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Risk Hazard At Tourism Destination: Review Of Beach Tourism At Banyuwangi, Indonesia

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Abstract

Banyuwangi is a region in Indonesia renowned for its distinctive beach tourism destinations. The beach region of Banyuwangi is susceptible to significant disaster risk. This study aimed to identify, quantify, and build a prioritization scale for disaster risk management in coastal tourism regions in Banyuwangi. The approach employed for risk identification involves data analysis and stakeholder exploration. The HVA (hazard vulnerability assessment) method was employed for risk assessment. Mitigation assessments were conducted by identifying the hazards that pose the greatest risk. The study's findings indicate that material hazards (53%) and nature hazards (35%) pose the greatest risk. The highest risk in material hazards is exposure to marine waste and exposure to visitor/tourist waste. For nature hazards, the highest risks are tsunami (52%), extreme weather (52%), and earthquakes (50%). Mitigation was compiled by referring to the highest disaster risk by involving internal destination managers and external stakeholders, including visitors, local communities, government, and the private sector.

Keywords: *disaster, hazard, risk, tourism, mitigation.*

Introduction

Banyuwangi Regency is a prominent tourist destination in East Java, renowned for its wonderful destinations. Banyuwangi possesses significant tourism potential, making it a favored destination in East Java. Tourist visits have risen 8.83% during the past five years (Febriani, 2020). Banyuwangi Regency possesses diverse tourism potentials, encompassing natural, cultural, and manmade attractions (Febriani, 2020). The rise in tourism continues due to the initiatives and programs implemented by the Banyuwangi Regency Government.

The Banyuwangi Regency Government has identified three primary tourist attractions, apprised by the area's geographical conditions and the allocation of tourist sites within three Tourism Development Areas (WPP), as stipulated in Regional Regulation No. 8 of 2012 regarding the Spatial Planning and Region of Banyuwangi Regency. The formation of WPP will aid the Banyuwangi Regency government in identifying important locations for prioritizing WPP development. Sukomade Beach, Rajegwesi Beach, Pancer Beach, Teluk Hijau Beach, Lampon Beach, and Pulau Merah Beach are tourist destinations listed in (WPP) III. The turtle hatchery at Sukamade Beach is a notable attraction in Banyuwangi's coastal tourism industry (Wibowo et al., 2016).

Banyuwangi Regency is susceptible to disasters due to its position on the Circum-Pacific Ring of Fire and the Eurasian and Indo-Australian fault lines. Consequently, the potential for earthquakes, tsunamis, and volcanic eruptions is significantly elevated. Based on data from the Banyuwangi Culture and Tourism Office, in May 2020, Banyuwangi experienced a 60% decrease in tourists due to the tsunami threat. Tourism as one of the activities that is very vulnerable to news coverage, both positive and negative (Gusdini et al., 2020). Therefore, conditions that have the potential to have negative impacts need to be managed properly, including the risk of danger that may arise.

Banyuwangi is one of the areas that has great potential for tourism but has quite a lot of risk of disasters, both natural, social and economic. Therefore, the development of tourist areas such as the Banyuwangi area, needs to consider the conditions of the threat of danger risks. The hazard risk status needs to be known to design mitigation so that the risk of danger can be minimized and the existing tourism potential can be utilized optimally for the economic development of the region. In addition, the hazard risk status and mitigation scenario in tourist areas are one of the important information needed

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by tourists in determining the tourist destinations to be visited (Ratnasari et al., 2019); (Hanum & Saifudin, 2019).

Method

Hazard risk in this study was assessed using the HVA (Hazard Vulnerability Analysis) method. The HVA method uses several criteria to determine the highest risk in an area (Shojaei et al., 2024)). The criteria employed are as follows:

a. Probability of hazard

b. Impact of hazard on humans, property, and business (services).

c. Mitigation, which includes organizational readiness and the ability to deal with hazard against internal and external responses

Assessments were carried out on four types, namely:

a. Natural hazard

b. Technology hazard

c. Human hazard

d. Material hazard

Hazards related to the study location were identified from each assessment. After that, an assessment was carried out based on the criteria of each hazard assessment and its impact. The assessment was classified into four categories: NA (not applicable), low, medium, and high. The risk was assessed using the formula presented in Equation 1.

$$Risk = probability \times severity \quad (1)$$

Each hazard has a large risk value, so that it can be known which types of hazards have the highest to the lowest risk in the region. The assessment was carried out through a focus group discussion (FGD) mechanism involving resource persons from various stakeholders. The criteria for the resource persons are working in the field of disaster and/or coastal tourism for at least 5 years or having authority or expertise or being involved in disaster management and/or coastal tourism in Banyuwangi Regency. Based on these criteria, the expert involved in the FGD came from the Tourism Office, Regional Disaster Management Agency, Environment Agency, Chairman of the Tourism Village Group, Fisheries and Marine Service, Academics from the Banyuwangi State Polytechnic. Based on the risk from the results of the study, the hazard status is determined and a priority scale is prepared in mitigating it.

Result and Discussion

Identification

Historical data and stakeholder opinions expressed during the focus group discussion (FGD) were employed to identify potential hazards in the Banyuwangi beach tourism area. The level of hazard risk was evaluated based on the results of this identification. The definition of each hazard is:

a. Natural hazards are naturally occurring physical phenomena caused by geophysical, meteorological, hydrological, or biological processes. These include earthquakes, volcanic eruptions, floods, hurricanes, and landslides. Natural hazards pose threats to life, property, and the environment.

b. Material hazards refer to the risks posed by hazardous substances such as toxic chemicals, flammable gases, radioactive materials, or other dangerous substances.

c. Human hazards are hazards resulting from human actions or negligence, either intentional or unintentional. They include industrial accidents, pollution, operational errors, sabotage, and armed conflicts.

d. Technological hazards are defined as threats originating from human activities or technical systems that can lead to damage or disasters, such as industrial accidents or structural failures.

The potential hazards that would arise are presented in Table 1.

Table 1. Hazard Identification

Natural Hazard	Technology Hazard	Human Hazard	Material Hazard
Earthquake	Electrical interference	Incident (trauma)	Pollution due to dead marine life
High waves	Transportation disruption	Sink/drifting away	Chemical Exposure, external
Extreme weather	Fuel shortage	Interference from society	Marine waste exposure
Flood	Gas problems	Employee tdemonstrations	Poor sanitation
Drought	Clean water disruption	Fights between visitor/ employee	Exposure to tourist trash
Fire	Sewerage problems	Exposed to marine animals	Exposure to biological contamination
Landslide	Communication breakdown		
Tsunami	Information Systems Failure		
Erupting volcano			
Abrasion			

The identification of potential hazards presented in table 1 was obtained from various documents on potential disasters in Banyuwangi Regency and the agreement of the stakeholders present at the FGD. For natural hazard based on potential hazards that have arisen and the results of natural disaster studies in Banyuwangi. Other potential hazards related to technology, human and material are determined based on the views of stakeholders agreed upon during the FGD. In addition, interactions between potential hazards are also considered.

Hazard Assessment

Risk analysis is a method for assessing the likelihood and severity of a disaster and the potential losses associated with people, property, and environmental impacts (Liu et al., 2024). Risk analysis considers the source of risk, positive and negative consequences, and the possibility of those consequences occurring (Tehler *et al.*, 2024). The magnitude of the risk is seen from the interaction between hazards, risks, and individuals (Zhuang et al., 2024).

Based on the results of the FGD, the experts agreed to classify natural hazard risks that may occur in the Banyuwangi area into 10 types of hazard risks (Table 1). Of the 10 potential natural hazards, an assessment was carried out by the resource persons using questionnaire instruments on each risk to probability and mitigation efforts carried out both structurally and non-structurally. The results of the thoughts and data owned by each resource person stated in the questionnaire are extrapolated into the probability and severity values of each natural hazard. The results of filling out the questionnaire were validated by all speakers in the FGD. Based on this assessment, 3 types of natural hazards that have the highest risk are obtained, namely earthquakes, tsunamis and extreme weather. The probability and severity values of each type of natural hazard from the validated resource persons are presented in Table 2.

Table 2. Natural Hazard Assessment

EVENT	PROBABILITY	SEVERITY – (MAGNITUDE - MITIGATION)						RISK
		HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	PREPARED-NESS	INTERNAL RESPONSE	EXTERNAL RESPONSE	
	Likelihood this will occur	*Possibility of death or injury*	*Physical losses and damages*	*Interuption of services*	*Preplanning*	*Time, effectiveness, resources*	*Community/ Mutual Aid staff and supplies*	*Relative threat*
SCORE	*0 = N/A 1 = Low 2 = Moderate 3 = High*	*0 = N/A 1= Low 2 = Moderate 3 = High*	*0 = N/A 1= Low 2 = Moderate 3 = High*	*0 = N/A 1= Low 2 = Moderate 3 = High*	*0 = N/A 1 = High 2 = Moderate 3 = Low or none*	*0 = N/A 1= High 2 = Moderate 3 = Low or none*	*0 = N/A 1= High 2 = Moderate 3 = Low or none*	*0 - 100%*
Earthquake	1	2	2	2	1	1	2	50%
High waves	2	2	1	2	1	2	3	41%
Abrasion	2	0	0	1	0	3	3	26%
Flood	1	1	1	2	2	2	2	19%
Drought	2	1	2	3	2	3	2	48%
Fire	1	2	3	2	3	2	3	28%
Extrime weather	2	3	3	2	2	2	2	52%
Tsunami	2	3	3	3	1	2	2	52%
Erupting volcan	2	2	2	2	1	2	2	41%
Landslide	1	2	1	1	3	3	3	24%
AVERAGE SCORE	1.60	1.80	1.80	2.00	1.60	2.20	2.40	35%

Source: FGD Results, 2024

Natural Hazard Risk = Probability x severity

= 0.53 x 0.66 = 0.35

The risk value of natural hazards in the Banyuwangi beach tourism region is moderate (0.34-0.6) (Asadi et al., 2022). Based on geographical and topographic conditions, Banyuwangi Beach has a high risk of disaster risk. This is in line with the results of a study by the Banyuwangi Regency Regional Disaster Management Agency (BPBD) on the Banyuwangi Regency Disaster Risk Assessment (BPBD, 2021) andnatural hazard disaster risk data issued by the National Disaster Management Agency (BNPB), where Banyuwangi Regency has a moderate to high risk of earthquakes, extreme weather and tsunamis (Directorat of Mapping and Evaluation Disaster Risk, 2023). For tsunami disasters, in East Java province, Banyuwangi Regency has the highest risk (Figure 1). For the risk of earthquakes, Banyuwangi Regency has the highest (Directorat of Mapping and Disaster Risk Evaluation, 2023)moderate risk among other areas in East Java Province (Figure 2). And for the risk of extreme weather, Banyuwangi Regency has the highest high risk among other areas in East Java Province (Figure 3).

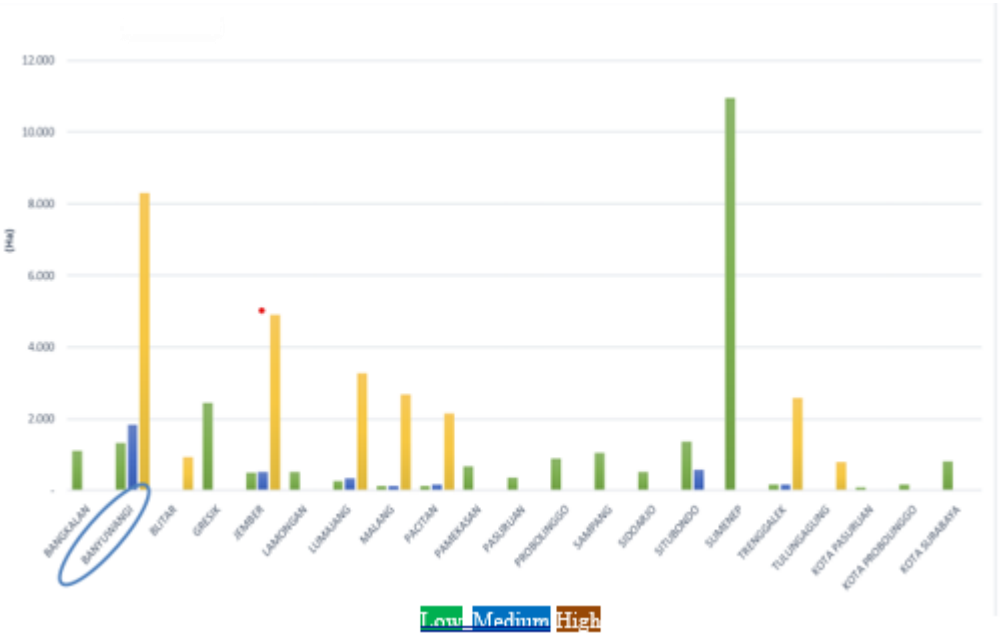

Figure 1. Tsunami Disaster Risk in East Java Province

Source: East Java National Disaster Risk Assessment Document for 2022 – 2026

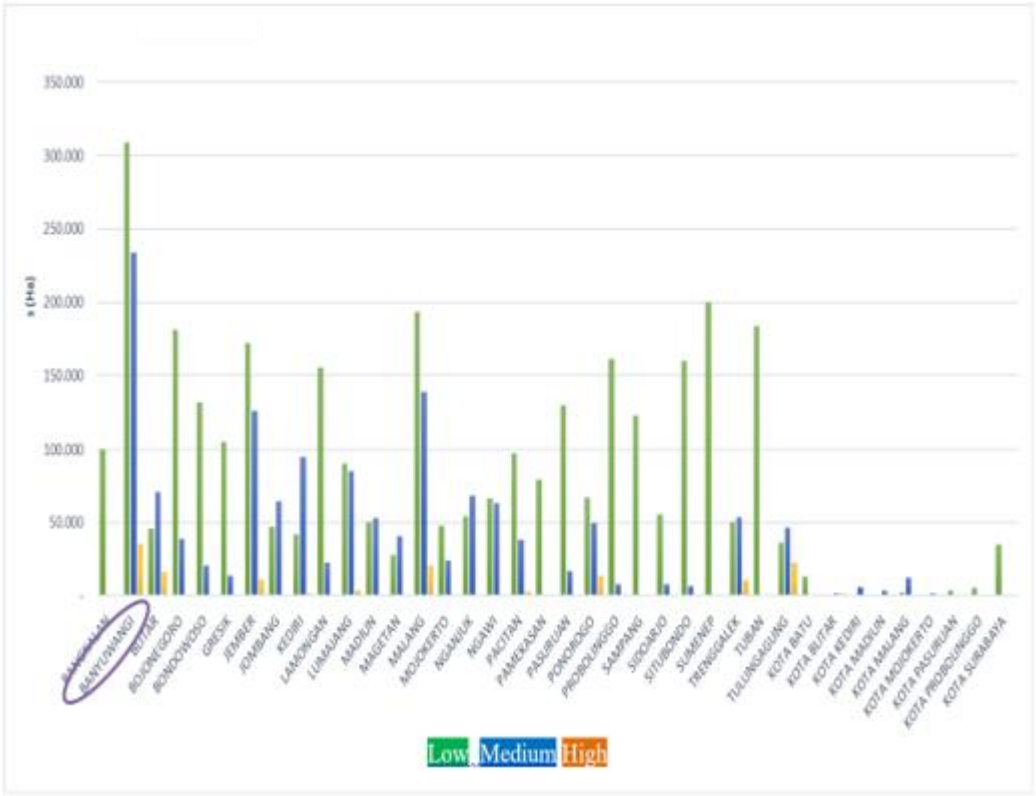

Figure 2. Earthquake Disaster Risk in East Java Province

Source: East Java National Disaster Risk Assessment Document 2022 – 2026

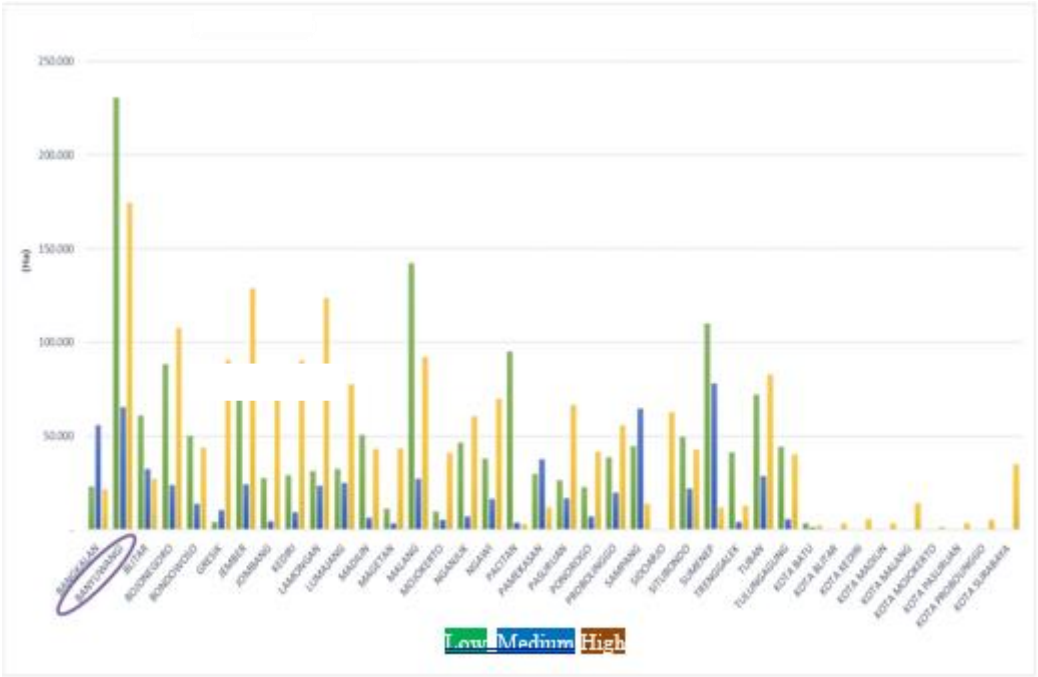

Figure 3. Risk of Extreme Weather Disasters in East Java Province

Source: East Java National Disaster Risk Assessment Document 2022 – 2026

Nevertheless, mitigating efforts have effectively addressed this risk. The mitigation involves the local government producing disaster management plan documents and controlling disaster risk at tourism locations in collaboration with the community (Jayasinghe et al., 2024).

According to the risk assessment, earthquakes, tsunamis, and extreme weather are the three most significant natural hazard. These three natural hazard are most likely to affect individuals, assets, and services. The government has initiated measures to mitigate adverse effects; nevertheless, these efforts are suboptimal and require strengthening. Earthquakes and tsunamis are disasters that can be interrelated, resulting in amplified consequences (Hu et al., 2024). Cascading hazards such as earthquakes followed by tsunamis, compounded with extreme weather disruptions, can significantly worsen the damage. Therefore, a holistic and integrated multi-hazard mitigation approach is required *(Hu et al., 2024; Dal Barco et al., 2024)*. Figure 4 illustrates the seismic hazard risk map for the Banyuwangi beach tourism region.

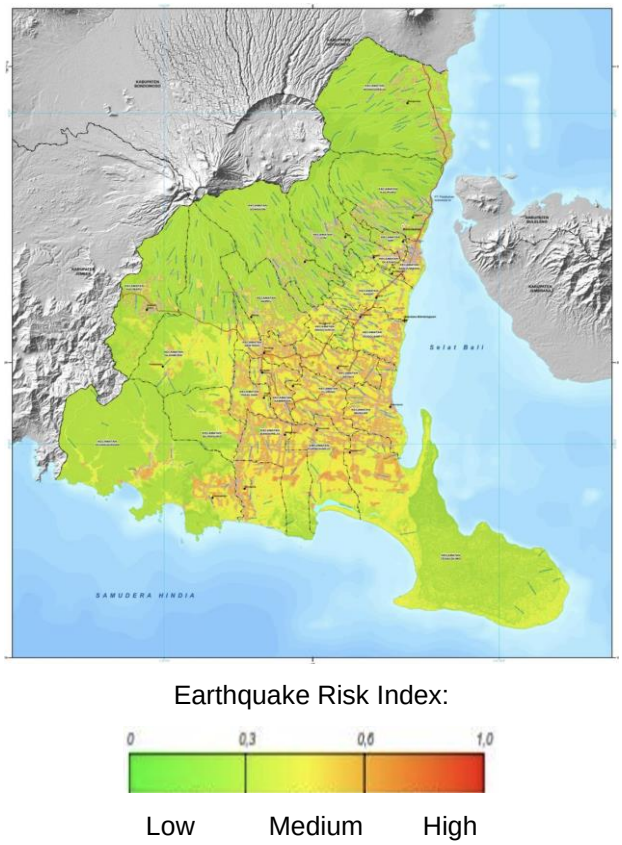

Figure 4. Earthquake Disaster Risk Map in Coastal Areas of Banyuwangi Regency (Regional Disaster Management Agency, 2021)

The coastline of the Banyuwangi region is highly susceptible to earthquakes. Tourism sustainability in the region significantly relies on disaster risk management due to the unpredictable nature of earthquakes (Khazai et al., 2018). Moreover, earthquakes can trigger secondary disasters, like tsunamis and landslides; therefore, preventive measures against the direct effects of earthquakes and associated calamities must be anticipated holistically. A tsunami represents another significant disaster risk in Banyuwangi.

Figure 5 illustrates a potential tsunami risk map for the Banyuwangi region.

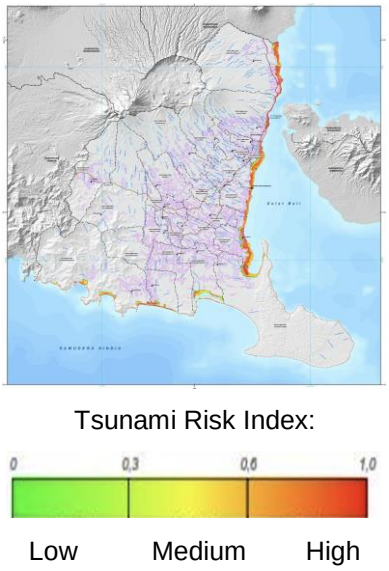

Figure 5. Tsunami Disaster Risk Map in the Coastal Area of Banyuwangi (Regional Disaster Management Agency , 2021)

Figure 5 depicts that all beaches in Banyuwangi are situated in a high-risk zone due to their proximity to the subduction zones of the Indo-Australian and Eurasian Plates. This subduction zone is the convergence point of two tectonic plates, capable of inducing significant earthquakes that may lead to tsunamis. Studies by the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) and the National Disaster Management Authority (BNPB) have identified Banyuwangi's coastline particularly areas such as Pulau Merah, Pancer, and Grajagan as being within a high tsunami risk zone. This is supported by tsunami modeling which indicates that under a worst case scenario (Mw 8.7–9.1), waves could reach coastal settlements within 20–30 minutes of an offshore megathrust earthquake

The 1994 East Java tsunami, although more concentrated around Banyuwangi's neighboring coast, highlighted the region's vulnerability. The relatively short travel time of tsunami waves in this region demands robust early warning systems and community preparedness initiatives.

Topographically, the sloping beaches in this area will have a wider impact from a tsunami (Zhao & Niu, 2022). Watu Dodol Beach, Cemara Beach, and Boom Beach possess very soft topography, allowing tsunami waves to penetrate deeper inland, resulting in greater damage to humans, buildings, and services (Glimsdal et al., 2019).

Another high-risk natural hazard in the Banyuwangi coastal tourism area is extreme weather. Watu Dodol, Cemara, and Boom Beach are very vulnerable to the impacts of extreme weather. Global climate change has increased the frequency and intensity of extreme weather events such as heavy rain, strong winds, high waves, and tropical storms (Dal Barco et al., 2024). The map of potential extreme weather risks in Banyuwangi is presented in Figure 6.

The occurrence of disasters in coastal areas often does not occur in isolation. In Banyuwangi's coastal zone, earthquake hazards are often intrinsically linked with tsunami events due to tectonic interactions at the subduction zones between the Indo-Australian and Eurasian Plates. This relationship is evident in historical events where seismic activities triggered cascading hazards. Earthquakes that generated tsunamis, followed by coastal erosion and sediment displacement. The concurrence of these events amplifies not only the physical damage but also delays the response and recovery processes. Furthermore, when such cascading hazards occur during periods of extreme weather such as high tides or storms the combined effects may exponentially worsen the impact on infrastructure, community safety, and tourism continuity. Therefore, integrated multi-hazard risk analysis is essential in developing coastal disaster mitigation plans.

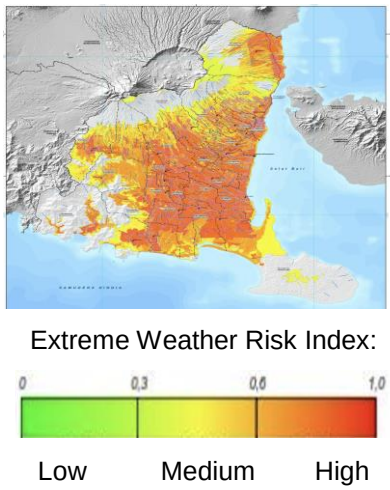

Figure 6. Extreme Weather Disaster Risk Map in Coastal Areas of Banyuwangi (Regional Disaster Management Agency, 2021)

In coastal tourism regions, severe weather can diminish tourist interest as tourism activities are obstructed under such conditions. This avoids risks from heavy rain, strong winds, or high waves (Masanja et al., 2024). Consequently, innovation, diversity, and explicit information regarding permissible activities and their constraints are essential for sustaining tourism services. The risk of hazard can be mitigated (Lukoseviciute & Panagopoulos, 2021).

As with the process in natural hazard risk assessment, an assessment of technology hazard is carried out. Risks were evaluated based on likelihood, effects on humans, buildings, and services, and the mitigating measures implemented. The assessment findings are displayed in Table 3.

Table 3 Technology Hazard Assessment

EVENT	PROBABILITY	SEVERITY = (MAGNITUDE - MITIGATION)						RISK
		HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	PREPARED-NESS	INTERNAL RESPONSE	EXTERNAL RESPONSE	
	Likelihood this will occur	*Possibility of death or injury*	*Physical losses and damages*	*Interuption of services*	*Preplanning*	*Time, effectiveness, resouces*	*Community/ Mutual Aid staff and supplies*	*Relative threat**
SCORE	*0 = N/A 1= Low 2 = Moderate 3 = High*	*0 = N/A 1 Low 2 = Moderate 3 = High*	*0 = N/A 1 =Low 2 = Moderate 3 = High*	*0 = N/A 1= Low 2 = Moderate 3 = High*	*0 = N/A 1= High 2 = Moderate 3 = Low or none*	*0 = N/A 1= High 2 = Moderate 3 = Low or none*	*0 = N/A 1= High 2 = Moderate 3 = Low or none*	*0 - 100%*
Elektrical interference	2	1	1	2	2	2	3	41%
Transportation disruption	2	0	1	1	3	2	2	33%
Fuel sortage	2	0	0	2	2	2	1	26%
Gas problems	1	0	0	2	2	2	1	13%
Clean water disruption	2	1	1	1	1	1	2	26%
Sewerage problems	2	0	0	1	1	2	1	19%
Communication breakdown	2	0	0	2	3	2	2	33%
Information Systems Failure	2	0	1	3	1	2	2	33%
AVERAGE SCORE	0.79	0.11	0.21	0.74	0.79	0.79	0.74	28%

Source: FGD Results, 2024

Technology risk value = probability x severity

= 0.63 x 0.44

= 0.28

According to Table 3, the technological risk in the Banyuwangi coastal tourism region is classified as low (≤0.34) (Asadi et al., 2022). The low risk is caused by the dominant impact of technology on services. Simultaneously, human and property casualties are comparatively minimal and have been effectively managed through structural and non-structural mitigating measures (Deb et al., 2024).

Based on the identification of technology hazards, risk management is focused on hazards that have the highest risk, namely electrical interference (41%), transportation disruption (33%), communication breakdown (33%), and information failure (33%). All activities conducted in the coastal tourism region of Banyuwangi rely on the electrical grid. Consequently, disturbances to electrical

components affect several systems, including communication and information systems (Nag & Sarkar, 2024), necessitating vigilance. Transportation, in relation to accessibility, is a critical determinant of success in tourism (Feng et al., 2023).

Through the same process as the assessment of natural hazards and technological hazards, an assessment of human hazards is carried out. The human hazard assessment was based on the severity of the disaster to humans and the response carried out to mitigate it (Fuchs et al., 2012). The results are presented in Table 4.

Table 4 Human Hazard Assessment

EVENT	PROBABILITY	SEVERITY = (MAGNITUDE - MITIGATION)						RISK
		HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	PREPARED-NESS	INTERNAL RESPONSE	EXTERNAL RESPONSE	
	Likelihood this will occur	*Possibility of death or injury*	*Physical losses and damages*	*Interuption of services*	*Preplanning*	*Time, effectiveness, resources*	*Community/ Mutual Aid staff and supplies*	*Relative threat**
SCORE	*0 = NA 1= Low 2 = Moderate 3 = High*	*0 = NA 1= Low 2 = Moderate 3 = High*	*0 = NA 1= Low 2 = Moderate 3 = High*	*0 = NA 1= Low 2 = Moderate 3 = High*	*0 = NA 1= High 2 = Moderate 3 = Low or none*	*0 = NA 1= High 2 = Moderate 3 = Low or none*	*0 = NA 1= High 2 = Moderate 3 = Low or none*	*0 - 100%*
Mass Casualty Incident (trauma)	2	3	0	1	2	2	2	37%
Sink/drifting away	2	2	0	1	2	1	1	26%
Interference from society	1	1	1	3	2	3	3	24%
Employee demonstrations	1	2	1	3	3	2	2	24%
Fights between visitor/employee	0	1	1	1	3	0	0	0%
Exposed to marine animals	1	2	0	0	2	1	2	13%
AVERAGE	**1.17**	**1.83**	**0.50**	**1.50**	**2.33**	**1.50**	**1.67**	**20%**

Source: FGD Results, 2024

Human hazard risk value = probability x severity

= 0.39 x 0.52

= 0.20

Human hazard is included in the low-risk category (≤34%). The low-risk value is because the chance of a disaster due to interaction in the coastal tourism area in Banyuwangi is relatively low in impacting humans, property, and services, and efforts have been made to reduce the impacts that arise. Beach tourism in Banyuwangi has involved local communities to minimize disharmonious relationships due to tourism activities (Rocca & Zielinski, 2022), (Bhakuni & Das, 2024). The highest risk of human hazard conditions is community trauma due to a disaster (37%) and drowning or being carried away by waves (26%) at a tourist destination.

The coastal tourism areas of Watudodol, Cemara, and Boom in Banyuwangi, like other coastal areas, have high vulnerability to various types of hazard. Analyzing hazard risk based on material hazards is essential for mitigation and adaptation strategies (Khondaker, 2014). Material risks in coastal tourism may originate from internal tourist sites or external sources, such as waste or pollutants transported by sea waves (Chai et al., 2022; Estay-Ossandon & Mena-Nieto, 2018). The assessment of material hazard risks in the Banyuwangi coastal tourism area is presented in Table 5.

Table 5 Material Hazard Assessment

EVENT	PROBABILITY	SEVERITY = (MAGNITUDE - MITIGATION)						RISK
		HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	PREPARED-NESS	INTERNAL RESPONSE	EXTERNAL RESPONSE	
	Likelihood this will occur	*Possibility of death or injury*	*Physical losses and damages*	*Interuption of services*	*Preplanning*	*Time, effectiveness, resources*	*Community/ Mutual Aid staff and supplies*	*Relative threat**
SCORE	*0 = NA 1= Low 2 = Moderate 3 = High*	*0 = NA 1= Low 2 = Moderate 3 = High*	*0 = NA 1= Low 2 = Moderate 3 = High*	*0 = NA 1= Low 2 = Moderate 3 = High*	*0 = NA 1= High 2 = Moderate 3 = Low or none*	*0 = NA 1 = High 2 = Moderate 3 = Low or none*	*0 = NA 1= High 2 = Moderate 3 = Low or none*	*0 - 100%*
Pollution due to dead marine life	2	2	0	3	1	2	3	41%
Chemical Exposure, External	2	2	0	3	1	1	3	37%
Marine waste exposure	3	3	1	3	2	1	2	67%
Exposure to tourist trash	3	3	2	2	2	2	2	72%
Exposure to biological contamination	2	2	0	2	2	3	3	44%
Poor sanitation	3	2	2	2	1	2	2	61%
AVERAGE	**2.50**	**2.33**	**0.83**	**2.50**	**1.50**	**1.83**	**2.50**	**53%**

Source: FGD Results, 2024

Material hazard risk value = probability x severity

= 0.83 x 0.64

= 0.53

The risk value for the material hazard criteria is included in the moderate qualification (0.34 - 0.6). The evidence suggests a high chance of occurrence and a suboptimal response to mitigate its adverse effects. The highest risk in the material hazard criteria is waste from tourism activities (72%) and waste transported by sea waves (67%). In tourist areas, waste generated from tourism activities and pollutants carried by sea waves significantly impacts environmental quality. This generates a multiplier effect, specifically the economic decline due to reduced visitor interest and the health risks associated with disease transmission (Ghulamrabbany et al., 2013). Therefore, significant and sustainable efforts are needed to address this problem.

The findings indicate that material hazard possesses the highest risk value compared to the other three disaster criteria. The disaster risk values for material hazards (0.53) and natural hazards (0.35) indicate moderate qualifications (0.34 - 0.6). Therefore, the control program can be focused on efforts to control marine pollution and waste management from tourism activities.

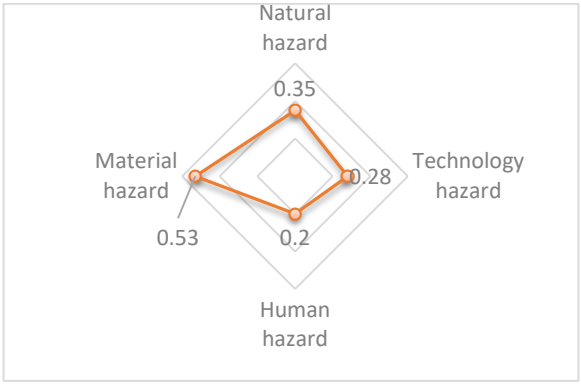

Figure 7 Positioning of Risk Hazard

Risk Mitigation and Mitigation Methods

Based on the results of the study, mitigation is focused on two main aspects. First, mitigation of material hazards related to marine waste and waste, whether from land to sea or from sea to land. Mitigation steps that can be taken include improving the waste management system generated from tourist activities, including the provision of adequate garbage cans, as well as supervision of beach cleanliness. Apart from the technical aspect, dealing with marine waste or debris needs to involve tourists to manage and reduce waste from tourism activities. This begins with socialization to tourists about the importance of maintaining cleanliness and avoiding littering by utilizing publication media in tourist areas (Yusnaidi et al., 2023). In addition, a local approach in tourist areas needs to use a more global approach through increasing public awareness of the importance of protecting marine ecosystems and avoiding waste disposal into the sea (Jayantri & Ridlo, 2022).

Second, natural hazard mitigation that focuses on the threat of tsunamis, extreme weather, and earthquakes. Mitigation fornatural hazard disasters includes strengthening building infrastructure that is resistant to earthquake and tsunami shocks, as well as effective early warning systems as well as periodic monitoring of natural conditions and environmental quality. In addition, there is a need for evacuation training for tourist area managers, people around tourist areas and tourists. Tourism area managers and the government can work with the private sector to provide adequate evacuation facilities and facilities, such as clear evacuation routes and safe evacuation centers (Noviantoro et al., 2022).

To enhance the resilience of the coastal tourism system in Banyuwangi, the mitigation strategy must evolve from hazard-specific approaches into a multi-hazard integrated framework. This includes establishing a comprehensive monitoring and alert system that combines seismic, meteorological, and oceanographic data to anticipate compound disaster scenarios (e.g., earthquake-induced tsunami during extreme weather). Additionally, infrastructure design should adopt adaptive standards, such as elevated evacuation shelters that account for both flood and seismic safety. Community-based drills must also simulate multi-hazard scenarios to improve response coordination. This systemic and layered mitigation model supports the adaptive capacity of stakeholders and reduces systemic vulnerability across tourism, public safety, and environmental sectors.

Risk reduction strategies should also include the utilization of mobile-based waste reporting applications, installation of segmented waste bins along coastal areas, and periodic tsunami evacuation simulations as a form of direct education for visitors and tourism workers *(Chai et al., 2022; Rocca & Zielinski, 2022).*

Collaborative Approach in Risk Mitigation

The complexity of disaster conditions caused by various hazard conditions causes the disaster risk mitigation process to be carried out by one party only. Effective mitigation requires an approach that involves a variety of parties, both internal and external. Internal tourist destination managers must play an active role in compiling and implementing relevant mitigation measures. Meanwhile, external stakeholders, including the surrounding community, local governments, and the private sector, also have a very important role in providing support, both in the form of policies, resources, and education to the community.

Local communities need to be trained on disaster preparedness, as well as invited to be part of the existing early warning system. The government must also provide support in the form of infrastructure development that supports disaster mitigation, while the private sector can contribute by providing the necessary funds or facilities for disaster management (Pasaribu et al., 2023).

Conclusion

Beaches are one of the potential assets in supporting the tourism sector in Banyuwangi, but this area has a fairly high potential for hazard risk. The risk is in the form of dominant hazard materials in coastal tourist areas, both those resulting from tourist activities and those brought from outside tourist areas originating from the sea. The risk level of material hazards in the Banyuwangi Beach tourist area is moderate. Tourist behavior and global conditions of pollution are contributors to disaster risk due to material hazards. Natural hazards in this area, also show potential risks with moderate qualifications. The topographic and geographical conditions of the region contribute to the risk of natural hazards and the level of impact caused. The response carried out to minimize the effect of existing disasters, mitigation efforts are carried out based on 1) waste management, 2) conservation in coastal areas, 3) water quality monitoring, 4) the development of disaster-resilient infrastructure, 5) increasing the involvement of the community and tourists through education and early warning, 6) involving many parties in hazard management in tourist areas.

This study offers a substantial contribution to strengthening evidence-based disaster risk governance by prioritizing types of hazards within the context of vulnerable coastal tourism destinations. The HVA-based prioritization model applied in this study can serve as an initial reference for integrating disaster mitigation policies into local tourism management frameworks.

References

1. Asadi, G., Karampourian, A., Kalatpour, O., & Khazaei, S. (2022). Assessment of safety status and functional, structural and non-structural preparedness of health centers in Hamadan against disasters. Journal of Occupational Hygiene Engineering, 8(4), 69–77. https://doi.org/10.52547/johe.8.4.69
2. Bhakuni, M. S., & Das, A. (2024). A cost-efficient relocation model minimizing economic and social disruption of the disaster-affected population of the Kedarnath considering uncertainty. Computers and Industrial Engineering, 190(December 2023), 1–30. https://doi.org/10.1016/j.cie.2024.110005
3. BPBD, Regional Disaster Management Agency. (2021). Disaster Report, 2021, 1–59.
4. Chai, B., Li, Y., Wang, L., Zhang, X. T., Wan, Y. P., Chen, F., Ma, J., Lan, W., & Pan, K. (2022). Microplastic Contamination on the Beaches of South China. Frontiers in Marine Science, 9(March), 1–10. https://doi.org/10.3389/fmars.2022.863652
5. Dal Barco, M. K., Maraschini, M., Ferrario, D. M., Nguyen, N. D., Torresan, S., Vascon, S., & Critto, A. (2024). A machine learning approach to evaluate coastal risks related to extreme weather events in the veneto region (Italy). International Journal of Disaster Risk Reduction, 108(October 2023). https://doi.org/10.1016/j.ijdrr.2024.104526
6. Deb, D., Uddin, M. M., Mahbub-E-Kibria, A. S. M., Kumar Das, M., & Hasan, M. (2024). Coastal vulnerability assessment to multi hazards in the exposed coast of Southeastern Coastal Region of Bangladesh. Regional Studies in Marine Science, 73(February). https://doi.org/10.1016/j.rsma.2024.103484
7. Directorat of Mapping and Disaster Risk Evaluation. (2023). Nasional Risk Disaster Analysis, East Java Province 2023 - 2026.
8. Estay-Ossandon, C., & Mena-Nieto, A. (2018). Modelling the driving forces of the municipal solid waste generation in touristic islands. A case study of the Balearic Islands (2000–2030). Waste Management, 75, 70–81. https://doi.org/10.1016/j.wasman.2017.12.029

9. Febriani, I. B. S. (2020). KABUPATEN BANYUWANGI Jurnal Destinasi Pariwisata. Journal of Tourism, 8(1).
10. Feng, Y., Pitafi, A. H., & Zhang, C. (2023). Support for tourism development in Pakistan: A study of road and transportation infrastructure development. Heliyon, 9(7), e18014. https://doi.org/10.1016/j.heliyon.2023.e18014
11. Fuchs, S., Birkmann, J., & Glade, T. (2012). Vulnerability assessment in natural hazard and risk analysis: Current approaches and future challenges. Natural Hazards, 64(3), 1969–1975. https://doi.org/10.1007/s11069-012-0352-9
12. Ghulamrabbany, M., Afrin, S., Rahman, A., Islam, F., & Hoque, F. (2013). Environmental Effects of Tourism. American Journal of Environment, Energy and Power Research, 1(7), 117–130.
13. Glimsdal, S., Løvholt, F., Harbitz, C. B., Romano, F., Lorito, S., Orefice, S., Brizuela, B., Selva, J., Hoechner, A., Volpe, M., Babeyko, A., Tonini, R., Wronna, M., & Omira, R. (2019). A New Approximate Method for Quantifying Tsunami Maximum Inundation Height Probability. Pure and Applied Geophysics, 176(7), 3227–3246. https://doi.org/10.1007/s00024-019-02091-w
14. Gusdini, N., Ratnasari, L., Hasibuan, B., & Waluyo, S. D. (n.d.). Effectiveness of Tanjung Kelayang Tourist Destination Publication with the Epic Model Approach. 1–4. https://doi.org/10.35248/2167-0269.19.8.421
15. Hanum, W. S., & Saifudin, A. (2019). Rancang Bangun Aplikasi Panduan Pariwisata di Kabupaten Banyuwangi Mobile Berbasis Android. Jurnal Teknologi Sistem Informasi Dan Aplikasi, 2(2), 59. https://doi.org/10.32493/jtsi.v2i2.2798
16. Hu, G., Li, L., Satake, K., Wu, T. R., Wang, P., Doong, D. J., & Liu, P. L. F. (2024). Source characteristics of the 2006 Pingtung earthquake doublet off southern Taiwan and the possible contribution of submarine landslides to the Tsunami. Earth and Planetary Science Letters, 643(August). https://doi.org/10.1016/j.epsl.2024.118921
17. Jayantri, A. S., & Ridlo, M. A. (2022). Strategi Pengelolaan Sampah Di Kawasan Pantai. Jurnal Kajian Ruang, 1(2), 147. https://doi.org/10.30659/jkr.v1i2.20021
18. Jayasinghe, G. Y., Perera, T. A. N. T., Perera, H. A. T. N., Karunarathne, H. D., Manawadu, L., Weerasinghe, V. P. A., Sewwandi, B. G. N., Haroon, M. H., Malalgoda, C., Amaratunga, D., & Haigh, R. (2024). A systematic literature review on integrating disaster risk reduction (DRR) in sustainable tourism (SusT): Conceptual framework for enhancing resilience and minimizing environmental impacts. International Journal of Disaster Risk Reduction, 111(August). https://doi.org/10.1016/j.ijdrr.2024.104742
19. Khazai, B., Mahdavian, F., & Platt, S. (2018). Tourism Recovery Scorecard (TOURS) – Benchmarking and monitoring progress on disaster recovery in tourism destinations. International Journal of Disaster Risk Reduction, 27(April 2017), 75–84. https://doi.org/10.1016/j.ijdrr.2017.09.039
20. Khondaker, A. M. (2014). Environmental Pollution and Management. International Journal of Environmental Science and Development, 5(4), 412–416. https://doi.org/10.7763/ijesd.2014.v5.519
21. Liu, Y., Yang, T., Wang, H., Zhang, P., Dong, X., Zhao, Y., & Liu, Y. (2024). Risk assessment of disaster chain in multi-seam mining beneath gully topography. International Journal of Disaster Risk Reduction, 111(August). https://doi.org/10.1016/j.ijdrr.2024.104750
22. Lukoseviciute, G., & Panagopoulos, T. (2021). Management priorities from tourists' perspectives and beach quality assessment as tools to support sustainable coastal tourism. Ocean and Coastal Management, 208(January 2020). https://doi.org/10.1016/j.ocecoaman.2021.105646
23. Masanja, F., Luo, X., Jiang, X., Xu, Y., Mkuye, R., & Zhao, L. (2024). Environmental and social framework to protect marine bivalves under extreme weather events. Science of the Total Environment, 946(February). https://doi.org/10.1016/j.scitotenv.2024.174471
24. Nag, A., & Sarkar, S. (2024). Integrating choice freedom, economic health, and transportation infrastructure to forecast tourism demand: A case study of Bishnupur and its alignment with sustainable development goals. Transport Policy, 147(May 2023), 198–214. https://doi.org/10.1016/j.tranpol.2024.01.001
25. Noviantoro, K. M., Widjaja, H. R., & Ridwan, M. (2022). Penataan Ruang Wilayah Pesisir sebagai Upaya Mitigasi Bencana Tsunami di Pantai Watu Pecak, Kabupaten Lumajang. Jurnal Wilayah Dan Lingkungan, 10(3), 236–245. https://doi.org/10.14710/jwl.10.3.236-245
26. Pasaribu, L. P., Apsari, N. C., & Sulastri, S. (2023). Kolaborasi Penta Helix Dalam Penanganan Pasca Bencana Gempa Bumi. Share : Social Work Journal, 13(1), 140. https://doi.org/10.24198/share.v13i1.47909
27. Rocca, L. H. D., & Zielinski, S. (2022). Community-based tourism, social capital, and governance of post-conflict rural tourism destinations: the case of Minca, Sierra Nevada de Santa Marta, Colombia. Tourism Management Perspectives, 43(July). https://doi.org/10.1016/j.tmp.2022.100985
28. Shojaei, F., Sohrabizadeh, S., Qaraeian, P., Yousefi Khoshsabeghe, H., Jandaghi, J., & Farivar, F. (2024). Comparative analysis of two disaster risk assessment tools for primary health care centers: The case of Iran. International Journal of Disaster Risk Reduction, 107(January 2023), 1–10. https://doi.org/10.1016/j.ijdrr.2024.104466
29. Tehler, H., Cedergren, A., de Goër de Herve, M., Gustavsson, J., Hassel, H., Lindbom, H., Nyberg, L., & Wester, M. (2024). Evidence-based disaster risk management: A scoping review focusing on risk, resilience and vulnerability assessment. Progress in Disaster Science, 23(May). https://doi.org/10.1016/j.pdisas.2024.100335

30. Wibowo, E., Suryono, & Saputra, T. (2016). Effect of Giving Dry Shrimp with Different Concentration on the Growth of Green Turtle Baby [Chelonia Mydas (Linnaeus, 1758)] in Sukamade Coastal Areas Meru Betiri National Park, Banyuwangi Regency, East Java, Indonesia. Aquatic Procedia, 7, 54–58. https://doi.org/10.1016/j.aqpro.2016.07.007
31. Yusnaidi, Y., Fahlevi, M., & Hidayat, M. R. (2023). Analisis Persepsi Wisatawan Tentang Peran Stakeholder Terkait Mitigasi Bencana di Destinasi Wisata Kabupaten Aceh Jaya. Jurnal Bisnis Dan Kajian Strategi Manajemen, 7(1), 46–57. https://doi.org/10.35308/jbkan.v7i1.7470
32. Zhao, G., & Niu, X. (2022). Relation between the period of leading tsunami wave and source parameters. Ocean Engineering, 249(February). https://doi.org/10.1016/j.oceaneng.2022.110891
33. Zhuang, H., Yasufuku, N., Kasama, K., & Ishikura, R. (2024). Proposal of a comprehensive risk assessment model for cut slope considering long-term deterioration characteristics based on the concept of disaster immunity. International Journal of Disaster Risk Reduction, 108(February). https://doi.org/10.1016/j.ijdrr.2024.104538