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LUSI Burst: Overcoming Toxic Mud Flows in Indonesia Through Disaster Recovery and Mitigation Strategies

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KEYWORDS

Lapindo Mud, Mitigation, Recovery and Planning, Strategy, Toxic Mud

ABSTRACT A major volcanic eruption in May 2006 near a gas drilling site in Sidoarjo, Indonesia, continued to emit toxic substances, including the dangerous chemical phenol. Phenols, which are found in oil and gas, pharmaceuticals, paint, and electronics, can cause human skin, eye, and mucous membrane irritation if exposed. The impact of the Lapindo mudflow has been detrimental to the economy, society, and ecology, including damage to agricultural land, disruption of livelihoods, and business closures. This research aims to identify effective disaster recovery and mitigation strategies in dealing with toxic mudflows. Authorities have planned to divert mud into the Porong River, convert the affected area into a tourist attraction, and use control pumps to deal with flooding. However, the collapse of the mud embankment caused public concern about flooding and loss of life. This study uses snowball sampling and phenomenology methods, focusing on residents around the Lapindo embankment area in Gempolsari Village. Data was collected through interviews, observation, and photo documentation. The research results show the importance of mitigation strategies that involve village halls to provide information and build residents' confidence in facing disasters. It is hoped that these findings will provide insights for the development of more effective disaster mitigation systems.

1. INTRODUCTION

The 2006 Sidoarjo mudflow disaster, commonly referred to as the Lapindo mudflow, remains one of Indonesia's most catastrophic environmental crises (Eggers, 2020; Khalaf & Hamad, 2023; Rubonis, 1991a). Originating near a gas drilling site, the eruption has continued to release toxic substances (Ekawati, 2021; Flanagan, 2020a; Palupi, 2021), including phenols, which are known for their hazardous effects on human health and the environment. Phenols, ubiquitous in various industrial applications such as oil and gas, pharmaceuticals, and electronics (Hao, 2020a; Ramadan, 2024; Zandalinas, 2021), can cause severe irritation to the skin, eyes, and mucous membranes upon exposure (Al-Taee & Kashkooul, 2023). The long-term discharge of these chemicals has led to significant socio-economic and ecological damage (Ekawati, 2020; Flanagan, 2020b; Mujahidin et al., 2023), necessitating comprehensive disaster recovery and mitigation strategies.

Empirical studies have documented the extensive impact of the Lapindo mudflow on the local economy and society (Hao, 2020b; Nalarsih, 2024). For example, research conducted by Davies et al. (2007) highlighted the extensive damage to agricultural land and the subsequent disruption of livelihoods. Business closures and the displacement of communities have further compounded the economic strain on the region. Additionally, environmental studies have underscored the adverse effects on local ecosystems, with significant alterations in soil composition and water quality reported by Mazzini et al. (2009).

The Lapindo mudflow disaster, also known as the LUSI (Lumpur Sidoarjo) mudflow (Hendarto & Hiat, 2024), remains one of Indonesia's most significant environmental calamities. Despite various efforts over the past 17 years (Kouadio, 2012; North, 2013; Whittaker, 2015a), the toxic mudflow continues to pose severe threats to the local population, economy, and environment. Previous research has highlighted multiple challenges in managing such large-scale disasters, including the complexity of coordinating effective recovery strategies, the technical difficulties in controlling the continuous flow of toxic substances, and the socio-economic impact on affected communities.

Empirical evidence from earlier studies underscores the critical need for innovative and sustainable disaster recovery and mitigation strategies (Bonanno, 2010a; Faturechi, 2015; Whittaker, 2015b). For example, a study by Davies et al. (2007) illustrated the long-term environmental degradation caused by mudflow and its adverse effects on human health due to prolonged exposure to hazardous chemicals like phenol. Additionally, the socio-economic impact, as documented by Susilo (2010), reveals that thousands of residents have experienced displacement, loss of livelihood, and psychological distress. These findings emphasize the necessity for comprehensive research that not only addresses immediate recovery but also ensures long-term resilience and safety for the affected communities.

The current research aims to bridge these gaps by focusing on a holistic approach to disaster recovery and mitigation. By employing snowball sampling and phenomenology methods, this study delves into the lived experiences of residents in Gempolsari Village, an area severely impacted by the Lapindo mudflow (Bonanno, 2010b; Gabaix, 2012). Data collection through interviews, observations, and photo documentation provides a robust framework for understanding the community's needs and concerns. This research aspires to offer actionable insights and recommend effective strategies that can be implemented by local authorities and stakeholders to enhance disaster preparedness and recovery efforts in Indonesia.

Given the complexity and severity of the situation, this research aims to identify and evaluate effective disaster recovery and mitigation strategies for managing toxic mudflows (Nursaid, 2024). Current efforts by authorities to divert the mud into the Porong River, transform the affected area into a tourist attraction, and implement control pumps to manage flooding have faced considerable challenges, including the failure of mud embankments, which heightened public concerns about additional flooding and potential loss of life. By employing snowball sampling and phenomenology methods, this study focuses on the lived experiences of residents in Gempolsari Village, near the Lapindo embankment. Data collection through interviews, observations, and photo documentation aims to provide a nuanced understanding of the efficacy of current mitigation strategies and highlight the critical role of community engagement and information dissemination through village halls in building resilience against future disasters.

In conclusion, this research not only aims to offer a comprehensive analysis of the current disaster mitigation efforts but also seeks to amplify the voices of the affected residents, ensuring their experiences and insights contribute to more effective and sustainable disaster management strategies. By emphasizing community engagement and thorough data collection, the study strives to present a detailed picture of the challenges and opportunities in disaster recovery. Ultimately, the goal is to foster a more resilient and prepared community in Gempolsari Village and similar areas across Indonesia, ensuring that future mitigation efforts are informed by those who have lived through these devastating events.

2. METHODS

This research employs a mixed-method approach, integrating both qualitative and quantitative data collection and analysis techniques. The main methodologies utilized are snowball sampling and phenomenology, which are particularly effective in understanding the lived experiences and perspectives of the affected community members.

1. Snowball Sampling:

Snowball sampling is an effective method for identifying and recruiting participants who are knowledgeable about the Lapindo mudflow disaster. This technique begins by identifying a small group of initial subjects who meet the study's criteria. These subjects then refer other potential participants who are similarly knowledgeable and affected by the mudflow. This

sampling method is ideal for reaching a target population that may be difficult to access through conventional sampling techniques. The process of snowball sampling in this research involved the following steps:

a. **Initial Contact**: Establishing contact with key informants from Gempolsari Village, who have firsthand experience with the Lapindo mudflow.

b. **Referrals**: Requesting initial informants to refer other residents who are also affected by the disaster.

c. **Confirmation** (Hendarto et al., 2023): Verifying the eligibility of referred participants to ensure they meet the study criteria.

d. **Inclusion** (Sungkawati, 2024): Including referred participants into the study, and repeating the referral process until a sufficient sample size is achieved.

2. Phenomenology:

Phenomenological research is employed to delve deeply into the personal experiences and perceptions of the residents living near the Lapindo embankment. This method allows for a detailed exploration of their lived experiences and the impact of the mudflow on their daily lives. The phenomenological approach involves:

a. **In-depth Interviews** (Nalarsih, 2024): Conducting semi-structured interviews with participants to gather detailed narratives about their experiences, challenges, and coping mechanisms. Interviews are recorded and transcribed for thorough analysis.

b. **Participant Observation** (Darmayanti et al., 2023): Observing the daily activities and interactions of residents in Gempolsari Village to gain contextual insights into their lives and the ongoing impact of the mudflow.

c. **Photo Documentation** (Awad et al., 2024): Collecting visual data through photographs to document the physical and environmental changes in the area, providing empirical evidence to support the analysis.

Empirical Evidence from Previous Studies
Previous studies on disaster recovery and mitigation have highlighted the effectiveness of community involvement and local knowledge in developing resilient strategies. For instance, a study by (Gandy, 2008) found that community-based disaster risk reduction (CBDRR) significantly enhances the capacity of local communities to manage and mitigate disaster risks. Similarly, research by Wisner et al. (2012) emphasized the importance of integrating local knowledge and practices into formal disaster management frameworks to ensure sustainability and effectiveness.

In this research, the use of snowball sampling ensures that a diverse range of perspectives is captured, while phenomenology provides a deep understanding of the individual and collective experiences of affected residents. The combination of these methods facilitates a comprehensive analysis of the challenges and potential solutions for overcoming the toxic mudflow disaster in Sidoarjo.

Table 1: Steps in Research Methods

Step	Description	Purpose
Initial Contact	Contacting key informants in Gempolsari Village	Establish initial participant pool
Referrals	Asking initial informants to refer other knowledgeable and affected residents	Expand participant pool
Confirmation	Verifying eligibility of referred participants	Ensure study criteria are met
In-depth Interviews	Conducting semi-structured interviews with participants	Gather detailed narratives and personal experiences
Participant Observation	Observing daily activities and interactions in the village	Gain contextual insights
Photo Documentation	Taking photographs to document physical and environmental changes	Provide empirical evidence

By systematically applying these methods, the research aims to uncover effective disaster recovery and mitigation strategies that are rooted in the lived experiences and local knowledge of the affected communities.

3. RESULT AND DISCUSSION

3.1 Economic Impact and Recovery Strategies

The economic repercussions of the LUSI mudflow have been profound, disrupting local businesses and forcing many to close (Yuniwati et al., 2023). The destruction of agricultural land has led to significant financial losses for farmers who depended on their crops for income. Previous studies, such as those by Sutikno (2008), highlight that the immediate economic impact included a sharp decline in agricultural productivity and a surge in unemployment rates. To counteract these effects, recovery strategies have been proposed (Sudiantini et al., 2023), including financial compensation for affected families and the creation of alternative employment opportunities through government-funded programs (Dahliani et al., 2024). The introduction of microfinance initiatives

has shown promise in helping local businesses regain stability and foster economic resilience.

3.1.1 Economic Impact

The LUSI mudflow has rendered thousands of hectares of fertile land unusable, crippling the agrarian economy of the region (Sungkawati et al., 2023). According to a study by Kartomo et al. (2010), the mudflow displaced over 13,000 families and led to the closure of more than 20 small and medium enterprises (SMEs). This displacement also caused a significant drop in the regional GDP, estimated at around 5% in the first year alone (Sutikno, 2008). The agricultural sector, which was the backbone of Sidoarjo's economy, experienced the most severe blow, with rice and sugarcane plantations being the worst hit.

3.1.2 Recovery Strategies

To mitigate these economic impacts, several recovery strategies have been implemented and proposed. One of the primary measures is the provision of financial compensation to affected families. A report by the Ministry of Social Affairs in 2009 indicated that over IDR 1.5 trillion was allocated for compensation, although the distribution process faced numerous bureaucratic hurdles. Additionally, the government introduced livelihood programs aimed at creating alternative employment opportunities. For instance, the "Rebuild Sidoarjo" initiative focused on skill development and vocational training, enabling displaced farmers and workers to transition into new trades.

Comparing the LUSI mudflow disaster recovery with other international cases provides valuable insights. In the aftermath of the 2011 Tōhoku earthquake and tsunami in Japan, the Japanese government implemented extensive economic recovery plans, including direct financial aid, tax breaks, and infrastructure rehabilitation (Mimura et al., 2011). Similarly, the response to Hurricane Katrina in the United States involved federal assistance through the Federal Emergency Management Agency (FEMA), which focused on rebuilding infrastructure and providing financial aid to affected businesses (Baker, 2006).

Empirical evidence supports the efficacy of these strategies in fostering economic resilience (Hendarto et al., 2024). A longitudinal study by Yulianti (2012) on the microfinance initiatives in Sidoarjo found that small loans significantly helped local businesses to restart and grow, reducing unemployment by 15% over two years. Additionally, the introduction of vocational training programs has enabled nearly 30% of displaced workers to secure new jobs in different sectors (Sugiono, 2011).

In conclusion, effective disaster recovery and mitigation strategies are crucial for economic resilience in the face of catastrophic events like the LUSI mudflow (Rubonis, 1991b). By learning from both local and international experiences, and through the implementation of well-planned economic recovery initiatives, it is possible to restore livelihoods and promote sustainable economic development in disaster-affected regions.

Table 2: Economic Impact of the LUSI Mudflow

Impact Category	Description	Source
Agricultural Loss	Destruction of over 1,000 hectares of rice and sugarcane fields	Kartomo et al., 2010
Business Closures	Over 20 SMEs closed due to the disaster	Sutikno, 2008
Unemployment Surge	Unemployment rate increased by 25% in affected areas	Yulianti, 2012
Regional GDP Decline	Approximately 5% drop in the first year	Ministry of Social Affairs, 2009
Financial Compensation	IDR 1.5 trillion allocated for affected families	Ministry of Social Affairs, 2009
Microfinance Initiatives	Small loans are provided to help restart local businesses	Sugiono, 2011
Vocational Training Programs	30% of displaced workers secured new jobs through vocational training	Sugiono, 2011

By analyzing these strategies and their outcomes, this research aims to provide a comprehensive understanding of the best practices for economic recovery in the wake of environmental disasters.

3.2 Social and Psychological Impact

The social and psychological impact on the residents of Gempolsari Village has been significant and multifaceted. The displacement and loss of property caused by the Lapindo mudflow have led to widespread distress among the affected communities. Herawati and Santoso (2010) found that residents displayed symptoms of anxiety and depression due to the uncertainty surrounding their living conditions and future prospects. These psychological effects are compounded by the disruption of social networks and community structures, which are vital for emotional and practical support.

Psychological Support and Transparent Communication

Mitigation strategies must address these social dimensions by incorporating psychological support and ensuring transparent communication from authorities. According to a study conducted by the International Federation of Red Cross and Red Crescent Societies (IFRC, 2014), effective disaster response includes psychological first aid and ongoing mental health support to help individuals cope with the aftermath of such traumatic events. Establishing village halls as information centers can serve as a pivotal strategy in this regard. These centers can distribute accurate information, provide a platform for community support, and build residents' confidence in disaster management efforts. For instance, the integration of mental health professionals and trained volunteers in these centers can offer immediate psychological assistance, while regular community meetings can keep residents informed and involved in recovery plans.

Empirical evidence from previous studies supports the efficacy of these approaches. Research conducted by Norris et al. (2002) on disaster mental health services highlighted the importance of community-based interventions in mitigating the psychological impact of disasters. Similarly, a comparative analysis of disaster recovery efforts in Japan and the United States by Uchida et al. (2011) demonstrated that communities with robust communication channels and mental health support systems exhibited better psychological resilience and quicker recovery.

In conclusion, addressing the social and psychological impact of the Lapindo mudflow requires a comprehensive approach that includes psychological support, transparent communication, and community engagement. By leveraging the experiences and best practices from other disaster recovery efforts globally, authorities can develop effective strategies to mitigate the adverse effects on residents, thereby fostering a more resilient and informed community.

Table 3. The experiences and best practices from other disaster recovery efforts globally

Study	Findings	Recommendations
Herawati & Santoso (2010)	Residents exhibit anxiety and depression due to uncertain living conditions.	Provide psychological support and transparent communication to alleviate distress.
IFRC (2014)	Psychological first aid is crucial in disaster response.	Establish village halls as information centers with mental health professionals.
Norris et al. (2002)	Community-based interventions are effective in disaster mental health support.	Integrate community meetings and ongoing mental health services in recovery efforts.
Uchida et al. (2011)	Strong communication and mental health systems lead to better resilience.	Develop robust community engagement and information dissemination strategies.

By implementing these recommendations, the mitigation and recovery efforts in Gempolsari Village can be significantly improved, ensuring that the residents are better equipped to face future disasters with confidence and resilience.

3.3 Environmental Degradation and Control Measures

The environmental damage caused by the toxic mudflows in Sidoarjo has been extensive, adversely affecting soil quality, water sources, and overall biodiversity. Phenol contamination, in particular, poses a long-term threat to the ecosystem. According to Lestari et al. (2011), phenol contamination has significantly reduced biodiversity in the region, impacting both plant and animal life. The toxic substances present in the mud, such as phenol, can persist in the environment, leading to prolonged ecological damage if not properly managed.

3.3.1 Bioremediation Techniques

Bioremediation has emerged as a promising control measure to mitigate the environmental impact of the toxic mudflows. This technique involves the use of microorganisms to break down harmful substances into less toxic or non-toxic compounds. Studies conducted in various countries, such as the United States and Canada, have shown the effectiveness of bioremediation in dealing with oil spills and other types of chemical contamination. For instance, a study by Jones et al. (2010) demonstrated that bioremediation reduced phenol levels in contaminated soil by more than 70% within six months. Applying similar techniques in Sidoarjo could help restore soil quality and support the recovery of local biodiversity.

3.3.2 Diversion of Mud into the Porong River

Another proposed strategy is the diversion of mud into the Porong River. This method aims to prevent further land degradation and manage the volume of mud being produced. However, this approach raises concerns about potential flooding and water pollution. According to a study by the Environmental Protection Agency (EPA) in the United States, diverting contaminated materials into water bodies must be carefully managed to avoid secondary pollution. The construction of more effective embankments and the installation of control pumps are essential measures to mitigate these risks. These structures can help control the flow of mud, prevent flooding, and minimize the spread of toxic substances.

Empirical evidence from previous studies supports the effectiveness of these control measures. For example, a

comparative study by Wang et al. (2012) on flood control measures in China and the Netherlands found that well-designed embankments and pumping systems significantly reduced the risk of flooding in areas prone to water-related disasters. Additionally, a study by Smith et al. (2015) on the use of bioremediation in oil spill sites in Alaska showed that microbial treatments accelerated the breakdown of toxic substances, leading to faster ecological recovery.

The environmental degradation caused by the Lapindo mudflow necessitates the implementation of effective control measures to mitigate its impact. Bioremediation techniques and the diversion of mud into the Porong River, supported by robust embankments and control pumps, can help manage the ecological damage. Empirical evidence from previous studies underscores the potential success of these strategies. By integrating these approaches, authorities can work towards restoring the affected areas and preventing future environmental disasters.

Table 4: Summary of Empirical Evidence from Previous Studies

Study	Location	Control Measure	Outcome
Jones et al. (2010)	United States	Bioremediation	Reduced phenol levels in soil by over 70% within six months
Wang et al. (2012)	China and Netherlands	Embankments, Pumps	Significantly reduced flooding risk in water-prone areas
Smith et al. (2015)	Alaska, United States	Bioremediation	Accelerated breakdown of toxic substances, leading to faster recovery
Lestari et al. (2011)	Sidoarjo, Indonesia	Phenol Impact Study	Highlighted significant reduction in biodiversity due to phenol

By drawing on these insights and incorporating proven strategies, this research aims to contribute to the development of effective disaster recovery and mitigation systems for the Lapindo mudflow and similar environmental crises.

3.4 Infrastructure and Urban Planning

Overview of Infrastructure Integrity and Urban Planning The failure of mud embankments in Sidoarjo has underscored the urgent need for robust infrastructure and strategic urban planning. Effective urban planning is essential for mitigating risks and enhancing the resilience of communities against future disasters. According to Nugroho (2012), integrating disaster risk assessments into urban planning is fundamental to strengthening infrastructure and ensuring community safety. This section delves into infrastructure and urban planning strategies, supported by empirical evidence and expert opinions from various countries, to provide a comprehensive understanding of best practices in disaster mitigation.

Reinforcement of Embankments and Flood Control Systems One of the critical infrastructure projects in mitigating mudflow disasters is the reinforcement of embankments. Empirical studies, such as those conducted by Setiawan et al. (2015), have shown that reinforced embankments significantly reduce the risk of collapse during extreme weather events. In Japan, for instance, the use of advanced materials and engineering techniques in embankment construction has proven effective in preventing flood-related disasters (Yamamoto, 2018). Similarly, the Netherlands employs sophisticated flood control systems, including levees and storm surge barriers, which have been instrumental in protecting low-lying areas from flooding (de Moel et al., 2014).

Dual-Purpose Strategy: Economic Recovery and Disaster Awareness Converting affected areas into tourist attractions serves a dual-purpose strategy that promotes economic recovery and raises disaster preparedness awareness. In New Orleans, post-Hurricane Katrina recovery efforts included developing tourism centered around the city's resilience and recovery. This approach not only rejuvenated the local economy but also educated visitors on disaster preparedness and resilience (Smith, 2010). Similarly, in Iceland, the Eyjafjallajökull eruption site has been transformed into a tourist destination, providing economic benefits while highlighting the importance of disaster mitigation (Gudmundsson, 2016).

Table 5: Comparative Analysis of Disaster Mitigation Strategies

Country	Strategy	Empirical Evidence	Outcome
Japan	Advanced embankment reinforcement	Yamamoto (2018)	Reduced risk of flood-related disasters
Netherlands	Sophisticated flood control systems	de Moel et al. (2014)	Protection of low-lying areas
New Orleans, USA	Tourism-based economic recovery	Smith (2010)	Economic rejuvenation and disaster awareness
Iceland	Tourist attraction development	Gudmundsson (2016)	Economic benefits and increased preparedness
Indonesia	Community-based risk reduction	Lassa (2013)	Enhanced local resilience

In conclusion, the integration of disaster risk assessments into urban planning is crucial for enhancing community resilience and infrastructure integrity. Reinforced embankments and sophisticated flood control systems (Chen, 2016; Kaplanski, 2010a; Lesk, 2016), coupled with innovative strategies like converting disaster-affected areas into tourist attractions, can significantly mitigate the impact of toxic mudflows. Empirical evidence from various countries demonstrates the effectiveness of these approaches, providing valuable insights for the development of more robust disaster mitigation systems in Indonesia.

3.5 Community Engagement and Education

Community involvement is pivotal in disaster recovery and mitigation. Engaging residents in planning and decision-making processes can foster a sense of ownership and cooperation (Gray, 2012a, 2012b; Zhao, 2019a). Educational programs aimed at increasing awareness about the risks associated with toxic mud and the importance of disaster preparedness can empower residents. Studies by Wijaya (2013) demonstrate that community-driven initiatives have a higher success rate in disaster recovery. Establishing regular training sessions and drills can ensure that the community is well-prepared to handle future emergencies.

Community engagement and education are effective in various disaster-affected regions globally. In Japan, for instance, community-based disaster risk reduction (CBDRR) has been a cornerstone in managing frequent natural disasters. According to Shaw (2006), community participation in disaster drills, evacuation planning, and hazard mapping significantly reduces casualties and enhances resilience (Middleton, 2014; Sprang, 2013; Yuan, 2016). This approach can be adapted to the situation in Sidoarjo, where residents can participate in designing evacuation routes, understanding the health risks of phenol exposure, and learning about safe practices during mudflow incidents.

Further empirical evidence from the United States supports the importance of community involvement in disaster recovery. A study by Paton and Johnston (2001) in the context of wildfire preparedness highlighted that communities that actively engage in educational programs and preparedness activities are better able to respond to and recover from disasters. These programs often include workshops, public meetings, and the distribution of informational materials, all of which serve to inform and empower the populace. This participatory approach can be mirrored in Gempolsari Village (Goldmann, 2014; Smith, 2013a, 2013b), where authorities can collaborate with local leaders to facilitate knowledge transfer and build a culture of safety and preparedness.

In addition, research conducted in the aftermath of the 2004 Indian Ocean tsunami underscores the value of local knowledge and community engagement in recovery efforts. According to Rigg and Law (2005), communities that leveraged local knowledge and skills in rebuilding efforts were more successful in long-term recovery (Loayza, 2012; Moussaïd, 2011). This finding suggests that in Gempolsari Village, harnessing local knowledge about traditional land use and water management could enhance recovery strategies and ensure they are culturally appropriate and sustainable.

In conclusion, the integration of community engagement and education into disaster mitigation strategies is crucial. By involving residents in decision-making, providing continuous education (Cameron, 2015; Kaplanski, 2010b; Lurie, 2018), and leveraging local knowledge, authorities can enhance the resilience and preparedness of communities facing the ongoing threat of toxic mud flows. The empirical evidence from various global contexts underscores that such participatory approaches are not only effective but also essential for sustainable disaster management.

4. CONCLUSION

This research concludes that effective mitigation and recovery strategies are needed to overcome the impact of the LUSI toxic mudflow in Sidoarjo. The research found that despite efforts by authorities to divert mud into the Porong River, turn affected areas into tourist attractions, and use control pumps to deal with flooding, challenges remain. One of the major challenges was the collapse of the mud embankment which raised public concern about the risk of flooding and loss of life.

Using snowball sampling and phenomenology methods, this research collected data from residents around the Lapindo embankment area in Gempolsari Village. Data was collected through interviews, observation and photo documentation. The research results show the importance of mitigation strategies that involve village halls to provide information and build residents' trust in facing disasters. Apart from that, education and training for residents on how to deal with emergency situations is also very important to increase community preparedness.

It is hoped that these findings can provide insight for the development of more effective disaster mitigation systems in the future. Collaborative efforts between government, communities and related organizations are needed to ensure that mitigation and recovery strategies can be implemented well and provide maximum protection for the community.

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