Abstract—Community service activities have been carried out in the Pudak Payung area of Semarang city. The research aim was constructing a map of the vulnerability zone that can provide information on areas prone to landslides. The research will be expected to provide information support to the local government when it will give permission or arrangement of residential areas as well as building structure construction recommendations. The method used in this research is recording microtremor data and based on the parameters of wave propagation amplification, the distribution of HVSR spectrum values, finally determine the soil vulnerability maps and ground shear strain maps. The results obtained indicate a compatibility between the distributions of soil vulnerability values to the location of the previous landslide during heavy rains.

Keywords— vulnerability; microtremor; amplification; ground shear strain

I. INTRODUCTION

There are some method could be applied to detect landslide vulnerability zones by various disciplines of science. One of geophysical methods was effective be applied to detect the stability of slopes vulnerability. It can also be used to characterize material inhomogeneity based on physical properties. The Pudak Payung area is located in the southern part of Semarang City where a landslide occurred on the banks of the Sendangpring River on February 2019. The incident had claimed lives. Based on this incident, motivated conducting such a community service activities to detect the physical properties of soil vulnerability using the microtremor method.

Based on the Semarang regional geological map (Thanden et al, 1996), the location consist of Kalibeng Formation which is result of tertiary marine sediments [1]. Lithologically composed of sandstone, claystone and limestone. Based on geoelectric measurements there are claystones with two readings of resistivity values, namely 24 ohm-m at a depth of 5.34 m with a thickness of 1.34 m, and 39.4 ohm-m at a depth of 7.16 has the potential to become a slip slip. The depth of the slip plane is at a depth of 5.34 to a lower limit that is not yet known because the reading depth of the data processing results only reaches a depth of 7.16 m [2]. There was classified the Pudak Payung area as an area that is quite prone to landslides [3]. The microtremor method has been widely used to map soil vulnerability zones in various locations, this method has been applied to determine the mechanism of landslides and even to predict the chances of landslides in 3D [4]. Monitoring to detect landslides continuously is also done by using 5 seismometers in Tokushima, Japan. This researcher examines the various events that are read on a seismogram to distinguish various materials and their effects on altitude [5]. 2D and 3D modeling is also carried out to determine differences in vulnerability in one place to another in Tasmania. The modeled data is sourced from seismic data records in the past [6]. The use of seismic data is also carried out to determine the direction of the tilt of the graben in the basin in Switzerland [7]. This microtremor method is also commonly used to search for historical objects by combining with geoelectric measurements. From these two measurements then correlated and interpreted the location of historical objects [8].

In the series of implementation of this activity, the scope of work includes two main components, namely the scope of the area and the scope of activity material. The map of the research location is shown in Figure 1.
II. METHODS

Situation observation activities carried out by mapping the situation of the research area. This activity is carried out to get a picture of the situation of the study area to be carried out geoelectric measurements. The basic map used is a topographic map which is then developed by adding existing objects whose coordinates are measured using the Global Positioning System (GPS).

Regional geological studies are carried out by reviewing existing geological studies from various previous studies for areas related to the location where the geoelectric survey is carried out, so that the geological position of the investigation area can be determined within the regional geological framework. The purpose of this regional geological study is to determine the distribution and association of lithology found in the area of investigation as well as the possibility of geological structures passing through the area of investigation on a regional scale. Therefore this regional geology discussion will cover physiography, stratigraphy and geological structures at a regional scale and their influence on the geological conditions of the area of investigation.

One method to determine the condition and physical properties of the soil with a geophysical approach is the HVSR method. Horizontal to Vertical Spectral Ratio (HVSR) method is a method that calculates the comparison of horizontal component seismic recording data with its vertical components. The HVSR method was applied to estimate resonant frequencies and local geological amplification factors from microseismic data. The HVSR method is usually used on passive seismic (microtremor) three components. Important parameters generated from the HVSR method are natural frequency and amplification [9]. Measured HVSR on land aimed at local geological characterization, natural frequency and amplification related to subsurface physical parameters [10], while measured HVSR on buildings is related to building strength and building balance[11]. Measurement of 17 points using DI 170 data loggers and vibration sensitive seismometer recorders. Measuring points are distributed around locations where landslides have previously occurred, namely around residents' homes and also carried out along river banks that occur in landslides. Measurement points as shown in table 1.
Table 1. Distribution of microtremor recording points

| Titik | Easting | Northing  |
|-------|---------|-----------|
| P1A   | 434965  | 9215896   |
| P1B   | 434959  | 9215901   |
| P1C   | 434953  | 9215907   |
| P1D   | 434950  | 9215911   |
| P2A   | 435007  | 9215925   |
| P2B   | 434998  | 9215932   |
| P2C   | 434993  | 9215937   |
| P2D   | 434988  | 9215943   |
| P3    | 435042  | 9215950   |
| P3A   | 435073  | 9215978   |
| P3B   | 435067  | 9215983   |
| P3C   | 435061  | 9215990   |
| P3D   | 435052  | 9215996   |
| P4A   | 435091  | 9216013   |
| P4B   | 435080  | 9216017   |
| P4C   | 435069  | 9216021   |
| P4D   | 435058  | 9216026   |

II. RESULT AND DISCUSSION

Data processing using Geopsy software produces HVSR graphics and HVSR spectra profiles. The Graph of HVSR frequency spectrum obtained as much 17 charts. The following figures are some example of the HVSR spectrum of both configurations as shown in Figures 2 and 3.

![Figure 2. HVSR graph of P4D seismic record](image-url)
Measurements were made stretching from the southwest to the northeast by taking each stretch consisting of four measurement points. Amplification is magnification of the seismic waves occur due to differences significant between layers. The measurements of the peak ground amplification is then determined and shown in Figure 7. Based on the distribution of the amplification values it can be seen that the high values are at the P1A and P2A locations.

Dominant frequency is the frequency value that often appears so recognized as the frequency value of the rock layers in the region so that the frequency value can indicate the type and characteristics of rock. The H / V spectral ratio on the microtremor is the comparison of the two components that produce a value [9][12]. The ratio between the horizontal and vertical components of the recording of ambient noise is closely related to the frequency and amplification factor [13]. Various structures can be analyzed using the H / V spectral ratio technique by obtaining the dynamic characteristics of a structure that changes the resonant frequency at the same point in a certain time.
span and certain conditions. This change occurs due to structural damage and certain conditions that cause structural instability. The spectrum H/V distribution as shown on figure 8.

Figure 8. H/V spectral distribution shows the high dominant frequency at P1C.

Figure 9 shows the distribution of the vulnerability index stated in parameter K which states how a land can defend against earthquake hazards (the response of soil vulnerability to earthquake events)[14]. Based on the map of the soil vulnerability distribution, it can be seen that the highest soil vulnerability value is seen in location P26 which corresponds to the condition of the location of the measurement that at that point which had previously occurred landslides during heavy rain.

Figure 9. Contour of soil vulnerability
The ground shear strain (GSS) value (figure 10) in the community service area has a range of 0.02 to 0.076 with the highest value located in the former landslide location (Point P1A) extending northeastward to Point P2A and Point P2B. Based on the large GSS values, then correlated with to the values have the potential to have a landslide phenomenon and soil compaction in the service area with dynamic nature of the soil is collapse.

IV. CONCLUSION

The identification of potential landslides in the area around the former landslide in Bumirejo Pudakpayung by using the microtremor method concluded that the potential for landslide symptoms existed in the former landslide location extending to the northeast about 50 meters with a width of about 20 meters. At Point P2B (434998, 9215932) it is necessary to watch out for potential landslides due to poor soil compacting.

REFERENCES

I. R. W. Van Bemmelen, Investigative journalism: Elena poniatowska (1932–) and anna politkovskaya (1958–2006), vol. IA, no. 1. 2008.

II. T. T. Putranto and T. R. Rüde, “Hydrogeological model of an urban city in a coastal area, case study: Semarang, Indonesia,” Indones. J. Geosci., vol. 3, no. 1, pp. 17–27, 2016.

III. J. Purba, S. Subiyanto, and B. Sasmito, “Pembuatan Peta Zona Rawan Tanah Longsor Di Kota Semarang Dengan Melakukan Pemobotan Parameter,” J. Geod. Undip, vol. 3, no. 2, pp. 40–52, 2014.

IV. K. Samyn, J. Travelletti, A. Bitri, G. Grandjean, and J. P. Malet, “Characterization of a landslide geometry using 3D seismic refraction traveltime tomography: The La Valette landslide case history,” J. Appl. Geophys., vol. 86, pp. 120–132, 2012.

V. N. Ma, G. Wang, T. Kamai, I. Doi, and M. Chigira, “Amplification of seismic response of a large deep-seated landslide in Tokushima, Japan,” Eng. Geol., vol. 249, no. January, pp. 218–234, 2019.

VI. M. Claprood and M. W. Asten, “Use of microtremors for site hazard studies in the 2D Tamar rift valley, Launceston, Tasmania,” no. November, pp. 169–172, 2006.
VII. U. Kastrup, N. Deichmann, A. Fröhlich, and D. Giardini, “Evidence for an active fault below the northwestern Alpine foreland of Switzerland,” Geophys. J. Int., vol. 169, no. 3, pp. 1273–1288, 2007.

VIII. M. Moisidi, F. Vallianatos, J. Makris, P. Soupios, and M. I. Nikolintaga, “Estimation of Seismic Response of Historical and Monumental Sites Using Microtremors: a Case Study in the Ancient Apera, Chania, (Greece),” Bull. Geol. Soc. Greece, vol. 36, no. 3, p. 1441, 2004.

IX. Y. Nakamura, “Clear identification of fundamental idea of Nakamura’s technique and its applications,” Proc. 12th world Conf. ..., p. Paper no. 2656, 2000.

X. R. Maresca, L. Nardone, F. T. Gizzi, and M. R. Potenza, “Ambient noise HVSR measurements in the Avellino historical centre and surrounding area (southern Italy). Correlation with surface geology and damage caused by the 1980 Irpinia-Basilicata earthquake,” Meas. J. Int. Meas. Confed., vol. 130, pp. 211–222, 2018.

XI. S. Bonnefoy-Claudet, F. Leyton, S. Baize, C. BERGE-THIERRY, L. F. Bonilla, and J. Campos, “Potentiality of microtremor to evaluate site effects at shallow depths in the deep basin of Santiago de Chile,” 14 World Conf. Earthq. Eng., p. 8, 2008.

XII. S. Bonnefoy-Claudet et al., “H/V ratio: A tool for site effects evaluation. Results from 1-D noise simulations,” Geophys. J. Int., vol. 167, no. 2, pp. 827–837, 2006.

XIII. M. R. Gallipoli, M. Mucciarelli, R. R. Castro, G. Monachesi, and P. Contri, “Structure, soil-structure response and effects of damage based on observations of horizontal-to-vertical spectral ratios of microtremors,” Soil Dyn. Earthq. Eng., vol. 24, no. 6, pp. 487–495, 2004.

XIV. Nakamura, Y. (1996), “Real Time Information Systems for Seismic Hazards Mitigation UrEDAS, HERAS and PIC”, Quarterly Report of RTRI, Vol. 37, No. 3, 112-127