



The Disruptions of Household Assets Due to Semeru Volcano Eruption, East Java, Indonesia

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Received: 30 January 2026

Revised: 29 April 2026

Accepted: 30 April 2026

Published: 30 April 2026

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Abstract: A failure to establish a clear connection between disruption and household assets may result in essential needs being overlooked by families attempting to rebuild their lives in the aftermath of disasters. This research conducted a comprehensive analysis to detect and chart the diverse disruptions inflicted upon household livelihood assets as a consequence of the 2021 Semeru Volcano Eruption. A mixed-method approach was employed, utilizing an open-ended questionnaire and interviews for data collection. The data underwent descriptive statistics and Colaizzi analysis. A comprehensive map of household asset disruption caused by the Semeru Eruption, following the Pentagon asset model framework, has been developed, encompassing different aspects of household livelihood security (HLS). The disruptions include 1) disruptions to human assets (88%), primarily affecting food assets, particularly their distribution; 2) disruptions to physical assets (100%), resulting in the loss of housing; 3) disruptions to financial assets (96,5%), characterized by the loss of valuable family assets and employment; 4) disruptions to social assets (60,5%), specifically impacting spiritual activities; and 5) disruptions to natural assets (50%), particularly the accessibility of clean water. This research also sheds light on the initial coping mechanisms employed by the affected community.

Keywords: Household asset, disruption, Semeru volcano eruption, pentagon asset, livelihood security.

Introduction

In recent decades, the world has witnessed a significant rise in the number of disasters. In 2021 alone, a staggering 367 major natural disasters occurred across 127 countries worldwide. These events had a profound impact, resulting in the loss of 10,492 lives, affecting approximately 104.2 million individuals, and causing economic losses amounting to approximately 252,138 billion USD (Academy of Disaster Reduction and Emergency Management et al., 2022). Indonesia, being a region prone to multiple types of disasters, has emerged as both a laboratory for disaster studies and a perilous area with numerous threats. According to the Academy of Disaster Reduction and Emergency Management et al., 2022 (BNPB), a total of 3,514 disaster incidents were recorded throughout 2021. The aftermath of these disasters has imposed a financial burden on the state, exceeding 20 trillion units of currency.

The eruption of the Semeru volcano had significant consequences, including damage to infrastructure, the environment, and productive economic assets. The macro-level impact of these damages was estimated by the government to be IDR 2.5 trillion / USD 159 million (BPBD Lumajang Regency, 2022). However, it is crucial to recognize that the eruption also had a profound effect on household livelihood assets at the micro level. Unfortunately, without a structured mapping of these disruptions, there is a risk of neglecting the essential needs of families during the recovery process following a disaster. The disruptions to people's livelihood assets are immediately felt when an eruption occurs, and these disturbances can have both direct and indirect long-term impacts on various aspects of community livelihoods (Markhvida et al., 2020; Wu et al., 2022; Parvez et al., 2022). The absence of household asset disruptions analysis resulted in the planning of post-disaster

How to Cite:

Suud, M.M., Sumarmi, Astina, I.K., Bachri, S. (2026). The Disruptions of Household Assets Due to Semeru Volcano Eruption, East Java, Indonesia. *Journal of Disaster Mitigation Research*, 1(1), 28–37.

recovery programs by local authorities not considering recovery strategies at the community level. This research assessed and documented the extent of disruption to livelihood assets within the first 60 days after the 2021 Mount Semeru Eruption.

This research focuses on households directly impacted by the pyroclastic flow resulting from the eruption of Mount Semeru in Lumajang Regency, East Java, in 2021. Mount Semeru holds the distinction of being the tallest volcano on Java Island, with its peak, Mahameru, reaching an elevation of 3,676 meters above sea level. The Semeru volcano is classified as a stratovolcano and exhibits a volcanic-strombolian eruption type. Geographically, it lies between 8°06' South Latitude and 112°55' East Longitude, spanning the administrative areas of Malang and Lumajang Regencies. On December 4, 2021, the Semeru Volcano experienced an eruption accompanied by hot clouds (also known as APG), which impacted eight villages across two sub-districts. In the Candipuro District, the affected villages include Sumber Wuluh, Candipuro, Sumber Mujur, Sumber Rejo, and Penanggal. In the Pronojiwo District, the affected villages are Supiturang, Sumber Urip, and Oro Oro Ombo. The eruption led to the tragic loss of 64 lives, displacement of 10,400 individuals (accommodated in 410 evacuation points), damage to 1,859 houses, infrastructure destruction, and the disruption of community livelihood assets, encompassing an area of 2,417.2 hectares of productive land.

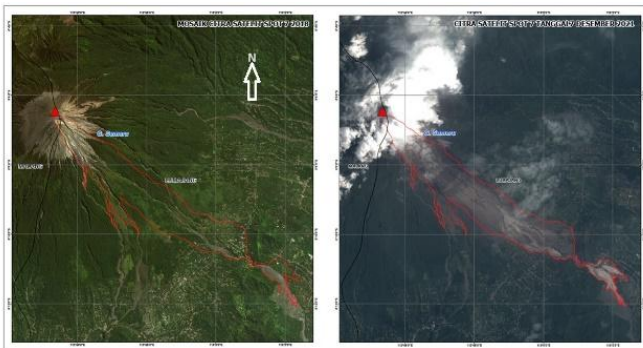


Figure 1. Satellite image of the Semeru 2021 Lava Flow
Source: National Research and Innovation Agency/BRIN, 2022

The research commences with a comprehensive literature review to gain insights into the various forms of disruption caused by natural disasters. This includes examining the specific ways in which household livelihood assets are impacted by these disasters, utilizing the Pentagon asset model as an analytical framework. Disruption to household livelihoods resulting from disasters is understood as a significant and transformative change that fundamentally alters the entire structure of household life and family well-being

(Markhvida et al., 2020; Wu et al., 2022). Disasters have the potential to directly disrupt household income, savings, induce household debt, affect household consumption, and alter household social behaviour. Moreover, if a disaster leads to infrastructure damage and hampers developmental efforts, it indirectly affects household economic activities (Esmalian et al., 2021). From a psychological standpoint, disasters can increase trauma and uncertainty (Frankenberg et al., 2008). The uncertainties surrounding work and social life can further exacerbate disruptions, including instances of domestic violence (Frankenberg et al., 2008).

In this study, household livelihood assets are examined through the lens of the household livelihood security (HLS) theory. HLS refers to sufficient and sustainable access to income and resources that enable households to meet their basic needs. These needs encompass various aspects, such as adequate access to food, clean drinking water, healthcare facilities, educational opportunities, suitable housing, and sufficient time for community engagement and social integration (Frankenberger et al., 1998). Natural disasters significantly increase the risk of undermining household livelihood security, rendering households more vulnerable to insecurities in income, food, health, and nutrition. The allocation of a larger portion of resources towards acquiring food and healthcare services contributes to heightened vulnerability to food and nutrition insecurities. When confronted with a disaster, factors such as land ownership, savings, level of education within the household, and the vision and leadership of the household head play pivotal roles in determining the vulnerability of household livelihoods (Parvez et al., 2022).

The attributes in ensuring household livelihood align with the concept of sustainable livelihood/pentagon asset model: (1) ownership of human capabilities (such as education, skills, and health); (2) access to tangible and intangible assets (social, natural, and economic capital); and (3) the presence of economic activities (Frankenberger et al., 1998). In its simplest form, livelihood assurance refers to a household's ability to meet its basic needs (or realize its fundamental rights). These needs include adequate food, health, shelter, minimum income levels, basic education, and community participation. If any of these basic needs are unmet, the household can be said to live in poverty (Lindenberg, 2002).

Livelihood refers to the assets, capabilities, and activities that individuals employ to meet their basic needs and sustain their lives (Mutea et al., 2019). Livelihood assets are fundamental conditions that influence and reflect people's livelihoods. The livelihood approach is used to gain a comprehensive understanding of people's capacities, also known as

assets or capital, and how they transform them into positive livelihood outcomes (Baiquni, M, 2007). These assets are classified within the Pentagon asset model framework, which includes: a) physical assets encompassing basic infrastructure, b) financial assets involving access to sources of financial capital, c) human assets comprising the knowledge, skills, and abilities of households to pursue better livelihoods, d) social assets encompassing social networks, norms, and beliefs, and e) natural assets involving natural and biological resources. This framework is rooted in the concept of sustainable livelihoods (DFID, 1999). Disasters can disrupt these assets, resulting in limited access and opportunities for individuals to acquire them (Fauziyanti & Hizbaron, 2020).

Several studies have highlighted the severe impact of disasters on livelihood assets. For instance, a study conducted by Lu et al., (2022) demonstrated that the shocks, intensity, and frequency of natural disasters significantly increase the vulnerability to poverty among farming households. Disruptions in agriculture caused by disasters can lead to long-term negative consequences for both agricultural and national development. These consequences include the loss of productive labour, infrastructure damage, forced migration, disruptions in supply chains, and a decrease in people's income potential (Gauchan et al., 2017). Furthermore, Tasri et al., (2022) emphasized that the impact of disasters is particularly harsh on groups with lower income levels or those already living below the poverty line. In such cases, the disruption of livelihood assets due to disasters exacerbates economic capacity and further deepens poverty levels. When resources are damaged, a decline in resource productivity ensues, leading to decreased income levels and an increase in income inequality. Nevertheless, the negative effects of these disturbances can be mitigated if communities have access to resources, diversified livelihoods, and individual adaptive capacities (Kwazu & Chang-Richards, 2021). It is important to note that such adaptation is developed through the interaction between individuals or community groups and their environmental conditions (Marlina et al., 2020).

The primary objective of this study is to investigate and analyse the various ways in which the eruption of Semeru Volcano in 2021 has disrupted household livelihood assets. The research questions are derived from the conceptual framework of household livelihood security proposed by T.R. Frankenberger and M.K. McCaston (1998), as well as the Pentagon asset livelihood framework developed by DFID (1999).

Method

This study employed a mixed-method approach, primarily focusing on quantitative analysis to map the

various forms of disruption to household assets caused by the Semeru Eruption. Qualitative methods were also utilized to delve into topics related to the impact of the eruption on household assets.

Research Location

This research was conducted in the immediate vicinity affected by the 2021 Semeru Volcano Eruption, including eight villages spanning two sub-districts: Candipuro District, including Sumber Wuluh Village, Candipuro Village, Sumber Mujur Village, Sumber Rejo Village, Penanggal Village; and Pronojiwo District, consisting of Supiturang Village, Sumber Urip Village, and Oro Oro Ombo Village in Lumajang District, East Java Province. The study area falls within KRB III and KRB I (lava flow platforms) based on the updated 2021 KRB Mount Semeru Map. The Geological Agency is currently revising the disaster-prone area (KRB) map for Mount Semeru following the 2021 eruption, resulting in a broader coverage compared to the 1996 KRB Map. In the 1996 Semeru KRB, the total area of the KRB was 72.16 hectares, whereas the 2021 KRB update expanded it to 80.43 hectares. Specifically, Supiturang and Oro-oro Ombo Villages in Pronojiwo District, Lumajang Regency, are now included in KRB III and KRB I in the updated 2021 KRB. The KRB area in Supiturang Village has increased to 9.19 km², while Oro-oro Ombo Village covers 0.03 km². Furthermore, Sumber Wuluh Village in Candipuro District has expanded to 3.24 km² (PVMBG, 2021).

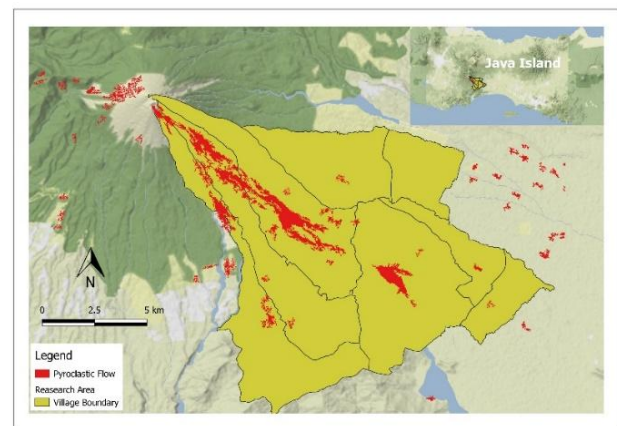


Figure 2. Research Site

Population and Sample

The population under study consisted of 1,859 households residing in the areas affected by the Semeru Eruption in 2021. To ensure representative sampling, a random sampling technique was employed using the Isaac and Michael Smith (1983) table with a significance level of 5%. Following this approach, a sample size of 294 was determined, which was rounded up to 300 for practical purposes.

Data Collection and Procedure

Data collection for this research took place from January 10, 2022, to January 21, 2022. A survey was conducted using an open-ended questionnaire to gather comprehensive data on the disruption of household assets following the Mount Semeru Eruption disaster. The objective was to explore the various possibilities of disruptions to family livelihood assets within the framework of the Pentagon asset model. Respondents were selected for interviews to obtain in-depth descriptive data. The procedure involved providing respondents with a questionnaire, where they were asked to indicate whether there was any interference with specific livelihood assets by choosing "Yes" or "No" as their response. This initial response served as a reference for further questions, specifically regarding the forms of disruption experienced in family livelihood assets. Multiple options were provided, allowing respondents to select more than one form of interference or even add types of disruption that were not initially listed.

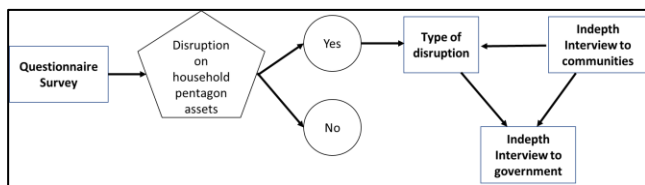


Figure 3. Data Collection Procedure

Data Analysis

The data that were obtained from the questionnaires underwent tabulation and descriptive statistics analysis. Meanwhile, the results of the interviews were analysed using the Colaizzi technique which consisted of 1) reading and understanding the interview notes; 2) selecting and identifying meaningful statements; 3) coding meaningful opinions; 4) summarizing after coding; 5) describing the phenomenon; 6) describing the fundamental structure of the phenomenon; and 7) making confirmations to respondents (Priyanti et al., 2019) (Kr, 2021) (Yuan et al., 2022).

Table 1. Respondents' Profile

Profile	Category	Freq.	Percentage (%)
Age	>50 yo	119	39.67
	≤ 20 yo	3	1.00
	21 yo - 30 yo	33	11.00
	31 yo - 40 yo	81	27.00
	41 yo- 50 yo	64	21.33
	Total	300	100.00

Profile	Category	Freq.	Percentage (%)
Sex	Male	240	80.00
	Female	60	20.00
	Total	300	100.00
Latest Education	Elementary	242	80.67
	Junior High	30	10.00
	Senior High	6	2.00
	Not Schooled	22	7.33
	Total	300	100.00
Main Occupation	Industry	1	0.33
	Service	17	5.67
	Employee	1	0.33
	Repair Shop	1	0.33
	Trading	14	4.67
	Agriculture	187	62.33
	Carpentry	2	0.67
	Animal Husbandry	20	6.67
	Sand Mining	57	19.00
	Total	300	100.00

Result and Discussion

The Forms of Disruption of Household Assets Due to Semeru Volcano Eruption

The forms of disruption are elaborated based on the Pentagon asset model framework and components based on household livelihood security as follows.

1. Disruptions to Human Assets

The aftermath of the Semeru Volcano Eruption has had a significant impact on the survivors, particularly in terms of health issues and disruptions to food availability. The survey results indicate that the majority of survivors (98%) experienced food disturbances, which were more prevalent than health problems (78%). This disparity can be attributed to the fact that their food sources before the disaster relied on stored supplies, direct harvesting from fields, or purchasing ingredients from local markets and nearby shops, all of which were severely disrupted by the eruption. During the 60 days following the eruption, the survivors resided in evacuation centres and heavily depended on food aid from donors.

The survey results revealed that this dependency on aid had a disruptive effect on their food assets, with 73.04% of respondents expressing this concern. Survivors also reported that limited access to food resulted in a decrease in nutrition for 68.94% of them, leading to health issues such as digestive disorders (55.56%). Furthermore, interviews conducted with the respondents shed light on the psychological impact of

the eruption. Approximately 30.34% of the survivors expressed experiencing depression during their evacuation period. They described feelings of excessive anxiety, worry, fear, or persistent thoughts when recalling the events surrounding the Semeru eruption. However, the survivors acknowledged that these emotional reactions were a natural response given the circumstances they had endured.

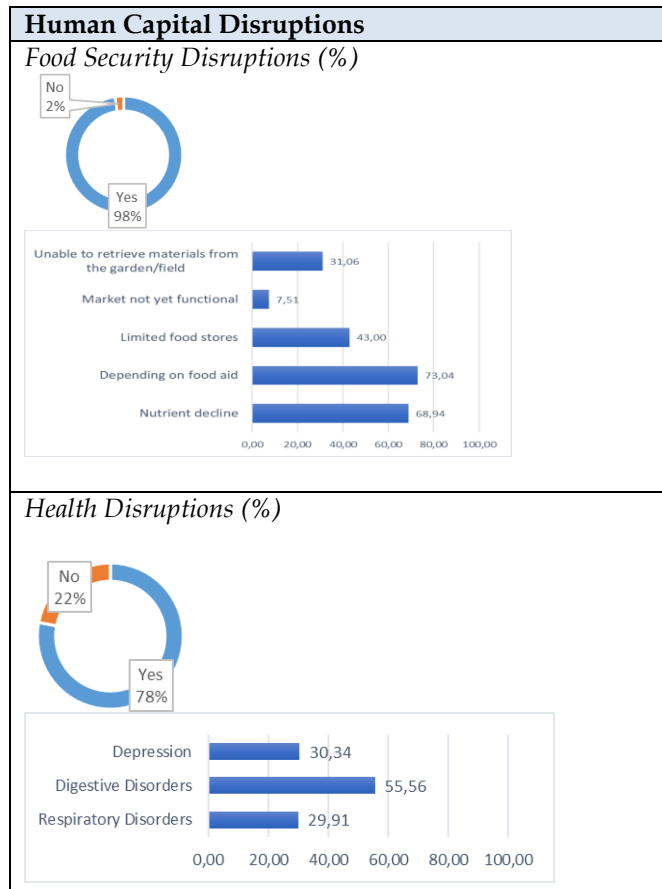


Figure 4. The Mapping of Human Capital Disruptions (Analysis, 2023)

2. *Disruption to Physical Assets*

The 2021 Semeru Volcano Eruption resulted in destructive lava flows that impacted the homes of residents. According to the official release from the Lumajang Regency BPBD (Regional Disaster Management Agency), a total of 1,859 houses were damaged due to the eruption. The damage to these houses can be categorized as follows:

Table 2. Number of Households by Level of House Damage

District	Heavy Damage	Moderate Damage	Low Damage
Candipuro	287	95	537
Pronojiwo	820		120
Total	1.107	95	657
Population Total	1.859		

Source: Disaster Agency Luamajang, 2023

The damage caused by the eruption directly impacted household assets, which are crucial for the well-being of families. Central Asia (2015) defines the house as a family living environment, fulfilling various functions such as efficient resource utilization, protection, social and emotional bonds among family members, cultural influences, religious practices, and social status. All respondents (100%) in the study stated that their house assets were disrupted by the eruption. From the survey and interview results, it was revealed that 87.67% of the houses were no longer inhabitable.

The survivors expressed their desire to relocate, despite considering the potential impact on their livelihoods if the new location is far from their sources of income. Research on relocation has shown a significant negative effect on family livelihood security (Liu et al., 2020). This is because households tend to seek a place to live close to economic opportunities to safeguard their livelihoods (Garcia-Fry et al., 2022).

The decision to relocate the survivors was made by the Government of Lumajang Regency through a Lumajang District Decree, which outlined the Relocation Master Plan for Semeru Eruption Survivors to Sumbermujur Village, Candipuro District. This village is situated 5-9 km away from the affected villages. As a result, the survivors are forced to live far away from their sources of livelihood. However, they have no other choice as the government has designated the lava-affected area as a restricted zone for residential use based on the new Semeru Volcano Disaster Prone Area (KRB).

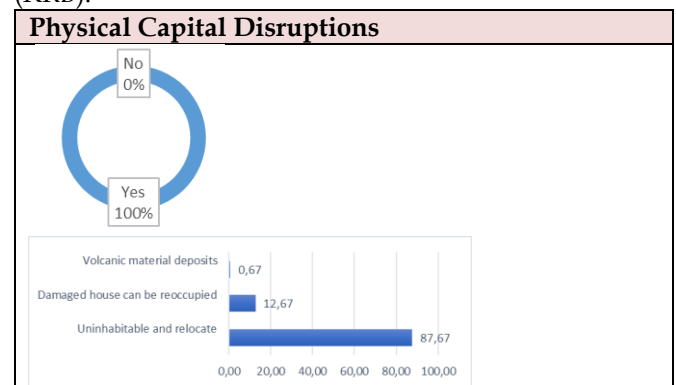


Figure 5. The Mapping of Physical Capital Disruptions (Analysis, 2023)

3. Disruption to Financial Assets

The livelihoods of the survivors, represented by the respondents, were heavily reliant on natural resources that were affected by the Semeru Volcano Eruption, particularly in agriculture (63.33%) and sand mining (19%). According to BRIN mapping (2021), approximately 400.5 hectares of agricultural land and plantations were directly impacted by the lava flows. Consequently, work disruptions were inevitable for the majority of survivors (95%). These disruptions included job losses (85.96%), loss of production assets (58.30%) such as daily work equipment, and loss of capital (28.77%) in the form of cash and production materials like agricultural fertilizers for farmers.

valuable assets that could have been sold or utilized in times of urgency, including savings, livestock, gardens, and rice fields. The interview results revealed that all respondents experienced a decline in income since the eruption occurred. Among them, those classified as poor with an income of less than 1 million experienced the greatest disturbances. This group had no food reserves, savings, or valuable family assets to rely on. Furthermore, the financial pressures placed on families can significantly impact their psychological well-being (Taylor et al., 2017). Financial strain creates feelings of being unable to meet financial demands, make ends meet, and have sufficient funds to cover basic needs (Davis & Mantler, 2004).

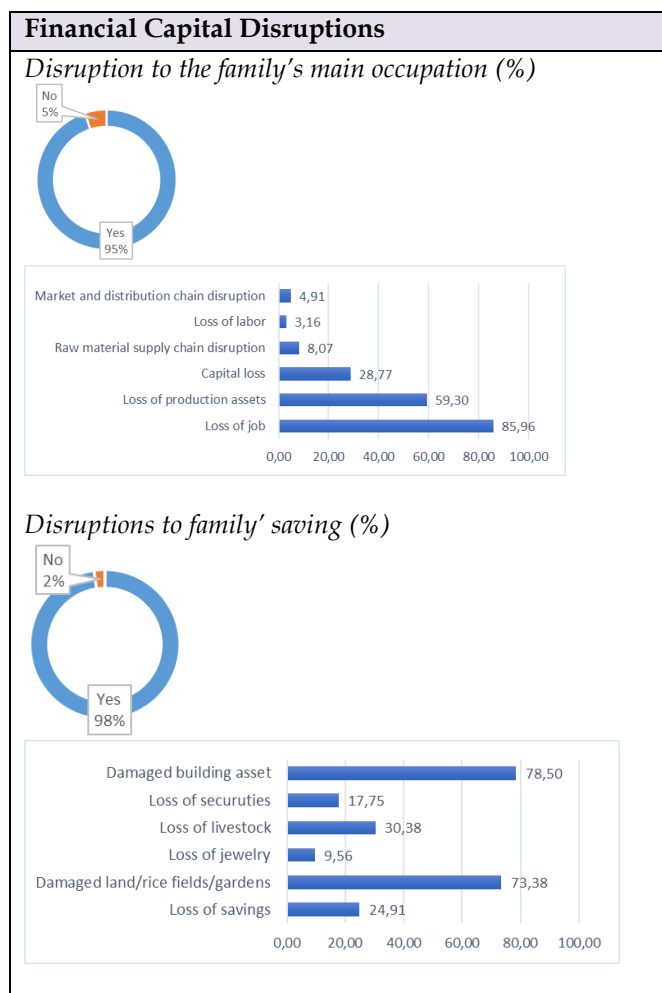


Figure 6. The Mapping of Financial Capital Disruptions (Analysis, 2023)

The survivors acknowledged their high dependence on government and donor assistance and aid. This reliance on aid has made it difficult for them to meet financial obligations such as repaying loans, covering school fees, and managing family healthcare costs. Moreover, the eruption's impact extended to

4. Disruption to Social and Environmental Assets

In terms of the social aspect, 70% of the respondents reported experiencing disturbances in their social activities. The community was particularly affected by their religious ritual activities, with 83.3% of respondents expressing disruptions in this area. Spiritual activities, especially those conducted in groups, such as praying for Muslim communities or practices that promote harmony with humans, nature, and the environment for long-term prosperity in the Hindu community (Fadul Allah Dian Presilia et al., 2018), were also significantly impacted. Religious activities not only hold personal significance for individuals but also serve as socio-spiritual expressions that strengthen cohesion and spirit within society (Fahm, 2019) (Lormans et al., 2021). This highlights the social dimension inherent in disasters, as they can disrupt long-standing social norms and institutions (Weitzman & Behrman, 2016). Social institutions play a crucial role in fostering social cohesion, which is essential for human well-being (Fan et al., 2020). Furthermore, the survivors also expressed concerns about security disruptions. Incidents of looting of aid and cases of violence at evacuation sites contributed to a sense of insecurity among the affected population

Survivors also experienced disruptions to education, although it was not the primary concern for the majority (51%) of respondents. The most significant disturbance was the inability of children to attend school due to damage to school buildings (57.52%) and the unavailability of school equipment (54.90%). Although emergency school assistance was provided by several non-governmental organizations, it was limited to certain areas. The head of the family expressed uncertainty about the sustainability of such assistance. They still longed for access to education that was as comprehensive as it was before the eruption, considering it to be essential for their children's development.

Furthermore, approximately half of the respondents expressed concerns about limited access to drinking water, which was not an issue they experienced before the eruption. This limited access took two main forms: limited distribution of drinking water (63.58%) and a decrease in the cleanliness of the available water (45.70%). At the time of data collection, the respondents heavily relied on drinking water assistance and had to share and alternate the use of clean water in the locations where they sought refuge.

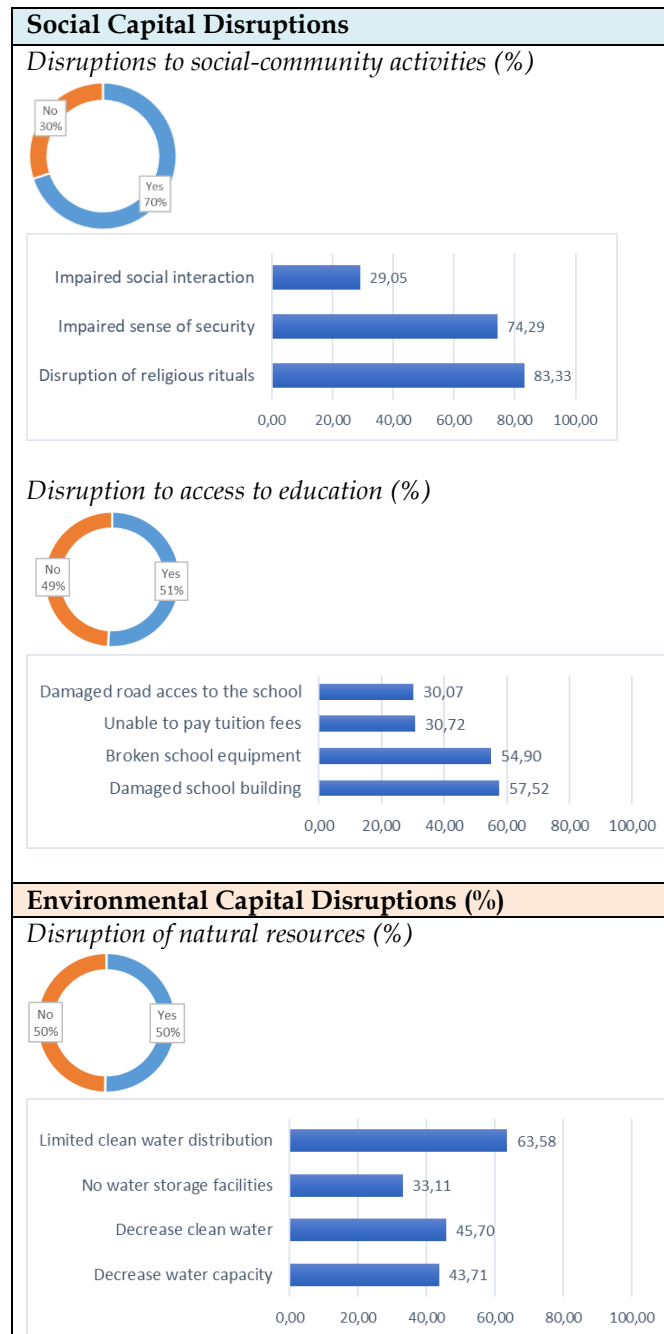


Figure 7. The Mapping of Social and Environmental Disruptions (Analysis, 2023)

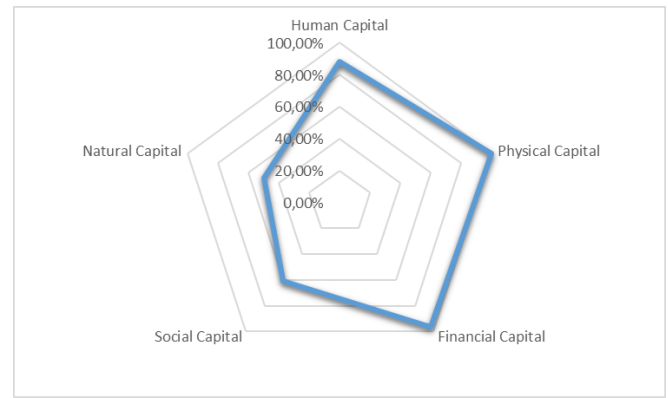


Figure 8. Pentagon Assets Disruption of Household (Analysis, 2023)

Initial Coping Mechanisms for Unintentionally Revealed Asset Disruptions

While the main focus of this research is to understand the forms of disruption to household assets, it is important to note that during the interview process, respondents often shared their initial coping strategies. These strategies are indicative of their resilience and resourcefulness in the face of adversity. For instance, some respondents mentioned actively seeking alternative employment, such as working as labourers, to compensate for their reduced income. Others relied on support from relatives and friends living outside the affected area. Some were able to utilize their savings to sustain themselves and even provide assistance to their fellow survivors. These expressions of resilience and adaptive behaviour are understandable, as individuals affected by disasters often possess the intuition to find solutions and develop methods to cope with stress and pressure (Otsuyama et al., 2019). Even in threatening situations, people in disaster-affected areas tend to prioritize the protection and preservation of their remaining assets (Otsuyama et al., 2019), highlighting their determination to overcome the challenges caused by asset disruption.

The research findings highlighted the willingness of affected communities to actively participate in the construction of relocation houses, regardless of the challenges they faced. This aspect should be taken into account by the government in their post-disaster rehabilitation and reconstruction programs. Involving the survivors in the recovery process can have positive and wide-ranging effects. On the side of the survivors, it can contribute to the restoration of disrupted household assets and livelihoods. On the government's side, such involvement can contribute to achieving sustainable recovery objectives. Community involvement is crucial not only in the implementation phase but also in the planning process (Smith & Wenger, 2007). By actively involving the community, a sense of strong commitment

and ownership can be fostered (Irawan et al., 2021). This aligns with the Schumpeterian creative destruction theory, which suggests that growth can be achieved in disaster-prone and affected environments through reconstruction, infrastructure development, and investment in advanced technologies. These efforts can enhance productivity and create long-term economic opportunities (Bringas et al., 2022).

Conclusion

The research conducted aimed to uncover and map the various forms of disruption in household assets caused by the 2021 Semeru Eruption. The study followed multiple paths to achieve this objective. Firstly, it engaged in discussions during the initial stages of the disaster, focusing on the micro (household) scale. This helped in understanding the impact of the eruption and provided insights to guide post-disaster recovery policies after the Semeru Eruption in 2021. Secondly, the research focused on analysing the disruption of household assets within the framework of the Pentagon asset model and the components of household livelihood security (HLS). By utilizing this approach, the study aimed to contribute to the understanding of how the 2021 Semeru Eruption disrupted the achievement of sustainable development. Thirdly, data collection techniques such as questionnaires and interviews were employed to gather information. Through these methods, the research revealed initial coping mechanisms utilized by the affected community. These findings can serve as a basis for further research and exploration of the topic.

Eruptions exert both macro-level impacts, involving damage and losses within the development sector, as well as micro-level impacts that affect household assets, which are crucial for individuals' sustenance and livelihoods. Firstly, there were disruptions in human assets, particularly in food distribution. Secondly, physical assets, such as houses, were severely affected, leading to widespread damage and loss. Financial assets also suffered, with valuable family assets and jobs being lost. Social assets, particularly spiritual activities, were disrupted, impacting the cultural and social cohesion of the affected communities. Access to clean water, a natural asset, was also limited, affecting daily life and well-being. These disruptions collectively compromised household livelihood security. The research also sheds light on the initial coping mechanisms employed by the community, including livelihood diversification and utilization of existing assets and savings. Importantly, survivors expressed a strong desire to be actively involved in recovery programs. The findings emphasize the significance of community participation in post-disaster

recovery efforts to ensure their engagement and ownership in the process.

The research therefore advances the following recommendations:

- Recovery initiatives should encompass the sustainability of household livelihoods alongside macro-level development considerations
- Engage the local community in both the planning and execution of the recovery program.
- Securing the presence of employment opportunities that align with the skillsets of survivors in the relocation.

Acknowledgments

Gratitude is expressed to the Government of Lumajang Regency, local stakeholders and survivors for providing a positive contribution to this research and article.

Author Contributions

Mohamad Mambaus Suud: Conceptualization, Methodology, Data Collection, Design Questionnaire, Analysis, Writing – original draft, Visualization. Sumarmi: Supervision, Writing – review & editing. I Komang Astina: Supervision, Writing – review & editing. Syamsul Bachri: Conceptualization, Methodology, Writing – review & editing.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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