Identification of Ground Motion Prone Areas Triggering Earthquakes

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Identification of Ground Motion Prone areas Triggering Earthquakes Based on Microtremor Data in Jati Agung District, South Lampung Regency, Lampung, Indonesia

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Abstract. Jati Agung District is an area planned by the Lampung government to become a new city of the central government in Lampung. Aspects of city planning include aesthetics and safety. The geophysical study is conducted as disaster mitigation efforts to make the city have a good level of safety. The purpose of this study is to measure earthquake activities in the research areas that could be developed as data in disaster mitigation. The geophysical study was conducted by measuring the microtremor at 15 points. The microtremor signal is processed by the HVSR method to obtain information on natural frequency and amplitude. Natural frequencies and amplifications were analyzed to obtain the Peak Ground Acceleration (PGA) and Ground Shear Strain (γ) values. The results of PGA values and Ground Shear Strains indicate indications of soil fracture-prone areas. The results showed that the PGA value was 12.34638 gal to 22.18974 gal, while the Ground Shear Strain (γ) value was 53.34322×10^{-6} to 729.6847×10^{-6}. The area of this study is a very safe area against the impact of earthquakes. Because the deformation in the event of an earthquake is very small, this is due to the type of rock found. In the study area, the type is rock that has large compacting properties. Also based on the geography on this research area is a region that is quite safe from tsunami waves, because in the west there are high mountains, and there are also small islands that can reduce tsunami waves from the southwest of the research location (Jati Agung Area).

Keywords: Earthquake, Geophysics, PGA, Ground Shear Strain, Microtremor

INTRODUCTION

Jati Agung is a district planned by the Lampung provincial government as a new city as the center of government. Jati Agung Regency as a city center of government caused Jati Agung to have high human activities. Kota Baru, which is a city center for governing government policies to drive regional development, needs to consider aspects of urban planning. One aspect of urban planning is the aspect of disaster. One of the unpredictable natural disasters is the earthquake.

Jati Agung as a New City is located on the island of Sumatra which has a fault **(FIGURE 1).** The fault extends from the Sunda Strait to the north of the island of Sumatra. In addition there is a Subduction zone in western Sumatra because the Indo-Australian oceanic plate moves below the Eurasian continental plate [1,2]. This situation caused Lampung to be in an earthquake-prone area. One of the impacts of the earthquake is the occurrence of ground cracks.

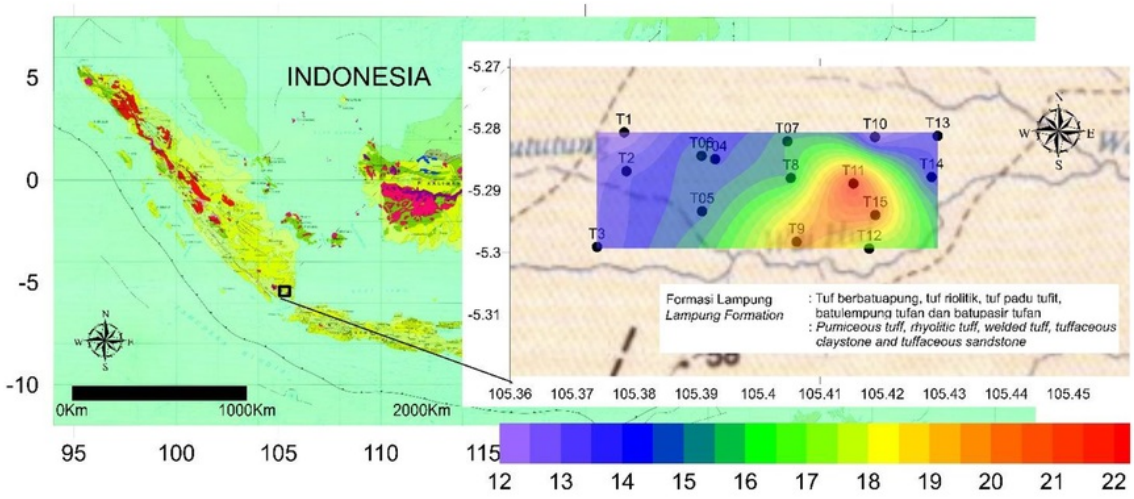

FIGURE 1. Recording Locations Denotes by Solid Black circle. The Entire Research Area is Part of the Same Geological Formation, the Quartenary Tuff Lampung

Efforts to prevent the occurrence of casualties and buildings due to earthquakes in Jati Agung, namely by mitigating the disaster caused by earthquakes. In addition to earthquake disaster mitigation parameters such as dominant frequency, amplification factor, and seismic vulnerability, the Peak Ground Acceleration also requires ground shear strain parameters. In this study, the parameters can be known by analyzing the microtremor signal. Microtremor signals have a Horizontal Vertical Spectral Ratio (HVSR) method. The HVSR method is a method used by many researchers previously in analyzing vibrations under the earth's surface [3].

In this case, the study was conducted in Jati Agung, South Lampung Regency, Indonesia. In addition, the location of this study has a distance of about 23 km from the city of Bandar Lampung. Based on the Tanjung Karang geological map (**FIGURE 4**), the Kota Baru Area (research site) is part of Barisan zone volcanic sedimentary. The research location is dominated by tuffaceous claystone, pumiceous tuff, welded tuff tuffit, rhyolitic tuff, and tuffaceous standstones [3].

Horizontal to Vertical Spectral Ratio

This method can be used to determine the local site effect of an earthquake by identifying the fundamental frequency and amplification factors. In this method, the ratio of the Fourier spectra of the horizontal and vertical components of seismic noise recorded on a threecomponent seismometer (H/V ratio) is calculated. The spectrum must be smoothed before the H/V ratio can be computed. In this study, the Konno and Ohmachi smoothing function was used [4]. Each time window produces one H/V ratio; the average H/V ratio was then calculated. The average H / V peak curve can be connected to the base frequency as amplification. The HVSR method can be assumed ideally as follows: 1) The environment consists of a rigid substrate but covered by a soft layer of soil, 2) Microtremor or the wave formed is considered a Rayleigh wave [5]. From these assumptions, transfer function (HVSR) can be derived from the spectral ratio to the horizontal and vertical microtremor components of the recording at a certain point [6,7,8,9]. The following equation is used

$$HVSR = \frac{H_S}{V_S} \quad (1)$$

Where H_S is the spectral amplitude of the horizontal components of the microtremors measured at the surface of the soil layer and V_S is the spectral amplitude of the vertical components of microtremors measured at the surface of the soil layer.

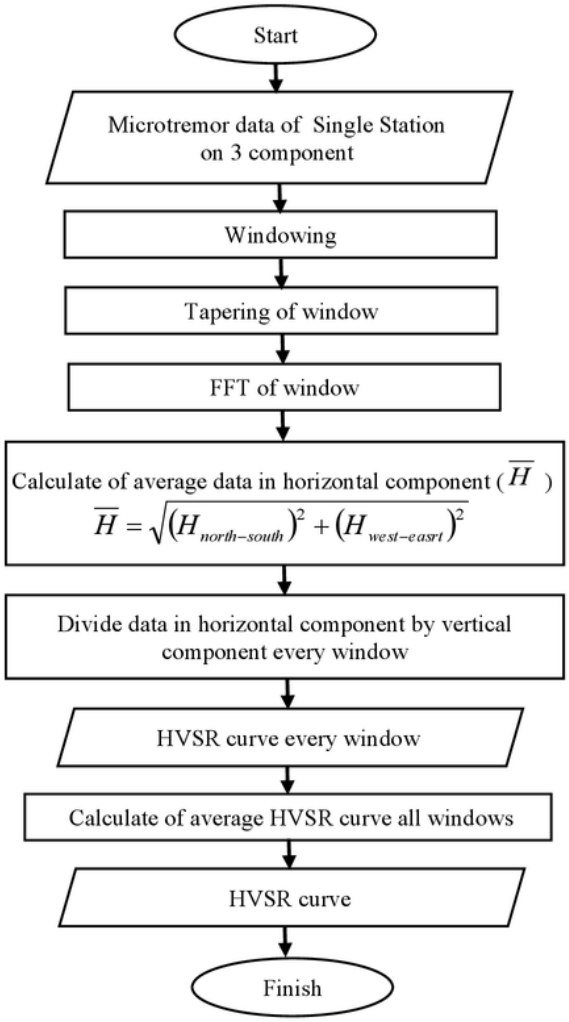

FIGURE 2. Flow chart of HVSR method

JATI AGUNG CLASSIFICATION OF GROUND MOTION MAP

To get microtremor recordings, the seismometer used in this study consisted of 15 stations in Jati Agung district (location distribution can be seen in **FIGURE 2**. Microtremor signal waves were analyzed using the HVSR method. Some parameter were inputted in smoothing parameter based on the condition of curve. The majority value was 10 for Konno & Ohmachi smoothing parameter. All of H/V peak from 15 data were reliable peak (**FIGURE 3**). Parameter analysis of ground motion is peak ground acceleration (PGA) and vulnerability of seismic (Kg). All of these values can be seen in **TABLE 1**.

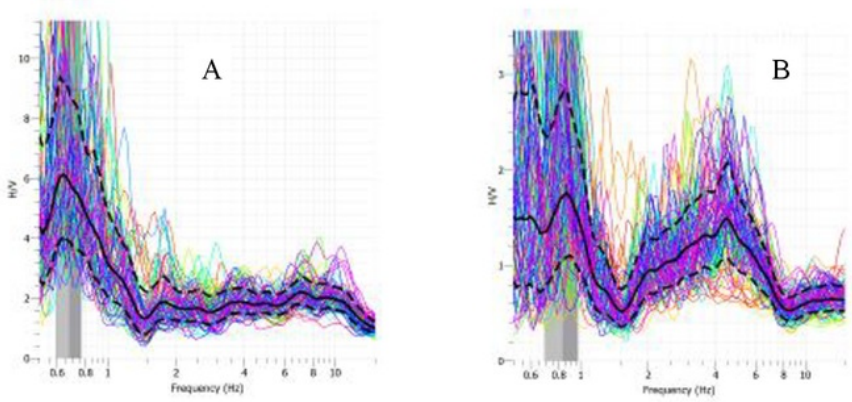

FIGURE 3. Spectrum of HVSR results A) station T03 B) station T07

TABLE 1. The Results of HVSR Method

Station	PGA (gal)	Kg	GSS (10^{-6})
T01	12.34638	27.6519	341.400785
T02	13.91497	24.92382	346.8140976
T03	13.45653	54.22534	729.6846841
T04	14.32403	27.28414	390.8187688
T05	14.82664	23.65949	350.7907167
T06	15.09484	26.19514	395.4114677
T07	15.54194	3.432212	53.34322499
T08	15.53131	25.88355	402.0052739
T09	19.7306	22.26596	439.3208074
T10	12.57888	36.32959	456.9855332
T11	22.18974	22.02943	488.8273892
T12	16.82669	37.25144	626.818392
T13	13.89055	38.6345	536.6544683
T14	14.12916	36.72581	518.9049256
T15	20.32767	9.775245	198.7079871

The calculation of ground shear strain value is been influence by PGA in bedrock. The earthquake that used in PGA calculation is in range 10 years earthquake histories in around of Lampung. Sedimentary layer have plastis characteristic and became surface deformation is crack in γ = 1000 ×10-6 and sedimentary layer will get masiv deformation (landslide) and liquefaction if γ = 10.000 ×10-6. The result show that all of the value of ground share strain in the all station less than 1000 ×10-6. The conclusions of Jati Agung district as the new Town is not disturbed toward ground motion that is caused by earthquake. **FIGURE 4** is map of ground share strain in Jati Agung.

Based on **FIGURE 4**, the results of 2D interpretations using surfers provide very good information that in the study area is a very safe area against the impact of earthquakes. These results show that the deformation in the event of an earthquake is very small, this is due to the type of rock found in the study area is rock that has large compacting properties. So, if an earthquake occurs, the shape of the rock or soil structure in the area can reduce oscillations[10] or waves of earthquakes that spread[11;12]. This result has a positive relationship to the geological conditions that exist in the southern Lampung region. The float area has a slight fault or branch fault[13;14;15]. So that there is a small chance of strengthening the vibration of an earthquake. Besides that, the research area is a

region that is quite safe from tsunami waves, because in the west there are high mountains, and there are also small islands that can reduce tsunami waves from the southwest of the research location (Jati Agung Area).

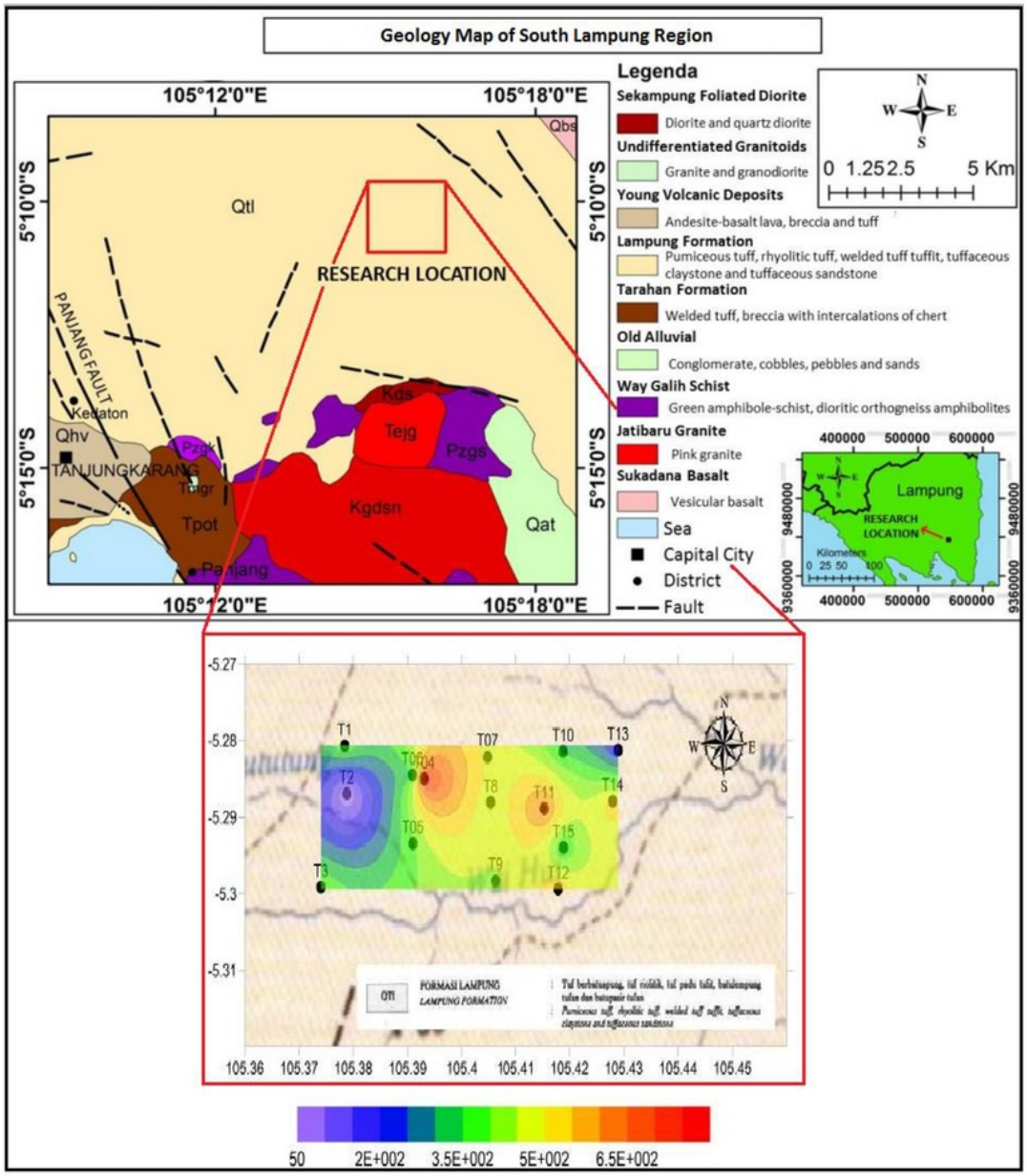

FIGURE 4: Interpretasi 2D menggunakan surfer in this study (Jati Agung Area of South lampung, Indonesia. Source : Update from [13])

CONCLUSIONS

The highest value of ground shear strain was observed in coordinate (105.3740, -5.299), at 0.00072968, so that it is not prone to deformation and soil movement. The area of this study is a very safe area against the impact of earthquakes. Because the deformation in the event of an earthquake is very small, this is due to the type of rock found in the study area is rock that has large compacting properties rock also based on the geography on this research area is a region that is quite safe from tsunami waves, because in the west there are high mountains, and there are also small islands that can reduce tsunami waves from the southwest of the research location (Jati Agung Area).

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