Diyala Agricultural Sciences Journal, 2024, Vol. (16) No. 1: 41-51
ISSN: 2073-9524
eISSN: 2310-8746

Developing Farmers' Community Resilience in the Volcanic Area of Mount Merapi, Indonesia

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Article history:

Received: 27 December 2023
Accepted: 4 March 2024
Published: 30 June 2024

Keywords: *Disaster, Resilience, Volcano peak, Farmers' communities, Qualitative approach.*

Abstract

Mount Merapi is one of the active stratovolcanoes in Indonesia, and its slopes are not only home to the powerful forces of nature but also to thriving communities of farmers. Many farmers' communities are found around the slopes of this mountain, relying on the fertile volcanic soil for their agricultural activities. This research was undertaken near Mount Merapi, approximately 4 km from the volcano peak, to investigate the resilience of farmers' communities in the face of Mount Merapi's potential disasters. It affects the farmer's behavior, with the majority of residents being farmers. The primary objective of this study was to understand why and how these farmers' communities demonstrate resilience in the wake of Mount Merapi's potential disasters. The qualitative approach was used in this research and the key informants were determined by using the purposive sampling technique. Data obtained were analyzed using an interactive data analysis model. The study identified three primary themes that significantly influenced the resilience of farmers' communities. The first theme encompasses social aspects, highlighting the importance of social capital, including strong social relations, trust, and community networks. The second theme revolves around economic factors, specifically business capital and the various forms of income within the farmers' communities. Lastly, the third theme focuses on environmental considerations, emphasizing the role of natural capital, particularly effective land use, as the most impactful in maximizing community resilience. Additionally, it was also found that the strong engagement among farmers within their communities made their resilience ability toward disaster highly formidable.

https://dx.doi.org/10.52951/dasj.24160104

Introduction

Mount Merapi is one of the strato-type Mountains (strato *volcano*) that is active today and has an altitude of 2,980 meters above sea level. Administratively Mount Merapi is located between Central Java Province and Yogyakarta Special Region Province with four regencies, namely Sleman, Magelang, Boyolali, and Klaten (BNBP, 2011). This active volcano, one of the largest eruptions occurred on October 26, 2010 and continued with further eruptions in early November 2010. According to BNBP (2011), the eruption that occurred in 2010 was the largest eruption compared to the previous years, namely in 1994, 1997, 1998, 2001, and 2006. In addition to casualties, the eruption of Mount Merapi also had varying impacts on other sectors of life such as the economic, social, infrastructure, settlement and agricultural sectors. These residual impacts have more or less persisted to date. In fact, in some instances, the eruption of Mount Merapi has caused psychological impacts or post-traumatic stress

disorder (PTSD) (Suharyono *et al*., 2020; Yusrifa; Danugroho, 2022). The large number of casualties and material losses is due to the large number of people living around the slopes of Mount Merapi (Budiyanto, 2021; Ferdiyansyah and; Muta'ali, 2014; Fiantis *et al*., 2019). Thus, effective disaster management is needed to minimize negative impacts pre-disaster, during, and post-disaster to ensure maximum safety of the people living in the area will be safe (Andreastuti *et al*., 2019; Rustinsyah *et al*., 2021; Sullivan and; Sagala, 2020).

Communities living side by side with nature realize that disasters are a series of natural events or conditions and situations that can threaten their lives (Sabir, 2016). Thus, community preparedness is important in dealing with disasters. In Indonesia in accordance with Law Number 24 of 2007 concerning Disaster Management Indonesia (2007), preparedness is defined as a series of activities carried out to anticipate disasters through organizing and appropriate and efficient steps. Disaster preparedness is not only the responsibility of the government but is more directed at individuals or communities. In essence, people facing disasters or events form coping mechanisms through knowledge, understanding, experience, and meaning of each event or problem faced in the surrounding environment (Pramono, 2016). In implementing community capacity, community-based mitigation programs are needed to carry out disaster management.

Disaster mitigation according to the Government Regulation of the Republic of Indonesia Number 21 of 2008 concerning the Implementation of Disaster Management Indonesia (2008) is a series of disaster risk reduction efforts, both through physical development, awareness and capacity building in dealing with disaster threats. Thus, mitigation can be defined as planning actions before a disaster occurs with the aim of minimizing the impact of disasters on society and the environment (Kusumasari, 2014). There are two types of mitigation, namely physical and non-physical. Physical mitigation is an effort to reduce risk through physical development or providing physical facilities such as the construction of disaster evacuation roads while non-physical mitigation is risk reduction that leverages risk management capacity building without requiring the use of structures designed with the aim of improving community preparedness so that risks can be minimized, for example, SAR (Search and Rescue) training (Anjasni, 2013). In the book Disaster Management, efforts to mitigate volcanic disasters, namely; 1) Monitoring, using seismographs (earthquake detection devices); 2) Emergency response, evaluation of reports and data, team building, dispatch of the emergency response team to the location, integrated checking; 3) Mapping Disaster Prone Areas (KRB) volcanoes can explain the type and nature of volcanic hazards, disaster-prone areas, self-rescue directions, evacuation locations, and disaster management posts; 4) Investigation, using Geology, Geophysics, and Geochemistry methods; 5) Socialization, conducting socialization, especially to people living around volcanoes (Nurjanah *et al*., 2012).

Although the Mount Merapi area is an area with high potential danger, the community actively uses the land for agricultural activities (Bachri *et al*., 2015). Relying on natural resources to practice agriculture is commonplace. In addition to the risks and dangers of volcanoes, the eruption of Mount Merapi has a good impact on the surrounding community, namely fertile land. Examples of management on land with agricultural activities are using terracing techniques, horticulture with an agroforestry system including vegetable crop commodities such as cayenne pepper, cauliflower, carrots, cabbage and eggplant (BPS Boyolali Regency, 2022). Remarkably, the farming community near Mount Merapi defies adversity by fostering a culture of collective work through community agriculture, as noted by Partelow (2021). These communities, established in volcano-prone areas, have a positive impact on the lives of farmers and are

geared towards enhancing overall resilience among the farming population.

Community resilience is the ability of a community to prepare, respond and recover from disaster threats (Wisner and Kelman, 2015). The definition of resilience generally reflects how the community responds to any adverse events such as natural disasters. The exact definition in terms of an increased ability for recovery post-disaster, explicitly or implicitly incorporates five fundamental concepts: attribute, sustainability, adaptation, trajectory, and comparability (Community and Regional Resilience Institute (CARRI), 2013). A community is defined as a group of people engaged in continuous social interaction within a specific territory, grappling with the potential consequences of shared risks (Kirmayer *et al.*, 2009). Community resilience is characterized by knowledgeable and adaptive communities possessing the capacity to assess, estimate, manage, and monitor various risks in an organized manner. The definition of community resilience is intrinsically linked to supporting aspects, encompassing economic, social, and environmental resilience (Runtunuwu *et al.*, 2018).

These aspects serve as benchmarks for the community's ability to collectively act, ultimately enhancing their capacity to address and mitigate the impact of problems. The imperative to increase community resilience following Mount Merapi's eruption is underscored by the assumption that the volcanic disaster has a recurring period of 2-5 years, as long as Mount Merapi remains in an active status. Therefore, proactive efforts to bolster community preparedness are crucial, ensuring that when the next eruption occurs, the community is better equipped to navigate and mitigate the resulting impacts (Istikasari and Panjaitan, 2019).

The literature review reveals that research on community resilience has been extensively conducted in Indonesia, yielding diverse results that underscore the significance of resilient conditions within communities (Akbar *et al.*, 2017; Oktari *et al.*, 2021; Partelow, 2021; Widodo and Hastuti, 2019; Zaki *et al.*, 2020). Suharyono et al. (2020) highlight the positive impact of community adaptation in fostering resilience amid changes triggered by natural disasters. Despite this, research on the resilience of farmer communities remains limited. Therefore, this study aims to fill this gap by concentrating on the resilience of farmer communities. The focus is on understanding how these farming communities can collectively endure the challenges posed by the Mount Merapi disaster. Additionally, the study aims to elucidate the strategies employed by farmer communities to enhance resilience and effectively confront the Mount Merapi disaster.

Materials and Methods

The method used in this study is a qualitative approach with a descriptive method. Weaver-Hightower (2018) stated that qualitative research needs to be deep and comprehensive. Descriptive research is research that produces data in the form of written or spoken words of respondents or it could be from behavior that has been observed during the research process (Nurliza *et al.*, 2020). The use of qualitative descriptive research in this study is intended to obtain information about the resilience of farmers communities on Mount Merapi in depth and comprehensively (Neuman, 2002).

The researcher carried out a purposive sampling of informants who are considered appropriate to be used as data sources based on the purpose of the study, with a total of seven key informants involved. They include village officials, farmer group leaders, farmer elders (individuals who understand typical farmers' life at the research site) and related stakeholders such as government agencies (Figure 1). Both primary and secondary data were sourced for the study. Primary data entails all the bits of information sourced directly or obtained by conducting interviews. Secondary data sources in this study include documents, photos and literature studies related to the research concept. The data analysis technique used in this study is the interactive model data analysis model

(Miles, Huberman and Saldana, 2014), the process is shown in Figure 2.

Figure 1. Key Respondents

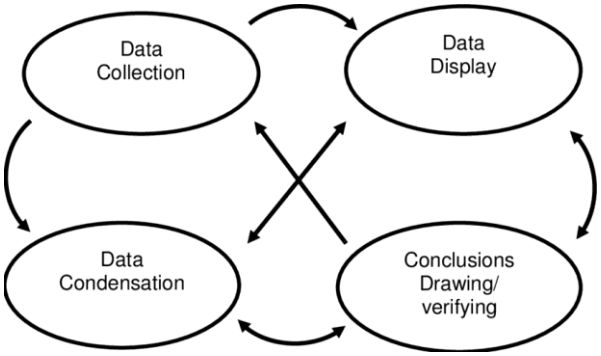

Figure 2. Data Processing

In the case of data processing, this study uses coding methods with the help of the QDA Miner Lite application. The purpose of coding is to interpret and group data into certain categories to facilitate analysis at a later stage (Prihapsari and Indah, 2021). In the coding process, there are several things that must be done, namely data preparation. Before coding, data is converted into text form. Then the interpretation of all the transcript data that has been obtained through the interview as a whole to understand the data and recognize all details. At this stage, in order to get the appropriate data, provided codes in each sentence or paragraph that is meaningful then the codes are collected in certain categories. After all data is given a certain code according to the coding scheme, then the interpretation back the data and codes that have been obtained and makes changes to the code results until confident and satisfied with the results of the coding that the codes are able to answer the research questions thereby addressing the research objectives.

Results and Discussion

The resilience of the farmers' community in the Mount Merapi area is intriguing and demonstrates unique characteristics compared to other community resilience. After conducting coding analysis using the QDA Miner Lite application, it produced 12 categories and 3 groups that appear in Table 1. In terms of phase, it is divided into pre-disaster, during disaster and post-disaster. Then in terms of grouping, namely social, economic and environmental. The categories of activities vary in each group, such as social groups there are social relations, adaptation and mitigation of farmers' communities, farmers' activities, community networks, and collective action. The economic group comprises business capital, adjustment of the farming community, and economic recovery,

while the environmental group involves natural resource processing, government support, availability and functioning of infrastructure, and infrastructure recovery. These findings suggest that the assessment of all components in the results indicates a relationship between the phase and category. Consequently, appropriate evaluation of resistance components yields the results depicted in Figure 3.

Table. 1 Results Grouping Farmers Community Resilience

Phase	Category	Group
Pre disaster	Social relation	Social
	Adaptation and mitigation of farmers communities	
During disaster	Farmers community activities	
	Community network	
Post Disaster	Collective actions	
Pre disaster	Business capital	Economy
During disaster	Farmers community adaptation	
Post disaster	Economic recovery	
Pre disaster	Natural resource management	Environment
	Government support	
During disaster	Availability and functioning of infrastructure	
Post disaster	Infrastructure restoration	

The assessment of each component of resilience in pre-disaster, during disaster and post-disaster phases reveals a high level of resilience in the farming community of Mount Merapi. Resilience in response to the Merapi stems from the understanding and behavior of the farmers' community, who are aware of the dangers and impacts caused by the eruption of Mount Merapi. This relationship is significant and essential for the Mount Merapi farmers' community. In the pre-disaster phase, in addition to what has been described in the research results, there are other relationships such as community networks and adjustments to the farming community. The relationship closely ties to the pre-disaster phase, where the community prepares and strategizes to survive in the event of a Merapi eruption. Community networks established by pre-disaster communities will have an impact on the community during the disaster. Within these community networks, farming communities have effective and efficient relationships with community stakeholders such as village governments and local governments, farming communities foster high trust in village apparatus so that it has a good impact on the adjustment of farmers' communities if one day there is a disruption. When an eruption occurs, farming communities are more capable of adjusting and adapting, such as the distribution of assistance and logistics, cooperation assistance and assistance in increasing resource utilization.

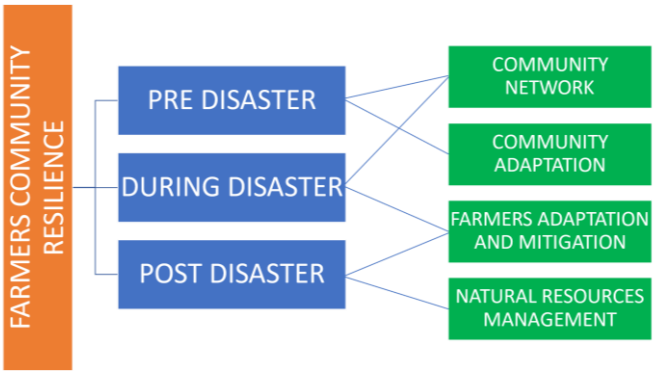

Fig 3. The Relationship between Phase dan Category

In times of disaster, in addition to the relationship with community networks, there is a relationship between adaptation and mitigation of farmers, where the farming community has prepared tools and evacuation routes in anticipation of possible situations. Consequently, when a disaster occurs, the farming community can adapt well, such as by avoiding predetermined radius locations and promptly evacuating to safer areas, avoiding valleys and watersheds, and utilizing recommended government equipment such as masks or wet cloths. After the disaster, the farming community demonstrates high recovery ability and effective adaptation. In this situation, the community makes efforts to minimize the risks faced by farmers by providing necessary infrastructure support for an adequate evacuation process, involving the farming community in the process. In addition, the community also maximizes land by analyzing the potential of the surrounding environment. This includes strategies such as determining the layout of land space with the establishment of isolated systems, mixed or intercropping gardens, and dryland agriculture. Consequently, it can be concluded that social-environmental resilience plays a role in transitioning to and reorganizing stable conditions. As stated by Keck and Sakdapolrak (2013), environmental problems cannot be addressed in isolation from the social context. Socio-economic aspects include the standard amount of farming, the level of management carried out by farming communities, the availability of human resources, and also market aspects which include the activities of farming communities in marketing (Abadega, 2021; Rokhani *et al.*, 2020).

In addition, the coding analysis resulted in 12 categories in the study's findings, culminating in a theme that addresses the study's purpose: analyzing the resilience of farming communities to the Mount Merapi disaster. This theme is elaborated on in full detail as follows:

1. Social

Farming communities in disaster-prone areas refer to formal and informal models of social organization that carry out collective actions on social empowerment contained in the community itself. The informant stated that people coexist harmoniously because people are aware that they have the same interests in order to achieve common goals. This awareness is what leads the community to become a community in order to survive certain conditions, namely areas prone to Merapi eruption disasters. The community itself is a unity that has geographical boundaries and shares the same fate (Norris *et al.*, 2008). A sense of comfort and security serves as a benchmark for the farming community to remain in the area. With that, the community must be capable of mitigating and adapting to various challenges during pre-disaster, disaster, and post-disaster phases.

Pre-disaster, social capital reflects networks and connectedness that are factors connecting people's trust and ability to work together and expand their communication networks such as government agencies and other community institutions. This adjustment of the farming community is a form of mitigation in normal conditions to deal with changing conditions so as to make the community resilient to disasters. This dimension of communication connectedness can be achieved due to the realization of government programs such as agricultural extension, socialization related to eruptions and others, which can help farming communities to continue to prioritize mitigation. The formation of social relations in the community of Mount Merapi is a form of community adaptability. With the existence of social interaction channels as a forum for social activities, formal and non-formal institutions such as RT / RW, BPBD and others, as well as non-formal institutions such as farmer / livestock groups, homestead dasa and others. The eruption of Merapi will damage the community's agricultural land for some time so they also experience losses. Therefore, in addition to community communication

interactions, farmers have ways or efforts to overcome these conditions, namely land owners will manage moor or dry land agricultural land with isolated systems and agroforestry. Although this effort is not 100% successful in protecting their land, it is one of the efforts or strategies carried out by the farming community in Tlogolele to minimize the risk caused by volcanic ash due to the eruption of Mount Merapi.

During disasters, community relations are strengthened when eruptions occur. The farming community has a high awareness, this is evidenced by community activities during the eruption. The community continues to carry out daily activities even though their land has been covered by volcanic ash but is still active in community activities such as feeding their livestock. For instance, some informants stated that in response situations people still took the time to go home and those who returned provided assistance to people who did not evacuate the refuge. People who depend on agriculture and animal husbandry have high social ties in the community. The activity of providing feed to livestock is carried out by people who have a productive and adult age. This is in line with the results of Kurnia and Pandjaitan (2021) in a research which explains that adulthood is closely related to their sensitivity in facing disasters that come, so that when in unexpected and urgent conditions, they can be more responsive in saving themselves and adapting to these changes to minimize disaster risk.

Post disaster, the condition of the Mount Merapi community showed that the level of collective community action was strong in the process of accelerating village development after the eruption. This can be seen from how they facilitate between communities by providing mutual assistance to restore conditions. The strength of this collective action is also influenced by the presence of leader figures who are able to direct their citizens to work together to overcome the conditions and challenges that the community is facing. Cutter (2014) mentioned that strong leadership from government and society is needed to achieve community resilience. If the community has leaders who are able to organize community members, then the community can build effective collective action. Hardiyanto and Pulungan (2021) also affirmed that the key to maintaining social energy is high solidarity and community awareness in interpreting their goals with social capital. This was proven in 2019 when various regions on Mount Merapi sought disaster management recovery through the establishment of Disaster Resilient Villages (DESTANA) directly by BPBD or the Regional Disaster Management Agency (Herlambang and Handayani, 2021).

2. Economics

Given the community's characteristics as farmers and ranchers, their livelihoods rely on the availability of natural resources, particularly the fertile agricultural land in the area. Therefore, any disruption to their livelihoods, such as the Merapi eruption disaster, will have a significant impact on their economic stability. To address this challenge, farming communities have developed strategies to sustain themselves during natural disasters. They also prioritize planting efficient crops like cassava for emergencies and set aside emergency funds for financial resilience. Additionally, they stockpile foodstuffs and utilize assistance from volunteers and local government. Post-disaster, they seek alternative employment and access capital assistance for recovery.

Pre disaster, farming communities had their main jobs as farmers and side jobs as ranchers. Animals that are usually managed by the community to raise livestock are cows and goats. This is because people considered that cows and goats have a high selling value, both from meat and milk. Production from these livestock can increase their source of income to meet needs and as a savings fund in case of urgent matters. In addition, the community regulates the cropping system by selecting efficient commodities such as planting cassava

and tubers, which serve as backup resources in urgent situations.

During disasters, the community has a strategy for preparing emergency fund reserves beforehand. In addition, farmers also have reserves of foodstuffs such as cassava, and tubers. The informant noted that if the volcanic ash from the eruption of Merapi does not interfere too much with seasonal plants and woody plants, so that people can rely on their plants as daily food (Ruhyana et al., 2020). The community also received assistance from volunteers and the local government in the form of food (instant noodle, canned milk, etc.), masks, and clothing. Therefore, people can still adjust their lives with the reserves and assistance they receive.

Post disaster, the majority of community members who lost their jobs after the eruption will find other jobs such as construction workers, sand miners or other odd jobs and depend on assistance from the government for the process of getting back on their feet. According to the informant, the assistance they received from the government or volunteers was in the form of daily necessities such as food and clothing. Whereas, the community also needs assistance in the form of business capital that can recover their income because the land which is the main benchmark for community income has been damaged by volcanic ash. Meanwhile, according to the village head and related village officials, capital assistance is prioritized for farmers' groups over individuals to address village development needs and improve joint facilities.

3. Environment

Pre-disaster, Mount Merapi eruption disaster risk reduction activities can be effectively managed through a comprehensive understanding and assessment of the land's potential. Implementing agricultural land use systems on mountain slopes, such as terracing and agroforestry systems is one of the strategies of farming communities to adapt to their environment. The predominant land use in Mount Merapi comprises forest plants, seasonal crops, and vegetable crops, with farming communities often utilizing land as pasture fields to support their livestock. However, despite these efforts, the farming community of Mount Merapi still requires assistance and support from the local government. Existing government programs, including extension and socialization initiatives aimed at enhancing community agricultural productivity, have yielded positive outcomes, such as the establishment of chili cluster groups that continue to operate successfully.

During a disaster, the environmental aspect of Mount Merapi includes areas with a well-established water catchment system. Farming communities rely on these water sources for their daily water supply. Despite the eruption of Merapi, the availability of water remains largely unaffected. These align with the informant's submission that the community's water source comes from a water source commonly called *PAM Mandiri* (self-water supply). However, the volcanic ash has impacted the water quality rather than its availability. Therefore, the surrounding farming community only needs to address the contamination caused by the volcanic ash to ensure clean water.

Post disaster, the challenge of developing food security amidst environmental damage due to declining soil fertility quality caused by the eruption of Mount Merapi is a step for recovery. Alongside the efforts of the community, the local government plays a significant role in revitalizing the farming community by conducting post-disaster counseling and providing assistance such as agricultural tools and machinery.

Conclusions

The results of this study show that farmers' communities have made several efforts to reduce vulnerability and increase their resilience to maintain community survival both pre-disaster, during disaster, and post-disaster. Aspects that can maximize community

resilience are social aspects consisting of social capital including social relations, trust and community networks, economic aspects consisting of business capital including forms of income for Mount Merapi farmer's communities, and environmental aspects consisting of natural capital including effective land use. The farming community of Mount Merapi has also been able to achieve *good community resilience* because the farmers' communities can adapt well to pre-disaster and during disasters and can carry out post-disaster recovery. Farmers' communities resilience is specifically able to help farmers act collectively to mitigate and / or adapt to the impact of the Mount Merapi eruption disaster. This is also their social capital in continuing their agricultural business and living in the dangerous area of Mount Merapi. Collective action from a community is not only effective in dealing with disasters, but can also be used to strengthen social closeness and harmony in society in general. Individualism in the life of the farmers' community or the general public will encourage apathy or indifference of community members toward other members or towards situations that occur in the community. This will cause acute vulnerability to the social system of society which has a long-term impact. As long as social closeness in the form of collective action for group interests still exists, it needs to be preserved through awareness from the community itself, as well as support from relevant stakeholders.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgments

The authors thank Universitas Muhammadiyah Yogyakarta for funding through an internal research grant.

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