

SOCIAL RESILIENCE OF NORTH COASTAL COMMUNITIES OF SUMBAWA ISLAND IN MITIGATING EARTHQUAKE AND TSUNAMI DISASTER

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Abstract: Indonesia's geographical position in the Ring of Fire increases the potential for high-intensity natural disasters such as earthquakes, volcanic eruptions, and tsunamis, which pose significant threats to coastal communities. Sumbawa Island, located in West Nusa Tenggara Province is particularly vulnerable due to its position along the Ring of Fire. The northern coastal areas of Sumbawa and the Satonda waters, which face the Flores Sea are especially affected by tectonic activity. This study analyses the social resilience of communities on the north coast of Sumbawa and Satonda waters in natural disaster mitigation efforts. A descriptive qualitative research approach was employed. Data collection was conducted using non-participatory observation, in-depth interviews, and documentation. The collected data were analysed using three dimensions of social resilience proposed by Keck and Saktapolrak (2013). The findings indicate that local communities have a limited understanding of the potential for earthquakes and tsunamis in their region, resulting in disaster mitigation not being prioritised by local governments. Coastal communities require greater awareness and knowledge of natural disaster mitigation. Therefore, increased outreach and education on disaster mitigation are essential in enhancing community resilience and reducing disaster risks.

Keywords: Social resilience, disaster mitigation, earthquake, tsunami, West Nusa Tenggara.

Introduction

Indonesia is a country with a high level of vulnerability to natural disasters. This is partly due to the country's position in the Pacific Ring of Fire, especially in the eastern region. The 2022 World Risk Report, released by Bündnis Entwicklung Hilft and the Institute for International Law of Peace and Armed Conflict (IFHV) of the Ruhr-University Bochum, ranks Indonesia as the third-most disaster-prone country in the world (Annur, 2022). The eastern region of Indonesia is located at the convergence of three large active plates: The Eurasian, Indo-Australian, and Pacific plates (Marwanta, 2005). The movement of these three plates contributes to the region's susceptibility to natural disasters, including volcanic eruptions, earthquakes, and tsunamis. However, Indonesia's vulnerability to natural disasters is not only due to its location on the Pacific Ring of Fire. Other contributing factors include diverse and rugged topography

(such as volcanoes, lowlands, and coastal areas), a tropical climate with high rainfall, high population density, unsustainable land use, deforestation, inadequate disaster-resistant infrastructure, and ineffective disaster planning and management (BNPB, 2010; Siagian *et al.*, 2014). These combined factors make Indonesia one of the most disaster-prone countries in the world.

Earthquakes are among the most frequent natural disasters in Indonesia (Nurrobikha *et al.*, 2021). Several major earthquakes and tsunamis have occurred in the past two decades, including those in Aceh, Padang, Palu, Lombok, and Banten, causing extensive physical destruction and loss of life. The Palu tsunami, for example, is believed to have been triggered by a seafloor landslide that generated the tsunami's force (Priadi *et al.*, 2019). Similarly, the Banten tsunami was likely caused by a seafloor

landslide resulting from the eruption of Mount Anak Krakatau (Fauzi *et al.*, 2020).

One area of particular concern is the north coast of Sumbawa Island and the Satonda waters in West Nusa Tenggara Province, which directly face the Flores Sea. According to data from the National Agency for Disaster Countermeasure (BNPB) (Adi *et al.*, 2022), the Lombok and Sumbawa regions fall within the high-risk category for natural disasters. Sumbawa Island consists of three districts—Bima, Dompu, and Sumbawa Besar—all within West Nusa Tenggara Province. It is bordered by Lombok Island to the west, Flores and Komodo Island to the east, the Flores Sea to the north, and the Indian Ocean to the south. Due to its location at the intersection of several major tectonic plates, Sumbawa Island faces multiple natural disaster risks. In addition to earthquakes and tsunamis, the island is prone to floods, extreme weather events, droughts, coastal erosion, landslides, volcanic eruptions, and extreme waves, as well as social conflicts that may impact the social resilience of communities along the north coast (StIRRR, 2016). The region has historically experienced numerous disasters, which have shaped the level of preparedness and resilience of local communities to natural disasters.

Historical research indicates that on December 12, 1992, a large earthquake and tsunami devastated the northern part of Flores Island to East Flores. The 7.8-magnitude earthquake claimed at least 2,100 lives and destroyed 18,000 houses and other vital infrastructure, with Maumere suffering the worst damage (Arif, 2021). Subsequently, the region experienced several moderate earthquakes. In July 2018, a 6.4-magnitude earthquake struck Lombok Island and its surroundings, including Sumbawa Island, though the damage was relatively minor. Following this, Sumbawa was hit by a 5.4-magnitude earthquake. More recently, on 29 April 2023, a 5.7-magnitude earthquake shook the Bima region. These earthquakes did not trigger the feared tsunami. Although the northern coastal area of Sumbawa was not the main epicentre, earthquake risks remain a concern, particularly for communities

along the north coast, as they directly face the Flores Sea and are within the earthquake zone. Natural disasters, especially earthquakes, pose a significant threat to human civilisation and warrant vigilance (Nurrobikha *et al.*, 2021).

Previous studies on the potential for earthquake and tsunami disasters have primarily focused on the waters of Lombok and Flores. Research in the coastal areas of Flores and Lombok has examined the probability of severe impact in the event of an earthquake or tsunami. The role of NTB geologists in mitigating geological disasters has also been studied (Kusnadi *et al.*, 2009). Given the region's high vulnerability to natural disasters, NTB geologists must address multiple hazards, including volcanic eruptions, earthquakes, tsunamis, landslides, and land subsidence. Additionally, research on thrust fault activity in Plampang, Sumbawa, based on earthquake analysis in 2020, identified relatively shallow active faults that pose a threat to Sumbawa Island if a high-magnitude, shallow-depth earthquake occurs in the future (Priyobudi & Ramdhan, 2021).

Given the significant threat of earthquakes and tsunamis in Sumbawa, an in-depth study on community social resilience is essential. Resilience refers to an individual's or group's ability to withstand disturbances. Social resilience is the capacity of a society to maintain stability, cohesion, and security in the face of external pressures or threats, including environmental changes caused by natural disasters. It also involves a process that enables communities to emerge stronger than before (Ghafur, 2016). When a community lacks resilience, it becomes vulnerable. Vulnerability leads to prolonged losses, affecting buildings, infrastructure, and essential facilities. Research on community social resilience is crucial as it reflects a society's ability to adapt, transform, and collaborate in response to external challenges (Maclean *et al.*, 2014; Wulandari *et al.*, 2021). Coastal communities demonstrate social resilience against earthquakes and tsunamis, reducing casualties and economic losses when disasters occur (Budianto, 2015). Furthermore,

studying social capital in the region is valuable, as it is a key dimension of national resilience.

Therefore, this study aims to measure community social resilience in facing potential natural disasters on the north coast of Sumbawa Island. The results of this study are expected to provide policy recommendations to local governments and local communities on strengthening community social resilience in facing the threat of natural disasters for communities on the north coast of Sumbawa Island.

Materials and Methods

This research employs a qualitative method to assess the social resilience of the northern coastal communities of Sumbawa Island in efforts to mitigate the risk of earthquakes and tsunamis in Flores sea waters. The research was conducted in the northern coastal area of Sumbawa Island, encompassing the Pekat, Tambora, Labuan Badas, and Satonda Island sub-districts. Data collection was collected using the following techniques (Table 1).

Informants for the interviews were selected using non-probability sampling through the snowball sampling method. They comprise both stakeholders and community members (Table 2).

Informants were selected based on their involvement in disaster mitigation efforts, their connection to the research area along the north coast of Sumbawa Island, their ability to provide relevant information on community social resilience, and the diversity of perceptions and experiences that can provide comprehensive insights into strategies and challenges in dealing with natural disasters in the region. An interview guide was prepared, with the responses recorded carefully, and the findings were documented through audio recordings, videos, and photos. The collected data were analysed using the Keck and Sakdapolrak framework, which assesses social resilience through three dimensions: Coping capacity, adaptive capacity, and transformative capacity (Keck & Sakdapolrak, 2013).

Each dimension was evaluated using specific indicators. The first dimension, coping capacity was assessed through three indicators. Rapid response refers to the community’s ability to recover quickly using available resources. Previous experience involves evaluating past disaster management experiences, particularly earthquakes. Disaster impact was examined by comparing earthquake impacts between Sumbawa and Lombok, where Lombok experienced greater destruction as the epicentre.

Table 1: Data collection techniques

No.	Data Collection Technique	Type of Data	Instrument
1	Non-participatory observation	Primary data	Observation guidelines
2	In-depth interview	Primary data	Interview guidelines
3	Documentation studies	Secondary data	

Table 2: Informant types

No.	Type of Informant: Stakeholder	Quantity	Remarks
1	Pekat Sub-district Head	1	Pekat is the sub-district furthest from the coast
2	Nangamiro Village Head	1	Nangamiro is a representation of a coastal village
3	Former Sebotok/Moyo Village Head	1	Sebotok is a representation of a coastal village
4	Satonda Island guard	2	The person who guards Satonda Island
5	People in several villages located and living along the north coast of Sumbawa Island	10	Consists of coastal residents with various professions such as teachers, nurses, students, housewives, traders, farmers, religious teachers, etc.

The second dimension, adaptive capacity, was examined through seven indicators, including risk prevention, learning from experience, preventive action, government and community response, infrastructure development, earthquake readiness, and risk awareness. The third dimension, transformative capacity was evaluated using seven indicators, including collaboration and cooperation, transformation leading to radical change, disaster mitigation priorities, post-disaster cooperation, government programmes, livelihood diversification, and coastal community attachment to the sea.

Finally, the data were systematically reduced and presented to evaluate the level of social resilience within the community as part of earthquake and tsunami mitigation efforts.

Results and Discussion

One critical aspect of national security is environmental or geographic security. An environment is considered secure when it is free from disaster risks or has the capacity to mitigate the impact of natural disasters. As one of the most disaster-prone countries globally, Indonesia must map potential natural disasters and identify high-risk areas. Based on the data collected, the findings from each data collection

method are presented in the following table (Table 3).

Disaster Risk Index in West Nusa Tenggara Province

As shown in Figure 1, the Province of West Nusa Tenggara (NTB) has established a disaster risk index for each district. The risk score calculation is based on the National Agency for Disaster Countermeasure (BNPB) Chairman’s regulation Number 2 of 2012, which considers three components: Hazard, vulnerability, and capacity. The disaster risk score is determined using the formula $\text{hazard} \times \text{vulnerability} / \text{capacity}$. Nine types of disaster are classified as hazards, including earthquakes, tsunamis, volcanic eruptions, floods, landslides, droughts, land and forest fires, extreme weather, and tidal waves or coastal abrasion. Capacity is assessed based on the region’s ability to manage these nine types of disaster. Based on data analysis conducted by BNPB and presented in the 2021 Indeks Risiko Bencana Indonesia (IRBI) report, a disaster risk score was assigned to each district and city in NTB Province, as illustrated in Figure 1. These risk assessments support efforts to minimise disaster impacts and losses while optimising disaster management strategies.

Table 3: Data collection techniques

No.	Data Collection Technique	Type of Data	Results
1	Non-participatory observation	Primary data	Observing the conditions of coastal communities and the geographical conditions of the waters along the coast of Sumbawa Island.
2	In-depth interview	Primary data	Dimensions of Community Social Resilience in Facing Disasters. In terms of coping capacity, the community’s social resilience tends to be weak because they have no experience in previous cases. In the adaptive capacity dimension, the condition is almost the same as the first dimension, where the lack of experience means that both the community and the local government do not have early prevention efforts against the impact of natural disasters. In terms of transformation capacity, local governments do not make coastal disaster management efforts a priority.
3	Documentation studies	Secondary data	Based on the documentation study, data was obtained on the disaster risk index score and risk index value for each district in NTB.

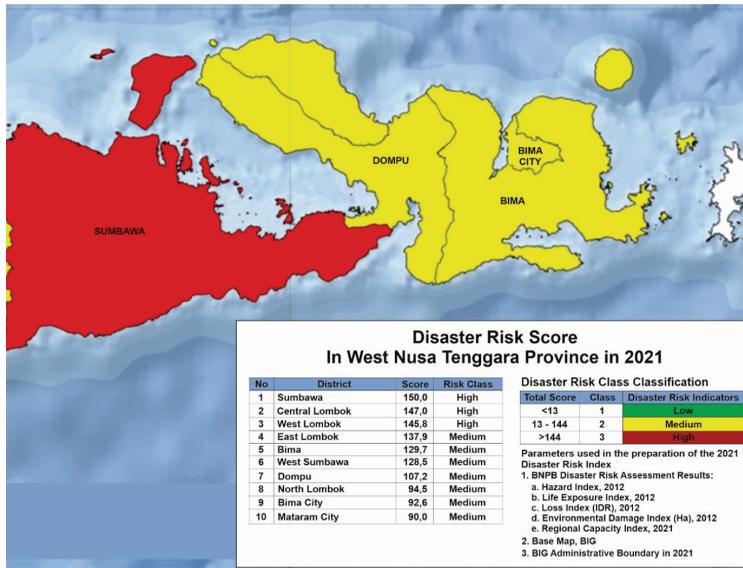


Figure 1: The disaster risk scores in NTB Province
Source: IRBI (2021)

The government is responsible for ensuring human security by protecting every citizen within the country (Indrajit, 2020). West Nusa Tenggara (NTB) Province is among the regions in Indonesia with a high level of vulnerability to natural disasters, which significantly impacts its social resilience. The province has a population of approximately 5.32 million people (BPS Provinsi NTB, 2020). According to the 2021 Indonesian Disaster Risk Index (IRBI) report published by the National Agency for Disaster

Countermeasure (BNPb), a table detailing the natural disaster risks in NTB Province from 2017 to 2021 was released (Table 4) (Adi *et al.*, 2022).

As shown in Table 4, the Sumbawa region has the highest disaster risk classification in NTB Province while Bima and Dompus are in the medium-risk category. It is essential to disseminate this information, particularly to local communities, to enhance their knowledge and preparedness for potential disasters. The

Table 4: West Nusa Tenggara Province risk index values (2017-2021)

No.	District/City	2017	2018	2019	2020	2021	Risk Class of 2021
1	Sumbawa	150.00	150.00	150.00	150.00	150.00	High
2	Central Lombok	168.28	166.12	157.08	157.08	146.99	High
3	West Lombok	205.20	181.20	161.83	161.83	145.84	High
4	East Lombok	172.76	157.06	142.75	142.75	137.88	Middle
5	Bima	139.36	137.43	129.95	129.95	129.72	Middle
6	West Sumbawa	152.40	152.40	142.30	142.30	128.53	Middle
7	Dompus	123.12	111.36	111.36	111.36	107.21	Middle
8	North Lombok	139.00	120.62	106.91	106.91	94.50	Middle
9	Bima City	104.03	94.91	89.37	89.37	92.61	Middle
10	Mataram City	96.68	96.68	88.95	88.95	90.03	Middle

Source: IRBI (2021)

major earthquake and tsunami in Aceh in 2004, as well as the Lombok tsunami in 2018, serve as critical lessons in disaster preparedness. Furthermore, the tsunami risk index specifically for the West Nusa Tenggara region is illustrated in Figure 2.

As illustrated in Figure 2, Sumbawa district has the highest tsunami disaster risk level, with an index of 150.00 for the period from 2020 to 2021. Natural disasters in Indonesia often result in significant casualties, in contrast to Japan, where disaster management measures have been more effective in minimising losses (Umar & Muksin, 2018). If an earthquake occurs in the northern region of Sumbawa Island, there is a significant risk of a tsunami threatening coastal communities, including Calabai Village, Labuan Kananga, Labuan Badas District on Moyo Island, and Medang Island. Additionally, a tsunami could severely impact the coral reef ecosystem surrounding Satonda Island.

have occurred multiple times, even when the epicentre was not located on Sumbawa Island. One of the most severe incidents was the 2018 Lombok earthquake, where tremors were felt as far as Sumbawa and Bali (Septia, 2018). While the earthquake caused only minor damage in Sumbawa due to its distance from the epicentre, Lombok experienced extensive destruction.

Interviews revealed that the community’s capacity to recover quickly from natural disasters remains limited, as they lack experience in dealing with major disasters. Many residents continue to perceive earthquakes as common natural occurrences rather than threats requiring immediate preparedness. Figure 3 illustrates a coastal area highly vulnerable to disasters, yet lacking essential disaster management infrastructure such as wave breakers. This absence highlights the community’s limited capacity to utilise available resources for disaster mitigation.

Dimensions of Community Social Resilience in Facing Disasters

(1) Coping Capacity

Coping capacity refers to a community’s ability to effectively respond to and recover from natural disasters by optimising available resources. This concept is particularly relevant in the aftermath of a disaster. Documentation of past events indicates that earthquakes

(2) Adaptive Capacity

Adaptive capacity refers to a community’s ability to mitigate major risks and anticipate potential disasters by learning from past experiences. Observations in Labuan Kananga village revealed that the community lacks structured and well-planned disaster risk prevention measures. Both local government and community responses to natural disasters



Figure 2: Tsunami disaster risk score year 2021
 Source: inarisk.bnpb.go.id (2021)



Figure 3: A coastal area without any wave breaker

remain largely reactive and informal. Notably, there are no designated temporary shelters for evacuation.

Findings from in-depth interviews further indicate that neither the local government nor the community has established early disaster prevention measures, primarily due to the absence of high-risk disasters in recent history. Many residents are unaware of earthquake-prone areas, as they have not experienced a significant earthquake for decades, leading to a diminished awareness of underlying fault lines (Umar & Muksin, 2018).

Despite this lack of preparedness, some efforts have been made in response to past incidents. For instance, in the Calabai area, high seawater waves have previously reached residential areas. Following this event, the government constructed a wave-retaining embankment. However, observations show that the embankment does not cover the entire shoreline and parts of it have already sustained damage. Figure 4 illustrates residential settlements along the shoreline, highlighting the community's social vulnerability to coastal disasters.



Figure 4: A resident's house that is only three metres from the coast

(3) *Transformative Capacity*

Transformative capacity refers to a community's ability to collaborate with government organisations, institutions, and other community groups in decision-making, collective action, and post-disaster recovery efforts. Transformation, in this context, aims not only to ensure security but also to improve overall community welfare in preparation for future risks (Hidayah *et al.*, 2017).

Consistent with previous findings, observations and interviews indicate that local governments do not prioritise disaster mitigation efforts, primarily because the community has not directly experienced high-risk natural disasters. Residents also acknowledge that collaboration in developing post-disaster rescue measures is minimal.

The Regional Disaster Management Agency (BPBD), Search and Rescue (SAR), and other relevant agencies were involved in recovery efforts following the 2018 Lombok earthquake. Some government initiatives such as the construction of embankments to prevent high waves from entering residential areas have been implemented. However, observations reveal that

in several locations, these embankments have cracked or even collapsed due to the impact of sea waves.

Despite many coastal communities residing near the shore, fishing is not their primary livelihood. Field research indicates that approximately 80% of coastal residents are engaged in the plantation sector, cultivating crops such as corn, sesame, and coconut. The plantation sector is generally more profitable than fisheries, as fertile land extends into the hills, supporting corn cultivation, and the ease of selling agricultural produce to local collectors enhances economic viability. The dominance of agricultural livelihoods among coastal communities is illustrated in Figure 5.

Instead of utilising Satonda's tourism potential, Calabai waters are more often used as a means of transportation between islands, especially from Moyo and Medang Island, to transport agricultural products such as corn, coconut, sesame seeds, cashew nuts, and others. This situation reflects a weak connection between coastal communities and the sea, both in terms of resource exploration and



Figure 5: The plantation sector remains the primary livelihood activity of coastal communities on Sumbawa Island

awareness of potential disasters. While coastal communities recognise natural signs of possible disasters such as earthquakes and tsunamis, their engagement with disaster preparedness remains limited.

Analysis of Social Resilience in the North Coastal Communities of Sumbawa Island

Social resilience is essential for communities to overcome various challenges, including the potential threats of earthquakes and tsunamis. The government's role in implementing policies, strategies, and programmes for social resilience is crucial, as it serves as one of the pillars of state development. The quality of social resilience in a community can be assessed through social relationships, community empowerment, social security, and the enhancement of capital or other potential resource.

Based on Keck and Sakdapolrak's (2013) Social Resilience theory, which includes coping capacity, adaptive capacity, and transformative capacity, the social resilience index of the northern coastal communities of Sumbawa Island falls into a less resilient category. This weak resilience is linked to the community's limited ability to face natural disasters, which may occur at any time. Additionally, weak social networks, institutional structures, and power relations further contribute to the low level of resilience in the region.

From a knowledge perspective, the northern coastal communities of Sumbawa Island are aware of disaster mitigation efforts. However, their coping, adaptive, and transformative capacities have yet to be effectively implemented.

Conclusions

Based on the results of data analysis and processing, it can be stated that the social resilience of the northern coastal communities of Sumbawa Island is less than resilient or experiencing vulnerability. The three aspects, namely coping, adaptive, and transformative capacity, demonstrate the communities' unpreparedness for potential natural disasters,

particularly earthquakes and tsunamis. The northern coastal communities of Sumbawa Island lack adequate coping capacity due to limited experience, resulting in a low ability to manage impacts effectively. Their adaptive capacity is also suboptimal, as evidenced by the absence of structured risk prevention measures and evacuation plans. Furthermore, the transformative capacity of the community is weak, shown by minimal collaboration with the government and related institutions in decision-making and collective disaster mitigation efforts, which hinders progress towards improving community welfare in the face of future risks. This unpreparedness stems from a lack of government attention to education, insufficient earthquake-resistant infrastructure, and inadequate community outreach.

Policy recommendations are needed to strengthen the social resilience of coastal communities so that they can improve natural disaster mitigation efforts. Stakeholders at the Dompu and Sumbawa Besar district levels must continue programmes that focus on mitigating natural disasters on the north coast of Sumbawa Island. This mitigation effort consists of three main aspects: Preparedness, awareness, and disaster management planning. Disaster preparedness is carried out by mapping existing resources, building earthquake-resistant infrastructure, and building settlements far from tsunami red zones. Then, public awareness efforts are needed so that people are mentally prepared for potential disasters that could occur at any time. Public awareness campaigns must ensure that residents remain vigilant, even if major disasters have not yet occurred in the area. Regular outreach initiatives and disaster simulations should be conducted before, during, and after natural disasters.

Additionally, local governments must establish supporting infrastructure such as earthquake detection systems, early tsunami warning mechanisms, and clearly designated evacuation routes and shelters. Collaboration between regional governments, communities, and the private sector is crucial in developing

a structured and effective disaster management framework.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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