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An Integrated Analysis of Disaster Mitigation Based on Social Vulnerability and Stakeholder Roles

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Abstract

This research aims to comprehensively analyze disaster mitigation issues and aspects linked to social vulnerability, while also scrutinizing the pivotal roles of stakeholders in pre-disaster, during, and post-disaster scenarios. Employing a sequential mixed method approach, our study amalgamates both qualitative and quantitative analyses, utilizing Atlas.ti and Mactor analysis (Matrix of Alliances and Conflicts: Tactics, Objectives, and Recommendations) as primary analytical tools. Our findings reveal nine principal aspects and their derivatives in the execution of disaster mitigation grounded in social vulnerability. These aspects encompass institutional dimensions, disaster mitigation strategies, support and assistance mechanisms, disaster education initiatives, vulnerable community involvement, disaster information systems, evacuation procedures, displacement protocols, and relocation strategies. Each aspect manifests its unique set of issues, as elaborated in the results and discussion section. Regarding the role of stakeholders in disaster mitigation, our research underscores the significance of community leaders and disaster-resilient village figures as key actors. These stakeholders significantly contribute to policy formulation, information dissemination, and the successful implementation of disaster mitigation strategies throughout all phases of disaster management. Their active involvement fosters convergence and alliance formation, which holds significant potential and intensification in disaster mitigation efforts. This study provides a comprehensive framework for disaster mitigation efforts, considering social vulnerability and the critical roles played by stakeholders, thereby advancing the field of disaster management.

Keywords: Disaster Mitigation, Social Vulnerability, Stakeholder Roles, Mixed Method Approach, Mactor Analysis.

1. Introduction

Mitigation constitutes a series of endeavors aimed at reducing disaster risk, encompassing physical development, awareness-building, and bolstering the capacity to confront potential disaster threats (Paton & Johnston, 2014; Wells et al., 2013). According to Law No. 24 of 2007 on Disaster Management, mitigation efforts span pre-disaster, during-disaster, and post-disaster actions, involving all relevant stakeholders. Pre-disaster activities entail preparedness measures that aim to provide the population with the understanding needed to anticipate disaster. This involves information dissemination and enhancing readiness in the event of a disaster, thereby establishing protocols to minimize disaster risk. The assessment of disaster risk hinges on the evaluation of threat magnitude and vulnerability in specific regions, wherein

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risk is defined by levels of vulnerability, susceptibility, and capacity. Non-physical vulnerability, including social vulnerability, is a determining factor in the extent of losses incurred during volcanic disasters. Social vulnerability reflects the estimated susceptibility to loss of life and health within the population when a disaster occurs (Habibi & Buchori, 2013). Macro-level impacts of disasters are illustrated in Figure 1.

Figure 1



Figure 1. Macro-level Impacts of Disasters

The Sendai Framework for Disaster Risk Reduction 2015-2030 identifies high-risk vulnerable groups characterized by their limited capacity to prepare for or respond to disaster risks and threats. These groups include infants, toddlers, children, pregnant and lactating mothers, individuals with disabilities, and the elderly (Paton & Johnston, 2014). Mitigation comprises several essential components. Firstly, natural disaster management involves the creation of maps for disaster-prone areas, preparation of public facilities, educational initiatives, and the promotion of public awareness. Secondly, planning is employed to minimize casualties and mitigate damage to public service facilities. This includes efforts to reduce risk levels, manage community resources, and provide training to residents in disaster-prone areas. Thirdly, response strategies are designed to minimize disaster-related hazards. Finally, recovery is a crucial phase following a disaster for the restoration of the community's conditions. The significance of this research lies in the limited exploration of vulnerability-based disaster mitigation patterns and the necessity of gender sensitivity to address existing inequalities (Musundi et al., 2013; Yumarni et al., 2014). Traditional gender role constructs significantly influence how disasters impact both men and women (Parkinson et al., 2015).

The impacts of natural disasters on human life encompass loss of life, health issues, mental distress, disruption of activities, lack of clean water and food, and economic losses, which can lead to worsened economic conditions. Increased attention to disaster risk reduction began in the 1990s. In 2005, the World Conference on Disaster Reduction took place in Kobe, Japan. The subsequent Sendai Framework, initiated by the United Nations, provided crucial guidance and activities for disaster risk reduction. Indonesia, as a nation, ratified and incorporated it into Disaster Management Law No. 24 of 2007. In disaster-prone communities, empowerment primarily involves how communities can anticipate potential disasters, prepare themselves

physically and mentally to face them, and take action after a disaster occurs. These three elements are crucial since disasters often result in various forms of loss, including loss of life, family members, and property. Therefore, vulnerable communities need to acquire literacy about disaster mitigation to better prepare for and recover from disasters. Empowerment necessitates various internal and external factors, including community involvement, geographical environmental factors, institutional support, and government policies.

The assessment of disaster impacts employs the Damage and Loss Assessment method, which is promptly compiled following a disaster. This method serves as the foundation for calculating the costs and investments required for post-disaster recovery. The calculation of damages includes the valuation of physical assets that are either partially or completely damaged, economic losses incurred due to damaged assets rendering them temporarily unusable for economic activities, and macro impacts resulting from the disaster. These macro impacts encompass effects on economic growth, GDP, and the government's fiscal condition (Alawiyah, 2015; Ratnatunga & Sopanah, 2015). This research aims to provide a comprehensive analysis of disaster mitigation, emphasizing its connection to social vulnerability, and to investigate the pivotal roles of stakeholders in disaster management across the phases of preparedness, response, and recovery. The research formulation centers on exploring the intricate relationships between disaster mitigation and social vulnerability while examining the dynamic engagement of stakeholders throughout the disaster management process. This study contributes to the existing body of knowledge by shedding light on the complex landscape of disaster mitigation, specifically in the context of social vulnerability, and by highlighting the indispensable roles played by stakeholders in disaster management. The insights gained from this research are expected to advance our understanding of disaster risk reduction and inform the development of more effective strategies for enhancing disaster resilience and response.

2. Materials and Methods

Natural disasters have varying gender-specific impacts, primarily attributable to their capacity to reconfigure the social structure of communities, particularly with regard to gender roles and responsibilities. According to the Resilience Development Initiative, women often experience more severe risk impacts than men when disasters strike, partly due to physical strength limitations and their roles as mothers responsible for safeguarding their children. This responsibility is magnified when women lose male family members, necessitating that they assume both the roles of economic providers and family protectors. Vulnerability extends to demographic factors, including education, age, occupation, income, and marital status. In practice, women can and do play a significant role in disaster management across all phases, yet they often remain under-recognized, particularly in marginalized societies where their roles are confined to domestic spheres. Disparities and imbalances in access to economic resources place women in vulnerable positions. Numerous studies underscore the essential roles women perform during and after disasters, including logistics, caregiving, and post-disaster trauma recovery (Nastiti et al., 2016; Tamalene et al., 2021).

Research involving case studies from the Philippines, Indonesia, and Samoa reveals that gender minorities exhibit distinct vulnerability patterns due to their marginalized status in society. Recognizing their unique needs, skills, and resources is imperative for the development of inclusive and gender-sensitive disaster reduction strategies. The Sustainable Development Goals (SDGs), particularly in the context of gender, promote an understanding of gender equality across all facets of life, including disaster management (Fothergill, 1998; Gaillard et al.,

2017). This research employs a mixed-method approach, combining both quantitative and qualitative methods. The mixed-method concept serves not only to address research methods but also to seek comprehensive answers to the issues under investigation. Creswell (2014) categorizes mixed methods into two main categories: sequential and concurrent. In this study, the sequential explanatory model is employed, where the researcher progresses in a sequence, initially analyzing data using qualitative methods to elucidate phenomena related to spatial analysis based on social vulnerability, followed by quantitative methods to reinforce the preceding discussion through explanation and scientific argumentation (Creswell, 2014).

The sequential explanatory method is employed to address the first and second objectives, which will be integrated into an overarching framework for vulnerability-based social risk management. The first objective involves the analysis of disaster mitigation based on social vulnerability levels, and this is accomplished using Atlas.ti, an analytical tool that structures existing issues and organizes them in a hierarchical framework, facilitating the sorting of problems according to their level of importance and influence. The second objective is the analysis of the roles of stakeholders in preparing for and addressing issues before, during, and after disasters. The stakeholders in this study encompass various actors at different levels, including government policy-makers, community members, volunteers, and other parties with direct or indirect interests in disaster mitigation efforts. The sequential explanatory method in this research involves the organization of qualitative analysis, followed by explanations based on empirical evidence obtained from quantitative analysis. The first tool employed is Atlas.ti, and this is followed by stakeholder analysis, which specifically examines the roles of stakeholders in disaster mitigation processes, encompassing their participation and efforts to resolve disaster mitigation issues. The Matrix of Alliances and Conflicts: Tactics, Objectives, and Recommendations (MACTOR) serves as the analytical tool for stakeholder analysis.

ATLAS.ti is one of the Computer-Aided Qualitative Data Analysis Software (CAQDAS) tools that facilitates researchers in conducting organized, systematic, effective, and efficient data analysis in their research endeavors. This software enables qualitative data to become more visually accessible, easily transferable, and also streamlines the process of analytical discussions among multiple researchers. ATLAS.ti serves as a valuable tool for researchers throughout the research process, commencing from the conception or initial development of the research objectives and extending to the study's conclusion. ATLAS.ti aids in the systematic and efficient organization, coding, and analysis of research data. The software has the capability to handle various types of data, including audio, video, images, and written materials such as articles, books, survey data, and interview transcripts. Additionally, ATLAS.ti allows for triangulation through the utilization of various data collection methods. As a qualitative analysis tool, ATLAS.ti offers several advantages compared to other software. It can accommodate a variety of data types, including videos, text, articles, as well as notes from focus group discussions and in-depth interviews. Furthermore, it can structure the issues being addressed by utilizing grounded theory and phenomenology to search for relevant data.

The final analysis pertains to stakeholder analysis. Stakeholders represent a diverse array of parties involved in a given activity, capable of exerting influence and being influenced by decisions made within that context. Stakeholders are commonly defined as individuals, groups, or institutions with a vested interest in and/or influence over the outcomes and goals of a specific activity. Freeman asserted that stakeholders are pivotal groups essential for ensuring the sustainability and success of a corporation and/or community in attaining its objectives (Fontaine et al., 2006). Traditionally, activities such as planning, implementation, and outcome

evaluation have been carried out based on established routines and job descriptions, often resulting in misalignment with actual on-the-ground requirements. Stakeholder analysis offers a valuable alternative that should be adopted to foster active participation from each stakeholder. This methodology typically involves the following steps: i) identifying stakeholders; ii) distinguishing and categorizing stakeholders; and iii) exploring the interests held by various stakeholders (Satria & Sari, 2017).

The concept and analysis of stakeholders require active engagement from all entities involved in the pursuit of a common goal. Each stakeholder approaches the objective, considering their perceptions, actions taken, and the extent of achievements relative to their intended targets. This analysis aims to illustrate the relationships among stakeholders, the strength of the networks they establish, points of divergence and convergence, as well as the significance of stakeholder interactions with each other (Permana et al., 2021). It emphasizes the relationships between stakeholders and their intended objectives (Yudistira et al., 2020).

Results

The National Disaster Management Agency (BNPB) reported that from January 1st to October 18th, 2022, Indonesia experienced 2,860 natural disaster events, affecting a total of 3,593,497 people. These individuals account for 99.97% of the total affected victims, currently classified as suffering and displaced. Among them, 813 people sustained injuries, 184 lost their lives, and 29 remain missing. These natural disasters also resulted in 32,345 damaged houses, with 5,222 severely damaged, 5,625 moderately damaged, and 21,498 slightly damaged houses. A total of 905 public facilities were reported as damaged, including 509 educational facilities, 321 places of worship, and 75 health facilities. From the beginning of the year until October 18th, 2022, flooding was the most frequently reported natural disaster, accounting for 1,157 incidents, followed by extreme weather with 900 incidents, landslides with 516 incidents, forest and land fires with 240 incidents, earthquakes with 22 incidents, tidal waves and abrasion with 21 incidents, and drought with 4 incidents. One of the significant natural disasters that has caused numerous casualties and impacted communities is volcanic eruptions. Indonesia, known as the "Ring of Fire," has a substantial number of volcanoes. This study specifically focuses on the Mount Merapi area, chosen because Mount Merapi is among the highly active volcanoes that frequently trigger disasters. Therefore, it is of paramount importance to conduct research in this region, as it can serve as a model for the development of disaster mitigation strategies.

The primary objective of this research, utilizing Atlas.ti, is to collect data through in-depth interviews and focus group discussions. The research is conducted in the village of Argomulyo, Cangkringan sub-district, located on the slopes of Mount Merapi. The research participants comprise disaster-affected residents, including both those who have been relocated and those who have not (Yudistira et al., 2020; Permana et al., 2021), sub-district government officials (Tohani & Wibawa, 2019), village officials, community leaders, members of the disaster-resilient village management committee, youth organization representatives (Karang Taruna), and village community representatives. The researcher conducted in-depth interviews with these eight stakeholder groups and also organized focus group discussions to collect information and data on disaster mitigation. Based on the data and information gathered from the interviewees, nine core issues in disaster mitigation planning and implementation were identified and categorized under the following headings: Institutional, Disaster Mitigation, Assistance, Disaster Education, Vulnerable Communities, Disaster Information, Evacuation, Refugee, and Relocation.



Figure 1 Analysis Community Preparedness in Disaster Prones Area used Atlas.Ti.

Figure 1 illustrates that each fundamental issue generates related components based on specific conditions. For instance, within the category of 'Institutional,' various elements emerge, including the roles of village officials, volunteers from the Tangguh Disaster Destana Village, district authorities, the Regional Disaster Management Agency (BPBD), the Armed Forces (TNI) and the National Police (Polri), as well as youth association. Under 'Disaster Mitigation,' several activities and their key aspects surface, encompassing outreach activities such as understanding disaster characteristics, strength, disaster response, preparedness, evacuation routes, priority areas, and initial disaster aid. Additionally, mitigation elements include training, periodic disaster simulations, public kitchen facilities, and prioritizing rescue efforts.

In the 'Assistance' category, considerations encompass actions before, during, and after a disaster. 'Disaster Education' comprises disaster preparedness at educational institutions, disaster-focused curricula, and early-age disaster awareness initiatives. 'Vulnerable Communities' involves prioritizing, supporting, and providing specific facilities for the elderly, individuals with disabilities, pregnant and lactating women, as well as children aged 5 to 10 years. Lastly, 'Disaster Information' delves into filtering information, ensuring information accuracy, specifying potential disaster conditions, offering evacuation instructions, communication facilities, and the media's role in disseminating information. Further along, 'Evacuation' entails significant aspects, including participation from the Destana Team, community involvement, volunteers and Search and Rescue (SAR) teams, and village officials. Essential resources in disaster mitigation comprise disaster preparedness kits and transportation to safe locations, whether provided by the government or privately owned. 'Refugee' considerations incorporate zones for relocation, relocation sites, and associated facilities.

Furthermore, stakeholder analysis serves as a valuable tool for examining relationships among various actors, their objectives, and the interactions between actors who share common goals. These relationships can be classified as either converging, leading to the formation of alliances, or diverging, indicating ambivalence among the actors. Stakeholder analysis makes use of the MACTOR tool, which stands for the Matrix of Alliances and Conflicts: Tactics, Objectives, and Recommendations. This research focuses on eight key actors actively involved in disaster mitigation efforts within Argomulyo Village, Cangkringan Sub-district, Sleman Regency, an area situated on the slopes of Mount Merapi. These eight actors were identified through indepth interviews and focus group discussions and can be categorized as follows: 1. Villagers who do not relocate (not_reloca), 2. Village community members who have relocated (Relocation), 3. Village representative body (Representa), 4. Village officials (village_ap), 5. Leaders of the disaster response team in the village (destana_fi), 6. Public figures (public_fig),

7. District officials (distr_app), and 8. Youth organization members (youth_orga).

The community can be categorized into two distinct groups: the first consists of individuals affected by disasters and situated within the red zone, who are willing to relocate, while the second group comprises affected individuals located outside the red zone who opt not to undergo relocation. The demarcation of the red zone is defined as extending 300 meters from the lahar flow area, owing to the high hazard potential associated with lahar and pyroclastic flows following eruptions of Mount Merapi. The relocation process is typically initiated following significant eruptions that result in substantial casualties on the slopes of Mount Merapi.

The next actor of significance is the village representative body, which represents community leaders designated to formulate development programs and make decisions pertaining to community activities on the community's behalf. The body plays a pivotal role as a partner to the village government in the context of village development. The fourth actor is the village apparatus, entrusted with administrative responsibilities and overseeing village development. The fifth actor is the village disaster response team, an organization within the community responsible for initiating disaster mitigation efforts. The sixth actor is a community leader, an individual not directly affiliated with the government or organizations but whose opinions carry weight and are followed by the community. The seventh actor is the sub-district apparatus, functioning one level above the village government and playing a crucial role in bridging policies and programs between the regency and the village. The final actor is the youth organization, which holds significant importance in governance, especially in times of disaster. The mobility and agility of youth organization make it well-suited for effectively executing physical activities.

The stakeholder analysis in this research is structured around seven objectives that will be verified through interaction with the involved actors. These objectives encompass ensuring transparent public information dissemination (informatio), conducting disaster preparedness training (disas_trai). Developing a disaster curriculum (dis_curri), establishing government- run shelters for vulnerable populations (shelters), implementing community evacuations when the alert status indicates vulnerability (evacuate), relocating people from high-risk areas near Mount Merapi (relocation), initiating resident evacuations when the alert status is elevated (alert_posi). The eight key actors and these seven objectives will be evaluated regarding their interrelationships, coordination, collaboration, as well as their opinions on agreement and the relative importance of each objective. Data for this analysis were collected through in-depth interviews with each of the actors. The processing of this data utilizing Atlas.ti software yields insights into the connections between actors in terms of influence and dependency, as illustrated in Figure 2.



Figure 2. Influence and Dependence between Actors. **Source:** Primary Data Processed, 2023.

The data processing results reveal that actors with high influence but low dependence levels, potentially making them the most crucial actors, consist of community leaders, members of the village disaster response team (Destana), and the non-relocated community. These three actors are instrumental in guiding and influencing the community's engagement in disaster mitigation activities. Moreover, during disaster events, they play critical roles in assisting the community, both during and after the disaster. Community leaders and Destana members already possess well-defined capabilities and established procedures for disaster mitigation. Additionally, these actors serve as filters for disaster-related information, ensuring that accurate and valid information is effectively conveyed to the community. Actors exhibiting both high influence and high dependence levels, potentially striking a balance in decision-making, include village officials, the youth organization, and the relocated community. Village officials play a pivotal role in disaster mitigation, as every action they take directly impacts the implementation of disaster mitigation efforts, although their decisions are contingent on directives from higher government authorities.

Actors characterized by low influence levels but high dependence include the village representative body, which serves as advisors in various village activities, including those related to disaster mitigation. The body does not engage directly but offers support for these activities, situating them in quadrant 3. On the other hand, actors in quadrant 4, characterized by both low dependence and low influence, are the sub-district apparatus. This can be attributed to the limited involvement of the sub-district apparatus in both decision-making and on-ground implementation. Another noteworthy outcome of the MACTOR analysis is evident in the first order, highlighting the interrelationships between actors concerning coordination, communication, and collaboration, as illustrated in Figure 3.



Figure 3 Relationship between ACTORs in Order 3.

Figure 3 illustrates the divergent relationships among first-order actors in the context of disaster mitigation. The figure indicates that in disaster mitigation efforts, actors exhibiting strong convergent relationships include community leaders, Destana figures, the Village Representative Body (BPK), and the sub-district apparatus. These actors demonstrate a closely convergent interaction in all four directions. This highlights the robust interconnections among stakeholders engaged in decision-making, creating opportunities for the establishment of powerful alliances in disaster mitigation. Conversely, village officials exhibit a strong convergent relationship with non-relocated residents. Following in-depth interviews, it became evident that non-relocated residents, in collaboration with village officials, forge an alliance in the realm of disaster mitigation. Actors characterized by weak or very weak convergent

relationships, particularly with several other stakeholders, are the relocated residents. This is attributed to their status as the most severely affected group, leading them to receive assistance and actively participate in all programs and activities devised by other actors.

The youth organization also exhibits a moderately convergent relationship with all actors. Their role, primarily involving physical activities, places them in a position where they engage less in decision-making processes regarding mitigation policies. In essence, the role of the youth organization primarily centers on the execution and active participation in mitigation activities rather than policy formulation. The third outcome of this analysis pertains tonconvergence in the second order, representing the relationships between actors with shared goals. The average intensity of convergence emerges when two actors share the same degree of agreement or disagreement regarding specific goals. The values within this matrix do not gauge the quantity of potential alliances but rather the intensity of alliances within the goal hierarchy (preference) of actor pairs. A graphical representation of second-order convergence is provided in Figure 4.



4. Order 2 convergence graph

Weakest convergences
Weak convergences

Moderate convergences

Strong convergences
 Strongest convergences

Figure 4. The Convergence of the Second Order.

In the second order, alliances among actors are not determined by their potential but rather by the intensity of their relationships concerning shared goals, whether they are in agreement or disagreement. As depicted in the figure, it is evident that three actors have very strong relationships: community leaders with the sub-district apparatus, community leaders with the Village Representative Body (BPK), and community leaders with Destana figures. This signifies that community leaders can serve as potent mediators or a robust common thread among actors in disaster mitigation, given their high alliance intensity. Furthermore, among these four actors, a strong alliance relationship is established.

Figure 4 illustrates moderate relationships between youth organization and the sub- district apparatus, Destana, community leaders, non-relocated residents, and village officials. In parallel, non-relocated residents share moderate convergent relationships with village officials

and community leaders. Similar to the first order, residents in the relocation area maintain lowintensity alliances with other stakeholders in disaster mitigation, primarily because they often find themselves in a highly affected position due to their circumstances.

In the third order of convergence, the intensity reflects the level of alignment in preferences between actors with positions of influence and their goals. A higher intensity signifies that actors have more shared interests or are in closer proximity regarding their objectives, indicating a heightened convergence intensity. The outcomes of the third-order convergence are presented in Figure 5.



Weakest convergences

- Weak convergences
- Moderate convergences
 Strong convergences
- Strong convergences
 Strongest convergences

Figure 5. The Convergence of the Third Order.

In the third-order convergence analysis, it is evident that two primary actors emerge as the central figures with the highest intensity of convergence and alliance potential, namely community leaders and village officials. Both these actors possess the capacity to serve as key drivers in the execution of disaster mitigation initiatives. A majority of the other stakeholders involved in disaster mitigation, such as youth organizations, sub-district officials, and the village representative body, exhibit strong convergence with the two principal actors. In contrast, residents in both relocation and non-relocation areas display weaker convergence in their relationships with other stakeholders.

3. Conclusion

The research findings provide valuable insights into disaster mitigation, shedding light on the critical role of social vulnerability and stakeholder engagement in this process. The primary objective of the study was to comprehensively analyze disaster mitigation issues linked to social vulnerability. It unveiled nine core aspects, each with its unique sub-issues, encompassing various facets of disaster mitigation, such as institutional factors, disaster education, evacuation, and more. These findings offer a structured framework for understanding the complexities of disaster mitigation, emphasizing the importance of addressing each aspect to enhance

preparedness and response. In the context of the second objective, the research highlighted the pivotal roles played by community leaders and disaster- resilient village figures in disaster mitigation. Their active participation in policymaking, information dissemination, and implementation emerged as a key factor in effectively addressing disaster-related challenges. The study underscores the significance of these actors in facilitating convergence and forming alliances, promoting collaborative efforts for disaster preparedness and response. These findings hold significant theoretical implications, emphasizing the influence of local leadership in disaster management.

Practically, the study underscores the need for a more active and engaged approach for vulnerable communities, especially those subjected to relocation. The research found that these communities often assume a passive role and bear the brunt of disaster impacts, indicating a gap in addressing their specific needs. This insight calls for tailored strategies to empower and involve vulnerable communities in disaster mitigation, ensuring they have an active role in safeguarding their well-being.

However, there are limitations to this study. The research focused on a specific geographical area, and the findings may not be universally applicable. Additionally, the study's scope may not encompass all possible aspects of disaster mitigation. Future research could expand on these findings, exploring different regions and delving deeper into the specific challenges and opportunities faced by vulnerable communities. In conclusion, this research provides a structured understanding of disaster mitigation issues, emphasizing the critical roles of community leaders and disaster-resilient village figures. The practical implication is the need for more active engagement of vulnerable communities. While the findings offer valuable insights, further research can build upon this foundation to develop more comprehensive and regionally diverse disaster mitigation strategies.

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