

Non-Structural Mitigation for Earthquake and Tsunami Risks in Pandeglang Regency

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Abstract— Indonesia, located at the convergence of several tectonic plates, including the Indo-Australian, Eurasian, Pacific, and Philippine plates, is widely known as a "disaster laboratory" due to its susceptibility to a wide range of hazards. One significant threat is the risk of earthquakes and tsunamis in the Pandeglang Regency, situated in the southwestern region of Java Island. To minimize the devastating impacts of these disasters, a collaborative effort between the community and local government is absolutely crucial in implementing non-structural mitigation measures. These measures are aimed at decisively reducing disaster risks and mitigating the potential damage and losses associated with earthquakes and tsunamis.

Keywords— Non-Structural Mitigation; Earthquake and Tsunami Risks; Pandeglang Regency.

I. INTRODUCTION

The path of these tectonic plates through the Indonesian archipelago is commonly known as the "Ring of Fire," which makes the islands in its vicinity susceptible to natural disasters. Java Island is one of the areas affected by the Ring of Fire. As a result, the Pandeglang Regency, located in the southwest part of Java Island, faces a significant threat from the Earthquake and Tsunami, especially in areas near the coastline.

Natural phenomena can be assessed as disasters resulting from geological changes, geographical conditions, and geophysical movements on the earth that cannot be prevented by humans and cause damage and even loss. This natural event cannot be tolerated by the human ability to deal with these natural changes. Disaster management as one of the human responses in facing changes in natural events is needed to minimize the damage and losses caused. Earthquakes and tsunamis often occur on the island of Java. One of the major events that occurred was the earthquake and tsunami in Pandeglang Regency which occurred in 2018. The earthquake that occurred in Pandeglang in 2018 was caused by the volcanic eruption of Mount Krakatau which resulted in a tsunami. In 2022, another large earthquake occurred in Sumur District, Pandeglang Regency with a magnitude of 6.7, followed by various aftershocks in the area.

The potential for earthquake disasters in Pandeglang can be understood through various historical records and events related to the occurrence of earthquakes and tsunamis in the area. Tsunami disasters often accompany earthquakes, leading to significant damage and loss, including human casualties, infrastructure damage, and psychological trauma. Reducing disaster risk requires the readiness of the community and local government to face the threat of future disasters, which are likely to occur again in the same area due to the recurring nature of natural disasters.

In disaster management, there are two types of mitigation: structural and non-structural. Structural mitigation involves physical developments such as buildings, while non-structural mitigation involves efforts to enhance disaster resilience from various aspects, including social, educational, and community-based activities. Community readiness in facing the threat of danger can be achieved through non-structural mitigation activities, which are crucial for increasing the capacity of communities to handle disaster threats (Wibowo et al., 2019).

II. RESEARCH METHODS

The research method used emphasizes non-structural mitigation planning methods for earthquake and tsunami disasters. The approach used is through a qualitative approach with literature studies and interviews as well as collecting secondary data through questions and answers at the Regional Disaster Management Agency (BPBD) of Pandeglang Regency. Literature studies were used to examine the historical areas vulnerable to earthquakes and tsunamis, while interviews were conducted to gather information about non-structural mitigation efforts implemented in the field. The scheme for carrying out this research is shown as follows:

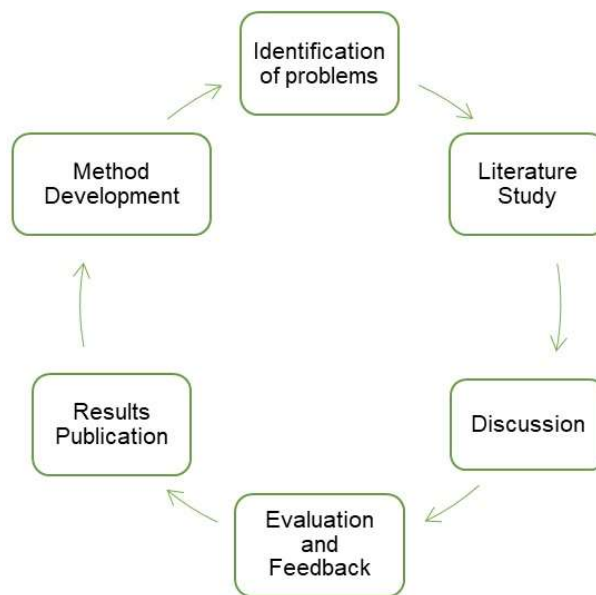


Fig 1. Research implementation scheme

III. RESULT AND DISCUSSION

Pandeglang Regency, located in Banten Province, has a history of earthquake disasters dating back to 1821-2019 and tsunamis from 416-2018. The potential for earthquakes and tsunamis in Pandeglang Regency is closely linked to the history of disasters in Banten Province. Potential sources of the Pandeglang earthquake and tsunami include:

1. M8.7 megathrust zone: Prone to earthquake and tsunami.
2. Mentawai, Semangko, and Ujungkulon Fault Zones: Prone to earthquake and tsunami.
3. Sunda Strait Graben Zone: Prone to seabed landslides.
4. Mount Anak Krakatau: Prone to volcanic eruption and tsunami.

The active fault studies involved the use of geological, geophysical, and geodetic observation methods, as well as a comprehensive earthquake catalog (Irsyam et al., 2020). The shakemap for the Pandeglang region, depicting an M8.7 earthquake scenario in the megathrust zone south of the Sunda Strait, can be summarized as follows:

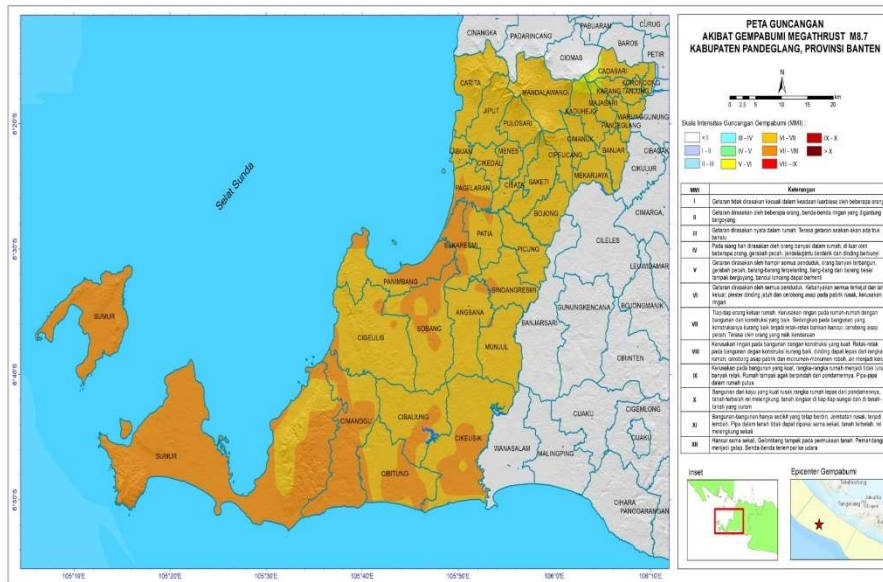


Fig 2. Shakemap of the Pandeglang region showing the impact of an M8.7 earthquake in the megathrust zone south of the Sunda Strait

Areas in southern Java that have potential sources of large earthquakes not only have the potential for strong earthquakes but also for tsunamis. In the worst-case scenario, these predicted earthquake zones may rupture individually or together. If a scenario with an earthquake model of the Sunda Strait subduction zone M8.7 occurs, the impact of shaking in Pandeglang could reach the MMI intensity scale of VII-VIII, resulting in moderate to severe damage. 10 sub-districts in Pandeglang Regency could potentially be affected by the tsunami.

1. Carita District
2. Labuan District
3. Pagelaran District
4. Sukaresmi District
5. Panimbang District
6. Cigeulis District
7. Sumur District
8. Cimanggu District
9. Cibitung District
10. Cikeusik District

Meanwhile, the danger zone for a potential tsunami in the Pandeglang Regency, caused by an M8.7 megathrust earthquake scenario, is illustrated in the image below.

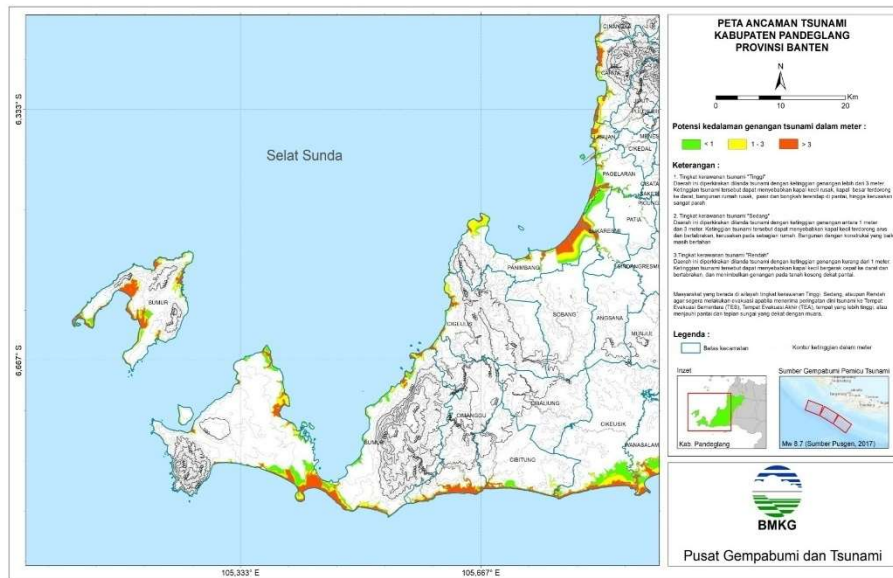


Fig 3. Pandeglang Regency is in a tsunami danger zone, particularly in the scenario of an M8.7 megathrust earthquake

To address the potential danger of a megathrust earthquake and tsunami in Pandeglang Regency, it is crucial to implement both structural and non-structural mitigation methods. This discussion will focus on the non-structural mitigation methods while also emphasizing the importance of implementing structural mitigation. Non-structural interventions are being implemented to minimize the risks and consequences of earthquake and tsunami disasters in Pandeglang Regency. These interventions encompass the following activities:

1. Disaster education involves raising awareness and increasing knowledge about actions to take when a disaster occurs.

Various disaster preparedness programs are implemented to enhance community resilience in dealing with disasters. The following are a few activities carried out in Pandeglang Regency:

- The Pandeglang Regency BPBD conducted Socialization and Disaster Mitigation Counseling to educate Subdistrict and Village Officials on Prevention and Preparedness for disasters. They also provided outreach activities to Disaster Preparedness Village volunteers to enhance their resilience in facing disasters (Padlani, 2024).
- The Ministry of Social Affairs conducts Disaster Simulation for Disaster Preparedness Cadets (Tagana) and disaster evacuation training for community representatives in high-risk villages. The National Disaster Management Agency (BNPB) also provides disaster training for all regencies/cities within Banten Province to test the implementation of disaster contingency plans. This includes Pandeglang Regency and aims to assess the effectiveness of the community and local government in carrying out their respective duties (BNPB, 2019).
- The Pandeglang Regency Government has taken steps to establish Disaster Resilient Schools (STB) and has recommended the inclusion of disaster-related material in the school curriculum. This is especially important for schools located in disaster-prone areas, such as those near the coast in Pandeglang Regency (Yuningsih et al., 2022). The material taught to students as STB practitioners is the Disaster Safe Education Unit (SPAB), as outlined in the Minister of Education and Culture Regulation number 33 of 2019 concerning the Implementation of the SPAB Program.
- Community empowerment takes the form of Disaster Preparedness Villages (KSB), which aim to strengthen the capacity of communities to serve as mobilizers for public awareness of disasters. KSB is expected to be vigilant in assisting local governments with disaster mitigation efforts in their respective areas (diskomsantik.pandeglangkab.go.id, 2023).

2. Building Policies and Regulations

Based on (Coburn et al., 1994), disasters are inevitable, but their impact can be reduced through the implementation of risk mitigation policies. While this may require significant investment, it is a crucial step towards safeguarding our communities

and minimizing the devastating consequences of disasters (Putera, R., E., 2017). However, to ensure successful disaster mitigation in this policy area, local governments can regulate various activities related to reducing the threat of disasters.

- The preparation of Pandeglang Regency Regional Regulations includes Banten Province Regional Regulation number 2 of 2011, which was replaced by Banten Province Regional Regulation number 5 of 2017 concerning Banten Province Regional Spatial Planning for 2010-2030.
- The development of building structure policy standards includes, among other things, following the rules of SNI 1726:2019 Procedures for earthquake resistance planning for building and non-building structures. Therefore, the construction of office buildings, residences, and every building located in earthquake-prone areas is starting to be monitored to ensure that it follows the composition of earthquake-resistant building components.
- The Disaster Risk Assessment Document (KRB) is prepared to assess the capacity and research areas with high vulnerability. This helps to map out which areas need further improvement in all villages and sub-districts in Pandeglang Regency. The KRB document for 2014-2018 will serve as the basis for preparing a 5-year Disaster Management Plan (RPB) for the local government. It is important to update the KRB every 5 years to ensure its relevance.
- The Disaster Management Plan (RPB) prepared by the Banten Provincial Government under Banten Governor Regulation Number 8 of 2023 for the period 2023-2027 is a key part of the regulations for Pandeglang Regency. Additionally, the Pandeglang Regency Regional Government has developed a Disaster Emergency Management Plan (RPKB) in accordance with Pandeglang Regent Regulation Number 17 of 2021. Other important documents prepared in Pandeglang Regency include the Earthquake Disaster Contingency Plan Document (Renkon) in Tamanjaya Village, Sumur District, in collaboration with the Indonesian Scale Foundation in 2023, and the Tsunami Disaster Renkon in Labuan District in 2019, which requires immediate updating (Fachreinsyah, 2023).
- The coordination between disaster response entities is facilitated by the Regional Disaster Management (PDB) task force, which operates through the Pandeglang Regency Regional Leadership Communication Forum (Forkopimda). This forum consists of the Regent, members of the DPRD, Dandim, Danrem, Police Chief, Religious Court, District Court, and other technical heads of the Regional Work Unit (SKPD).

3. Leveraging Technology and Information for Effective Disaster Risk Reduction

Technology is essential for the efficient dissemination of information about disasters to the local government and its residents. With equipment that provides quick and accurate warnings, the risk of damage and casualties due to disasters can be reduced.

- The BMKG has installed an alert system at various locations along the Pandeglang coast as part of the government's efforts to provide information to the public. In addition, the local government conveys daily and weekly weather warnings from BMKG to communities in coastal and disaster-prone areas. It is important for the community to be able to respond quickly to these early warnings. Therefore, training in disaster emergency response simulations is also essential (Antara News, 2019).
- The people in Pandeglang Regency are being trained to use the inaRisk application created by BNPB. This mobile system application helps them become familiar with disaster response procedures and can be easily used in areas prone to disasters.
- Utilizing social media through the Instagram application via (<https://www.instagram.com/bpbd.pandeglang/>), twitter X (https://twitter.com/Pandeglang_BPBD), facebook BPBD (https://web.facebook.com/bpbd.pandeglang.1/?_rdc=1&_rdr) and the Pandeglang Regency Regional Government website (<https://pandeglangkab.go.id>) has also been implemented to disseminate various important information related to disasters. The next stage which is also important is program monitoring, evaluation, and updating tactics in using social media communications (Yunia et al., 2020).
- Creating a map of disaster-prone areas based on the Pandeglang Regency Disaster Risk Study for 2014-2018 and the Banten Province Disaster Risk Study for 2022-2026. This map will be used for socialization, counseling, and identifying areas vulnerable to earthquake and tsunami disasters (BNPB, 2024).

IV. CONCLUSION

The research findings indicate that various activities aimed at reducing disaster risk through non-structural disaster mitigation have been carried out comprehensively and are interconnected among different disaster actors. However, certain supporting components, such as the KRB Document, have not been regularly updated every 5 years. The latest document was created for the 2014-2018 period, and the RPKB was prepared in 2021, valid for at least 5 years or until a disaster occurs.

As we know, in 2022, a large-scale earthquake with a magnitude of 6.6 struck Sumur Pandeglang Regency, resulting in numerous displaced victims and damaged houses. However, preparing documents such as KRB and RPKB involves significant costs, posing a challenge for the Pandeglang Regency Regional Government to implement necessary policies.

The Renkon Document for the Earthquake and Tsunami Disaster in the entire Pandeglang Regency area has reached the final stage of document validation. This means we now have the most updated data to use as the basis for decision-making in development activities and the implementation of non-structural disaster mitigation management in Pandeglang Regency.

The collaboration between local government and communities outside of the government is crucial. Therefore, NGOs, communities, civil society organizations, religious leaders, higher education and educational institutions, volunteers, entrepreneurs in the private sector, media, and other sectors can actively participate in developing non-structural mitigation activities and implementing innovative approaches to enhance disaster risk reduction efforts.

REFERENCES

- [1] Wibowo, Y. A., Ronggowulan, L., Arif, D. A., Afrizal, R., Anwar, Y., & Fathonah, A. (2019). Perencanaan Mitigasi Bencana Banjir Non-Struktural Di Daerah Aliran Sungai Comal Hilir, Jawa Tengah. *JPIG (Jurnal Pendidikan Dan Ilmu Geografi)*, 4(2), 87–100. <https://doi.org/10.21067/JPIG.V4I2.3632>.
- [2] Irsyam, M., Cummins, P. R., Asrurifak, M., Faizal, L., Natawidjaja, D. H., Widiyantoro, S., Meilano, I., Triyoso, W., Rudiyanto, A., Hidayati, S., Ridwan, M., Hanifa, N. R., & Syahbana, A. J. (2020). Development of the 2017 national seismic hazard maps of Indonesia. *Earthquake Spectra*. <https://doi.org/10.1177/8755293020951206>.
- [3] Padlani. (2024). Pemerintah Kabupaten Pandeglang Lakukan Pelatihan Simulasi Evakuasi Bencana di Desa Caringin. <https://lebak.indonesiasatu.co.id/pemerintah-kabupaten-pandeglang-lakukan-pelatihan-simulasi-evakuasi-bencana-di-desa-caringin>. Accessed on 16 Mei 2024 at 21.36 WIB.
- [4] BNPB. (2019). Latihan Simulasi Evakuasi Mandiri di Labuhan. <https://bnpb.go.id/berita/latihan-simulasi-evakuasi-mandiri-di-labuhan>. Accessed on 16 Mei 2024 at 21.39 WIB.
- [5] Yuningsih, Y., Legiani, W. H., & Bahrudin, F. A. (2022). Peran Pemerintah Kabupaten Pandeglang dalam Edukasi Mitigasi Bencana Tsunami di Sekolah Pesisir Pantai Pandeglang - Banten. *Jurnal Ilmiah Universitas Batanghari Jambi*, 22(3), 1876. <https://doi.org/10.33087/jiubj.v22i3.2726>.
- [6] Diskomsantik.pandeglangkab.go.id. (2023). 12 Tahun Usia, KSB Semakin Tangguh Sebagai Relawan Bencana. <https://diskomsantik.pandeglangkab.go.id/2023/08/01/12-tahun-usia-ksb-semakin-tangguh-sebagai-relawan-bencana/>. Accessed on 17 Mei 2024 at 0.42 WIB.
- [7] Coburn, A. ., Spence, R. J. ., & Pomonis, A. (1994). Mitigasi bencana II. Program Pelatihan Manajemen Bencana. Program Pelatihan Manajemen Bencana. UNDP.,” Cambrid Architectural Research Limited.United Kingdom.
- [8] Roni Ekha Putera. (2022). Mitigasi Pengurangan Risiko Bencana Gempa Bumi dari Perspektif Implementasi Kebijakan. Zenodo. <https://doi.org/10.5281/zenodo.6397661>.
- [9] Fachreinsyah, (2023). Penyusunan Draf Rencana Kontingensi Bencana di Pandeglang Masuki Tahap Akhir. <https://rri.co.id/index.php/daerah/308689/penyusunan-draf-rencana-kontingensi-bencana-di-pandeglang-masuki-tahap-akhir>. Accessed on 17 Mei 2024 at 2.59 WIB.
- [10] Antara News. (2019). Sistem peringatan dini dipasang BMKG di pesisir Pandeglang-Banten. <https://www.antaraneews.com/berita/794766/sistem-peringatan-dini-dipasang-bmkg-di-pesisir-pandeglang-banten>. Accessed on 17 Mei 2024 at 2.04 WIB.

- [11] Yunia, A., Pinariya, J. M., Forceila, D., & Ivana, L. (2020). Program Berbasis Masyarakat dalam Upaya Pengurangan Risiko Bencana di Kabupaten Pandeglang. *Communicare: Journal of Communication Studies*, 7(2), 172. <https://doi.org/10.37535/101007220205>.
- [12] BNPB. (2024). Dokumen Kajian Risiko Bencana Kabupaten Pandeglang 2014-2018. https://inarisk.bnpb.go.id/pdf/Banten/Dokumen%20KRB%20Pandeglang_final%20draft.pdf. Accessed on 17 Mei 2024 at 1.35 WIB.