



Determining The Location of The Earthquake Shelter Evacuation In School

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ABSTRACT

This study aims to analyze the typology of earthquake areas and find suitable locations to serve as evacuation shelters in school for the Lembang fault earthquake disaster in the districts of Padalarang, Ngamprah, Cisarua, Parongpong, Lembang, Cimenyan and Cilengkrang. The method used in this research is descriptive exploratory method which includes measurements and observations in this study. Location was focused by school and the suitable place. The data processing and analysis techniques used were overlay, buffer, query and marking using the GIS method. The results of this study are; the distribution of typology of earthquake-prone areas of the Lembang Fault is typology A, B and C; and locations suitable for refugee camps are scattered in seven sub-districts and 63 villages, of which there are three villages that do not have suitable refugee locations, namely the villages of Pasirhalang, Kertamulya and Sukatani because their land is densely populated with settlements and lack of land to accommodate residents. is in his village. The proposed evacuation shelter location also adjusts the location of the resident's domicile. The school in that area was suitable for disaster shelter.

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1. INTRODUCTION

Faults are also called fractures or fracture systems along moving rock (Fan, C. et al., 2020; Febriana et al., 2020). In this study the Lembang Fault is a crack or fracture that extends from the west (Padalarang) to the east (Between Batu Lonceng and Mt. Manglayang) approximately 29 Km. This fault is an active fault, it is said to be active because from the research results of Puslit Geoteknologi LIPI, this fault moves about 3-5mm every year (Fijra, 2018; Iqbal et al., 2021; Tande and Sudharmono, 2020). Besides that, Puslit Geoteknologi LIPI in 2010 conducted a study to see traces of ancient earthquakes and from his research produced evidence that the Lembang fault had shifted 500 years ago and produced an earthquake with a magnitude of 6.6 SR. According to Daryono (2018), currently the Lembang Fault is at the time of releasing energy which will release a large amount of energy that is collected every year (Hilmi et al., 2019; Nurrohman, 2021; Tamril et al., 2020).

The results of the interview with Badan Penanggulangan Bencana Daerah (BPBD) West Bandung Regency for activities in the field of Prevention and preparedness, currently BPBD does not yet have a map of the distribution of evacuation routes and evacuation shelters for the Lembang Fault Earthquake, because currently BPBD of West Bandung regency is currently focusing on landslides in the south of Kab. West Bandung. In addition to BPBD of West Bandung Regency, based on the results of the interview with the head of the data and information section of the Class I Bandung Geophysical Station 2019, BMKG also does not have a planning map for the distribution of shelter locations that can be used for evacuation shelters for the Lembang Fault disaster. Even though the Lembang Fault Earthquake is a time bomb (Kastolani et al., 2017; Isya, 2021), which will come suddenly without being predictable and is currently in the process of releasing a large amount of energy as a result of the energy that is collected every year, so that disaster mitigation efforts at this stage of emergency should have been prepared in the event of a disaster so that risk can be minimized.

School is the one alternative place for making disaster shelter (Tsioulou, et al., 2021; Rabia, H. O. S., 2016; Waters, T., 2005) specifically impacted from fault lembang. School have several spaces for emergency living such as class that can make evacuation area (Kim, et al., 2011; Scharrer, T., & Suerbaum, M., 2022). Shelter area must be have large space to evacuate affected residents (Xu, et al., 2014), and school is the suitable space. The architecture building is the one of parameter for shelter area (Tai, et al., 2010; Obyn, S., 2015; Coley, D., 2021). The Lembang fault can cause quite large earthquakes, requiring quite a lot and large evacuation locations. Schools can be an alternative, because they can accommodate many residents if evacuation is necessary.

Based on UUD No. 24 of 2007 concerning Disaster Management Article 45 explains that in disaster management there is preparedness that must be done to ensure prompt and appropriate efforts in dealing with disaster events. In the article it is stated that the preparation of evacuation sites is one thing that must be done in terms of preparedness. However, in reality, there is no such place for evacuation sites for the Lembang Fault earthquake disaster. Whereas the Lembang Fault is currently at the time of releasing energy which will suddenly release a large amount of energy (Kariadi et al., 2020; Kurniawan, 2022). Earthquakes are like a ticking time bomb. Departing from the above background, this study aims to analyze the typology of the Lembang Fault earthquake-prone area, and analyze the determination of appropriate shelter locations in the Lembang Fault earthquake-prone area using GIS (Geographical Information System) (Firmansyah et al., 2019; Hosseini., 2022; Lewis, J., 2003; Zhang, H., et al., 2019).

2. LITERATURE STUDY

2.1. Evacuation Shelter Locations

Determination of the location of the evacuation shelter for this earthquake is the process of evacuating the population (Xu et al., 2018; Kar, B., 2008; Park, S., 2012). This is related to previous research conducted in Sumber kelurahan, Banjarsari sub-district in determining the location of potential evacuation shelters for flood disasters where evacuation is basically the transfer of residents from disaster-prone areas to safe areas (Sutikno, 2012).

The parameter of the number of refugees/residents really needs to be analyzed in this study because if we don't consider the parameter of the number of refugees to be evacuated, we don't know whether the evacuation site being researched is sufficient or not (Chen, Z., et al., 2013; Kılıcı, F., 2015; Kanno, T., et al., 2015). The comparison of the number of refugee with the intended evacuation location was not analyzed in previous studies, only considering the physical, such as similar disasters, road distance, settlement distance, watershed distance and land use (Kar dan Hodgson, 2008).

2.2. Geography Information System (GIS) for evacuation shelter locations

When determining the location of the TEA or in this case a shelter, network analysis is used through the application of GIS (Geographical Information Systems). In accordance with previous research, this study uses Geographic Information Systems (Vergara-Perucich and Arias-Loyola, 2021).

Geographic Information System (GIS) is a system using a computer base that can process geographic data, the end result of which will be one of the decision makers in certain cases related to geograph. The analysis of determining the evacuation location using GIS is then continued by adding weights and using the SAW method to determine the evacuation location (Masykur, 2014). In accordance with previous research, in this study using GIS analysis and continued weighting (Arlym et al., 2019). The location of the shelter must adjust to the activities of the residents so that when the residents are evacuated they will continue to carry out their activities (Wang et al., 2022; Xu., et al., 2016). In previous research, it was explained that the results of the TES area or in this case a shelter need to show areas that are reached by activities through horizontal lines.

The parameter that is used as a reference is the policy of the BNPB Head Regulation in 2018 regarding the procedure for providing assistance to meet basic needs for communities affected by natural disasters. In accordance with the needs of researchers and previous studies, the parameters used to determine shelter locations also refer to the same policy, namely the BNPB Head Regulation policy at 2018.

Field conditions that do not have evacuation shelters and earthquake evacuation routes have an impact on the ineffective evacuation process (Amideo et al., 2019). It was explained in previous research that an effective evacuation really depends on many factors, one of which is the configuration of the placement of the evacuation shelter location.

3. METHOD

The location of this research is in the Lembang Fault area which stretches from east to west with a length of 29 km which includes the administrative locations of West Bandung Regency and Bandung Regency. The location of the Lembang Fault in the Bandung district is in the Cimenyan and Cilengkrang sub-districts, while the Lembang fault location in the West Bandung district is in the Padalarang, Ngamprah, Cisarua, Parongpong and Lembang sub-

districts. The population of the area used in this study is an earthquake-prone area of the Lembang Fault and temporary evacuation sites in an earthquake-prone area of the Lembang Fault.

The samples in this study are some of the objects that represent the population of the Lembang Fault earthquake-prone area and the location of evacuation shelters in the Lembang Fault earthquake-prone area. The area sampling technique used to determine the sample of disaster-prone areas and the proposed evacuation shelter in the Lembang Fault earthquake area uses a non-random technique (non-probability sampling) with the purposive sampling method, which is a technique that is determined based on certain considerations. The following are the researchers' considerations for determining the sample of the Lembang Fault earthquake-prone area based on the Minister of Public Works Regulation number 21 of 2007 :

- a. Based on the physical properties of the rock
- b. Based on the slope of the slope
- c. Based on the level of seismic intensity (Richter)
- d. Based on the geological structure (in the form of joints, folds or faults)

As for the consideration of determining the sample of the shelter area, the researcher uses considerations based on the minimum standard of assistance in BNPB head regulation policy number 7 of 2008 regarding the procedure for providing assistance to meet basic needs CHAPTER IV article A, the following are the considerations:

- a. 3 (three) square meters per person
- b. Have safety and health requirements
- c. Have accessibility to public facilities
- d. Ensure privacy between sexes and group.

In this study, the variables that will be discussed by the researcher are listed and explained in table 1.

Table 1. Variables of the research

Variabel penelitian	Indikator
Earthquake Prone zone	1. Based on the physical properties of the rock 2. Based on the slope of the slope 3. Based on the level of seismic intensity (Richter) 4. Based on the geological structure (in the form of joints, folds or faults)
Determining shelters area	1. 3 (three) square meters per person 2. Have safety and health requirements 3. Have accessibility to public facilities

source : Research results

(based on PERMEN PU No. 21 of 2007, PERKA BNPB No. 7 of 2008), 2022

The data used in this study are primary and secondary data. The primary data collection method that the researcher uses is a survey technique. While the secondary data used are data obtained from institutional, literature studies and documentation studies. To obtain research results, the analytical technique used in this study is by way of spatial overlay and buffer analysis and weighting techniques.

4. RESULT AND DISCUSSION

4.1. Typology of earthquake-prone from lembang fault earthquake disasters

Based on the results of the analysis of the stability the earthquake-prone area that was carried out previously, the researchers made a typology of the earthquake-prone area of the Lembang fault using the criteria in PERMEN PU No. 21 of 2007 which can be read in the attachment. The typology of disaster-prone areas in the earthquake-prone area of the Lembang fault is Typology A, B and C, as shown in Figure 1.

In disaster-prone areas with typology A found rock types Mtb (breccia member and sandstone), Qc (coluvial), Ql (reef limestone), Qob (old volcanic product), Qol (tuffaceous clay unit), Qvu (volcanic product). old irreducible), Qyd(Sand Tuff), Qyl(Lava), Qyt(Polystuff Tuff), and Qyu(Product of young volcanoes). The rock types in the typology A area in the study area have strong and massive physical properties, so that if they are exposed to ground motion even though they are near the fault zone (100-1000m) or in the fault zone (>100m), the damaging effect will be suppressed by the massive rock. The slopes in typology A found in this study area have a sloping class (7%-15%), moderately steep (15%-30%), steep (30-70%) and very steep (70%-140%).

Based on the analysis and identification of the four disaster-prone factors, the typology B area in this study area has rock types Mtb (Breccia members and Sandstone), Ql (Lava), Qol (Tufaan Lampung Unit), Qyd (Pasiran tuff), and Qyt. (tuffy rocky tuff). Meanwhile, the slopes of the slopes vary from sloping slopes (7%-15%) to moderately steep (15%-30%), steep (30%-70%) and very steep (70%-140%). Typology B found in the field is in the fault zone (<100m). This typology is an area typology that has a high level of vulnerability caused by high earthquake intensity factors and medium rock physical properties. Because the physical nature of the rock is not as massive as typology A, so that when exposed to earthquake vibrations.

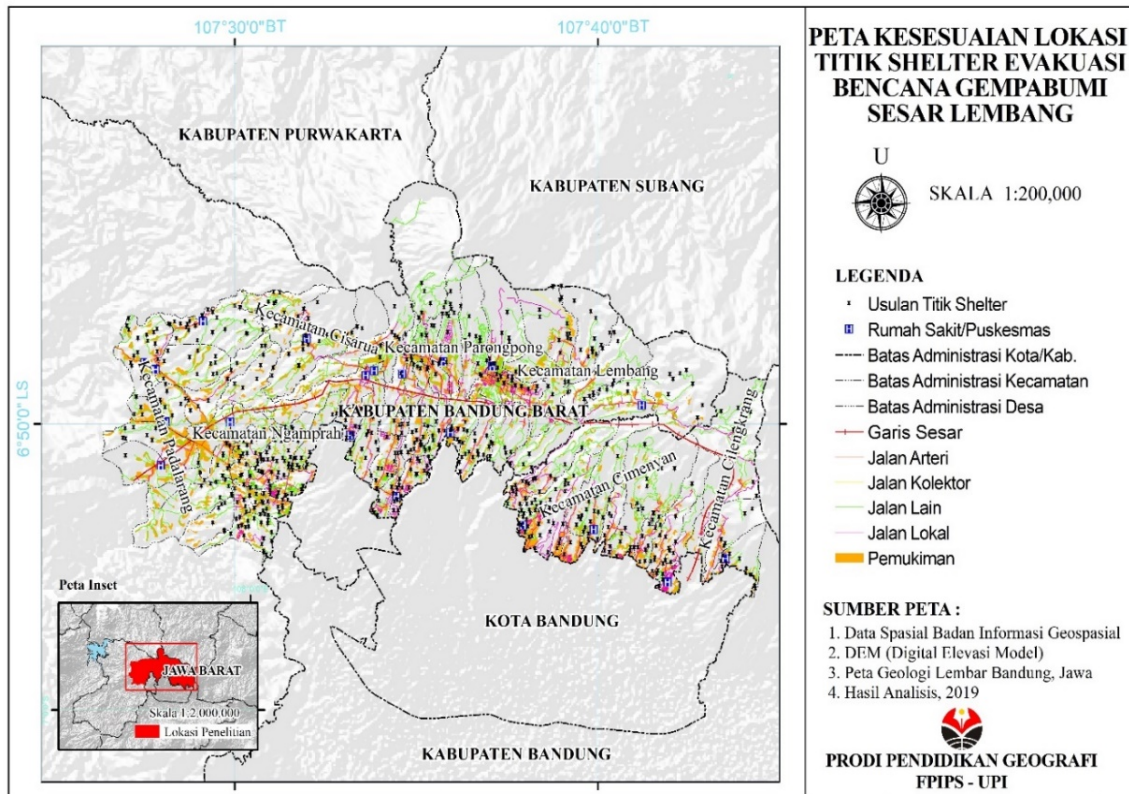
Based on the analysis and identification, the typology C area in the study area is in the fault zone (<100m) which means it is very close to the source of the earthquake, and in the research area identified typology C has the type of Tufaan or Qol clay rock which has weak physical properties or the rock cannot absorb earthquake vibrations. The area identified as typology C in this research area has a steep slope of 30-70% which has the potential for landslides in the area when exposed to earthquake vibrations. This area has a combination of dominant factors, namely being close to the fault zone, having weak rock physical properties and steep slopes.

4.2. Determining The Location Of The Earthquake Shelter Evacuation

From the results of the researcher's analysis, from the total population in the seven sub-districts that the Lembang fault traversed, it was found that the need for a temporary refuge location was 267.83 hectares. The result was obtained from the number of residents multiplied by three square meters. Then for the location that is generated from analyzing the area using settlement criteria where the criteria are: (1) located on a slope of 0-25%, (2) not in irrigated or rainfed rice fields, (3) not in similar disaster-prone areas, (4) not in a river, reservoir or lake.

The result of the proposed location was 10,025.92 Ha. These results facilitate distribution according to the needs of refugee assistance. Researchers divided the research locations based on the villages described in the appendix from seven sub-districts with 66 villages. The location was visualized in Figure 2.

Based on the references of previous researchers. In this case, the researcher determines the location of the earthquake evacuation shelter from the Lembang Fault using a Geographic Information System using the query, overlay and weighting methods. These locations were spread out in every sub-district and village in the Lembang Fault area, the distribution can be seen in Figure 2.



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Sources: Geospatial Information Agency; Digital Elevation Model; Geological Map Sheet Bandung; Researcher analysis, 2022

Figures 2. Map of Suitability of Evacuation Shelter Locations for the Lembang Fault earthquake.

Were spread over every sub-district and village in the Lembang Fault area. To In order to facilitate distribution according to the needs of refugee assistance, the researcher divides the research location by village from seven sub-districts with a total of 66 villages.

The village that does not have an evacuation shelter location is Sukatani village, while the area that has an evacuation shelter location but has less capacity because the population is more than the total area of the shelter is Pasirhalang village, Cisarua district and Kertamulya village, Padalarang district, all three are in West Bandung district. The proposed evacuation shelter location is also adjusted based on the domicile location of the residents. So that the location of the evacuation shelter is not too far from the location of residents' activities so that people can still carry out their activities.

Several locations in the analysis results describe the school. In this study, the school is a very suitable location to be used as a place of refuge. Schools are often used as evacuation places in disaster situations. Schools are usually located in different areas of the city or village, and people are familiar with the location of schools around them. This makes it more accessible to locals and relatively easy to find. Schools often have a capacity large enough to accommodate large numbers of people. Classrooms can be converted into temporary

sleeping areas, and public facilities such as school halls can be used for coordination and provision of basic services.

Schools are usually equipped with basic facilities such as toilets, clean water, and kitchen facilities that can be used to provide food and drinking water to refugees. Schools are usually built to high safety standards, including earthquake resistance. This makes it a relatively safe place in a disaster situation. Local authorities often have planned and trained to use schools as evacuation sites. This allows better coordination in providing emergency assistance to those affected by disasters. It is important to remember that the use of schools as evacuation sites must be well organized and needs to be done in coordination with local authorities and relevant authorities. Additionally, there are always plans to return students to school once the disaster is over, or to move evacuees to more suitable facilities if necessary.

5. CONCLUSION

This study examines the determination of the location of the evacuation shelter for the Lembang Fault earthquake that was effective and based on the Geographic Information System. Based on the results and discussion of this study, it can be concluded that: 1) The typology of disaster-prone areas in the Lembang fault is Typology A, B and C. 2) The proposed evacuation shelter location is 10,025.92 Ha. These locations are spread over every sub-district and village in the Lembang Fault area.

In order to facilitate distribution according to the needs of refugee assistance, the researchers divided the research locations based on the villages described in the appendix from seven sub-districts with 66 villages. The village that does not have an evacuation shelter location is Sukatani village, while the area that has an evacuation shelter location but has less capacity because the population is more than the total area of the shelter is Pasirhalang village, Cisarua district and Kertamulya village, Padalarang district, all three are in West Bandung district. The proposed evacuation shelter location is also adjusted based on the domicile location of the residents. So that the location of the evacuation shelter is not too far from the location of the activities of their respective residents so that people can still carry out their respective activities even though they are living in the shelter.

The school is described in several places in the analysis results. In this study, school is a very suitable place to live. During natural disasters, schools are often used as evacuation sites. Schools are usually located in different parts of a city or town, and people know where schools are nearby. This makes it more accessible for residents and relatively easy to find. Schools often have a capacity large enough to accommodate large numbers of people. Classrooms can be converted into temporary beds and public facilities such as classrooms can be used to coordinate and provide essential services.

6. RECOMMENDATION

Researchers hope that the agency that has responsibility for this disaster can be more focus on this disaster, so that the results of research on the Lembang Fault disaster will be more credible. This Suitability of Evacuation Shelter Locations must always be updated. Because there are always changes in the function of open land and the number of people who are always dynamic in every year around this Lembang fault area.

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