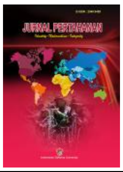

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Disaster Risk Reduction Efforts through Flood Hazard and Resilience Assessment in the Coastal Area of Pasuruan, East Java

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Abstract

Coastal areas play a strategic role in the economy, ecosystems, and habitats of high socio-cultural value. However, coastal areas also face serious dangers from natural disasters, such as floods. Flood events often disrupt community activities, make roads impassable, displace residents, damage infrastructure, and negatively impact the social and economic well-being of communities, cause property losses, and, in severe cases, loss of life. Addressing these issues requires effective strategies for coastal area management. This paper presents an analysis of the level of hazard and resilience of coastal areas to flood hazards. This study was conducted in the coastal area of Pasuruan, which frequently experiences seasonal flooding. The indicators used to analyze flood hazard and regional resilience are based on regulations established by relevant authorities and findings from previous related studies. Several parameters were measured, including flood-inundation height, frequency of occurrence, and rainfall intensity (both high and low). Meanwhile, regional resilience was assessed using several indicators, including disaster risk management (DRM) policies and institutions, preparation of disaster risk assessments and documentation, development of early warning systems, mitigation efforts, and disaster education programs. The results revealed that flood hazard in the Pasuruan coastal area ranges from moderate to high, with four areas classified as high risk and three as moderate. Conversely, the resilience level of all areas is categorized as moderate. Furthermore, the findings of this study are expected to be taken into consideration in policymaking for coastal area management, particularly in reducing flood disaster risk.

INTRODUCTION

Coastal areas play a strategic role in economic, environmental, social, and geopolitical aspects. Economically, these areas serve as centers for fisheries, tourism, trade through major ports, and contribute to national food security. However, coastal areas face significant challenges related to disaster risks, such as rising sea levels, which often cause tidal flooding. Flooding often disrupts community activities, makes roads impassable, displaces residents, damages infrastructure, and impacts the social and economic well-being of communities. These disasters also result in property losses and, in severe cases, loss of life (Allaire, 2018; Bubeck et al., 2017; Hammond et al., 2015; Pregnolato et al., 2017).

The coastal area of Pasuruan is one of the areas facing this challenge. Flooding occurs almost every year in several areas of Pasuruan. Data shows that climate change, characterized by prolonged heavy rainfall, often causes flooding in the region. For example, in 2021, reports indicated that flooding inundated 80 homes with water levels ranging from 10 to 95 cm, forcing some residents to evacuate their homes. Furthermore, 6,379 families in the Pasuruan area were reportedly affected by flooding (Faruq, 2021). In 2022, flooding affected more than 7,000 residents (M, 2022). Research on the vulnerability/potential losses in the Pasuruan coastal area due to flooding was also conducted. Noverma et al. (2024) highlight the vulnerability/potential losses in social, economic, physical, and environmental aspects. Based on the social aspect, measurement indicators include population density, age ratio, sex ratio, and poverty ratio. The results of the study Emil (2021) show that 6 out of 7 coastal villages are in the moderate to high vulnerability category. Then, using potential for economic losses/vulnerability as measured by indicators such as regional income and productive land area, the results of the study show a low to high classification. Based on physical vulnerability and potential physical losses, as measured by indicators such as building density and the number of public facilities, the results of the study reveal that the potential losses experienced are classified in moderate to high. Furthermore, based on environmental vulnerability, the Pasuruan coastal area is classified in low, with assessment indicators related to the availability of mangrove forests, shrubs, and swamps.

Figure 1 shows the coastal area of Pasuruan, which consists of seven zones: Tambaan Village, Gadingrejo Village, Ngemplakrejo Village, Panggungrejo Village, Mandaranrejo Village, Kepel Village, and Blandongan Village. These areas directly border the Java Sea, making them more vulnerable to sea level rise than other areas. Furthermore, the Pasuruan coastal area is crucial for the region's economic activities.

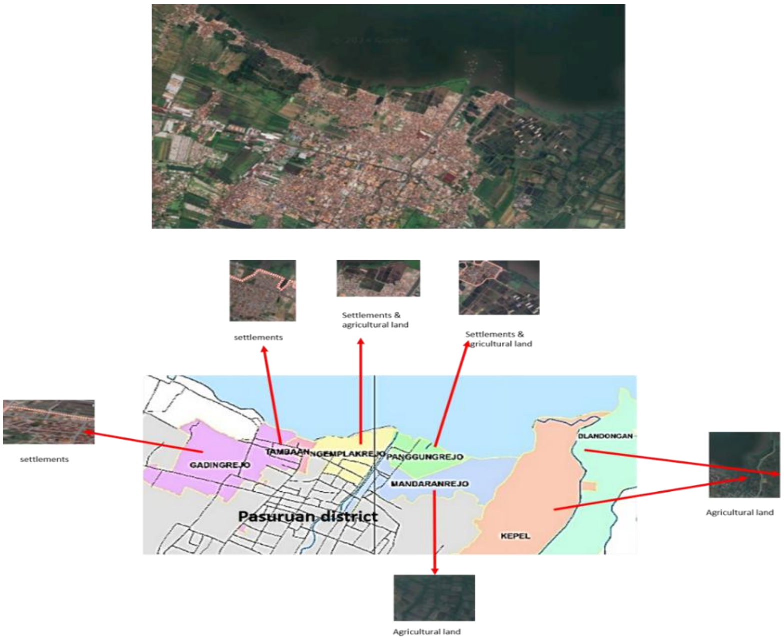

Figure 1. Map of the Pasuruan coastal area (Pasuruan - Google Maps, 2023)

Given the history and impact of flood disasters and the importance of the Pasuruan coastal area in supporting economic activities, analyzing flood hazard levels is an important initial step in disaster risk reduction efforts. This analysis can also form the basis for effective spatial planning and disaster management strategies. The purpose of this study is to assess and map the potential flood hazard into low, medium, and high classifications across the Pasuruan coastal area based on its zonation. Furthermore, this study aims to evaluate the resilience strategies currently implemented in coastal areas. Like threats, resilience is also closely related to disaster risk. The level of disaster risk will depend heavily on the hazard and the area's resilience. According to the BNPB regulation on General Guidelines for Disaster Risk Assessment, in general, the magnitude of disaster risk is directly proportional to the level of hazard and vulnerability/potential loss, and inversely proportional to the area's resilience or capacity.

This research seeks to provide practical, science-based recommendations for sustainable coastal management. Effective spatial planning requires careful consideration of disaster risks to reduce potential losses and support long-term development goals. Identifying flood hazard zones enables planners and decision-makers to develop more effective and strategic land-use policies. For example, planners can designate areas with high flood potential as restricted development zones or allocate them for land uses that help reduce flood impacts, such as green open spaces and water catchment areas. This research methodology uses a quantitative, descriptive approach, complemented by spatial visualization in ArcGIS. The indicators used to measure flood hazard and regional resilience are based on regulations established by authorized agencies and relevant previous (Clark-Ginsberg et al., 2020; Giardino et al., 2018; Gornitz, 1991; Latief et al., 2018; Mukhopadhyay et al., 2012a; Murshed et al., 2022; Peraturan Kepala Badan Nasional Penanggulangan Bencana No 02 Tahun 2012 tentang Pedoman Umum Pengkajian Risiko Bencana, 2012; Tariq et al., 2021; Zander et al., 2023).

Previous studies have emphasized disaster hazards and the importance of coastal resilience, measured using various approaches. For example, a study by Latief et al. (2018) highlighted flood hazards based on oceanographic parameters. Similarly, Murshed et al. (2022) developed a geospatial framework for assessing coastal disaster hazards by integrating environmental and anthropogenic parameters; this framework informs the selection of both physical and socio-economic variables in the present study. Another study by Utami et al. (2024) conducted disaster hazard mapping based on disaster characteristics, using hydrological and topographical analyses of the region with HEC-RAS software. Meanwhile, Wakhidatus et al. (2021) highlighted disaster hazards using Geographic Information System (GIS) methods with indicators of rainfall, land cover, regional topography, and flood history. These indicators are directly applied in this study's GIS-based hazard analysis to ensure comparability with established approaches. Research on coastal resilience has also been widely conducted. Yoon et al. (2016) measured community resilience to disasters by considering social, economic, environmental, and institutional factors. Tariq et al. (2021) reviewed the features and characteristics of community resilience measurements tailored to stakeholder needs and identified six dimensions of resilience: Physical, Health, Economic, Environmental, Social, and Governance. This classification is adopted in this study to provide a comprehensive resilience profile for the coastal area of Pasuruan.

This study contributes to the development of science by providing a detailed analysis of flood hazards in the Pasuruan coastal area and by integrating disaster hazards with regional resilience to produce a comprehensive risk profile. This integration supports evidence-based disaster risk reduction strategies and informs local policy-making for sustainable coastal management. In the context of disaster management, a threat is defined as an event that can cause a disaster and result in damage and loss. In contrast, regional resilience/capacity to disasters is defined as the level of a region's ability to respond to disasters or take action to reduce disaster risk. This means that regional resilience plays a crucial role in reducing disaster risk. Based on Law of the Republic of Indonesia Number 24 of 2007 concerning Disaster Management, measurements were made of parameters that could potentially cause flooding, including average annual rainfall, flood history, and inundation height. These variables were selected for specific reasons. Rainfall, for example, was chosen because high and prolonged rainfall has the potential to increase the risk of flooding in an area. The event history variable was included on the assumption that floods tend to recur in the same location; therefore, if an area has experienced frequent flooding in the past, it is more likely to flood again. Meanwhile, the inundation height variable was chosen because higher flood levels in an area are estimated to result in greater potential losses for the affected community. Furthermore, an evaluation of the resilience strategies implemented was conducted. The urgency of this research lies in the need to identify potential flood hazards in the Pasuruan coastal area and analyze the optimization of resilience strategies implemented to address annual flooding.

METHODS

Guided by laws and regulations on disaster risk assessment, as well as various relevant studies (Giardino et al., 2018; Klein et al., 2003; Latief et al., 2018; Tariq et al., 2021; Utami et al., 2024; Wakhidatus et al., 2021; Yoon et al., 2016). Flood hazard analysis is carried out by first scoring the parameters, then grouping the hazard levels into low, medium, and high. Table 1 shows some of the parameters measured for flood hazard, including flood-inundation height, occurrence frequency, and high- and low-rainfall events. Table 2 presents the indicators used to measure regional resilience levels, including Disaster Risk Management (DRR) regulations and institutions, preparation of disaster risk studies and documents, development of early warning systems, mitigation efforts, and disaster education. Furthermore, the analysis assigns a score (1–3) to each answer, as shown in Table 3. To obtain accurate results, the study was conducted through in-depth interviews with relevant parties, including stakeholders and the community.

Table 1. Parameters for Flood Hazard Level Analysis
(Peraturan Kepala Badan Nasional Penanggulangan Bencana No. 02 Tahun 2012 tentang Pedoman Umum Pengkajian Risiko Bencana, 2012)

No	Parameters	Classification of Hazard Categories			Weight
		Low (1)	Moderate (2)	High (3)	
1	Flood inundation height	<50 cm	50–150 cm	> 150 cm	35%
2	Frequency of occurrence	< 5x	5x-10x	> 10x	30%
3	High and low rainfall	<100 mm/year	100-300 mm/year	>300 mm/year	35%

Table 2. Indicators for Measuring Regional Resilience Levels
(Peraturan Kepala Badan Nasional Penanggulangan Bencana No. 02 Tahun 2012 tentang Pedoman Umum Pengkajian Risiko Bencana, 2012)

No	Indicators	Weight	Indicators and Scores for Assessment
1	Disaster Risk Reduction (DRR) regulations and institutions	20 %	- If there are no regulations within the Disaster Risk Reduction (PRB) framework = 1 (low) - There is a draft policy = 2 (moderate) - Rules and policies have been established = 3 (high)
2	Preparation of disaster risk assessment and documentation	20 %	- Not yet available = 1 (low) - Available, but in draft form= 2 (moderate) - Has been implemented = 3 (high)
3	Development of a disaster early warning system	20 %	- Not yet available = 1 (low) - There are plans for the development of an EWS (Early Warning System) = 2 (moderate) - EWS is now available and operational = 3 (high)
4	Mitigation/prevention development	20 %	- There are plans to implement mitigation efforts = 1 (low) - Mitigation efforts have begun = 2 (moderate)

5	Disaster education and training	20 %	- Mitigation efforts have been very effective = 3 (high) - Never been done = 1 (low) - It has been done before = 2 (moderate) - Done regularly at certain intervals = 3 (high)

Table 3. Classification of Flood Hazard and Resilience Assessment

Score Range	Hazard Classification
1.00-1.66	Low (Green)
1.67-2.32	Moderate (yellow)
2.33-3.00	High (red)

RESULTS AND DISCUSSION

Flood hazard

The parameters in the potential hazard analysis include rainfall data, processed in Figure 2, inundation depth data, and flood frequency in the Pasuruan coastal area in Figure 3.

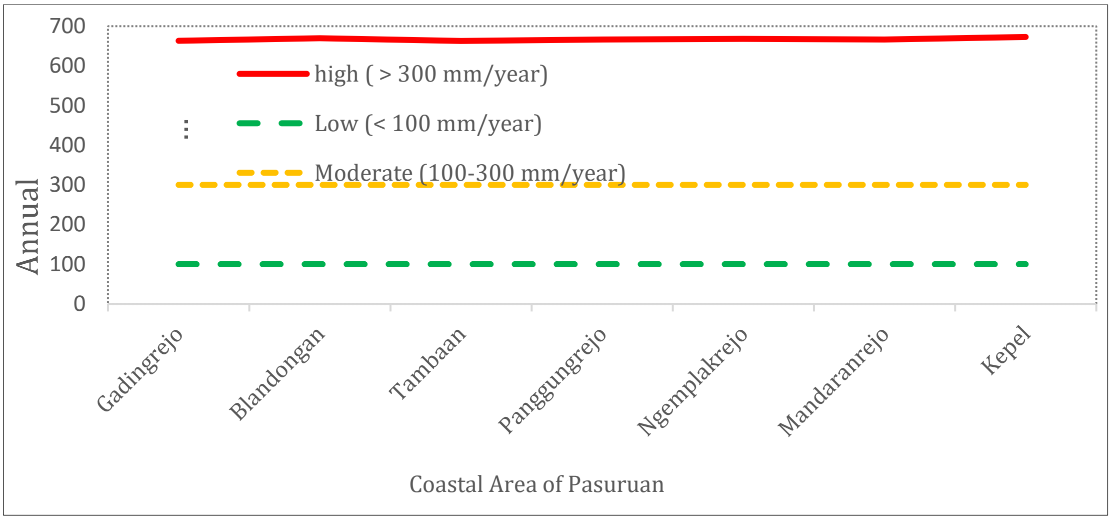

Figure 2. Annual rainfall (mm/year) in the coastal area of Pasuruan (2021-2023)(For Medium-Range Weather Forecasts (ECMWF), 2023)

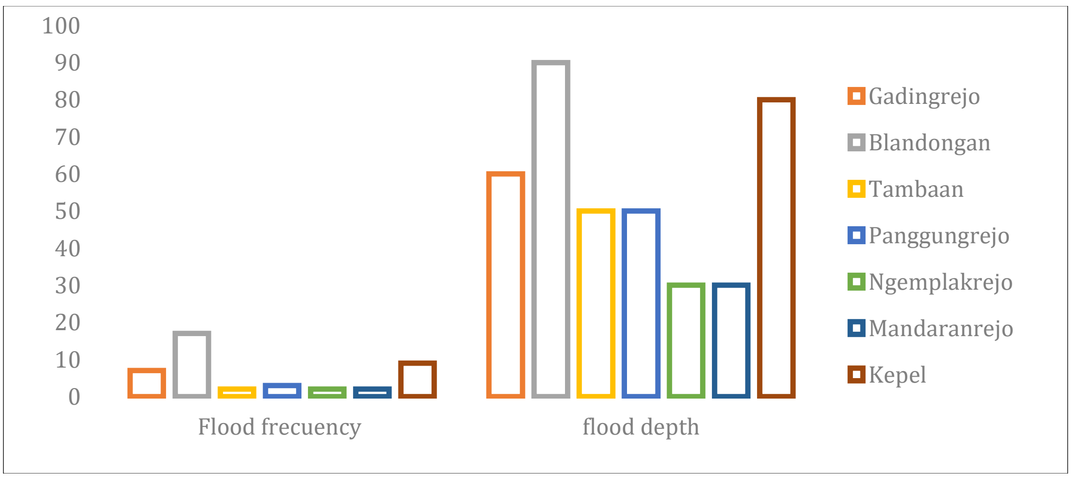

Figure 3. Flood Depth and Frequency in the Pasuruan Coastal Area (2021–2023) (Pasuruan, 2023)

High-intensity and frequent rainfall can lead to waterlogging, which, in turn, can cause flooding (Giardino et al., 2018; Klein et al., 2003; Latief et al., 2018; Mukhopadhyay et al., 2012b; Murshed et al., 2022; Tariq et al., 2021; Yoon et al., 2016). Often, more severe flooding leads to greater damage and losses while disrupting the daily activities of affected communities (Allaire, 2018; Bubeck et al., 2017; Hammond et al., 2015; Pregnolato et al., 2017). The coastal area of Pasuruan consists of residential settlements and productive land that support local livelihoods. The area has a population density of approximately 58,462 people/km^2 and contains around 1,228 hectares of productive land, including rice fields, dry fields, and fish ponds. Flood records from 2020 to 2023 show that flooding has repeatedly affected coastal communities in the area and has disrupted the use of productive land (BPS Kota Pasuruan, 2025). Given these conditions, understanding the level of flood hazard is important for supporting disaster management and mitigation efforts in the Pasuruan coastal area. Table 4 presents the flood hazard classification for each coastal zone, Figure 4 shows the R-matrix used in determining the hazard categories, and Figure 5 illustrates the spatial distribution of flood hazard levels across the study area.

Table 4. Results of the assessment of coastal flood hazard levels in the Pasuruan Coastal (Processed by Author, 2023)

No	Pasuruan coastal area	Annual Rainfall (1-3)	Flood Depth (1-3)	Flood Frequency (1-3)	Mean Score	Hazard classification
1	Gadingrejo	3	2	2	2.34	High (red)
2	Blandongan	3	2	3	2.67	High (red)
3	Tambaan	3	2	1	2.00	Moderate (Yellow)
4	Panggungrejo	3	2	1	2.00	Moderate (Yellow)
5	Ngemplakrejo	3	1	1	1.67	Moderate (Yellow)
6	Mandaranrejo	3	1	1	1.67	Moderate (Yellow)
7	Kepel	3	2	2	2.34	High (red)

Note: Hazard classification is based on the average score of three indicators (annual rainfall, flood depth, and flood frequency), with thresholds: Low (≤1.66), Moderate (1.67–2.33), High (≥2.34)."

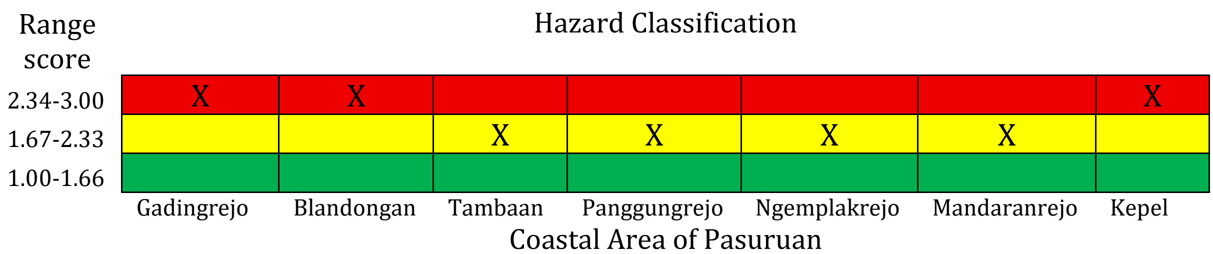

Figure 4. R-matrix-based Hazard Level Classification (Processed by Author, 2023)

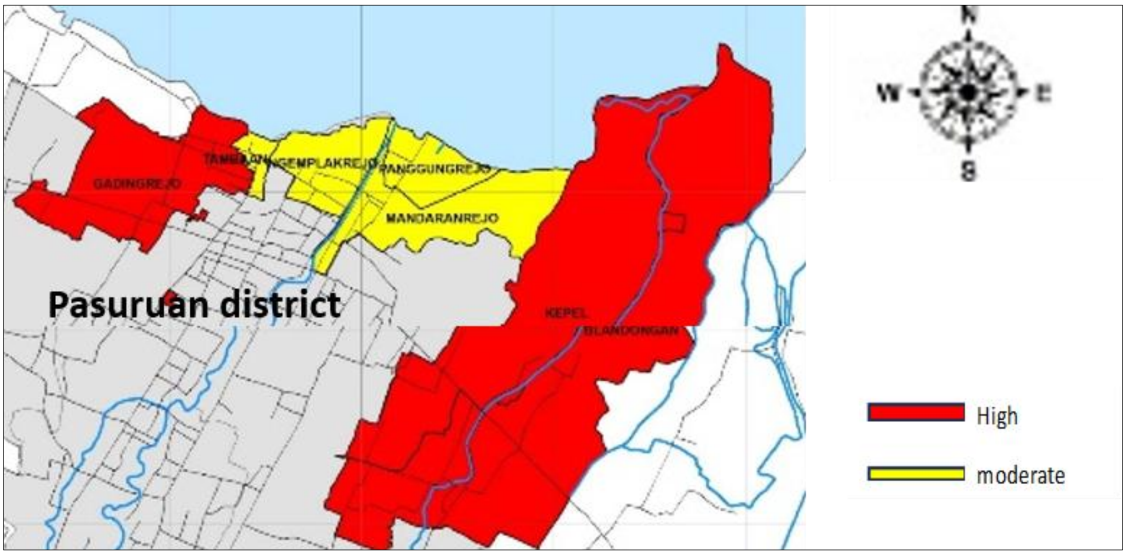

Figure 5. Zoning of Flood-Prone Areas in the Pasuruan Coastal Area (Processed by Author, 2023)

Based on Table 4, Figure 4, and Figure 5, the coastal areas of Pasuruan have varying classifications. Four villages are classified as having a moderate flood hazard level, including Tambaan, Panggungrejo, Ngemplakrejo, and Mandanrejo. Meanwhile, three villages are classified as having a high flood hazard level: Gadingrejo, Blandongan, and Kepel. The hazard level is influenced by parameters such as rainfall, event intensity, and inundation depth. The analysis was conducted by classifying these parameters into low, medium, and high categories. The high hazard classification in the three villages is largely influenced by high rainfall and high intensity of events, with more than seven events in one year, accompanied by inundation depths exceeding 60 cm. Furthermore, Pasuruan's low topography and elevation, coupled with minimal land cover, contribute to flooding during high-rainfall events. This is in line with research by Noverma et al. (2019), which states that regional geomorphological and elevation factors can make the Pasuruan coastal area vulnerable to flooding. Another study by Rizkiyah et al. (2015) on the causes of flooding in Manado City identified high rainfall, high-intensity events, and massive land-use conversion as the main factors driving waterlogging-related flooding. Similarly, Sulaiman et al. (2020) examined the causes of flooding in Samarinda City, revealing that high-intensity rainfall, regional topography, and land degradation due to loss of vegetation cover were the main causes. A study on major flooding events in Jakarta concluded that high rainfall combined with inadequate drainage systems to manage surface runoff led to waterlogging and subsequent flooding. Another study by Clement (2012) emphasized that the main cause of flooding was high rainfall intensity combined with rivers' inability to channel water, leading to waterlogging. This study also highlighted several factors contributing to flooding, including low relief, high groundwater levels, urbanization, and human activities.

Local Resilience

Capacity is the ability of a region and its communities to take mitigation and preparedness measures to reduce disaster risks. To measure local capacity, the study examined various factors, including the existence of disaster management regulations and institutions, disaster risk assessments and documentation, mitigation programs, and disaster education activities (Peraturan Kepala Badan Nasional Penanggulangan Bencana No 02 Tahun 2012 tentang Pedoman Umum Pengkajian Risiko Bencana, 2012).

The study collected information from various stakeholders, including local communities, village governments, the National Disaster Management Agency (BNPB), and the Indonesian National Armed Forces and National Police (TNI–Polri). The Hyogo Framework for Action (HFA) guided the assessment of local capacity. The indicators considered were disaster management regulations and institutions, early warning systems, disaster risk assessments, disaster education, mitigation, and preparedness. Between 2021 and 2023, the TNI and Polri contributed to a wide range of disaster management activities along the Pasuruan coast by supporting evacuation efforts, distributing logistics, and maintaining security during flood events. Their engagement highlights the role of military and paramilitary assets to enhance regional and community resilience to non-military threats, such as natural disasters. This participation is in line with the implementation of Military Operations Other Than War (MOOTW) as outlined in Indonesian Law No. 34/2004 on TNI. Disaster resilience in Pasuruan depends on effective collaboration between civilian institutions and security actors, with the armed forces and police playing an important role in supporting disaster management efforts (Kırbıyık, 2004).

Field observations and community interviews found that all coastal areas of Pasuruan, such as Gadingrejo, Blandongan, Tambaan, Panggungrejo, Ngemplakrejo, Mandaranrejo, and Kepel, have an emergency response organization for flood management. There are disaster response facilities such as emergency tents and rubber boats in the area. Floodgates are operational, and early warning systems and evacuation routes are in place in some flood-prone areas. Local government agencies have also developed disaster preparedness and public outreach programs for communities and schools, focusing in particular on flood hazards. This study assessed the level of resilience of the Pasuruan coastal area based on the percentage score for each indicator and its category (low, moderate, or high). There were five indicators in the assessment, each weighted at 20% of the overall resilience score. Table 5 presents the field observation results and the corresponding classification of coastal resilience in the Pasuruan area.

Table 5. Classification of the Results of the Measurement of Resilience in Coastal Pasuruan (Processed by Author, 2023)

No	Indicator of resilience	Indicator score	Weighted Contributions
1	Disaster management agencies (20 %)	Legal = 3 (high)	3 x 20 % = 0.6
2	Preparation of disaster risk assessments and documents (20 %)	Draft= 2 (Moderate)	2 x 20 % = 0.4
3	Development of a disaster early warning system (20%)	N/A = 1 (low)	1 x 20 % = 0.2
4	Mitigation/prevention development (20 %)	Process = 2 (Moderate)	2 x 20 % = 0.4
5	Disaster education and training (20 %)	Regularly = 3 (high)	3 x 20 % =0.6
Total scores			2.2 (moderate)

Notes:

1.00-1.66 = low resilience
1.67-2.32 = moderate resilience
2.33-3.00 = High resilience

Based on field data, disaster management regulations, and institutional arrangements across the Pasuruan coastal area, the area falls into the high-capacity category. The local government has established and implemented disaster-related regulations and institutions, including the Regional Disaster Management Agency (BPBD), to support disaster risk reduction and emergency response efforts. In contrast, the disaster risk assessment and documentation component remains in the moderate category because the relevant assessments and supporting documents are still under development. Disaster risk assessments play an important role in informing policy decisions and guiding disaster management strategies among stakeholders and relevant institutions (Akhirianto et al., 2024).

Pasuruan has established an early warning system; however, its coverage remains limited to certain areas. Early warning systems help reduce disaster risks by providing advanced information that enables residents to take precautionary actions before a hazard occurs. Timely warnings can reduce potential losses, including property damage and casualties, while improving community preparedness and response capacity (Atika et al., 2024; Diandra Cinta Parameswari, 2024).

The region has implemented both structural and non-structural mitigation measures, although several aspects still require further improvement. Structural mitigation efforts include constructing coastal protection infrastructure, such as retaining walls, and regularly planting coastal vegetation, including mangroves and casuarina trees. At the same time, local authorities have promoted non-structural mitigation through disaster education programs, public awareness campaigns, and community-based initiatives. These efforts aim to strengthen the region's capacity to manage disaster risks, particularly flooding, which occurs frequently in the Pasuruan coastal area (Urbanus et al., 2021; Wahid, 2023; Wibowo et al., 2019).

The Regional Disaster Management Agency (BPBD) has also organized disaster education and training activities to improve public understanding of disaster characteristics and mitigation measures, particularly those related to personal safety and property protection. The programs target both community members and schools located in coastal areas. Through these activities, local authorities seek to increase public awareness of potential hazards and encourage greater community involvement in disaster management. Evaluation results reported by the local government indicate that these programs have contributed positively to public awareness of disaster risks and self-evacuation practices (Azmiyati & Jannah, 2023).

The overall capacity assessment places the Pasuruan coastal area in the moderate category. Although local stakeholders have implemented various initiatives to strengthen disaster preparedness and response, several aspects of community capacity remain underdeveloped. Strengthening local capacity requires continued efforts such as hazard mapping, risk monitoring, information dissemination, community outreach, disaster education and training, and the expansion of early warning systems (Abbas et al., 2015; Peraturan Kepala Badan Nasional Penanggulangan Bencana Nomor 02 Tahun 2012 tentang Pedoman Umum Pengkajian Risiko Bencana, 2012). Increasing public awareness of disaster threats and risks also plays an important role in improving preparedness and resilience. Heinkel et al. (2022) identified several factors that contribute to stronger community capacity, including disaster knowledge, effective communication systems, volunteer management, the use of religious and public buildings for emergency response, and targeted preparedness measures.

CONCLUSIONS, RECOMMENDATIONS, AND LIMITATIONS

Flooding remains a significant concern in the coastal area of Pasuruan. The hazard assessment identified four coastal areas, namely Gadingrejo, Blondongan, Tambaan, and Kepel, as high-hazard areas, while the remaining three zones fall into the moderate-hazard category. While all study areas received a moderate resilience classification, the results suggest that existing preparedness and response capacities may not yet be sufficient to address the flood hazards faced by several coastal communities.

The four high-hazard areas require particular attention because they face greater flood exposure than other parts of the coastal area. The limited coverage of existing early warning systems and the moderate level of resilience observed in the study suggest the need to expand warning coverage, strengthen mitigation measures, and enhance disaster education programs. Ongoing collaboration among government agencies, local organizations, and community groups is crucial, particularly in regions that experience frequent flooding. Given the persistent nature of floods along the Pasuruan coast, efforts to improve preparedness should be a continuous priority, rather than just a reactive measure taken after flood events strike.

However, several limitations should be considered when interpreting the results from the Pasuruan coastal area. The hazard and resilience assessments were based on the spatial, environmental, and social data available during the study period. As conditions along the coast continue to change, particularly due to climate variability, land-use development, and shifts in community livelihoods, the results may not fully reflect future flood risk conditions. In addition, the resilience assessment focused on indicators that could be measured within the scope of this study. As a result, some aspects of resilience, such as informal community support, psychological readiness, and long-term recovery capacity, were not examined in detail. The findings also reflect the characteristics of the Pasuruan coast and should therefore be interpreted carefully when applied to other coastal regions with different environmental and socioeconomic settings. Further work in the area could track changes in hazard and resilience over time, incorporate additional resilience indicators, and consider climate change projections to understand better how flood risk may evolve in the future.

REFERENCES

Abbas, A., Amjath-Babu, T. S., Kächele, H., & Müller, K. (2015). Non-structural flood risk mitigation under developing country conditions: an analysis on the determinants of willingness to pay for flood insurance in rural Pakistan. *Natural Hazards*, *75*(3), 2119–2135. https://doi.org/10.1007/s11069-014-1415-x

Akhirianto, N. A., Ma'rufatin, A., Wardani, K. S., Kongko, W., & Kayadoe, F. J. (2024). Peran Regulasi Pemerintah Dalam Pengelolaan Risiko Bencana: Evaluasi Atas Kebijakan Peraturan Daerah Dalam Pengurangan Risiko Bencana Tsunami di Kota Ambon. *Jurnal Kawistara*, *14*(3), 303. https://doi.org/10.22146/kawistara.89353

Allaire, M. (2018). Socio-economic impacts of flooding: A review of the empirical literature. *Water Security*, *3*, 18–26. https://doi.org/10.1016/j.wasec.2018.09.002

Atika, P. Y., Alwin, A., & Sya'ban, Moh. B. A. (2024). Efektifitas penerapan sistem peringatan dini dalam upaya pengurangan risiko bencana banjir di kelurahan kampung melayu. *Geography: jurnal kajian, penelitian dan pengembangan pendidikan*, *12*(2), 671. Https://doi.org/10.31764/geography.v12i2.24533

Azmiyati, U., & Jannah, W. (2023). Edukasi Sadar Bencana Melalui Sosialisasi Kebencanaan Sebagai Upaya Peningkatan Pengetahuan Siswa Eco School Nusantara Terhadap Mitigasi Bencana. *Abdinesia: Jurnal Pengabdian Kepada Masyarakat*, *3*(1), 1–5. https://doi.org/10.69503/abdinesia.v3i1.281

BPS Kota Pasuruan. (2025). Kota Pasuruan dalam Angka 2025. In *BPS Catalog: 1102001.3575* (Vol. 38). BPS Kota Pasuruan.

Bubeck, P., Otto, A., & Weichselgartner, J. (2017). Societal Impacts of Flood Hazards. In *Oxford Research Encyclopedia of Natural Hazard Science*. Oxford University Press. https://doi.org/10.1093/acrefore/9780199389407.013.281

Clark-Ginsberg, A., McCaul, B., Bremaud, I., Cáceres, G., Mpanje, D., Patel, S., & Patel, R. (2020). Practitioner approaches to measuring community resilience: The analysis of the resilience of communities to disasters toolkit. *International Journal of Disaster Risk Reduction*, *50*. https://doi.org/10.1016/j.ijdrr.2020.101714

Clement, A. R. (2012). Causes of seasonal flooding in flood plains: a case of Makurdi, Northern Nigeria. *International Journal of Environmental Studies*, *69*(6), 904–912. https://doi.org/10.1080/00207233.2012.730668

Diandra Cinta Parameswari, h. w. (2024). efektivitas aplikasi sistem peringatan dini dalam upaya mitigasi bencana banjir di kota jakarta. *journal of public policy and management review*, *1*(1), 731–743. https://doi.org/https://doi.org/10.14710/jppmr.v1i1.49560

Emil. (2021). *14 Desa di 4 Kecamatan di Kabupaten Pasuruan, Terendam Banjir*. Pemerintah Kabupaten Pasuruan. https://www.pasuruankab.go.id/isiberita/14-desa-di-4-kecamatan-di-kabupaten-pasuruan-terendam-banjir

Faruq, U. (2021). *BNPB catat 6.379 KK di Pasuruan terdampak banjir - ANTARA News*.

for Medium-Range Weather Forecasts (ECMWF), E. C. (2023). *ECMWF annual precipitation data, 2021–2023*.

Giardino, A., Nederhoff, K., & Vousdoukas, M. (2018). Coastal hazard risk assessment for small islands: assessing the impact of climate change and disaster reduction measures on Ebeye (Marshall Islands). *Regional Environmental Change*, *18*(8), 2237–2248. https://doi.org/10.1007/s10113-018-1353-3

Gornitz, V. (1991). Global coastal hazards from future sea level rise. *Palaeogeography, Palaeoclimatology, Palaeoecology (Global and Planetary Change Section)*, *89*, 379–398.

Hammond, M. J., Chen, A. S., Djordjević, S., Butler, D., & Mark, O. (2015). Urban flood impact assessment: A state-of-the-art review. *Urban Water Journal*, *12*(1), 14–29. https://doi.org/10.1080/1573062X.2013.857421

Heinkel, S. B., Thiebes, B., Than, Z. M., Aung, T., Kyi, T. T., Mar, W. L., Oo, S. S., Miller, C., Willkomm, M., Maung, W., Myint, Z. N., Soe, K. K., Spohner, R., & Kraas, F. (2022). Disaster preparedness and resilience at household level in Yangon, Myanmar.

Natural Hazards, *112*(2), 1273–1294. https://doi.org/10.1007/S11069-022-05226-W

Kırbıyık, S. (2004). Undang-Undang Republik Indonesia Nomor 34 Tahun 2004 tentang Tentara Nasional Indonesia. *Metallurgical and Materials Transactions A*, *30*(8), 2221.

Klein, R. J. T., Nicholls, R. J., & Thomalla, F. (2003). Resilience to natural hazards: How useful is this concept? *Environmental Hazards*, *5*(1), 35–45. https://doi.org/10.1016/j.hazards.2004.02.001

Latief, H., Putri, M. R., Hanifah, F., Afifah, I. N., Fadli, M., & Ismoyo, D. O. (2018). Coastal Hazard Assessment in Northern part of Jakarta. *Procedia Engineering*, *212*, 1279–1286. https://doi.org/10.1016/j.proeng.2018.01.165

M, H. (2022). *Banjir di Pasuruan, Jatim Akibatkan 7. 275 Warga Terdampak*. Republika. https://news.republika.co.id/berita/r8h93f380/banjir-di-pasuruan-jatim-akibatkan-7-275-warga-terdampak

Mukhopadhyay, A., Dasgupta, R., Hazra, S., & Mitra, D. (2012a). Coastal hazards and vulnerability: A review. *International Journal of Geology, Earth and Environmental Sciences*, *2*(1), 57–69.

Mukhopadhyay, A., Dasgupta, R., Hazra, S., & Mitra, D. (2012b). Coastal hazards and vulnerability: A review. *International Journal of Geology, Earth and Environmental Sciences*, *2*(1), 57–69.

Murshed, S., Griffin, A. L., Islam, M. A., Wang, X. H., & Paull, D. (2022). Assessing multi-climate-hazard threat in the coastal region of Bangladesh by combining influential environmental and anthropogenic factors. *Progress in Disaster Science*, *16*, 100261. https://doi.org/10.1016/j.pdisas.2022.100261

Noverma, Alviani, V., & Perdanawati, R. (2019). Study Flood Threat Base on Elevation and Geomorphology Parameters. *The 6Th Annual Scientific Meeting on Disaster Research 2019*, *4*, 165–171.

Noverma, N., Hapsari, O. E., & Yusrianti, Y. (2024). Zonasi Tingkat Kerentanan Terhadap Banjir Berdasarkan Parameter Sosial,Ekonomi, Fisik, dan Lingkungan di Pesisir Pasuruan, Jawa timur. *Jurnal Kelautan Nasional*, *19*(3), 167. https://doi.org/10.15578/jkn.v19i3.13129

Pasuruan - Google Maps. (2023).

Pasuruan, B. N. P. B. D. (BPBD) K. (2023). *Layanan informasi PPID*.

Peraturan Kepala Badan Nasional Penanggulangan Bencana No 02 Th 2012 tentang Pedoman Umum Pengkajian Risiko Bencana, Bnpb 1 (2012). https://www.bnpb.go.id/uploads/24/peraturan-kepala/2012/perka-2-tahun-2012-tentang-pedoman-umum-pengkajian-resiko-bencana.pdf

Pregnolato, M., Ford, A., Wilkinson, S. M., & Dawson, R. J. (2017). The impact of flooding on road transport: A depth-disruption function. *Transportation Research Part D: Transport and Environment*, *55*, 67–81. https://doi.org/10.1016/j.trd.2017.06.020

Putra, A., Dewata, I., Hermon, D., Barlian, E., & Umar, G. (2023). Sustainable Development-Based Coastal Management Policy Development: A Literature Review. *Journal of Sustainability Science and Management*, *18*(1), 237–245. https://doi.org/10.46754/jssm.2023.01.015

Rizkiyah, R., Poli, H., & Supardjo, S. (2015). Analisi Faktor-Faktor Penyebab Banjir di Kecamatan Tikala Kota Manado Ria. *Jpen Journal Systems*, *1*(1), 1–8.

Sulaiman, M. E., Setiawan, H., Jalil, M., Purwadi, F., S, C. A., Brata, A. W., & Jufda, A. S. (2020). Analisis Penyebab Banjir di Kota Samarinda. *Jurnal Geografi Gea*, *20*(1), 39–43. https://doi.org/10.17509/gea.v20i1.22021

Tariq, H., Pathirage, C., & Fernando, T. (2021). Measuring community disaster resilience at local levels: An adaptable resilience framework. *International Journal of Disaster Risk Reduction*, *62*, 102358. https://doi.org/10.1016/j.ijdrr.2021.102358

Undang-Undang RI No. 24. (2007). *UU no. 24 tahun 2007 tentang Penanggulangan Bencana*. Pemerintah Republik Indonesia.

Urbanus, A., Sela, R. L. E., & Tungka, A. E. (2021). Mitigasi Bencana Banjir Struktural dan Non Struktural Di Kabupaten Bolaang Mongondow Selatan. *Jurnal Spasial*, *8*(3), 447–458. https://doi.org/https://doi.org/10.35793/sp.v8i3.36350

Utami, A., Permadi, D. F. H., Zen, B. P., Adhinata, F. D., & Saputra, W. A. (2024). Classification Analysis of Star Hotels in Banyumas Using the Random Forest Method. *2024 International Conference on Information Technology and Computing (ICITCOM)*, 139–144. https://doi.org/10.1109/ICITCOM62788.2024.10762547

Wahid, K. A. (2023). Kajian Upaya Mitigasi Struktural dan Nonstruktural Bencana Banjir di Kota Kendari. *Journal of Geographical Sciences and Education*, *1*(1).

Wakhidatus, N. S., Nugraha, A. L., & Awaluddin, M. (2021). Analisis Ancaman Terhadap Bencana Banjir Dan Tanah Longsor Pada Wilayah Permukiman Di Kabupaten Jepara. *Jurnal Geodesi Undip*, (10).

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 Jurbal Pendidikan Dan Ilmu Geografi*, *4*(2).

Yoon, D. K., Kang, J. E., & Brody, S. D. (2016). A measurement of community disaster resilience in Korea. *Journal of Environmental Planning and Management*, *59*(3), 436–460. https://doi.org/10.1080/09640568.2015.1016142

Zander, K. K., Sibarani, R., Abunyewah, M., Erdiaw-Kwasie, M. O., Moss, S. A., Lassa, J., & Garnett, S. T. (2023). Community resilience across Australia towards natural hazards: an application of the Conjoint Community Resiliency Assessment Measurement. *Wiley Online Library*. https://doi.org/10.1111/disa.12590