominated by red so they have a very high level of risk [5].

Areas that have a low soil vulnerability index have little potential for damage during an earthquake. Meanwhile, areas that have a high soil vulnerability index have a high potential for damage during an earthquake. Building damage caused by an earthquake occurs when the earthquake force exceeds the strain limit of a building. This causes changes in the basic position and the collapse of buildings that have low structural stability [7].

4. Conclusion

The results of this research show that the soil vulnerability index value in Nagari Sumani ranges from 3.65 x 10^{-6} s^2/cm to 99.51 x 10^{-6} s^2/cm which was obtained through calculating the value of the dominant frequency (f0) and the value of the factor amplification (A0). The microzonation results of the soil vulnerability index (Kg) in the low category marked in blue are at point 1 with a value of 36.32864799, point 2 with a value of 29.20463307, point 7 with a value of 41.02213039, and point 8 with a value of 3.654619022. Next, the medium category marked in yellow is at point 3 with a value of 50.0288889, point 5 with a value of 54.23575931, and point 6 with a value of 63.32701474. Next, the high category marked in red is at point 4 with a value of 99.51558759. From these results it is known that Nagari Sumani is dominated by areas that are prone to low soil vulnerability during earthquakes.

Acknowledgments

The author would like to thank the PTSP NAKER Service of Solok Regency and Wali Nagari Sumani for giving permission for the writer to conduct research in the Sumani area.

References

[1] Y. Nakamura, "Clear Identification of Fundamental Idea of Nakamura'sTechnique and Its Application," 12nd Word Conf. EarthquakeEngineering, 2000.

[2] C. I. A. Benyamin, Noer Aziz Magetsari, Agus Handoyo Harsolumakso, "Modul Kuliah Geologi Fisik. Bandung," ITB, 2014.

[3] Z. Wang, "A technical note on seismic microzonation in the central United States," Kentucky Geol. Surv., vol. 1, no. 8, 2008.

[4] Muhammad Fachrul Rozi, "Analisa SeismisitasPulauJwaPeriode 1921-2016 dan Mikrozonasi Daerah Di KlatenMenggunakanMetode HVSR (Horizontal to Vertical SpectralRatio)," Progr. Stud. Fak. MIPA UNS, 2016.

[5] Marjiyono, "Estimasi KarakteristikDinamika Tanah Dari Data Mikrotremor Wilayah Bandung," Thesis ITB, 2010.

[6] S. . Motamed, R., Ghalandarzadeh, A., Tawhata, I. and Tabatabei, "Seismic Microzonation and Damage Assessment of Bam City," J. Earthq. Eng., vol. 11, no. 1, pp. 110–132, 2007.

[7] Y. Nakamura, "On the H/V Spectrum," 14th World Conf. Earthq. Eng., 2008.

[8] Refrizon, "AnalisisPercepatanGetaran Tanah Maksimum dan TingkatKerentananSeismik Daerah Ratu Agung Kota Bengkulu," ProsidingSemirata FMIPA Univ. Lampung, 2013.

[9] Y. Nakamura, "A Method For Dynamic Characteristics Estimation Of Subsurface Using Microtremor On The Ground Surface," Q. Reports, vol. 30, no. 1, 1989.

[10] R. A. Putri, "Pemetaan Mikrozonasi Gempabumi Daerah Solok Sumatera Barat Berdasarkan Pengukuran Mikrotremor Dengan Metode HVSR(Horizontal to VerticalSpectral Ratio)," Jur. Tek. Geofis., 2017.

[11] Sunaryo, H. U. Mala, and A. Prasetio, "Earthquake microzonation study on Batubesi Dam Of Nuha, East Luwu, South Sulawesi, Indonesia," *Int. J. GEOMATE*, vol. 15, no. 48, pp. 148–154, 2018, DOI: 10.21660/2018.48.40882.

[12] Y. Nakamura, "Seismic vulnerability indices for ground and structures using microtremor," *World Congr. Railw. Res.*, pp. 1–7, 1997.

[13] Y. Nakamura, "Real-time information systems for seismic hazards mitigation UrEDAS, HERAS and PIC," *Quarterly Report of RTRI (Railway Technical Research Institute) (Japan)*, vol. 37, no. 3. pp. 112–126, 1996.

[14] R. Edison, S. Rohadi, Y. Perdana, N. F. Riama, and D. Karnawati, "Seismic Vulnerability Index Calculation for Mitigation Purposes at Cilacap District," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 873, no. 1, 2021, DOI: 10.1088/1755-1315/873/1/012005.

[15] B. Legowo, R. A. Lazuardian, and S. Koesuma, "Microzonation of the seismic vulnerability index by using the horizontal to vertical spectral ratio in Boyolali, Central Java," *AIP Conf. Proc.*, vol. 2202, no. December, 2019, DOI: 10.1063/1.5141743.

[16] M. Mirzaoglu and U. Dykmen, "Application Of Microtremors to Seismic Microzoning Procedure," *J. Balk. Geophys. Soc.*, vol. 38, no. 3, pp. 144–157, 2003.

[17] N. A. F. Tanjung, H. P. Yuniarto, and D. Widyawarman, "Analisis Amplifikasi Dan Indeks Kerentanan Seismik Di Kawasan Fmipa Ugm Menggunakan Metode HVSR," *J. Geosaintek*, vol. 5, no. 2, p. 60, 2019, DOI: 10.12962/j25023659.v5i2.5726.