

Tsunami Disaster Mitigation and Preparedness in the South Coast Area of Malang Regency

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Abstract

The Indonesian archipelago is located on the subduction tectonic plate path, the existence of the Indonesian archipelago is on the subduction tectonic plate path, the existence of this subduction process makes the Indonesian archipelago vulnerable to earthquakes of both low and high magnitude. A violent plate collision or shift accompanied by an earthquake in the ocean has the potential to cause a tsunami. The South Coast of Malang is a beach located in the south of Java Island and is one of the beaches directly facing the subduction zone which causes a high frequency of earthquake events and can even trigger tsunamis in this area. This research aims to determine community preparedness in facing the threat of the tsunami disaster using data collection methods in the form of interviews, questionnaires, field observations and literature studies. The research results show that community preparedness in Tambakrejo Village, especially in Sendang Biru Hamlet, is still relatively low with a lack of basic community knowledge about disasters and potential disasters around them.

Keywords: preparedness, mitigation, tsunami

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1. Introduction

Natural disasters can occur through processes and occur slowly so that they can be predicted and can also occur suddenly. As with earthquakes, until now it is almost impossible to accurately predict where, when, and how strong the earthquake will be. Earthquakes and tsunamis are natural disasters that cannot be prevented or avoided, however, the impact of earthquakes and tsunamis can be minimized by equipping people with the ability or skills to respond to disasters, such as skills on how to save themselves when an earthquake occurs, and minimizing vulnerability to the impact of natural disasters themselves, such as building earthquake-resistant houses of a certain strength (Uswatun Khasanah & Sarjanti, 2014).

Indonesia's territory is located at 6°N - 11°S and 95°E - 141°E which causes Indonesia to be located in a strategic location on the equator. Indonesia is a country that is at the

meeting point of three main tectonic plates, namely the Indo-Australian Plate, the Eurasian Plate and the Pacific Plate. The movement and interaction of these plates can cause high tectonic activity such as earthquakes, volcanic eruptions and tsunamis. Apart from that, Indonesia's territory is also located at the confluence of continental plates, namely the Pacific Circum and Transasiatic Alpide (Munir, 2014). This condition causes the southern region of Java Island to be very at risk of tsunami disasters, one of which is the southern coastal area of Malang. The southern part of Malang Regency is generally known as "South Beach Malang".

According to Law Number 24 of 2007 concerning disaster management, it is emphasized that mitigation is an effort to minimize the impacts caused by disasters. These efforts can take the form of physical development, understanding how to handle mitigation, as well as increasing capabilities in resilience to face disasters (Kurnia Maulidi Noviantoro, 2022). Coastal areas are often vulnerable to various natural disasters such as earthquakes, tsunamis, tropical storms and tidal floods. These disasters are caused by several factors such as geographical location, topography, and human activities such as development activities in coastal areas which can also increase the risk of disasters occurring in coastal areas.

Preparedness means planning actions to respond if a disaster occurs. Preparedness is also defined as a state of being ready to face a crisis, disaster or other emergency situation (Utomo et al., 2018.). Based on this understanding, it is important to examine the preparedness of the community in Tambakrejo Village, Sumbermanjing Wetan District in facing the tsunami disaster. This research aims to understand the action plans that will be taken by the community when a tsunami occurs and their awareness in increasing knowledge and skills related to tsunami disaster mitigation.

Steps that can be taken to increase community preparedness for the threat of earthquakes and tsunamis on an ongoing basis include understanding the potential dangers in the surrounding environment, recognizing early warning systems such as evacuation routes and evacuation plans, and having the skills to evaluate the situation quickly. Apart from that, it is important to prepare a disaster anticipation plan for the family, reduce risks through mitigation exercises, and actively participate in related training. Preparedness for earthquakes and tsunamis aims to ensure a quick and appropriate response when a disaster occurs, in order to minimize risks and losses. This requires knowledge, understanding and skills in efforts to prevent, early detect and anticipate various types of disasters, known as disaster preparedness (Nada et al., 2022).

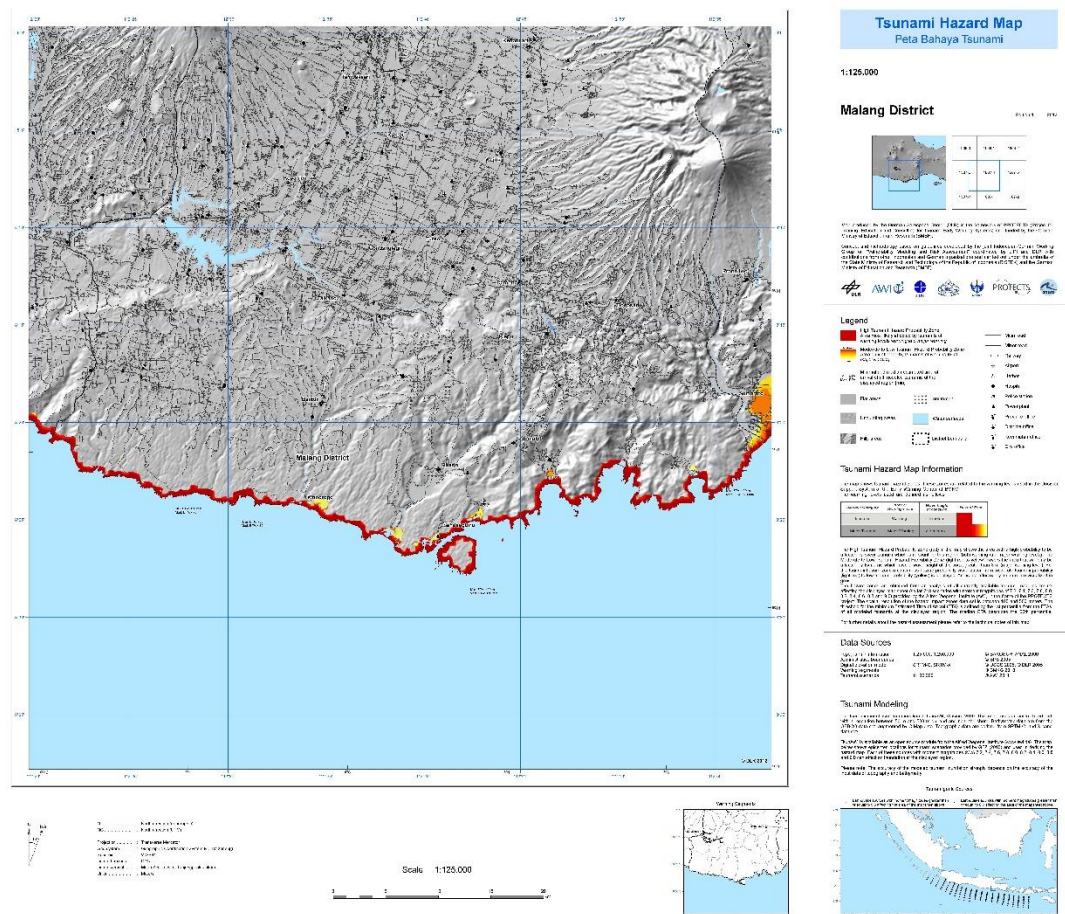


Figure 1. Tsunami Hazard Map

Malang Regency is located along the southern coast of Java Island, which is a zone prone to earthquakes and tsunamis due to tectonic activity, including the movement of the Indo-Australian and Eurasian plates. History records several destructive tsunami events in this region, such as the tsunami that occurred in 1994 in Banyuwangi which resulted in many fatalities. With a coastline of approximately 103 km, Malang Regency faces significant risk from tsunami waves. Research shows that tsunami waves can reach heights of more than 14 meters, and the estimated arrival time of waves after an earthquake can range from 18 to 30 minutes.

Disasters are events or series of events that threaten and disrupt people's lives and livelihoods caused by either natural factors and/or non-natural factors or human factors, resulting in human casualties, environmental damage, property loss and psychological impacts (Saparwati et al., 2020). Natural disasters occur because threat factors meet vulnerability factors and the inability or low ability to respond to the threat, both of which cause disruption to people's lives such as damage to houses, loss of property and loss of life. Generally, disaster hazards can occur anywhere with little or no warning, so it is very important to be prepared for disaster hazards to reduce the risk of their impact.

Several similar studies such as "Community Preparedness in Facing Earthquake and Tsunami Disasters on the Coast, Case Study: Negeri Liang. This research is based on four parameters that follow the LIPI - UNESCO/ISDR 2006 standards, namely knowledge and attitudes (KA), emergency response plans (EP), disaster warnings (WS)

and resource mobilization (RMC). This study, which was located in the coastal area of Negeri Liang, which was affected by high damage due to the earthquake, showed the results of a good level of preparedness starting from aspects of community knowledge and attitudes, and a fairly effective disaster warning system (Ruman et al., 2023). Furthermore, the research "Earthquake and Tsunami Disaster Preparedness in the SDN 21 Banda Aceh School Community". This research focuses on studying earthquake and tsunami disaster preparedness in school communities located in tsunami-prone areas. This research uses preparedness parameters in the form of knowledge, emergency response plans, disaster warnings and resource mobility which were assessed using a closed questionnaire. The results of this research show a good level of preparedness by the school community in the very ready category ((Nada et al., n.d.). Next is the research "Tsunami Disaster Mitigation at Pangandaran Beach, West Java". This research aims to determine tsunami disaster mitigation efforts on Pangandaran Beach which is prone to earthquakes and tsunamis because it is directly facing a plate subduction zone. This research focuses on structural and non-structural mitigation efforts implemented at this location. The research results show structural mitigation in the form of planting mangroves, creating evacuation routes, building temporary evacuation sites (TES), building wave breaker forts, and installing a tsunami early warning system. Non-structural mitigation which includes the implementation of land use policies, development and publication of early warning systems, as well as tsunami disaster mitigation simulations. This research also provides disaster mitigation innovation programs such as Mitigation Kindergarten Children, Goes to School Disaster Education Tour, Disaster Education Sharing Gathering, Mitigation Learning Mother, Community and Hotel Early Preparedness Forum, Disaster Resilient Restaurant (Setya Lestari & Setiawan, n.d.).

Based on the description above, research on Tsunami Disaster Mitigation and Preparedness in the South Coast Region of Malang Regency, carried out with a focus on the micro level, will provide a deeper understanding of the challenges and level of local preparedness when compared with studies of wider coastal areas. The selection of research locations that are also disaster resilient certified villages still shows significant gaps in community knowledge and preparedness. This research examines community mitigation and preparedness efforts with various individual community backgrounds, thus influencing the perceptions of these individuals or community groups.

2. Method

The research was conducted on September 4, 2024, located in Malang Regency, specifically in Sumbermanjing Wetan District, Tambak Rejo Village, Sendang Biru Hamlet. This research is a type of qualitative research with a descriptive approach to describe the state of preparedness and mitigation efforts carried out by the government and community in facing the potential tsunami disaster in their area in more depth.

The variables used in this research were taken from the TRC (Tsunami Ready Community) program framework and combined other relevant research. This research uses 3 variables, namely knowledge and attitudes, emergency response plans and disaster warning systems (Ruman et al., 2023). Community knowledge and attitude variables were assessed through questionnaires and interviews regarding community awareness of tsunami risk in their area, perception of tsunami disaster risk based on personal experience, age and status of the individual and understanding of natural signs that indicate the arrival of a tsunami. Next, the emergency response plan variable is assessed

by the evacuation plan, socialization of the plan to the community and community participation in disaster drills/simulations. The final variable is the early warning system (EWS) and evacuation route signs.

The target of this research is the surrounding community or more precisely in Sendangbiru Hamlet, Tambakrejo Village, Sumbermanjing Wetan District, Malang Regency. Data collection was carried out using the document study method by collecting previous reading sources that were relevant to this research. Some of the data used in this research are disaster documents such as tsunami hazard maps and previous research articles. Meanwhile, to determine community preparedness and mitigation efforts carried out, data collection techniques using interview, questionnaire and field observation methods were carried out. Then, the data obtained will then be analyzed and described in the discussion.



Figure 1. Research Map Location

3. Result and Discussion

Tambakrejo Village is located in Sumbermanjing Wetan District, Malang Regency, East Java. This village has two hamlets, namely Tamban Hamlet and Sendang Biru Hamlet, and is part of the southern coast of Java Island. Administratively, Tambakrejo Village consists of 8 RWs and 45 RTs. Tambakrejo village has an area in the form of a beach that borders directly on the Indian Ocean. Tambakrejo Village has several beaches which are leading tourist attractions in Malang Regency, including Panati Sendang Biru, Gatra Beach and Tiga Warna Beach.

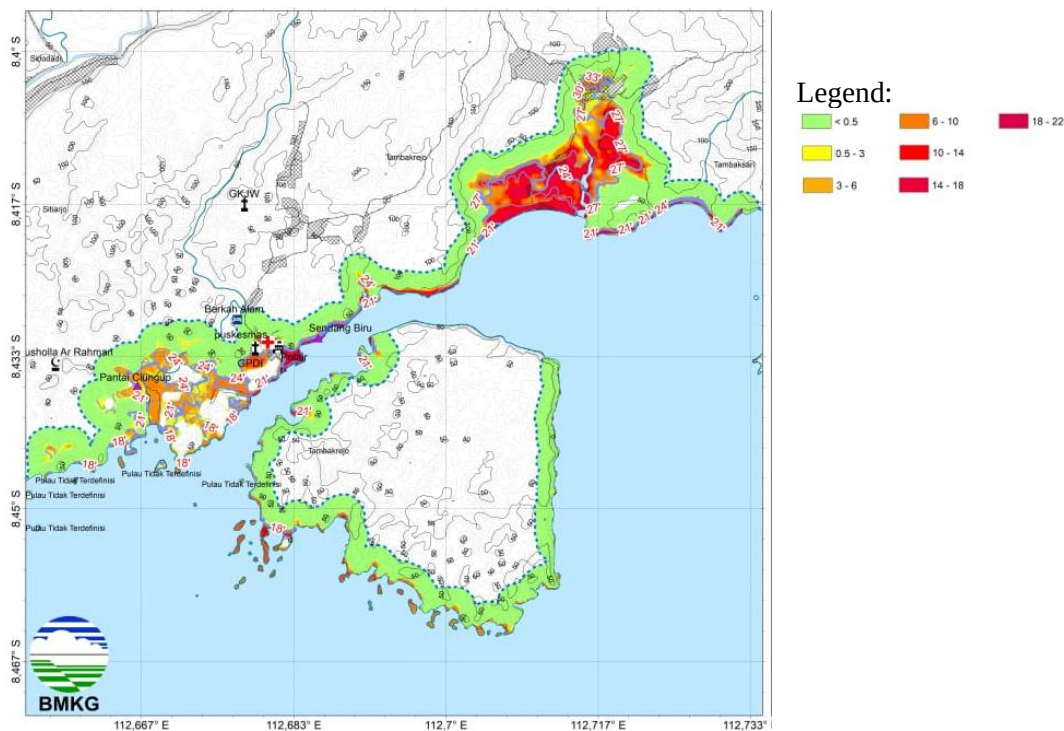


Figure 2. Hazard Map of Sendang Biru Beach and Surrounding Areas

Tambakrejo Village in the Tsunami Hazard Map in Figure 2 shows that the CMC coastal area, Sendangbiru Beach and its surroundings have the potential for inundation of 0.5 – 14 m. With the potential for very large wave inundation, preventive measures for disaster mitigation efforts are very necessary to minimize losses due to disasters. Apart from preventive measures, thorough preparation is also needed when a disaster occurs or a disaster emergency response plan and post-disaster handling.

The research was carried out on September 4 2024 by conducting observations, interviews and distributing questionnaires to the community. Observations were carried out to observe the facilities or infrastructure supporting structural mitigation efforts in Sendangbiru Hamlet, Tambakrejo Village. Meanwhile, interviews and distributing questionnaires to the community were carried out to find out the efforts made by the government and community in non-structural mitigation efforts in Sendangbiru Hamlet, Tambakrejo Village and also to find out the preparedness of the community in this area in facing the tsunami disaster.

Identification from the results of observations and interviews with the community obtained the following results:

A. Knowledge and Attitudes of Society

In this research, it was found that the level of awareness of tsunami disaster mitigation in Malang Regency, specifically in Sumber Wanjingwetan District, Tambakrejo Village varied greatly between local residents and tourists. Differences in personal experiences between local residents and tourists greatly influence how each group views tsunami risk and their overall knowledge about tsunamis. These differences in experience lead to varying attitudes, behaviors, and levels of preparedness, which can have significant implications for disaster safety and response.

Generational differences may also influence this perception. Older residents who

have experienced tsunamis before have an understanding of the symptoms of earthquakes and changes in sea water that lead to tsunamis. Meanwhile, younger residents, who had heard stories about but not directly experienced the tsunami, had a lower perception of the threat. This age difference can cause different levels of awareness and preparedness in society. Based on the earthquake and tsunami disaster preparedness questionnaire distributed to the community in Tambakrejo Village, it shows that their level of knowledge and preparedness is still lacking. Most of the people who still lack understanding about the potential for disaster in their area are immigrants. Meanwhile, for the native residents of Tambakrejo Village, they have a good level of preparedness and understanding regarding the potential for a tsunami disaster in their village.

There are several benefits of community-based disaster mitigation, including providing and developing knowledge about mitigation to the community so that their level of awareness of the risks faced can increase, stimulating the community to be more prepared and responsive in facing disasters in their environment and helping to understand where and how disasters might occur, strengthening and improving the community's ability to deal with disasters, for example making plans for evacuation routes and establishing synergy with institutions that can help when a disaster occurs, forming disaster management community groups, and increasing community understanding and awareness of the natural environment and its role in reducing disaster risks..

B. Emergency Preparedness and Response

Some of the questions asked on questionnaires and interviews in collecting emergency response plan data are the adoption of the 12 tsunami ready community (TRC) indicators set by UNESCO – IOC. The following is some information gathered based on questionnaires and the results of interviews with the public.

Table 1. Community Preparedness Indicators

No	Indicator	Availability		Information
		There is	There isn't any	
1.	Division of tasks in rescue actions			
	a. Communities involved in rescue efforts	✓		There is a division of tasks in Tambakrejo Village when responding to disaster emergencies. The community involved is the FPRB (Disaster Risk Reduction Forum) Tambakrejo Village.
2.	Availability of evacuation routes and signs pointing to evacuation routes	✓		There are several intersections in Sendangbiru Hamlet and several points in the CMC (Clungup Mangrove Conservation) area.
3.	Communities that provide temporary shelter.		✓	-
4.	Availability of disaster preparedness bags for village residents.		✓	-

5.	Availability of emergency communication tools such as Handytalky (HT).	✓	-
6.	Availability of equipment for emergency disaster response (generators, flashlights, stretchers, tents, medicines and stretchers).	✓	There are several disaster emergency response equipment stored at the Tambakrejo Village Hall. There is several equipment such as tents, generators, stretchers.
7.	Education and preparedness materials tsunami disaster to the community.	✓	Disaster education is carried out in Tambakrejo Village, especially in Sendangbiru Hamlet, which is carried out regularly in the community, both through community gatherings at the Village Hall and even going directly to the RT and also in houses of worship.
8.	Implementation of earthquake and tsunami disaster simulation training activities.	✓	Tambakrejo Village carries out routine disaster simulations every 2 years.

Based on the results of interviews, emergency preparedness and response plans in Tambakrejo Village are quite good, but they are still not widely disseminated to the community. When interviewing several residents of Sendangbiru Hamlet, Tambakrejo Village, there were some residents who still lacked knowledge of the potential for disaster in their area. One of the villagers interviewed stated that he had never attended disaster training/disaster simulation, especially earthquakes and tsunamis. Even though Tambakrejo Village is a village that has received a national tsunami alert certificate. It is important to distribute disaster information, especially earthquakes and tsunamis, to the wider community so that mitigation efforts can run optimally while increasing local community preparedness.

C. Disaster Early Warning System

In this research, field observations were carried out to directly observe the forms of structural mitigation that exist in Sendangbiru Hamlet, Tambakrejo Village. Observations were carried out by combing the Sendangbiru Hamlet area to the CMC (Clungup Mangrove Conservation) area. The results of the observations show that in Sendangbiru Hamlet there is no tsunami early warning system or Early Warning System (EWS). Based on explanations from the local community, this has been overcome by using high wave detection equipment at Sendangbiru Harbor to determine the potential for tsunami waves. Apart from that, during the observations, several evacuation route signs were also found at intersection points in Sendangbiru Hamlet and several points in the CMC area. These evacuation route signs are very important in facilitating the evacuation of the public, especially tourists who visit the tourist area in Tambakrejo Village, more specifically in Sendangbiru Hamlet.

Looking at the conditions in Sendangbiru Hamlet, based on the results of

observations, structural mitigation in this area still needs to be improved. Bearing in mind that the condition of Sendangbiru Hamlet is included in a zone that has a high level of tsunami danger or is included in the red zone, it is very important for the government or related parties to increase efforts to increase structural mitigation in this area. By increasing mitigation efforts, it is hoped that the impact of the tsunami disaster will be minimized, including loss of life.

The following is some documentation taken directly during the observation process in Sendangbiru Hamlet:



Figure 3. Documentation of Evacuation Route Signs

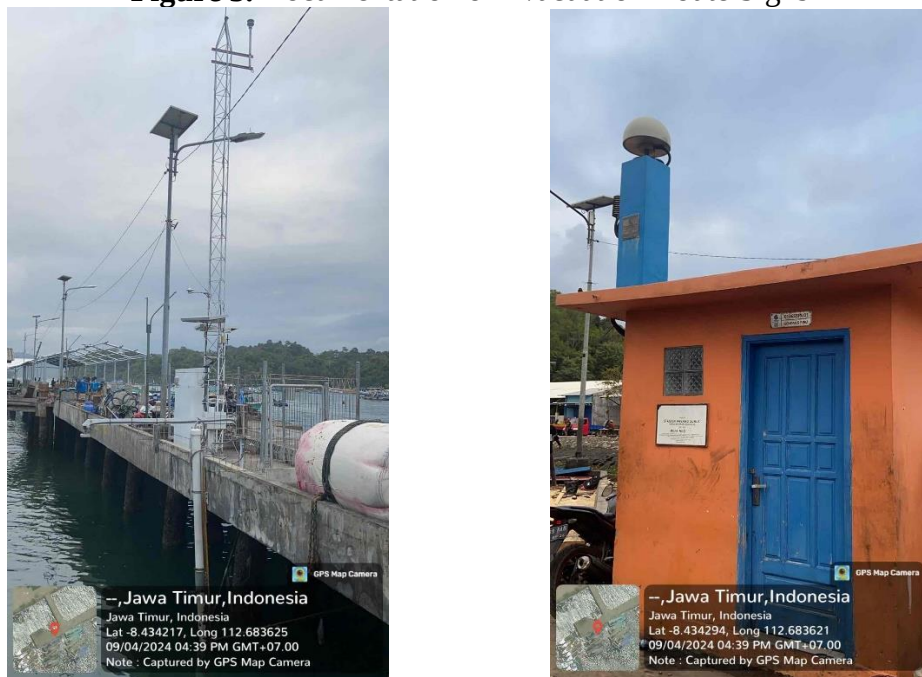


Figure 4. Tidal Wave Detection Documentation

D. Conclusion

The South Coast area of Malang Regency, especially in Tambakrejo Village, Sendangbiru Hamlet is an area that is vulnerable to earthquakes and tsunamis due to its location close to the active subduction zone between the Indo-Australian and Eurasian Plates. Based on the research results, the level of awareness and preparedness of local communities towards disasters is still relatively low because age and personal experience also influence their perception of disaster risk. The unavailability of an Early Warning System (EWS) is a big challenge for the community in responding quickly to disaster threats, and the disaster education that has been carried out has not fully spread throughout the community so that the dissemination of information regarding disaster mitigation needs to be maximized.

The government and related parties really need to increase structural mitigation efforts by adding infrastructure such as refugee camps, emergency communication tools and other disaster response equipment. Collaboration between the government, community and related institutions is very important to increase preparedness and effectiveness of mitigation in order to minimize the impact of the tsunami disaster and ensure community safety.

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