

Recommended Addition of Evacuation Signage to Support Tsunami Disaster Risk Reduction Efforts in Gorontalo Village, West Manggarai Regency, East Nusa Tenggara

Donny Alviandi, S.A.P¹

¹Indonesia Defense University, Indonesia

Dr. Ernalem Bangun, M.A., CIQaR²

²Indonesia Defense University, Indonesia

Kolonel Caj Dr. Arifuddin Uksan, S.Ag., M.Ag., CIQnR.³

³Indonesia Defense University, Indonesia

Corresponding Author: donny.alviandi@kn.idu.ac.id

Abstract

Labuan Bajo, with its stunning natural beauty, has become one of Indonesia's premier tourism destinations. The Komodo Islands, exotic beaches, and rich local culture attract visitors from around the world. However, behind this beauty, Labuan Bajo also faces potential natural disaster threats, particularly in several areas such as Gorontalo Village. This village is located in a coastal zone that is vulnerable to tsunami risks. Therefore, it is crucial for the government and local community to improve awareness of tsunami hazards and to prepare effective mitigation measures. To minimize the adverse impacts of a potential tsunami disaster in Gorontalo Village, it is necessary to identify and recommend additional locations for installing tsunami evacuation signs.

KeyWords : Tsunami, Gorontalo Village, Evacuation signs, disaster risk reduction, mapping

INTRODUCTION

Labuan Bajo, located in West Manggarai, East Nusa Tenggara (NTT), is a tourism destination known for its spectacular natural beauty and significant economic potential. The area has rapidly developed into one of Indonesia's premier tourist attractions, offering unique landscapes both on land and at sea, including the Komodo National Park, which has been

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recognized as a World Heritage Site. However, behind its natural charm, this region possesses notable geographical vulnerabilities to various natural hazards, particularly tsunamis, which pose a real risk due to Indonesia's geological position at the convergence of active tectonic plates.

Referring to Law Number 24 of 2007 on Disaster Management, the government is responsible for conducting comprehensive risk and vulnerability analyses for all regions. Geographic Information Systems (GIS) serve as a key instrument in identifying, analyzing, and mapping potential disaster threats, particularly in coastal areas that face high levels of risk, such as Labuan Bajo and its surroundings. This approach enables both local and national governments to design appropriate mitigation strategies, determine safe evacuation sites, and develop effective disaster-resilience infrastructure to protect communities and tourism areas from potential damage caused by natural hazards.

The complexity of disaster threats in the West Manggarai region requires a multidimensional approach that not only focuses on disaster-related aspects but also considers social, economic, and environmental dynamics. Strengthening local community capacities, developing early warning systems, ensuring accurate geospatial risk mapping, and integrating traditional knowledge with modern technology are key strategies in building regional resilience. Through comprehensive risk analysis, the government can design policies and interventions that not only protect the community but also safeguard the sustainability of the tourism sector, which serves as the backbone of the local economy.

The area examined in this study is specifically Gorontalo Village, located in Komodo District, West Manggarai Regency, East Nusa Tenggara Province. The total area of Gorontalo Village, as represented in the 2021 administrative boundary shapefile from BIG, is 747.37 hectares. The topography ranges from 0 to 200 meters above sea level, with the majority of the area situated at elevations between 5 and 12 meters above sea level. In this study, the village's spatial extent is defined based on the 2021 administrative boundary shapefile from BIG, covering an area of 747.37 hectares. Geographically, Gorontalo Village lies between 119° 51' 43" – 119° 53' 52" East Longitude and 8° 29' 38" – 8° 32' 8" South Latitude.

Administratively, the village is bordered by:

1. North : Labuan Bajo Urban Village
2. East : Wae Kelambu Urban Village and Golo Bilas Village
3. South : Macang Tanggar Village
4. West : Flores Sea



Based on data from the *Komodo Subdistrict in Figures 2022* published by BPS, Gorontalo Village consists of 6 SLS (Local Environment Units) and 20 neighborhood units (RT). The distance from Gorontalo Village to the subdistrict center, Labuan Bajo, is approximately ± 1 km. Labuan Bajo also serves as the administrative center of West Manggarai Regency. Gorontalo Village is accessible by land transportation from the regency capital, with paved road conditions, and is served by public transportation operating on fixed routes.

Gorontalo Village has never experienced a tsunami disaster. Based on the available literature, there are no historical records of tsunami events reaching Gorontalo Village. However, the geographical location of West Manggarai Regency is situated near three tsunami-generating sources that pose potential threats to the region, namely the Flores Back-Arc Thrust, the Sape Strike-Slip Fault, and the Indo-Australian Subduction Zone.

In the *National Disaster Risk Assessment for East Nusa Tenggara* as well as the *Final Report of the Disaster Risk Assessment for the Labuan Bajo Priority Tourism Destination (KSPN)*, there has been no in-depth analysis regarding the required evacuation signage. Based on these gaps, the researcher will conduct an assessment to determine the tsunami hazard zones that may be affected and to identify the additional evacuation signs needed in Gorontalo Village to minimize casualties in the event of a tsunami.

OVERVIEW OF CONNECTIVISM

Modern-day learning is taking place via network connections as people exchange respective skills, information, viewpoints, experience, and views in digital or online learning settings (Dunaway, 2011; Siemens, 2008). Because knowledge is continually evolving, its usefulness and correctness may vary significantly when new contributions to a field are discovered. As a result, one's grasp of a matter, as well as student ability to learn about the subject at hand, will vary from time to time. Connectivism emphasizes two crucial abilities that help to learn: the capacity to search for existing knowledge and the capacity to eliminate alternative and superfluous knowledge. The process of learning is continuous in the sense that individuals will access the network to exchange and discover new knowledge, subsequently adjust existing views based on new understanding, and then reconnect to a community to communicate such experiences and discover new knowledge again. Essentially it is, the ability to understand is much more important than what is known. The capacity to make judgments based on learned knowledge is seen as essential to the education process (Siemens, 2008). Driscoll's (2005) research was used to classify knowledge among three main philosophical frames notably objectivism,



pragmatism, and interpretivism. Objectivism holds that reality exists outside of the mind and that learning and perception are gained via experience.

Pragmatists view learning as the result of a bargain involving thought and practice (Siemens, 2008). The Internet has been reshaped into a huge blended learning environment, with knowledge storage tanks such as online virtual classrooms, online forums and virtual societies to successfully execute, replicate, communicate, and convey content in to the grip of students and teachers (Kropf, 2013). More significantly, the Internet has become a central focus of connectivism, which is potentially dynamic in innovative educational philosophy. Adelstein (2013) states that students nowadays are 'do-it-yourself' thinkers. Connectivism sees learning as an unstructured chance and it converts individual students into 'networks' themselves, equally skilled in exchanging their skills and experience with other people after gaining knowledge from a sequence of nodes (Albert & Steve, 2013). Individuals may alter or reform their behavior in response to stimuli such as incentives and penalties. Online communication platforms can turn students into someone who can manage their schedule and arrange their duties appropriately amidst the everyday turmoil of plentiful data (Couros, 2009; Garcia et al., 2012).

OBJECTIVES AND BENEFITS

Formulating recommendations for disaster evacuation signage aims to provide guidance for Local Governments in policy-making to reduce risks, serve as a basis for preparing disaster management plans within development planning, and act as a reference for enhancing local government capacity in communication and information access related to earthquake and tsunami warnings. It also supports the improvement of evacuation routes, the management of evacuees during evacuation events, and facilitates the mobilization of resources from within and outside the region.

METHODOLOGY

The methods used in this article are descriptive and quantitative approaches. The study area selected for this research is Gorontalo Village in West Manggarai Regency, East Nusa Tenggara. Data collection techniques were carried out through several methods, including documentation review, literature study, and data processing using the QGIS application. The data were obtained from the websites of the National Disaster Management Agency (BNPB) and the Geospatial Information Agency (BIG).



RESULTS AND DISCUSSION

The term *tsunami* originates from Japanese, where “*tsu*” means harbor and “*nami*” means sea wave. Literally, the word initially referred to sea waves that strike a harbor. A tsunami is a natural phenomenon characterized by high-energy sea waves generated by a sudden disturbance affecting a large volume of seawater. As a long-period gravity wave, a tsunami typically has a recurrence interval ranging from 10 to 60 minutes. When entering shallow coastal waters, the wave amplitude increases significantly, causing inundation in coastal areas. Interaction with varying seabed topography further concentrates the wave energy, resulting in highly destructive waves upon reaching the shoreline.

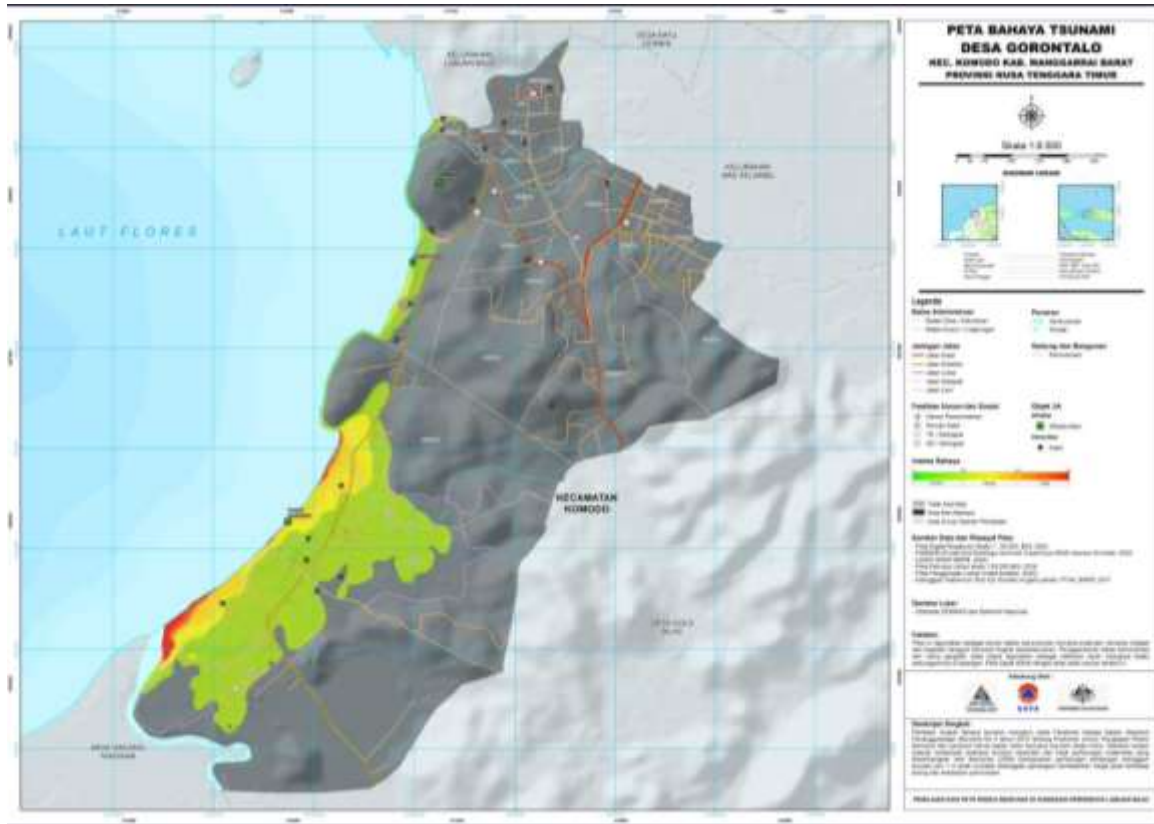
In Indonesia, this phenomenon poses a serious threat, as the country is an archipelagic nation located at the convergence of three major tectonic plates: the Eurasian, Indo-Australian, and Pacific plates. Tsunamis can be triggered by various factors, primarily undersea earthquakes, volcanic eruptions, or submarine landslides—all of which are common in the Indonesian region. Based on their generating mechanisms, tsunamis can be categorized into three main types: tectonic tsunamis triggered by earthquakes, volcanic tsunamis produced by volcanic activity, and tsunamis caused by anthropogenic or human-related factors, although the latter is rare in Indonesia.

Gorontalo Village has never experienced a tsunami event. Based on a review of the available literature, no historical records indicate that a tsunami has ever reached Gorontalo Village. However, the geographical location of West Manggarai Regency lies in proximity to three tsunami-generating sources that pose potential threats to the region, namely the Flores Back-Arc Thrust, the Sape Strike-Slip Fault, and the Indo-Australian Subduction Zone. To enhance community preparedness in facing the possibility of a tsunami disaster, it is necessary to establish clear guidelines regarding evacuation signage in Labuan Bajo, particularly in Gorontalo Village.



Source: BNPB Analysis Results, 2023

Figure 1. Tsunami Hazard Map of Gorontalo Village



The total population of Gorontalo Village in 2022 (BPS, 2022) was 7,328 people, consisting of 2,135 households. The male population was 3,652 and the female population was 3,676, with an average annual population growth rate of 2%. The population density reached 1,176 people per square kilometer, with a sex ratio of 99. The demographic composition of Gorontalo Village by age group can be seen in the figure below.

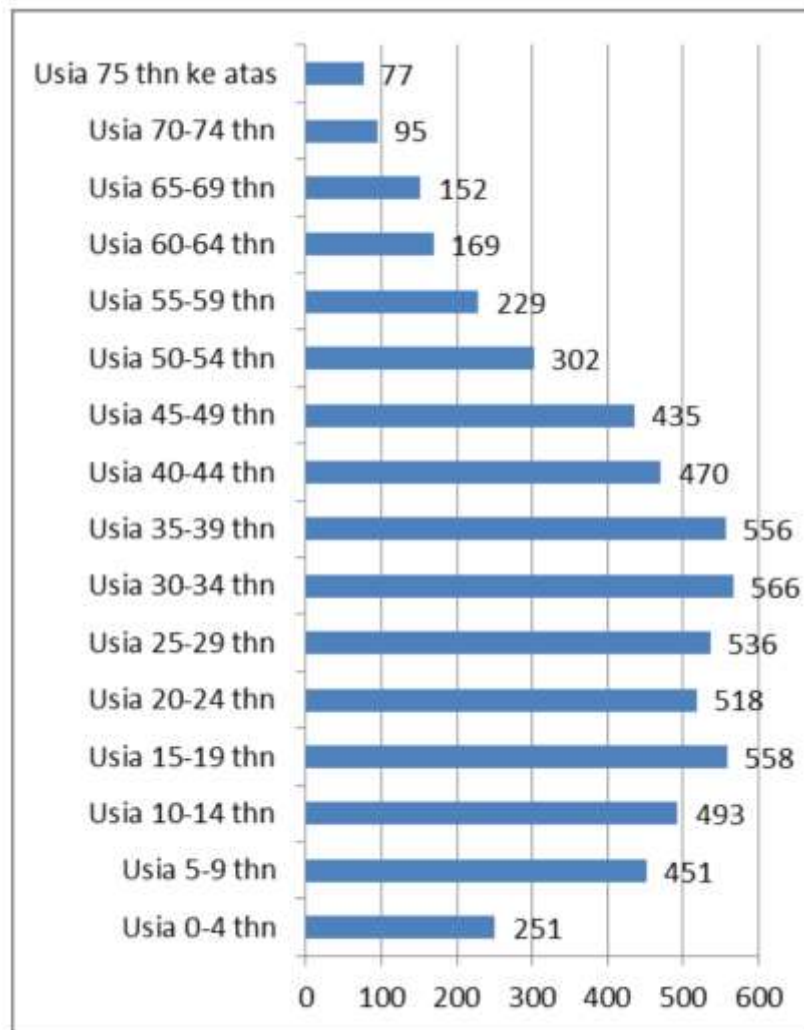


Figure 2. Population Composition by Age Group in Gorontalo Village

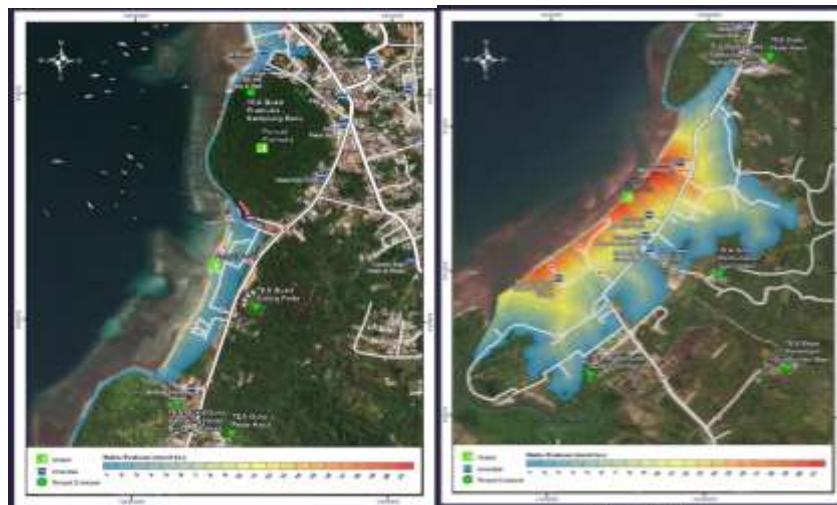
The figure shows that the population aged 15–59 years is relatively large. Meanwhile, the elderly and toddler populations account for 8.4% and 4.3% of the total population of Gorontalo Village, respectively. These groups fall into the category of vulnerable age groups during disasters. In contrast, the younger population represents a significant potential asset in disaster situations, as they are expected to be able to evacuate independently and assist vulnerable groups who may require additional support.

The population composition based on educational attainment in Gorontalo Village is dominated by individuals with senior high school education, comprising 26.2% or 1,919 people.

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This is followed by junior high school graduates at 10.6% or 780 people, and elementary school graduates at 14.6% or 1,071 people. The proportion of residents who have pursued higher education is 13.28% or 973 people. Meanwhile, those who have not completed elementary school account for 10.8% or 789 people. The remainder, 24.5% or 1,796 people, are individuals who have not attended or are not currently attending school.

Based on the available evacuation time requirements, the following calculations were compiled by BNPB in collaboration with Siap Siaga for the *2023 Disaster Risk Assessment of the Labuan Bajo Priority Tourism Area (KSPN)*: The required evacuation time to avoid tsunami waves is 16 minutes from Pede Beach and 17 minutes from Gorontalo Beach. Residents and tourists can evacuate to the nearest hotel amenities, namely The Jayakarta Hotel and Laprima Hotel/Pramuka Hill/Pede Hill. In Gorontalo Village, the earliest tsunami arrival time is 23 minutes at Laprima Hotel; therefore, the recommended evacuation time needed is 16 minutes. These four hotel amenities in Gorontalo Village can each serve as Temporary Evacuation Sites (TES). This indicates that the hotel amenities are adequate to function as evacuation points during a tsunami, based on both the calculated tsunami arrival time and wave height. Hazard warning signs, dissemination of evacuation alerts, and clear evacuation procedures at each amenity are essential to ensure that visitors can evacuate effectively and safely.



Source: BNPB Analysis Results, 2023

Figure 3. Available Evacuation Time at Gorontalo Beach

According to the *Guidelines for Tsunami Evacuation Routes and Signage Planning* (Harkunti, 2014), evacuation signage is a type of road equipment in a specific form that contains symbols, numbers, text, directional arrows, and/or a combination of these elements, used to

provide information related to tsunami evacuation. These signs function to indicate or provide instructions, warnings, and regulations for anyone located within tsunami hazard zones and tsunami safe zones.

Tsunami evacuation signs are placed within tsunami hazard zones and along the routes leading to tsunami safe zones. They are installed at road intersections to prevent misdirection, and they are also positioned where obstacles or barriers may appear along the evacuation route, such as steep or ascending paths.

Tsunami evacuation signage consists of several types of signs. There are five categories of signage that follow technical standards to support community education and enhance response capacity during tsunami events, namely:

1. Tsunami hazard zone signs, which include signs located within the tsunami hazard zone and signs indicating entry into or exit from the hazard zone.
2. Tsunami evacuation orientation maps, which take the form of information boards containing details and directions regarding the locations of Temporary Evacuation Sites (TES) and Final Evacuation Sites (TEA), as well as the evacuation routes that can be used to reach TES and TEA.
3. Evacuation direction signs, which consist of directional signs for pedestrians as well as for vehicle users such as motorists, drivers, and others.
4. Tsunami safe zone signs.
5. Tsunami event information boards, which display records of past tsunami events that have occurred in the area.



Source: 2024 Analysis Results

Figure 4. Existing Signage in Gorontalo Village

Based on the survey conducted in Gorontalo Village, several tsunami evacuation direction and route signs were identified, totaling eight signs. These signs are primarily located in areas that serve as tourist destinations with numerous inns and restaurants, such as Pantai Pede Street and Gorontalo Village Street. According to the *Guidelines for Planning Tsunami Evacuation Routes and Signage*, additional tsunami evacuation signs are needed to enhance the visibility and effectiveness of evacuation guidance for the community.



Source: 2024 Analysis Results

Figure 5. Recommended Signs, Warning Signs, and Assembly Point Signs

Based on the results of the analysis of directional signage needs, the recommended number of evacuation direction signs is 24 units. This figure was obtained from a GIS-based analysis that positions evacuation signs at every turn/intersection and places one sign along straight paths, guiding exposed residents from the coastline all the way to the Temporary Evacuation Shelters (TES).

CULTURAL EVOLUTION AND PRIMARY EDUCATION

Based on the observations, the current preparedness condition of the community in Gorontalo Village shows that they have never experienced a historical tsunami event and possess no disaster-risk knowledge derived from local wisdom. Therefore, the recommended non-structural mitigation measures include mainstreaming tsunami mitigation into village development planning and enhancing community capacity.

One of the key efforts is to provide regular and integrated education on tsunami hazards, as well as to strengthen community-based early warning systems by teaching residents how to listen to, seek out, and respond appropriately to early warnings issued by official sources. In addition, mainstreaming tsunami mitigation into development planning should involve programs such as initiating the establishment of *DESTANA* (Disaster-Resilient Village), installing evacuation signage, constructing Temporary Evacuation Shelters (TES), and maintaining coastal areas.

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