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COMMUNITY PREPAREDNESS FOR EARTHQUAKES BASED ON SETTLEMENT ENVIRONMENT ANALYSIS

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Abstract

Introduction: *Bengkulu is located on an active collision zone between two tectonic plates, namely the Eurasian Plate and the Indo-Australian Plate. As the result, earthquakes, floods, landslides, and tidal waves are common in Bengkulu. Sepang Bay is part of Bengkulu Province adjacent to the ocean, making it vulnerable to earthquakes and tsunamis. This study aims to examine the relationship between the residential environment and natural disaster preparedness in Sepang Bay, Bengkulu Regency.* ***Methods:*** *The type of research used is analytical observation with cross-sectional design. Data are collected from interviews, questionnaires, observations, and documentation from a total of 100 respondents selected by proportional random selection from each neighborhood in Sepang Bay Village, based on the proportion of heads of family in each neighborhood.* ***Results and Discussion:*** *When an earthquake occurs, there is a relationship between the residential environment and the community's preparedness. As the existing supporting infrastructure is not properly utilized, people who live in substandard settlements do not have adequate equipment to deal with seismic disasters. When an earthquake occurs, there is a relationship between the settlement environment and the community's preparedness. Because the existing supporting infrastructure is not being used properly, people who live in poor settlements have poor preparedness as well.* ***Conclusion:*** *The Sepang Bay Village Community, Bengkulu, which is located along the Panjang Beach, found a relationship between the settlement environment and earthquake preparedness (p = 0.021, PR 2.127).*

INTRODUCTION

Bengkulu Province is located on the west coast of Sumatra Island, Indonesia. Bengkulu has a coastline of 525 kilometers that stretches parallel to the Indian Ocean. Bengkulu Province lies between 101°41'E and 02°16'-03°31'S (1). With an area of 19,919.33 km^2, it has nine regencies, 126 sub-districts, one city, and 148 villages. These areas are divided into three physiographical areas: including lowlands located along the west coast, hills located in the central region, and mountains located in the eastern region, precisely adjacent to South Sumatra and Jambi. Bengkulu is located on an active collision zone between two tectonic plates, namely the Eurasian Plate and the Indo-Australian Plate. Therefore earthquakes, floods, landslides, and tidal waves are common in Bengkulu (2).

An earthquake of 8 on the Richter scale hit Bengkulu on June 4, 2020, causing devastating effects. From January to February 2020, there were 168 earthquakes recorded in Bengkulu Province as revealed by the Meteorological, Climatological, and Geophysical Agency (BMKG) Geophysics Station Kepahingan (3).

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Previously, on September 12th, 2007, an earthquake with a magnitude of 7.9 on the Richter scale also hit this province, claiming the lives of 15 residents and damaging 67,191 buildings. Meanwhile, throughout September 2018, there were five earthquakes hitting Bengkulu and its surroundings. The earthquake with a magnitude of 5.3 on the Richter scale on September 12th, 2018 was the largest, hitting 127 km southwest of Manna, South Bengkulu (4). Based on the findings of previous studies, it was determined that the maximum earthquake hazard level in the Bengkulu area was 6,144,513 ha or 39.84% of the entire area. This data were obtained based on the overlay base data of the shaking hazard and the tsunami hazard. The most affected areas include seven sub-districts, namely: Kampong Malay Sub-District, Gading Cempaka Sub-District, Sungat Serut Sub-District, Teluk Segara Sub-District, Ratu Samban Sub-District, Ratu Agung Sub-District, and Muara Bangkahulu Sub-District (5).

This research is very much needed by the community to be a reference for the community to deal with all the possibilities if natural disasters happen in the future. The people must better prepare themselves optimally to deal with disasters to minimize the number of casualties and prevent greater loss (6). Disaster management is a systematic and complete approach to dealing with disasters so that victims and losses due to disasters can be discovered quickly, precisely, and accurately. Disaster management investigates disasters along with elements of disasters, including how to deal with risks from disasters and how to avoid risks due to disasters (7). Disaster management is essential, including for preparing for natural disasters and unwanted events in the future, identifying victims and losses due to disasters that occur, developing community awareness about disasters so that everyone can participate in the disaster management process, and protecting all elements of the community from the hazards and impacts of disasters that occur (8). Based on the results of previous research, it was stated that the earthquake that occurred in August 2018 in Lendang Village, West Lombok Regency caused 90% of the residents' houses to suffer severe damage, forcing 750 affected people to relocate. However, it is deeply regretted that this evacuation resulted in environmental pollution and the spread of diseases due to the limited number of emergency toilets available. In addition, in such situation, public health is crucial to be maintained and enhanced. Clean water and sanitation facilities supply must really be considered as this problem not only prevents an increase in infection cases, which may have a short-term impact, but also for the long-term impact. According to these findings, an adequate living environment is needed to reduce the impact of an earthquake (9). The above problems are the impact of the lack of disaster management; therefore, the discussion related to disaster management is very important for the public to know.

The Bengkulu City Government is trying to create a residential environment that accommodates the conditions of the Sepang Bay area because this is a disaster-prone area. Previously, an evacuation route connecting Sepang Bay Village with Padang Serai was built by the government at the end of 2014. In addition, the government has also built a tsunami post in the form of a four-storey building in the middle of a residential area, as well as network monitoring tools such as GPS and seismometers (10). Due to the frequent occurrence of disasters in this area, the government has provided disaster preparedness education and built shelters, but the community, in general, is indifferent and still resistant – resulting in huge casualties so it still results in loss of life and material losses when an earthquake occurs as the government facilities are underutilized and under-maintained by the local residents. This negative mindset will result in failure to understand disasters and reduce preparedness for disasters. Instead, what must be built is a positive mentality (11) by, among others, considering disasters as a kind of opportunity to move forward to become a well-prepared, intelligent and responsive community in facing the threat of disasters in the future. With this way of thinking, it is expected that everyone in the community will adjust to their abilities and gain positive attitude (12). Building a "disaster-resilient community" is one of the projects that have been implemented to meet this goal. This village is planned to be a village that can inform disasters in its area and manage community resources to reduce vulnerability and increase disaster risk capabilities (13–16). A disaster-resilient community has been formed in Bengkulu Province, especially in the Sepang Bay Coastal area, which is located right near the Indian Ocean.

Based on this explanation, the author would like to investigate, specifically in Sepang Bay as a disaster-prone area, whether the quality of settlements in the form of facilities and infrastructure as well as education provided by the government is appropriate to prepare the community to face disasters. The purpose of this study is to see whether there is a relationship between the settlement environment and the preparedness of the Sepang Bay Village community around the Panjang Coast in dealing with earthquake disasters.

METHODS

This study used an analytic study with a cross-sectional design. The research was conducted in October 2021 in Sepang Bay, Bengkulu. The sampled population consists of 873 respondents who are the heads of families (KK) who live in each neighborhood, which consists of 15 neighborhoods in Sepang Bay Village, Bengkulu. A proportional random sampling approach was adopted in this research (13,17–18). The sample was taken from the proportion of family heads in each neighborhood in the Panjang Coast area, Sepang Bay Village, Bengkulu, while the formula used in the calculation is:

$$X = \frac{n}{k}$$

Description :

n = number of heads of families in each neighborhood
k = population

The samples obtained are 100 heads of families in each neighborhood in the coastal area of Sepang Bay Village, Bengkulu City, based on this calculation.

The data analysis technique used is univariate, bivariate, and multivariate analysis. This research was validated by the Health Research Ethics Committee, Faculty of Public Health, the University of Sriwijaya with the number 284/UN9.FKM/TU.KKE/2021.

This study used a questionnaire that has 19 yes or no questions. A total score of 10 was considered good, while a total score of less than 10 is considered bad.

The earthquake response instrument used a questionnaire, the earthquake preparedness variable, which had 17 yes or no answers, and was considered ready if the overall score was 9, and was considered not ready if the overall score was less than 9.

RESULTS

Based on the results of the univariate analysis of 100 respondents, 78% have a decent living environment while 22% have a poor living environment. As many as 68 percent said they are prepared, while 32% said they are not ready.

Based on the bivariate test analysis of 22 respondents, there were 12 respondents (54.5%) who have a poor living environment, and 10 respondents (10%) have poor preparedness, while from 78 respondents, there are 20 respondents (25.6%) with decent living environment and 58 respondents (74.4%) have poor preparedness. According to the findings, there is a significant relationship between the environment and preparedness (p = 0.021, PR 2.127); this indicates that respondents who live in a poor environment are 2.127 times more likely to be unprepared.

Disaster risk management is the process of recognizing, assessing, and calculating potential losses to prevent, reduce, or recover from them. The role of humans in dealing with disasters covers the inability to avoid and minimize hazards and the inability to eliminate or minimize vulnerabilities. As a matter of fact, humans are becoming more vulnerable to disaster as they ignore potential disasters. Vulnerability is an environmental situation in which an individual is unable to respond to a disaster-related hazard. Women, for example, are vulnerable as they have periods and expect pregnancy, childbirth, and breastfeeding which, if left untreated, can lead to gender inequality, and the community expects women to be excluded from disaster management methods in terms of accessing, participating, and controlling decision-making.

One of the four characteristics of vulnerability is physical vulnerability (infrastructure), which describes a physical condition exposed to certain risks. Various indicators can be used to identify these vulnerabilities, including the built-up area ratio, building density, the proportion of emergency buildings, power grid, long-distance dimensional ratio, communication network, agricultural environment, forest, and other features (19). Environmental vulnerability refers to the lack of existing resources (soil, water, and air) and environmental damages that are caused. Vulnerable populations may include children, the elderly, and the homeless. They are people who need special care as well as evacuation and disaster preparedness drills.

Table 1. Frequency Distribution of Family Heads Characteristics

Variable	n	%
Age		
25-49 years old	47	47
50-74 years old	53	53
Education		
Low	48	48
High	52	52
Occupation		
Working	90	90
Not Working	10	10
Quality of Life		
Good	82	82
Not Good	18	18
Settlement Environment		
Decent	78	78
Poor	22	22
Preparedness		
Good	68	68
Poor	32	32
Total	**100**	**100**

Based on the results of the analysis of the settlement environment, from the 100 respondents taken, 78% said the residential environment is very decent, while 22% said the residential environment is

poor. One of the factors that could support a community's preparedness for natural disasters is the residential environment. If the residential environment is good, the community's preparedness in dealing with disasters in that environment will also be good.

Among 56 respondents with decent settlement environment conditions, 89.3% have good preparedness, and 10.7% have poor preparedness. Meanwhile, among 44 respondents from a poor settlement environment, 45.5% have good preparedness, and 54.5% have poor preparedness. According to the research findings, there is a significant relationship between the characteristics of the settlement environment and preparedness (p = 0.021, PR 2.127), which implies that respondents with a decent living environment are 2.127 times more likely to be prepared. The National Standards Agency (BSN) has issued many SNIs for Seismic Risk Forecasting, including SNI 1726:2019 Earthquake Resistance Planning Process for Buildings and Non-Construction Structures. Therefore, when carrying out construction in earthquake-prone areas, such as houses, buildings, or other types of buildings, they must follow the standards set out in SNI.

Table 2. The Relationship between the Settlement Environment and Earthquake Disaster Preparedness in the Panjang Beach Coastal Community, Sepang Bay Village, Bengkulu

Settlement Environment	Preparedness				n	%	p-value	PR CI 95%
	Good		Poor					
	f	%	f	%				
Poor	12	54.5	10	45.5	22	100	0.021	2.127 (1.305-9.283)
Decent	20	25.6	58	74.4	78	100		
Total	**32**		**68**		**100**			

Table 3. Multivariate Analysis of Logistic Regression Method

Variable	B	Wald	p-value	PR	95% CI	
					Lower	Upper
Quality of Life	2.587	15.051	0.000	13.296	3.598	49.136
Settlement Environment	2.094	11.834	0.001	8.114	2.462	26.746
Education	1.344	6.179	0.013	3.836	1.329	11.073
Constant	-3.407	13.909	0.000	0.033		

Buildings that are built or not, must go through a seismic planning process. SNI 1726:2019 was adopted to link SNI with the Ministry of Public Works and Public Housing (PUPR) through regulation No. 29/PRT/M/2006 concerning Technical Requirements for Buildings, as well as references in Spatial Planning. The guidelines for using the principles of leading mining technology are appropriate with the regulation of the Ministry of Energy and Mineral Resources Number 1827 K/30/MEM/2018. This is related to the question on the questionnaire about the residential environment variable that asks about the structure, roof, and walls of the respondent's house to determine the level of earthquake vulnerability.

DISCUSSION

This study is contrary to previous research that found a relationship between depression and environmental quality in post-earthquake in Sleman Regency (20), indicating the higher the depression score, the lower the quality of life and environmental quality will be. Emotional states such as melancholy and irritation may be indicators of depression. People experience cognitive distortions such as self-criticism, self-blame, feeling worthless, low self-esteem, pessimism, and hopelessness as well as feeling lethargic, weak, psychomotor disorder, and avoiding social contacts (21). The difference arises because determining the quality of life that is measured in this study is the level of depression and aspects of physical health. This aspect of physical health is very important because it can be the main asset for the community in establishing a better relationship with the social environment. Or it can be said that depression and anxiety experienced by the family heads in Sepang Bay Village, Panjang Coast can still be controlled so that the interactions are still well-established (20).

Earthquake has social and psychological impacts on the entire earthquake-affected community in L'Aquila, according to research by Valenty et al. This earthquake caused the community to lose many things, such as family members, houses, and properties which resulted in trauma, desperation, and mental health problems for the individual (22).

The condition of the living environment is one of the supporting aspects of the local community's disaster preparedness; the better the settlement environment, the better the community's preparedness for disasters (23). According to the findings of the univariate analysis, 78% of the respondents rated their living environment as satisfactory.

Based on the answers given by respondents, they said that the source of clean water owned by the communities comes from Drinking Water Company (PAM) which is odorless and clear. Likewise, from the observations found, several communities have shelters for storing clean water, where water for bathing and washing is stored in a reservoir and drinking water is stored in a small drum with a lid because the distance between the source of clean water and the landfill is more than 10 meters, so it is considered safe.

Sewerage systems, trash cans, and drinking water supplies from the Regional Drinking Water Company (PDAM) are already accessible for sanitation

facilities. Disposal of solid waste and medical waste should be prohibited in a communal context. Meanwhile, before harming public health, domestic waste must be disposed of or buried. At the market, there are garbage pits, wastebaskets, or special garbage disposal sites, as well as a daily waste collection system. After that, the waste is disposed of in certain areas as a final disposal site. If domestic waste is not buried on the spot, two trash cans sized 100 liters are available for 80–100 people. However, some individuals continue to throw garbage into rivers and sewers.

The public is also concerned about the food and beverages' hygiene and health, including facilities for washing hands before and after eating and closing food and beverage storage areas. The distance between the respondent's house and health facilities is less than 10 kilometers – accessible by public transport.

The quality of the building can be seen from the ventilation system which is already good and equipped with natural ventilation based on the inspection. Natural/ artificial lighting systems, as well as emergency lighting, are part of the lighting system. A rainwater distribution system is installed in the building and yard, the leaked water will flow into the yard. In the event of minor earthquake, the building components, both structural and non-structural, are not damaged, in accordance with the concept of earthquake-resistant buildings (24–25). However, when moderate earthquake hits, it will damage non-structural components but will not affect the structural components. The main material of the house is reinforced concrete, which has been mixed with brick walls.

In temporary camps, residents face environmental problems as shelters for disaster victims often do not meet health requirements, harming their immune systems. If not handled promptly, it will lead to more serious health problems. On the other hand, the provision of health services often encounters various obstacles in the form of defects to health facilities, insufficient number and types of medicines and medical devices, as well as a shortage of health workers and operational funds, which will adversely affect the handling of disaster victims if not addressed immediately.

When handling after the disaster occurs, there are several factors that need to be considered, including the number of disaster victims passing away, becoming sick, or who are disabled. In addition, the demographic characteristics, the number of functioning government and private health facilities, supply of medicines and medical equipment, medical personnel who are still working, high-risk community groups, such as infants, toddlers, pregnant women, postpartum mothers, and the elderly, and local capacities and resources must also be taken into account. This research is supported by previous research which shows the absence of emergency planning, inadequate disaster management infrastructure, untrained human resources, and insufficient budget funds to deal with fire disasters in densely populated areas, and the lack of Regional/Villages Revenue and Expenditure Budgets will exacerbate the impact of natural disasters.

Building flood disaster preparedness and resilience in Bangladesh demonstrates the importance of socioeconomic interventions, targeted and community-centered flood management, and flood management that consider the age, material composition, and structural qualities of houses to increase the adaptive capacity of the dwelling and the duration of flood resilience in the long term (26).

A community's adaptive capacity and long-term flood resilience is imperative to improve local flood risk and vulnerability response performance, as well as the structural conditions of dwellings. According to the research conducted in West Lombok Regency, the earthquake in Lendang Village, West Lombok Regency, in August 2018 destroyed or damaged more than 90% of the residence, forcing 750 people to evacuate. However, it is deeply regretted that this evacuation has resulted in environmental pollution and the spread of diseases due to the limited number of emergency toilets provided. The main focus here is to maintain and improve public health essentials making clean water and sanitation facilities imperative since it is important not only in terms of preventing more infection, which may have a short-term impact, but also in terms of preventing long-term consequences (9).

Earthquake is a natural disaster that severely affects human and causes pain. When it hits humans are helpless due to poor emergency management, humans become impotent, resulting in losses in various fields, including finance, structural fields, and even death. The amount of damage caused is determined by the community's ability to prevent and avoid disasters, as well as their resilience. Landscape conditions can change after a disaster, and many infrastructures, especially environmental infrastructure, are also damaged.

The same can be said about the pollution caused by forests and land fires causing thick smoke contaminating the air during and after the tragedy. Many people become victims in such situations. The survivors will undoubtedly be severely affected in terms of loss of material, non-material, property and casualties. These survivors have a more active, strong, and optimistic perspective than the 'victim' who appears to be suffering and hurt.

Because basic needs such as food, clothing, and shelter are not fulfilled due to the many disasters, the suffering of the victims is more severe. The government and local residents have supplied food and clothing, but they have not been able to reach the victims. The main reason for this is that road access has been disrupted, making it impossible to transfer relief materials to disaster victims and survivors in a timely manner. Inadequate food supply has a long-term negative impact on health and can have a direct impact on the ability of disaster victims to meet their nutritional needs (27).

The same can be said for evacuee camps. Temporary shelters for disaster victims often do not meet health standards, lower body resistance directly or indirectly, and create difficulties in the health sector if not treated immediately. Meanwhile, health services provided in disaster situations generally face several obstacles, such as damage to health facilities, lack of quantity and types of medicines and medical devices, limited medical personnel, and operational costs (28). This obstacle will have a significant impact if not addressed immediately. As a result, governments in earthquake-prone areas must be able to recognize hazards, assess the hazards they pose, and build infrastructure to reduce these threats. Technology has the potential to address all social issues in the field of health and safety workplace, as well as assist in disaster mitigation, particularly earthquakes.

CONCLUSIONS

Among the residents of Sepang Bay, Bengkulu City, there is a relationship between the settlement environment variable and the preparedness variable to face earthquake disasters. Based on this, it is necessary to increase health promotion related to occupational health and safety, as well as improve the quality of services and infrastructure for the people in Sepang Bay, to reduce the risk of loss and loss of life in future disasters.

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