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Exploring the Dynamics of Community Transformation in the Indonesian Volcanic Region: An Analysis of Socioeconomic Metamorphosis

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ABSTRACT

This research highlights that the livelihood systems of individuals residing in disaster-prone regions are undergoing significant changes as a result of explosive eruptions. Volcanic eruptions do significant harm to the infrastructure and ecosystems that serve as vital resources and means of support for populations. The group is very susceptible due to their dependence on natural resources for their survival. This study employs a combined qualitative and quantitative methodology to track the progression of individuals' livelihoods and presents descriptive quantitative data on the distribution of changes in livelihood systems. The findings of this study suggest that the introduction of the horticulture commodity market led to alterations in natural resources. Consequently, a significant number of individuals who were previously engaged in growing essential crops shifted to cultivating agricultural commodities to meet the demands of the market. This research has produced a compilation of community-driven disaster management strategies that are specifically designed for the local context. This research has both theoretical and practical ramifications. In theory, this research provides a substantial addition to the understanding of livelihood systems. The research findings indicate that society has a significant level of adaptability in exploiting resources within its surroundings. This research demonstrates that individuals possess inherent adaptations to endure the ecological strain caused by volcanic eruptions.

1. INTRODUCTION

Indonesia is prone to periodic volcanic disasters. Indonesia is home to around 130 currently active volcanoes [1, 2]. From 1966 to 2017, almost 150,000 individuals were relocated because of volcanic agitation on multiple islands in Indonesia [3]. Volcanic eruptions of a catastrophic nature have profound effects on the surrounding environment, such as the inundation of lava, the presence of scorching clouds, and the deposition of ash. Consequently, those residing in volcanic regions are exceptionally susceptible to the perils associated with volcanic eruptions. When assessing long-term hazards in volcanic slope areas, it is important to carefully evaluate the regular occurrence of eruptions [4].

Mount Merapi, located on the island of Java, is one of the most active volcanoes in Indonesia. The volcano experienced a catastrophic eruption in 2010 and continues to erupt as of December 2023 [1]. Volcanic eruptions are a repetitive occurrence of a natural danger. Volcanic natural hazards, together with other disasters, have substantial effects on economic livelihoods, migration, settlement patterns, and access to services and infrastructure [5-7]. Volcanic eruptions can result in the forced relocation of individuals, the interruption of economic activities, and the destruction of essential infrastructure, leading to significant economic and social upheaval [8]. The economic research on volcanic hazards is still in its early stages, but it is essential to comprehend the immediate and long-term effects of these hazards on household behavior and economic progress. The interdependent and systematic character of risks and disasters underscores the necessity for regional coordination and cross-sectoral collaboration to effectively manage community safety and promote sustainable economic development. Gaining a comprehensive understanding of the economic consequences of volcanic hazards is crucial to formulate efficient methods for mitigating risks, adapting to changes, and enhancing resilience.

Community vulnerability is primarily attributed to natural calamities [9]. Disasters in agriculture-based regions, such as the Philippines [10], and India [11], as well as Pakistan [12], could threaten food security and the well-being of rural communities. Ironically, vulnerable communities frequently reside in locations that are prone to hazards. In the Philippines, over half of the informal settlements are situated in places that are both dangerous and prone to disasters [13]. To mitigate susceptibility in regions prone to natural disasters, such as

volcanic eruptions, the local economy must be robust. Preparing for livelihood transformation requires the implementation of an integrated strategy to effectively handle the difficulties faced and involve community participation. This is necessary because the community directly experiences the impacts of the disaster.

It is crucial to acknowledge the changes in people's ways of making a living, by the initial and second Sustainable Development Goals (SDGs) of eradicating poverty and eliminating hunger. China's experience has shown that social and economic transformation is crucial for reducing poverty [14]. This transformation is achieved through development programs, rather than relying just on social aid [15]. Conversely, in some African nations such as Rwanda, Nigeria, Tanzania, and Uganda, there has been a successful shift from the agricultural sector to the service sector, resulting in social and economic transformation. This transformation is also known as structural transformation [16]. In Bangladesh, the process of changing and expanding the ways individuals in disaster-prone areas make a living has been achieved through the use of play capital and social learning [17].

The transition of livelihood patterns in the Mt. Merapi volcanic area has already taken place [18]. The expulsion of sand and stone from the volcano resulted in the emergence of a new economic activity known as sand mining, which provided a fresh means of subsistence for the residents residing on the slopes of Mt. Merapi. The transformation of the environment into a vast expanse of stony sand along the Gendol River and Woro River has sparked the community's ingenuity in establishing a tourism business centered around 'volcano tours' and nature-based tourism [19]. However, most individuals are unaware that they are residing in an area highly susceptible to catastrophes, necessitating a more suitable approach to mitigate the risk of additional calamities.

The objective of research on livelihood system transformation is to offer a thorough examination and detailed analysis of the socioeconomic factors that impact alterations in the livelihood systems of communities residing in volcano disaster areas. Additionally, it aims to depict the process by which communities adapt to environmental and socioeconomic changes. Therefore, this analysis showcases the intricate nature of the alteration of livelihood systems in Indonesia's volcanic regions. It aims to explore the implications of study findings on the establishment of policies that promote sustainable development and community resilience in these places. The research on livelihood system transformation seeks to offer a thorough examination and detailed analysis of the socio-economic factors that impact alterations in community livelihood systems in volcanic disaster zones, as well as to depict the process of community adjustment to environmental and socio-economic changes. This text highlights the intricate process of transforming livelihood systems in volcanic areas of Indonesia. The purpose is to examine the implications of research findings for the establishment of policies that promote sustainable development and community resilience in these places.

This study examines the social, economic, and environmental effects that occur when the livelihood systems of people living in volcanic regions of Indonesia are changed. Next, we will explain the strategies and methods associated with community adaptation in response to these changes, and then analyze livelihood systems and community resilience in the event of volcanic disasters.

2. LITERATURE REVIEW

The increase in population has resulted in more people living in dangerous areas and exposing themselves to the potential dangers of natural disasters, leading to a more complex and varied strategy for managing these disasters [20]. The goal of disaster management in society is to improve the overall quality of life by fundamentally changing the livelihood system. To attain sustainable livelihoods, it is vital to adopt changes that are resilient to crises and shocks, while also preserving or improving capacities and assets without causing harm to natural resources [21]. The Department for International Development (DFID) has embraced a sustainable livelihoods approach, as stated by the DFID [22]. The DFID team developed the basic framework to analyze sustainable rural livelihoods as a component of the transformation. This framework consists of three essential elements: livelihood resources, livelihood strategies, and institutional processes and organizational structures. Entrepreneurship development, community empowerment, and livelihood systems are frequently cited as key components in rural areas.

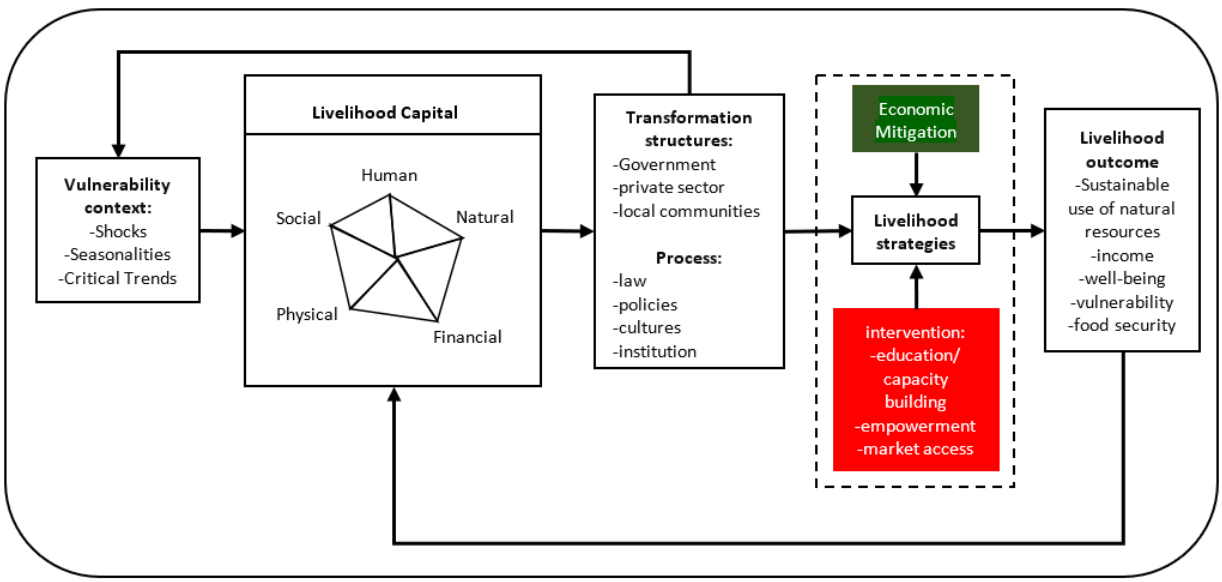

Figure 1. Illustrates the sustainable livelihood system within communities impacted by disasters

To implement a sustainable livelihood approach, it is crucial to actively involve the local population, taking into account their knowledge, attitudes, and interests in a thorough manner [21]. Examining techniques for conserving and distributing knowledge across society through formal education is crucial [23]. Researchers can subsequently examine the relationship between knowledge, sustainable behaviors, and resource management. They can then design innovative alternative techniques for sustainable development that communities might embrace to improve their lifestyles [23].

Experts adopt the sustainable livelihood approach (SLA) as the fundamental framework for converting livelihood systems. The paper is organized based on the framework outlined in references [21, 22, 24-32]. The indigenous knowledge in Indonesia, specifically in the Mount Merapi area, serves as the basis for creating practical solutions to the livelihood systems of communities in disaster-prone locations. Furthermore, it is imperative to enhance the theory as an analytical instrument in response to the increasingly complex problems that exist in society. The importance of socio-economic mitigation in altering community livelihood systems in disaster-prone areas cannot be emphasized enough. Improving the theory indicated earlier (Figure 1) will help in the overall development and enhancement of the theory about the livelihood systems of communities affected by disasters [22, 30-32].

To strengthen the ability of coastal communities to withstand and recover from challenges, it is essential to foster their capacity for innovation. This includes nurturing their networks by providing them with various opportunities and connections to external organizations that promote collaboration and the sharing of knowledge [33]. Our findings indicate that policy makers should consider long-term transformation processes, which have significant ramifications. Moreover, to enhance the ability of coastal communities to withstand and recover from challenges, it is crucial to enhance their ability to generate new and creative ideas, particularly by promoting their connections through different avenues and interactions with other entities that facilitate cooperation and sharing of knowledge.

3. MATERIALS AND METHOD

In February 2023, we conducted a survey in three villages (Kemiren Village, Magelang Regency; Balerante Village, Klaten Regency; and Klakah Village, Boyolali Regency) in the Mount Merapi area, Central Java Province, Indonesia. The purpose of the survey was to investigate the socio-economic factors that influence changes in people's livelihood systems.

We selected these three areas based on careful analysis of their distinctiveness and the direct impact of Mount Merapi's volcanic activity on the danger level. In addition, these settlements have a lengthy history of being impacted by the eruption of Mount Merapi. The historical occurrence of recurrent calamities offers a fertile framework for examining enduring transformations in the societal, economic, and cultural frameworks of communities in all three areas.

We gathered qualitative data to determine the magnitude of changes in individuals' livelihoods. Typically, social research conducted in Indonesia does not necessitate obtaining explicit approval from the ethical commission. Nevertheless, the Indonesian government mandates that researchers must complete research license processes at several administrative levels, including province, district, sub-district, village, and group levels, through the National Unity and Political Agency. Before commencing our research, we sought authorization from the National and Political Unity Agency, to whom we had submitted applications for permissions about research involving human contact.

Upon obtaining authorization, we proceeded to request study consent from the sub-district and village authorities. We also communicated to the informants our dedication to upholding the confidentiality of all participants and sources involved in this research. Thus, we have verified that the individuals participating in this study have willingly and freely given their informed consent to share information. We explicitly communicated to the informants that we were dedicated to upholding the confidentiality of all participants and informants involved in this research. Hence, we have verified that the individuals participating in this study have willingly and voluntarily granted their informed consent to share information, without any kind of pressure or manipulation.

We engaged 90 participants to gather quantitative data to assess the magnitude of changes in livelihoods. This was done through a descriptive approach and the production of a scalogram using survey data. According to Serrat [28], states that the idea of livelihood system indicators is closely connected to sustainable livelihood indicators. These adaptations are precisely customized to suit the existing conditions in the field, including several areas of human capital, including health, nutrition, education, knowledge, skills, job capacity, flexibility, and the ability to efficiently utilize local resources. Conversely, social capital includes a range of components such as networks and connections (including patronage, neighborhood, and kinship), trust and mutual support, formal and informal groups, shared values and behaviors, established rules and penalties, collective representation, mechanisms for participating in decision-making, and leadership. Natural capital refers to a wide range of resources including land, agriculture, horticulture, grass, water, aquatic resources, trees and forest products, animals, biodiversity, environmental services, and tourism. Physical capital refers to a range of components including transportation infrastructure, roads, automobiles, secure housing, buildings, water supply, sanitary facilities, energy sources, communication networks, tools and equipment for production (including seed, fertilizer, and pesticides), traditional technology, and appropriate technology. Financial capital encompasses several forms of income, such as savings, credit, debt, remittances, jewelry, pensions, salaries, and cash.

To gain a thorough understanding of the changes in livelihood systems in volcanic regions, we conducted in-depth interviews with 30 community leaders from three villages to gather and analyze their collective recollections. The leaders were questioned and classified based on their employment (farmers, livestock breeders, and sand miners). Additionally, all of them were above the age of 35 and had seen volcanic eruptions. When evacuating volcanoes, it is important to focus on ensuring the accuracy of data and minimizing mistakes in data collecting. During the eruption, data triangulation was conducted on key informants, including Hamlet Heads and local government officials. Systems that operate behind pseudonyms or anonymously can process information with high efficiency and accuracy [34].

Subsequently, we conducted a Focus Group Discussion (FGD) including several stakeholders to engage in a comprehensive exchange of ideas and get a deeper

understanding. The individuals involved in this project comprise community leaders, subject matter experts, regional government officials, BNPB and BDPB officials, scholars and disaster specialists, village heads, volunteers from the Disaster Risk Reduction group, and members of Village-Owned Enterprises who have been assigned project responsibilities. Focus group discussions (FGDs) are conducted due to their numerous advantages in permitting the collection of transparent data from participants on the discussed themes promptly and efficiently [35], FGDs have become increasingly popular in recent times [36]. The data collected from Focus Group Discussions (FGD) were utilized to enhance the precision of information gathered from individual interviews.

The utilization of secondary data collection facilitated a more comprehensive elucidation of the theoretical framework. The initial coding categories for disaster management and sustainable lifestyles were established through the identification of fundamental concepts and variables. The categories were then implemented following the methodology suggested by Kuenkel [37]. Supplementary information is collected from relevant sources, including reports from BNPB and BPBD.

Mayring's approach was employed to process the interview results. This entailed analyzing the responses to each question set, categorizing the answers, selecting the most commonly cited responses, consolidating paragraphs, and arranging them into sentences with comparable meanings, such as summarizing, explaining, and organizing. Krippendorff further clarified this technique [38], Krippendorff also elucidated this approach [39]. We use both quantitative and qualitative data to obtain a thorough understanding, allowing study findings to enhance each other and form a mutually comprehensive perspective.

4. RESULTS AND DISCUSSION

4.1 Dynamics of community livelihood systems in volcanic areas of Indonesia

The Merapi volcano is located in the Central Java Province of Java Island, Indonesia. It has an elevation of 2968 meters above sea level [40], and is renowned as one of the most active volcanoes in Indonesia [1]. Mount Merapi has a notorious record of hazardous eruptions, especially in 2010, when it unleashed tremendous eruptions that caused fatalities and extensive destruction. The 2010 eruption involved the expulsion of incandescent lava, hot clouds, and various volcanic elements that were projected a considerable distance out from the volcano's crater. The volcanic eruption resulted in the displacement of hundreds of thousands of individuals and inflicted substantial economic damage. The 2010 eruption of Mount Merapi was deemed one of the most significant in its documented history and had comparable effects to the very massive eruption that occurred in 1872. Before the eruption, several indicators foreshadowed the event, such as heightened seismic activity, deformation of the volcano's peak, and a significant amount of dome extrusion [41, 42].

The respondents, who were chosen to represent the population, have an average age of 48.6 years. They have received approximately 8 years of education, equivalent to the 2nd grade of junior high school. On average, each respondent has 3.5 family members, with most households consisting of between 3 and 4 people. The majority of the respondents (70%) rely on the agricultural sector, including livestock, as their main source of income. This was true both before and after the eruption that occurred in 2010. Aside from agriculture, there are other sectors such as the private service sector, sand mining, and labor.

Based on the sample villages, it is evident that the predominant type of villages in the Mount Merapi region is traditional villages, where the primary agricultural product is horticulture crops. The natural area lies near Mount Merapi National Park. Upon closer examination, it becomes evident that the local (village) government maintains a significant influence, whereas local communities play a prominent part in disaster mitigation during times of calamity. The society exhibits a robust sense of unity in crisis management, however, it heavily depends on economic and moral reasoning, with the primary forms of capital being human capital (knowledge), social capital, economic capital, and cultural capital. The issue of sustainable lifestyles in society is evident in the subpar human resources (HR) due to low levels of education and limited access to economic opportunities. However, there have been some improvements in road and network infrastructure, but these are not yet fully optimized.

The qualitative data processing results demonstrate the alteration of the community's livelihood system in the volcanic region, based on a sample of three villages (Kemiren, Balerante, and Klakah). The socio-economic dynamics are observable, as depicted in Figure 2.

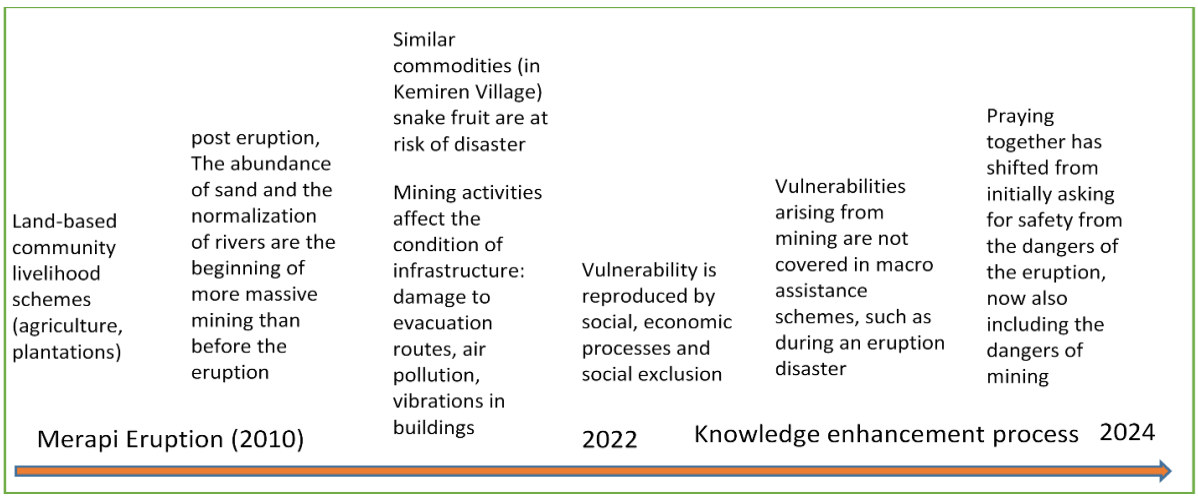

Figure 2. Illustrates the socio-economic relationships of village communities impacted by volcanic disasters

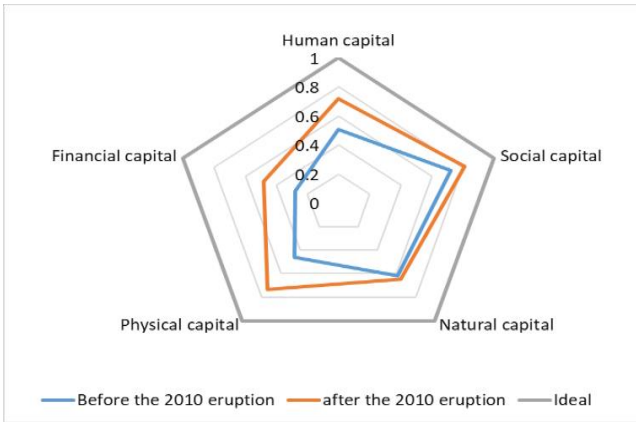

Figure 3. Changes in capital in the community livelihood system in the Mount Merapi area

To assess the extent of transformation in the livelihood systems of the communities, the survey findings (consisting of 90 data points) were analyzed using the methodology outlined by Rondinelli [43], incorporating the indicators proposed by Serrat [28]. The processing findings indicate a transformation in the five livelihood assets, as depicted in Figure 3. If the transformation of the ideal community livelihood system has a value of 1 for each livelihood asset (human, social, natural, physical, financial), this indicates that a shift has taken place. There was a significant increase in strength both prior to and following the eruption in 2010. Conversely, a change value of at least 0.8 indicates significant changes, a minimum of 0.6 indicates changes, a minimum of 0.4 indicates minor changes, while values around 0.2 (which may vary) and 0 indicate no change.

Figure 3 indicates a little alteration in the social capital component. Before and following the 2010 eruption, the individuals residing in the vicinity of Mt. Merapi exhibited similar patterns in terms of their social networks and connections (such as patronage, neighbourhood ties, kinship), relationships based on trust, mutual understanding, and support, as well as leadership dynamics. However, there were notable alterations in formal and informal groups, shared values and behaviours, established rules and consequences, collective representation, and mechanisms for participating in decision-making processes. The process of social capital transformation is facilitated by the promotion of social structure and culture, as observed from a sociological perspective [44]. Social systems both restrict and facilitate. Furthermore, there have been noticeable improvements in physical capital, including enhanced accessibility of transportation, roads, automobiles, secure housing, structures, water supply, and communication. Currently, there have been no notable alterations in the aspects of sanitation, energy, production tools and equipment (such as seeds, fertilizers, and pesticides), conventional technology, and appropriate technology.

Additionally, Figure 3 illustrates a minor alteration in natural capital. The changes were prompted by the liberalization of the market for horticulture goods, resulting in a shift by the majority of farmers from cultivating staple crops to producing agricultural commodities in response to market demand. The advancement of information technology has facilitated open communication and access to commercial opportunities. The volcanic activity in the Mount Merapi area catalyzed the restructuring of farmers' livelihood systems, empowering the community to initiate proactive measures. The community's operations are facilitated by favourable resource availability and ecological infrastructure. Several individuals have engaged in several inventive endeavours, such as substituting staple crops with market-friendly or higher-value crops. However, such initiatives have not yet been implemented in Kemiren Village. Individuals who originally cultivated essential crops such as maize made a transition to growing vegetables due to their high marketability as cash crops. Additionally, some individuals opted not to cultivate any crops at all, as the area was naturally covered in grass, which serves as a readily available source of animal feed and does not require deliberate planting.

The recurring calamities resulting from the persistent volcanic activity of Mount Merapi serve as a valuable lesson for the population, prompting them to adopt a more prudent approach towards their future by accumulating savings in financial institutions and possessing easily marketable jewellery in times of crisis. This results in alterations in financial capital (Figure 3).

The augmentation of public knowledge (human capital) is evident in the process of transformation. The accessibility of technical information fosters a mindset of receptiveness towards knowledge. The adverse consequences, such as a decrease or complete absence of earnings, shifts in livelihoods towards more challenging circumstances, or other detrimental outcomes, undoubtedly arise due to the community's susceptibility, as elucidated by Barclay et al. [45]. Conversely, the presence of effective emergency alerts leads to favourable outcomes due to the establishment of clear communication [46]. The dissemination of information on disasters and their management by the government, as well as establishing ongoing communication between the community and the relevant government authorities in charge of monitoring and managing these risks, can greatly enhance disaster management efforts in the field [45].

The evolution of livelihood systems in disaster-prone populations is influenced by several variables. From a sociological perspective, changes in livelihood systems may be attributed to both structural and cultural reasons. The community's livelihood system is primarily driven by pressing and enabling structural variables. The driving forces for social transformation may be attributed to five primary factors: human capital, financial capital, physical capital, natural capital, and social capital. The key catalysts propelling social and economic development are these five variables. Social capital is the primary catalyst for social change. Values, social networks, and trust serve as catalysts for societal transformation. The natural resources possessed by Mount Merapi play a crucial role in instigating transformation. The

ample availability of natural resources, such as rich soil, sand, and stone, has a significant role in influencing the dynamics and transformations within civilization. On one side, humans depend on soil fertility, while on the other hand, they depend on the amount of sand. Human capital and physical capital are major determinants. A significant discovery derived from this empirical data is that financial capital serves as a driving force for the change of livelihoods in communities located in areas prone to disasters. Among the four variables, this financial capital has the least impact on driving change.

The alteration of people's livelihoods on the ground provides a level of complexity beyond what is described in the idea of sustainable livelihood systems by DFID [22] and Ellis [31]. Burger et al. [47] argue that there is a connection between assets, activities, and the ability to acquire skills and engage in alternative activities. This connection allows individuals in society or households to improve their economic situation by raising their income. Nevertheless, this interaction is highly intricate. Volcano village communities respond to volcanic disasters by implementing adaptive measures to ensure the continuation of life. The many components of livelihood assets (human, social, physical, natural, financial) are interconnected and have a mutual influence on each other, resulting in the establishment of a productive and sustainable livelihood system in volcanic hillside locations. This transforms into a dynamic and intricate system that can facilitate the advancement of sustainable development and enhance the ability of community livelihoods to withstand challenges [47].

Based on Burger et al.'s [47] analysis, communities that experience many dangers from frequent volcanic eruptions would adapt by integrating five dimensions of assets (capital) that interact and mutually influence the complex community livelihood system at both the individual and community levels. This holds for the livelihood systems of those residing in volcanic regions. The physical environment, as defined in the theory developed [22] encompasses physical capital, including both general (public facilities, roads) and individual (houses, buildings, agricultural land, livestock, vehicles), as well as environmental capital (nature). It interacts with the social environment, which comprises community social capital, such as government social structures and community social networks, and together they shape the socio-ecology of society. Individuals in society who possess financial capital, human assets (such as knowledge), and social capital, which are inseparable from social capital in society interacting with physical capital, contribute to the development of resilience in the face of calamities. The combined efforts of individuals, which then extend to society, form a socio-ecological system that undergoes evolution as it confronts, responds to, and adjusts to reoccurring crisis challenges [47].

4.2 Community adaptation to socio-economic changes in volcanic areas

Communities residing in volcanic zones might mitigate economic risks by diversifying their sources of income, as exemplified by the communities in Mt. Merapi [18], These communities have successfully developed tourism as well as other ventures, including coffee farms, to capitalize on the growing market demand for coffee. In addition to this, the community can be motivated to engage in sustainable management of natural resources by ensuring the equilibrium of the environment, which involves conserving biodiversity, such as promoting the growth of orchids in the original habitat of Mt. Merapi [48].

All regional administrations in the Central Java region, including the three sampled districts [49], have adopted the construction of infrastructure and an efficient early warning system to mitigate the risk of volcanic eruptions or lava floods. These activities encompass the establishment of temporary housing facilities for emergencies and the creation of alert mechanisms that are easily available to the general population. The government has implemented a program (BNPB, 2012) to educate and raise awareness among the public about catastrophe risk and environmental change. Enhancing comprehension enables society to implement more effective adaptation strategies.

The Indonesian government has implemented a program to enhance community involvement in decision-making processes about disaster risk reduction. This will enable community members to actively participate in the execution of policies related to disaster risk management within their community. Establishing a Forum for Disaster Risk Management (FPRB) in each region is a measure taken to enhance community resilience. Based on extensive interviews with community leaders, it is observed that the FPRB group in the village promptly fulfils its responsibilities during volcanic eruptions. This includes prioritizing the rescue of the elderly, infants, and the general public. The presence of DRR groups in the community is crucial, as it motivates the federal government (BNPB), regional governments (BPBD), and village governments to organize DRR training sessions in each village (Figure 4). Communities in the Mt. Merapi area strongly feel and require the presence of DRR groups. Concurrently, the training facilities prioritize BPBDs and villages in their respective regions (Figure 4).

Kapala (Magmagama Nature Lovers Family) gave support to the community catastrophe forum. Upon further investigation, it was discovered that the FPRB was established, created, and operated autonomously by the community. The formation of FPRB aims to support the village administration in mitigating the risks of disasters by establishing connections between the village's disaster risk reduction efforts and relevant agencies. Additionally, FPRB seeks to promote awareness and understanding of disaster risk reduction throughout the community, with the ultimate goal of minimizing the impact of future catastrophes on human lives [50].

Sustaining community participation in disaster management is crucial. Japan's response to the 2011 earthquake disaster has led to improvements in community and government preparedness. Policymakers are now focused on increasing public awareness of disaster risks and addressing the lack of preparedness to minimize future damage from disasters [51]. Similarly, in Chile, it has been demonstrated that firsthand experience and a greater occurrence of disasters (such as earthquakes and tsunamis) lead to the highest levels of preparedness [52]. Nevertheless, there exists a substantial correlation between the educational attainment level and characteristics related to disaster preparedness [53].

The primary challenges encountered in applying countermeasures [54] are a deficiency in information and inadequate database management. The amount of institutional facilities (government) can be used to predict disaster preparedness [55]. These findings highlight the significance of examining and executing community preparedness initiatives and their efficacy in managing catastrophes, particularly volcanic disasters.

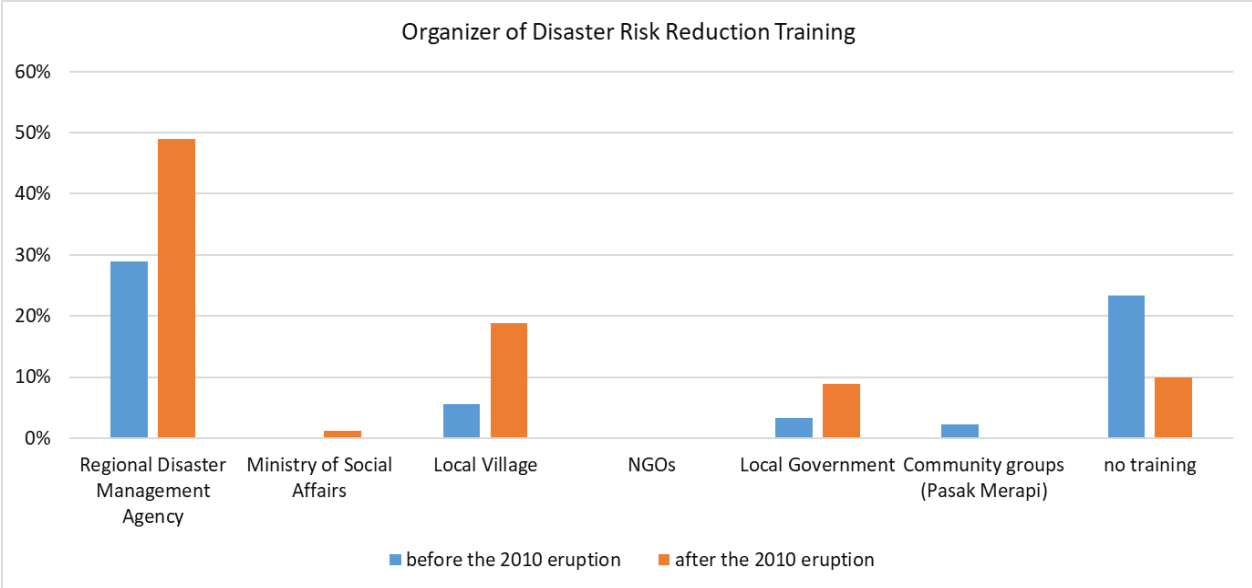

Figure 4. Disaster Risk Reduction (PRB) in the volcano area

Public participation, specifically through the involvement of community representatives, is a crucial component of the disaster management process, particularly at the local level of decision-making. Amid a crisis or tragedy, it is essential to engage in ongoing and thorough risk communication with the community [46]. The case of Portola Valley in California demonstrates that including public engagement into disaster management planning and public planning leads to effective and long-lasting disaster mitigation [56]. The dependence of disaster-affected communities on financial assistance from philanthropic organizations worsens the susceptibility of rural communities in the aftermath of catastrophes and crises [57].

Volcanic regions experience a variety of natural calamities, including volcanic eruptions, lahars, earthquakes, and hot clouds. Volcano hazard maps offer crucial information to decision makers and communities, encompassing the periods before, during, and after a volcanic crisis arises [58]. Communities acquire knowledge from their perilous encounters and convert this knowledge into assurance and flexibility for subsequent events [59]. The significant quantity of individuals affected by disasters promotes transformative change [17]. By promoting community-driven activities during the stages of readiness, response, and recovery, the level of disaster risk can be diminished [60].

Due to its strategic position at the epicenter of the Ring of Fire, Indonesia is very susceptible to natural phenomena. Residing in a region that is highly susceptible to disasters does not necessarily result in individuals having a comprehensive understanding of their circumstances and the actions they can take in the event of a disaster. In the past, volcanic catastrophes used to happen unexpectedly, without any predictable indications. However, with the advancement of technology that enables the monitoring of volcanic activity, the potential for disasters can be reduced by implementing various methods for disaster mitigation. While it is possible to forecast the indications of volcanic eruptions, not all communities possess the necessary technical or financial resources to adequately plan for mitigating the impact of such disasters. The utilization of the livelihood strategy and community resilience approach is a valuable method for accurately assessing the shift that occurs after a disaster [17].

The socio-economic plan to mitigate the impact of disasters in Indonesia's vulnerable areas comprises three phases: risk mitigation (disaster risk management), emergency response (emergency management), and post-disaster rehabilitation (recovery management). Both the federal government and each province have fully implemented all stages, with a specific concentration on the federal Java Province region [49].

It is crucial to implement specific policies that target priority groups and prioritize inclusion. This is necessary as an economic strategy to reduce the impact of catastrophes and create a sustainable livelihood system for populations living in disaster-prone areas [61]. This study suggests the implementation of economic mitigation policies or initiatives to effectively address and alleviate poverty within communities that are susceptible to unforeseen calamities. These solutions may encompass the incorporation of social welfare initiatives, financial support for entrepreneurs, vocational training, and the availability of job prospects [62-65].

4.3 Enhancing livelihood systems to enhance community disaster resilience

As explained by Ellis [31] the notion of the five capitals includes human resources (human), financial, social, natural, and physical resources. The presence of these capitals is essential for the sustained recovery of people's livelihoods, since they strengthen the ability of communities living in disaster-prone areas to withstand and recover from adverse events. Therefore, Figure 5 depicts a model that showcases the socioeconomic mitigation framework for the livelihood systems of communities affected by volcanic eruptions.

Figure 5 was developed using the fundamental framework of livelihood systems established by previous researchers, Chambers and Conway, Ellis and Scooness [30-32], with additional insights from the latest clarification by Paksi and Pyhälä [66]. The construction of the livelihood system framework [67-69], involves the contributions of several professionals. This framework focuses on the institutional structure, particularly in the context of mitigation, which can be classified as socioeconomic mitigation. In order to improve the restoration of sustainable livelihood systems, it is crucial to prioritize the strengthening of economic and social

measures to reduce negative impacts. This can be accomplished by improving social and financial institutions, ensuring community food security, promoting collective action, and actively involving local actors [61]. Socioeconomic mitigation is the collective endeavors of a society to tackle and diminish the consequences of calamities.

Figure 5 demonstrates that the community's livelihood assets serve as the basis for government policies, including institutional frameworks and the implementation process. These policies reduce community vulnerability by taking into account the dominant culture, norms, and social interactions. The ability to bounce back is strengthened when faced with various shocks caused by disasters, particularly volcanic eruptions. The community is confronted with various disastrous risks that prompt the adoption of policies that have formal legitimacy. This continuous process helps to the progress of community resilience.

The acquisition of wealth, also known as livelihood assets, is unquestionably the primary catalyst for the socio-economic mitigation process, as seen in Figure 5. The process of community adaptation to vulnerabilities, shocks, and trends that lead to catastrophe contingency events involves the development of capital (assets) to improve livelihood outcomes. The cited references include [70-72].

Through field interviews, it is clear that society needs significant reserves of resilience to adequately handle shocks. Furthermore, it is advantageous to consider the social networks and systems that can promote resilience, as well as the skills and capabilities that communities need to develop in order to effectively address the challenges they face during catastrophes. Members of resilient communities engage in collaborative efforts and combine their resources, leveraging their collective expertise and skills to effectively address and adjust to various forms of change [73].

Each nation faces unique circumstances and challenges while creating agencies and meeting the needs of its populations. When faced with a circumstance marked by considerable ambiguity, it is essential to select a specific approach for each action in the field. The importance of collaboration among diverse stakeholders in disaster management efforts is evident in multiple situations across different countries, including America activities can be confirmed through various cases in America [20, 56], Etophia [74], China [75], Bangladesh [76], Jepang [77], and Thailand [78], and the people residing on the slopes of Mount Merapi. Furthermore, it acts as a method to improve and perfect the implementation of disaster management in the community, while also promoting professionalism. During disasters in various locations, it is imperative for both the national and regional governments to actively involve and provide comprehensive support to their respective people.

Hence, it is crucial to formulate and customize a comprehensive framework of community-oriented disaster management concepts that are specifically adapted to the distinct circumstances of the community in question. The government, as the main institution responsible for disaster management, plays a crucial role in promoting a strong connection between local government, the community, and the business sector. The synergistic collaboration of the three variables, often referred to as the triple helix, might influence the efficacy of disaster management.

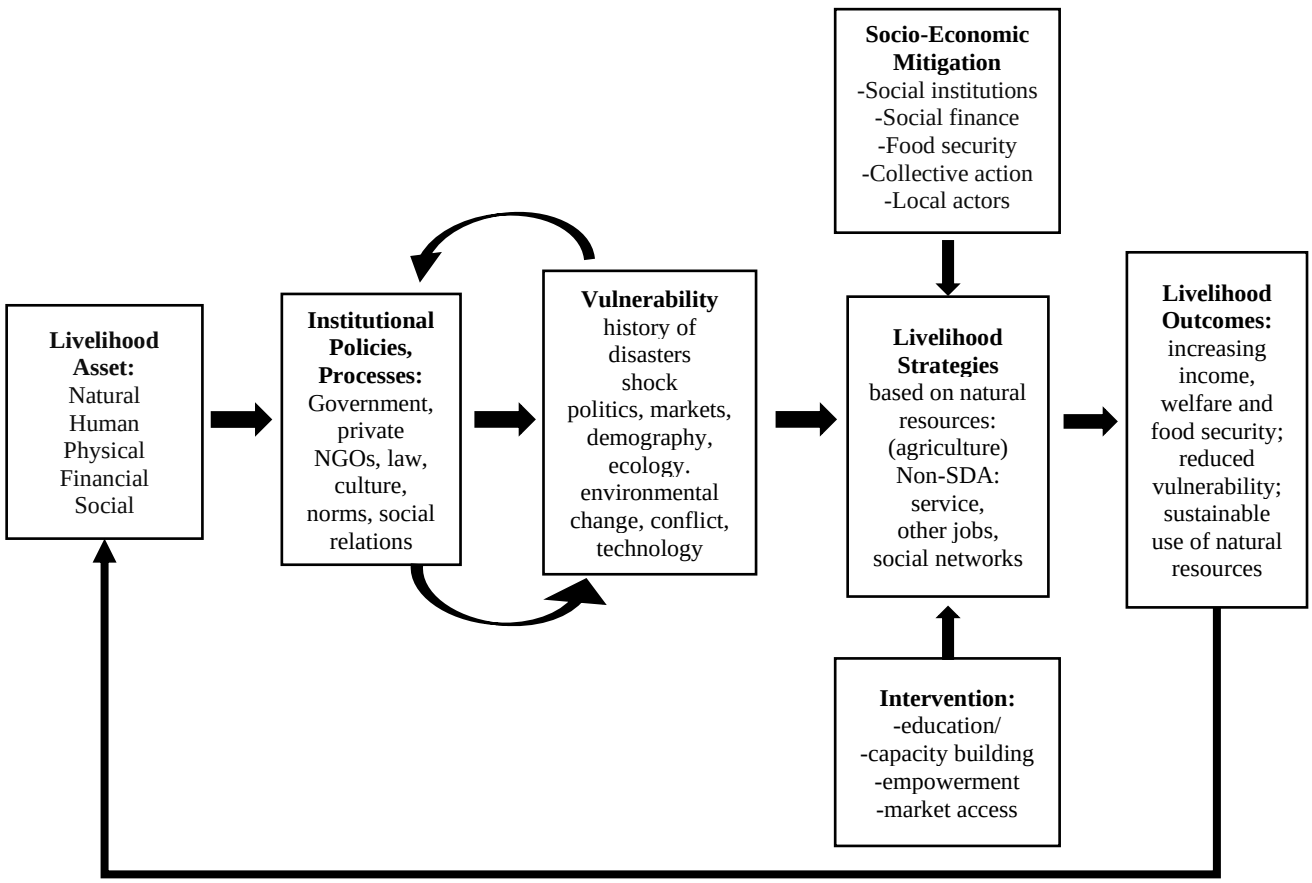

Figure 5. Socioeconomic mitigation and intervention framework for sustainable livelihood systems
Source: adapted from [30-32, 66]

5. CONCLUSION

Based on this study, the dynamics of volcanic occurrences have a significant impact on the local community's livelihood system, which is reliant on sustaining life. An analysis of transformation and livelihood systems is essential for establishing effective strategies for survival, supporting economic revival, and encouraging social transformation. The rise of the horticultural commodity market caused a change in the value of natural resources, resulting in a shift from growing basic crops to producing agricultural commodities to meet market needs. The current study produces a set of community-based disaster management principles that have been customized to fit the unique conditions of the community's geographic environment.

The main goal of this community-based disaster management concept is to improve the preparedness level for dealing with catastrophes and strengthen the social and economic resilience of local communities. By implementing transformation and a carefully constructed livelihood system, communities are expected to successfully recover from the impacts of disasters and improve their economic and social conditions. By using this strategy, the promotion of sustainability can be cultivated within the community and its surrounding environment. The community's participation in the planning and execution of disaster management is highly significant as it cultivates a heightened sense of ownership and responsibility within the community. This promotes improved efficiency in fostering cooperation among government institutions, society, and other pertinent stakeholders. It is crucial to reduce the dangers of disasters and speed up the process of recovering from them to quickly restore persons' lives to their pre-disaster condition. Furthermore, this endeavour can also bolster the community's capacity to endure and surmount forthcoming challenges.

This study offers recommendations to the central and local governments on implementing stimulus programs and initiatives that can effectively bolster the community's livelihood system before, during, and after a disaster. The utilization of local talent and resources in economic empowerment projects is crucial for achieving sustainable empowerment in the future. Community-wide savings are crucial for the community in case of an emergency. Through the accumulation of these combined reserves, society may autonomously bolster the economy in the face of calamities, without relying on external assistance. Enhancing the resilience and durability of livelihoods in disaster-prone regions relies on the crucial aspect of fortifying communities and networks.

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