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Disaster Mitigation in a World Heritage City: BPBD's Strategy to Deal with Landslides in Sawahlunto, UNESCO Site

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A B S T R A C T

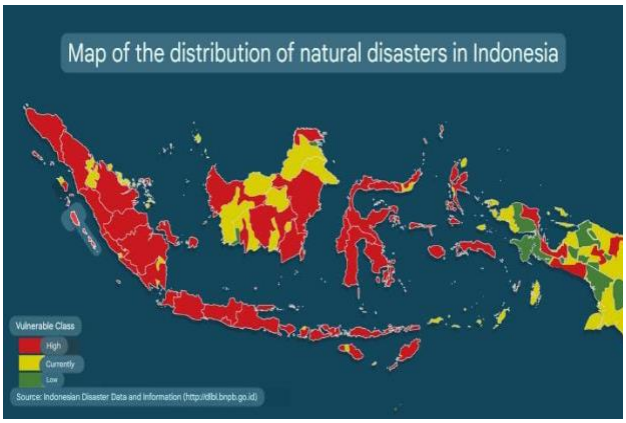
This study analyzes the landslide mitigation strategy by the Regional Disaster Management Agency (BPBD) in Sawahlunto, which faces high landslide risks due to steep topography, land use changes, and high rainfall. Using a descriptive qualitative approach, data were collected through interviews, observations, and document analysis. The findings show that while BPBD has implemented strategies such as the Disaster Resilient Village program and community socialization, their effectiveness remains limited. Challenges include low community awareness, budget constraints, inadequate infrastructure like early warning systems, and weak coordination among Regional Apparatus Organizations (OPDs). Non structural mitigation is hindered by a lack of public understanding of preventive measures, while structural mitigation faces geographical and resource limitations. This study underscores the need for stronger cross sector collaboration and optimized infrastructure. Key recommendations include establishing a comprehensive early warning system, expanding disaster education programs, and strengthening inter agency coordination. Additionally, increasing budget allocation and integrating technology based solutions can improve mitigation efforts. The impact of this research lies in its contribution to more effective disaster mitigation policies in high risk areas, enhancing community resilience and preparedness. The findings also serve as reference for other cities facing similar challenges, providing insights into best practices for disaster risk management.

INTRODUCTION

Indonesia is ranked as the second most disaster-prone country in the world due to various geological, geographical, and climatic factors (Fahrudin et al., 2022). It is located in the Pacific *Ring of Fire*, an area of high seismic and volcanic activity due to the meeting of several large plates, including the Indo-Australian, Eurasian, and Pacific plates (Rasyid et al., 2022).

Earthquakes and volcanic eruptions occur frequently in Indonesia, as there are more than 130 active volcanoes in the country (Malawani et al., 2021; Putera et al., 2019). Global climate change is also affecting weather patterns in Indonesia, with extreme weather events such as tropical storms and extreme rainfall becoming more frequent and intense (Haryanto et al., 2020).

Figure 1. Map of the Distribution of Natural Disasters in Indonesia



Source: www.vrogue.co,2024

Figure 1.1 shows Indonesia's high vulnerability to disasters. In addition, the islands of Sumatra, Java, Kalimantan and Sulawesi, shown in red in the figure, are the most at risk (Robbani et al., 2025). The following data describes the impact and damage that occurred in Indonesia due to disasters in the time span from January 2021 to May 2024, namely:

Table 1. Impact and Damage from Natural Disasters in 2021 - 2024

No.	Year	Impact of Natural Disasters		Natural Disaster Damage		Total Disaster Cases
		Died	Evacuate	Damaged House	Damaged Facilities	
1	2021	728	7.630.692	158.658	4.445	5.402
2	2022	858	6.144.534	95.403	1.983	3.544
3	2023	275	8.491.288	47.214	1.291	5.400
4	2024	239	3.526.054	37.287	706	783

Source: Author's Extract from BNPB Disaster Infographic, 2024

Based on Table 1.1, the impact of various disasters that occurred in Indonesia in 2021 to 2024 is very concerning, based on this data, damage due to disasters is increasing every year, and the total number of disasters continues to increase until in May alone in 2024 it has reached 783 disaster cases.

The province located on the west coast of the island of Sumatra is West Sumatra (Suparno et al., 2022). Which is one of the regions in Indonesia that is very prone to natural disasters (Rozi et al., 2021). Every region in West Sumatra province has more than one potential disaster (Alhadi et al., 2024; Hidayat et

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al., 2021). One of them is Sawahlunto City which has the potential for landslides and fires. This is evidenced by the disasters that always occur in West Sumatra and can be seen in table 1.2 below.

Table 2. Landslide Disaster in West Sumatra per District/City 2017

No.	District/City	Landslide Disaster
1	District 50 City	8
2	Agam District	15
3	Dhamasraya district	1
4	Mentawai district	1
5	Padang Pariaman District	3
6	Pasaman District	8
7	West Pasaman District	9
8	South Pesisir District	7
9	Sijunjung district	12
10	Solok district	8
11	South Solok district	2
12	Tanah Datar Regency	9
13	Bukittinggi City	3
14	Padang City	12
15	Padang Panjang City	2
16	Pariaman City	0
17	Payakumbuh City	2
18	Sawahlunto City	126
19	Solok City	0
	total	**226**

Source: Report of Pusdaslops PB BPBD West Sumatra Province 2017

Table 3. Number of Landslides in Sawahlunto City

No.	Year	Landslides
1	2018	123
2	2019	136
Total		259

Source: Researcher's compilation from BPS Sawahlunto City, 2024

Based on table 1.2 and 1.3 above, it can be concluded that Sawahlunto City is the most frequent area for landslides, which as of 2017 there have been 126 landslides. In 2018 and 2019 there have been 259 landslides. Sawahlunto City has hilly contours and land slope conditions from 45', 50' to 75', this has the potential to cause landslides in Sawahlunto City if hit by continuous rain (Andriani et al., 2024; Purnama et al., 2025).

According to Law No. 24/2007, disaster mitigation is a series of efforts to reduce disaster risk through physical development as well as increasing awareness and ability to deal with disaster threats (Ahmad et al., 2024; Triastari et al., 2021). To deal with disaster threats, the Indonesian government has an important role in building a disaster management system (Rahmafitria et al., 2021). Disaster management in Indonesia is carried out by BNPB, which is regulated in Presidential Regulation Number 8 of 2008 concerning the National Disaster Management Agency (BNPB) (Achmad, 2023). BPBD is responsible for planning, coordinating, and implementing various mitigation strategies and actions aimed at minimizing disaster risk (Framesthi et al., 2023).

Non structural mitigation focuses on reducing disaster risks without physical construction, relying instead on regulations, education, training, and public awareness campaigns (Righi et al., 2021). These efforts aim to strengthen community preparedness through initiatives such as disaster awareness programs, risk based spatial planning, and the development of disaster resilient villages. Complementing these measures, structural mitigation involves physical construction and engineering solutions designed to minimize disaster impacts (Abbas et al., 2021). In the context of landslides, this approach includes building retaining walls to stabilize slopes, improving drainage systems to manage water flow, and installing early warning systems to enhance disaster preparedness.

This study has several limitations. First, it focuses solely on the mitigation strategies implemented by BPBD Sawahlunto City, without an in depth analysis of community and private sector involvement in disaster mitigation. Second, the study employs a qualitative approach through interviews and document analysis, meaning it does not quantitatively measure the effectiveness of the strategies. Third, most of the data used comes from government agencies, so the perspectives of affected communities need further exploration in future research.

There are several relevant previous studies that can be used as references in this research. First, research by H. Haeril (2022) entitled "The Strategy of the Regional Disaster Management Agency (BPBD) in Natural Disaster Risk Reduction in Bima Regency" (Haeril et al., 2022). This research discusses the various strategies implemented by BPBD Bima District in reducing the risk of natural disasters. Second, research from Nindy (2023) entitled "Landslide Disaster Risk Reduction Strategy in Bogor Regency, West Java Province" (Pratiwi, n.d.). This research explores the strategies implemented by BPBD Bogor Regency in reducing landslide risk, including the development of landslide retaining infrastructure. Furthermore, research by Chintya (2022) entitled "Flood Disaster Management Strategies by the Regional Disaster Management Agency (BPBD) of Solok City, West Sumatra" (Chyntia Aulia & Geovani Meiwanda, 2022). This study examines the strategy of BPBD Solok City in dealing with flood disasters, including river flow management, embankment construction, and provision of evacuation facilities.

While this research offers novelty by highlighting the landslide disaster mitigation strategy implemented by the Regional Disaster Management Agency (BPBD) in Sawahlunto City. In contrast to the research by Haeril (2022) which focused more on general natural disaster risk reduction in Bima District, this research specifically addresses landslide mitigation in a mining area with distinctive geographical characteristics. While Haeril emphasized community involvement and the effectiveness of BPBD programs broadly, this study emphasizes BPBD's role in developing disaster resilient villages as well as the long-term evaluation of non-structural strategies. In addition, compared to Nindy's (2023) research that highlighted infrastructure and early warning systems in Bogor District, this research also explores collaboration between BPBD, related agencies and local communities in Sawahlunto City, but with a focus on community-based mitigation approaches in the context of a vulnerable area due to steep slope conditions.

METHOD

This research used a qualitative approach with a descriptive design to to analyze the landslide mitigation strategies

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implemented by the BPBD of Sawahlunto City, West Sumatra. The qualitative approach was chosen to explore and describe mitigation strategies in depth, considering the city's steep topography and history as a coal mining area, which increases its vulnerability to landslides. This approach allowed for a comprehensive understanding of government efforts, community participation, and institutional collaboration in disaster risk reduction.

Primary and secondary data were utilized to ensure a holistic analysis (Taherdoost, 2021). Primary data were collected through in-depth interviews with key informants, including BPBD officials, representatives from relevant DPOs, members of Disaster-Preparedness Groups (KSB), and residents in landslide-prone areas. These respondents were selected purposively based on their roles and experiences in disaster mitigation. Secondary data were obtained from official documents, reports, and field observations, which provided contextual background and supported the primary data findings (Hamzani et al., 2023).

Table 4. Informant Data

No.	Position	Reason
	Head of BPBD Sawahlunto City	To obtain data and information related to disaster management programs and activities that researchers need
	Secretary of BPBD Kota Sawahlunto	To obtain data and information related to management or administrative management that researchers need
	Head of Prevention and Preparedness	To obtain data and information related to prevention and preparedness programs that researchers need
	Head of Prevention and Preparedness Section	To obtain technical data and information related to the implementation of prevention and preparedness programs in the field.
	Head of Emergency and Logistics	To obtain data and information related to emergency disaster management and logistics that researchers need
	Head of Emergency and Logistics Section	To obtain technical data related to logistics distribution and the implementation of emergency response in the field.
	Head of Rehabilitation and Reconstruction	To obtain data and information related to disaster management in the field of reconstruction that researchers need
	Head of Rehabilitation and Reconstruction Section	To obtain technical data related to the implementation of post-disaster rehabilitation and reconstruction in the field.
	Regional Secretary of Sawahlunto City	To obtain data and information related to the ex officio role as Head of BPBD of Sawahlunto City.
	Perkim Office of Sawahlunto City	To obtain data and information related to coordination with BPBD in disaster management in Sawahlunto City.
	BPKAD Sawahlunto City	To obtain data and information related regional financial management th supports disaster mitigation activities.
	Social Services of Sawahlunto City	To obtain data and information related to coordination with BPBD in handling and social assistance during disasters.
	PUPR Office of Sawahlunto City	To obtain data and information related coordination with BPBD in handli infrastructure during a disaster.
	Sub-districts in Sawahlunto	To obtain data and information related to the role of sub-districts in disaster mitigation coordination with BPBD.
	Kelurahan / Village in Sawahlunto	To obtain data and information related to the role of villages in disaster management and coordination with BPBD.

The research followed the Miles and Huberman interactive analysis model, which consists of three stages: data reduction, data presentation, and conclusion drawing (Salmona & Kaczynski, 2024). Data reduction involved selecting, simplifying, and organizing information relevant to landslide mitigation strategies. The data were then presented systematically to facilitate interpretation. Finally, conclusions were drawn based on patterns and relationships identified during the analysis. The credibility of the findings was ensured through triangulation, including method triangulation comparing interviews, observations, and documentation and source triangulation, where information from different respondents and secondary sources was cross-verified (Diaz-Mewes, 2024). To enhance clarity, a visual representation of the research process is provided in the form of a methodological flowchart. This ensures that readers can easily follow the sequence of data collection, analysis, and validation.

RESULTS AND DISCUSSION

Identification of Landslide Prone Areas

Identification of Landslide Prone Areas BPBD Sawahlunto City has mapped landslide prone areas as an initial step to understand the level of disaster vulnerability in the region. This step is in line with W.N. Carter's mitigation theory, which emphasizes the importance of early data collection in disaster risk management (Sarı, 2024). However, without the support of modern technology, the implementation of mitigation remains difficult to do thoroughly. The use of GIS technology can improve accuracy and efficiency in mapping disaster prone areas (Cui et al., 2021).

Figure 2. Landslide-Prone Areas in Sawahlunto City


Table 5. Landslide Hazard Area by Subdistrict and Village in Sawahlunto City

Num	Subdistrict	Village	Hazard Area (HA)
1	Talawi	Tumpuak Tangah Datar	530
2	Talawi	Mansiang	164
3	Talawi	Batu Tanjung	468
4	Talawi	Bukik Gadang	0
5	Talawi	Talawi Hilir	0
6	Talawi	Sijantang Koto	3
7	Talawi	Salak	90
8	Talawi	Rantih	499
9	Talawi	Sikalang	36
10	Talawi	Talawi Mudik	12
11	Talawi	Kumbayau	20
12	Silungkang	Silungkang Duo	103
13	Silungkang	Silungkang Tigo	140
14	Silungkang	Muaro Kalaban	98
15	Silungkang	Taratak Bancah	961
16	Silungkang	Silungkang Oso	620
17	Barangin	Kolok Nan Tuo	122
18	Barangin	Kolok Mudik	186
19	Barangin	Santur	37
20	Barangin	Talago Gunung	613
21	Barangin	Durian Ii	39
22	Barangin	Durian I	26
23	Barangin	Lubang Panjang	0
24	Barangin	Saringan	0
25	Barangin	Balai Batu Sandaran	480
26	Barangin	Lumindai	1000
27	Lembah Segar	Aur Air Dingin	91
28	Lembah Segar	Tanah Lapang	5
29	Lembah Segar	Aur Mulyo	23
30	Lembah Segar	Kubang Sirakuak Selatan	70
31	Lembah Segar	Kubang Sirakuak Utara	27
32	Lembah Segar	Pasar Kubang	84
33	Lembah Segar	Utara Sikabu Kubang	118
34	Lembah Segar	Tangah	244
35	Lembah Segar	Pasar Kubang	112
36	Lembah Segar	Lunto Timur	293
37	Lembah Segar	West Lunto	300
		TOTAL	7526

Source: Landslide Tabulation of Sawahlunto City, 2024

The data collected shows that the area of high landslide hazard reaches 7,526 hectares, with a potential population exposure of 41,093 people. In an interview, Drs. Dedi Ardona, Acting Head of BPBD Sawahlunto City, stated: *"We have mapped landslide-prone areas, especially in Silungkang and Barangin sub-districts. These areas have very steep slopes of more than 45 degrees, making them very risky during the rainy season."*

However, despite the availability of risk maps, the implementation of this data-based program has not been optimal. There are still villages that have not been prioritized in mitigation interventions, especially those related to supporting infrastructure such as evacuation routes. Another challenge is the lack of cross-sector coordination in utilizing the mapping results for concrete preventive actions. The data and analysis from BPBD is the basis for designing more effective mitigation strategies, both at the local (village) scale and the city level as a whole.

Non-Structural Mitigation Efforts

The main focus of these efforts is to increase community awareness and build preparedness through socialization and community-based programs (Kusumastuti et al., 2022). The program is like Desa Tangguh Bencana (Destana), the Destana program and socialization are important steps in building community preparedness (Ningtyas et al., 2021). However, the low level of community participation suggests the need for a more inclusive and culturally adaptive approach (Hamdan & Putera, 2023; Khatibi et al., 2021). Disaster mitigation theory emphasizes the importance of community empowerment as the main actor in reducing disaster risk (Imperiale & Vanclay, 2021; Saputra et al., 2025). A more inclusive and participatory approach can improve community awareness and preparedness (Mahajan et al., 2022).

The non structural approach to disaster mitigation, such as socialization programs and the Disaster Resilient Village (Destana) program, can be explained through disaster mitigation theory, which emphasizes the importance of community empowerment as the main actor in reducing disaster risk (Bonfanti et al., 2023). Based on Arnstein's (1969) theory of participation, the level of community involvement in mitigation programs can be categorized into various stages, ranging from symbolic participation to full engagement in decision-making. In the context of the Destana program in Sawahlunto, the low level of community participation indicates that their involvement is still at the informational or consultative stage, which has not yet reached the ideal partnership level in Arnstein's participation ladder model.

Additionally, the disaster preparedness theory by Paton & Johnston (2001) states that individual and community preparedness is greatly influenced by psychosocial factors, such as risk perception, past disaster experiences, and socio economic

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conditions. In this case, the lack of awareness and participation in disaster socialization and simulation activities can be linked to low risk perception, where the community tends to underestimate disaster threats until they experience them firsthand. Cultural factors and local customs must also be considered in mitigation approaches, as suggested by Khatibi et al. (2021), who emphasize the importance of a more inclusive and culturally adaptive approach.

Referring to adaptive capacity theory (Adger, 2003), the effectiveness of the Destana program also heavily depends on the extent to which the community has access to resources, including knowledge, skills, and institutional support. In this regard, the budget and facility limitations mentioned by BPBD Sawahlunto indicate that the community's adaptive capacity remains constrained, hindering the program's success in fostering sustainable preparedness. Therefore, a more integrative strategy is needed, including stronger collaboration between the government, non-governmental organizations, and the private sector to enhance available resources for the community to implement mitigation programs more effectively.

By incorporating these theoretical perspectives, the analysis of the effectiveness of non structural mitigation in Sawahlunto can be more comprehensive, providing deeper insights into how to improve community participation and preparedness in facing landslide disaster threats.

a. Community Socialization

BPBD routinely conducts socialization on landslide hazards and mitigation measures through various methods, including counseling in schools, community meetings, and distribution of educational materials (Partini & Hidayaht, 2024; Sijabat et al., 2021).

Figure 3. Documentation of Socialization and Disaster Simulation Activities by BPBD Sawahlunto

However, the effectiveness of this socialization is still hampered by low community participation. Many residents tend to be passive and only act reactively after a disaster occurs. In an interview, Drs. Bustami, Head of Prevention and Preparedness of BPBD, stated: *"We often face challenges when conducting socialization. Many residents are less enthusiastic and consider mitigation not a priority. This certainly affects the success of our program."*

b. Disaster Resilient Village (Destana) Program

BPBD also implements the Destana program as a preventive measure to improve community preparedness in landslide-prone villages. The program includes disaster preparedness training, evacuation simulations and the establishment of local volunteer groups (Gundran et al., 2022).

Figure 4. Implementation of the Destana Jamboree Across Sawahlunto City in Kubang Tangah Village, 2024

The training involves various parties, including local volunteers, community groups, and non-governmental organizations, to ensure a collaborative approach in building community resilience (Ganoe et al., 2023; Putera et al., 2020). However, the main obstacles faced are low levels of community participation and limited resources, such as budget and training facilities. Rafki Rusdian, Secretary of BPBD Sawahlunto City, explained:

"We focus on the Destana program to train the community to deal with disasters, but the main obstacle is the low participation of the community in these activities. We also need to improve facilities and infrastructure to support the training."

The results of interviews and observations show that out of a total of 5 Destana priority villages, only 40% of residents actively participate in training and simulations. In addition, based on BPBD reports, less than half of the villages have active disaster preparedness groups. This factor shows that the Destana program has not been optimal in reaching all communities that are vulnerable to disaster risks.

Structural Mitigation Measures

Early warning systems (EWS) that serve to provide early information to the public regarding landslide threats are also still very limited. Currently, BPBD only has a few EWS devices placed in strategic locations, but most of these devices are in a damaged or unmaintained condition. This is due to the limited budget for routine maintenance as well as the lack of competent technicians to handle the equipment. In an interview, Dedi Satria, Head of Emergency and Logistics of BPBD, explained: *"We do not yet have an optimal Early Warning System (EWS) system. Some of the existing tools are damaged and require significant repairs. We also need additional tools in villages that do not have EWS at all."*

The absence of optimal evacuation routes and EWS is an indicator that structural mitigation has not been prioritized in Sawahlunto. Improvement of mitigation infrastructure should be the main focus to effectively reduce disaster risk (Haris et al., 2023). The unavailability of key infrastructure indicates weak policy and budget support (Orengo Serra & Sanchez-Jauregui, 2022). This contrasts with the high urgency of disasters in the region. Investment in adequate mitigation infrastructure can improve disaster preparedness and response (Wu et al., 2021).

Structural mitigation measures are crucial in reducing disaster risk by enhancing physical infrastructure and technical systems designed to anticipate hazards (Freddi et al., 2021). According to disaster risk reduction theory, effective mitigation requires strong engineering solutions, technological interventions, and institutional support (Righi et al., 2021). However, in Sawahlunto, the limited functionality of Early Warning Systems (EWS) and the absence of proper evacuation

routes indicate weak prioritization of structural mitigation. The institutional capacity theory explains that insufficient budget allocation and lack of technical expertise hinder the sustainability of disaster infrastructure (Ziga-Abortta & Kruse, 2023). Without adequate funding and trained personnel, mitigation efforts become reactive rather than preventive, increasing community vulnerability to landslides.

Furthermore, the protection motivation theory suggests that individuals and institutions are more likely to take preventive actions when they perceive both a high risk and effective mitigation strategies (Kim & Crimmins, 2021). In this case, the underdeveloped EWS and evacuation routes may reflect an underestimation of landslide threats at the policy level. Research by Wu et al. (2021) highlights that investment in mitigation infrastructure significantly improves disaster preparedness and response. Therefore, strengthening structural mitigation in Sawahlunto requires not only financial commitment but also proactive policy interventions to ensure that disaster-prone areas are equipped with functional early warning systems and safe evacuation routes.

Challenges in Mitigation Implementation

One of the main challenges is the low awareness of the community in dealing with disaster risks (Cui et al., 2021). Most communities tend to be reactive, taking action only after a disaster occurs, rather than taking preventive measures beforehand. This can be seen from the lack of community involvement in socialization activities and mitigation training. Based on BPBD data, only around 40% of residents in landslide-prone villages actively participate in mitigation activities such as landslide hazard socialization or disaster response training. Drs. Dedi Ardona, Acting Head of BPBD, revealed that low public awareness often hampers prevention efforts, with people preferring to blame others rather than focus on mitigation.

In addition, budget constraints are a major obstacle affecting the implementation of mitigation programs. As a result, many strategic programs, such as procuring additional Early Warning System (EWS) equipment, opening evacuation routes, and building temporary evacuation sites, cannot be implemented optimally. Rafki Rusdian, Secretary of BPBD, explained that budget constraints forced BPBD to postpone some mitigation programs or reduce the scale of their implementation, resulting in less than optimal impact.

The hilly geographical condition of Sawahlunto City with steep slopes adds to the complexity of mitigation implementation. Sub-districts such as Silungkang, Lembah Segar, and Barangin have land slopes of more than 45 degrees, making them highly prone to landslides. These three challenges low public awareness, budget constraints and difficult geographical conditions are interrelated and directly affect mitigation implementation. Low community participation reduces the effectiveness of community-based programs, while budget constraints slow down the procurement of critical infrastructure such as evacuation routes and EWS.

Low public awareness and budget constraints point to the need for a more integrated strategic approach (Cvetković et al., 2021). In addition, geographical challenges are external factors that require innovative solutions. Cross-sector collaboration and community capacity building are key to overcoming these barriers (Mosley, 2021). These barriers illustrate the lack of synergy between the government and the community, which should be at the core of disaster mitigation implementation. Urgent recommendations are to strengthen budget allocations, improve community training, and strengthen the role of cross-sectors. An integrated and collaborative approach can improve the effectiveness of disaster mitigation in Sawahlunto.

Challenges in mitigation implementation can be analyzed through risk perception theory, which explains that low public awareness is due to the underestimation of disaster risks (Haque & Fatema, 2022). This aligns with protection motivation theory, where people take action only when they perceive high risk and believe in effective mitigation measures. However, weak engagement in Sawahlunto suggests the need for stronger awareness campaigns. Additionally, institutional capacity theory highlights that budget constraints limit BPBD's ability to implement key programs like EWS and evacuation routes, weakening disaster preparedness.

The steep terrain of Sawahlunto adds complexity to mitigation efforts, requiring adaptive strategies. Adaptive capacity theory emphasizes the need for flexible, localized solutions to address such challenges. Moreover, multi stakeholder collaboration (Mosley, 2021) is essential to overcoming funding and resource limitations. The lack of synergy between the government and the community weakens disaster response, making it crucial to strengthen budget allocations, improve public participation, and enhance cross-sector cooperation for more effective mitigation.

CONCLUSION

This study concludes that landslide mitigation efforts by the Regional Disaster Management Agency (BPBD) of Sawahlunto City remain suboptimal in addressing the region's high disaster risk. The findings indicate that while several mitigation measures such as mapping landslide-prone areas, implementing the Disaster Resilient Village (Destana) program, and conducting community socialization have been undertaken, their effectiveness is constrained by low public awareness, budget limitations, and challenging geographical conditions.

Non-structural mitigation strategies, including education and community empowerment, have not significantly increased public participation in disaster preparedness. Meanwhile, structural mitigation efforts, such as the construction of evacuation routes and the provision of early warning systems (EWS), remain insufficient due to minimal budget allocation. The city's hilly terrain with extreme slopes further complicates mitigation efforts, underscoring the need for more innovative and integrated strategies. Strengthening cross-sectoral coordination, securing adequate budget allocations, and adopting a collaborative approach that positions communities as key actors in disaster risk reduction are essential steps toward improving mitigation outcomes.

This study acknowledges several limitations. First, the research primarily focuses on BPBD-led mitigation efforts and does not extensively explore the role of private sector or non-governmental organizations in disaster management. Second, while qualitative methods provide in-depth insights, they may limit the generalizability of findings to other regions with different socio-economic and geographical contexts. Future research should explore mitigation technologies tailored to Sawahlunto's topographical challenges, such as community-based early warning systems and adaptive environmental management strategies. Additionally, further studies could examine policy integration between local and national disaster management frameworks to enhance long-term resilience. By

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addressing these challenges and exploring innovative mitigation approaches, Sawahlunto can develop a more resilient and sustainable disaster risk reduction system.

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