



RESEARCH ARTICLE

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Assessing the Social and Economic Vulnerability of Farmers by Group Categories in Volcano-Prone Disaster Area in Sempu Village, Kediri Regency

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Abstract

Agriculture is the main livelihood of residents in Sempu Village, Ngancar District, Kediri Regency. Agriculture in this region has a high level of disaster risk because it is located in the disaster-prone area of Mount Kelud. The potential for damage to agricultural land due to the Kelud volcanic eruption will increase the vulnerability of farmers. Vulnerability assessment is important because one of the efforts to reduce disaster risk is to reduce vulnerability. Vulnerability assessments are often carried out on heterogeneous societal subjects and not based on specific subjects or professions. In fact, farmers are a profession that is more vulnerable than other professions and have various characteristics that can influence vulnerability. Therefore, this research aims to examine socio-economic vulnerability with a greater focus on farmers to find out how vulnerable farmers in Sempu Village are and what characteristics farmers are most vulnerable to. This research uses scoring and weighting methods using AHP (analytical hierarchy process) to analyze data and survey methods to collect data. The results of the vulnerability assessment show that 77% of farmers in Sempu Village have low social vulnerability. As many as 52% of farmers have moderate economic vulnerability, 31% have high economic vulnerability. Elderly farmers in Sempu Village have the highest level of social vulnerability. Farmers who have limited land and loan capital have the highest level of economic vulnerability. Women farmers show higher levels of social and economic vulnerability than all farmers.

Keywords: vulnerability; farmer; social; economy.

Introduction

Mount Kelud is a stratovolcano located in East Java, Indonesia with a height of around 1731 m (Sahay et al., 2023). Kelud is considered one of the dangerous volcanoes in Indonesia due to its frequent eruptions and proximity to densely populated areas (Goode et al., 2019; Indriyanto et al., 2023). Recent activity in Kelud is characterized by explosive eruptions spread over approximately 10 year intervals (Zaennudin 1992; Maeno et al., 2019). One of the villages in Kediri Regency, East Java that was affected by the eruption of Mount Kelud is Sempu village. Based on the disaster-prone area map shown in Figure 1, Sempu Village is located in the Mount Kelud Disaster-Prone Area II. Disaster-Prone Area II is an area within a radius of 38 km from the crater and has the potential to be hit by hot clouds, lava flows, and hit by rock falls and heavy ash rain (Priyono et al., 2020). The previous eruption of Kelud Volcano in 2014 had a significant impact on the agriculture industry in Sempu Village.



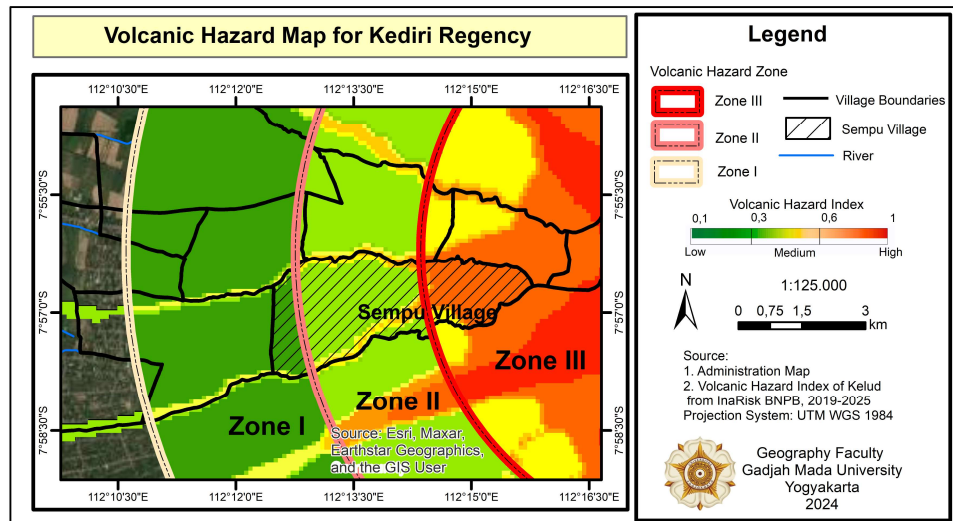


Figure 1. Volcanic Hazard Map for Kediri Regency.

Based on primary data obtained from the Sempu Village government in 2023, most of the people in Sempu (67%) depend on agriculture farming for their primary livelihood. After the disaster, many villagers, especially farmers, lost their income due to the eruption, making it impossible for them to grow crops and harvest due to lack of capital and land conditions that were not yet suitable for agriculture. Agricultural products in these lands reduced remarkably after the eruption of Kelud Volcano. Based on research results from Anugrah (2018), farmers' income after the eruption in the Kelud area decreased compared to before the eruption. There was a decline in agricultural production in the disaster-prone area after the eruption in 2014. In 2019, the amount of agricultural production was able to return to the level before the eruptions. Even though conditions have returned to normal, the eruption potentially occurs.

The agricultural sector and farmers in disaster-prone areas are at high risk. As one of the main elements of agriculture, if agriculture becomes a sector that is vulnerable to disaster then farmers will also become vulnerable (Rozaki et al., 2022). Under normal conditions without disasters, farming has a higher vulnerability than other sectors. This is because crop yields depend on changing natural conditions. The potential for disasters in agricultural areas will further increase the vulnerability of farmers in disaster areas.

Most risk analysis studies compute risk as a function of hazard, vulnerability, and capacity, which is widely accepted. One effort to reduce the risk of disasters for farmers in disaster-prone areas is to conduct vulnerability assessments. The need to assess vulnerability to natural hazards is based on the assumption that disaster risks and losses are not only a result of the hazard event but also determined by societal conditions and economic preconditions that shape the way society prepares for or responds to these events (Birkmann et al., 2022). Understanding various aspects of social vulnerability during and after a hazard is critical to preventing damage before the event, mitigating losses during the event and improving recovery capabilities after the event. Economic vulnerability is measured based on the economic conditions of society (Marfai et al., 2019). In the economic field, vulnerability is defined as the risk of a household's economic level declining or remaining in poverty, one of which is due to dangers originating from outside or the environment.

This research presents an analysis of the level of socio-economic vulnerability of farmers in Sempu Kediri Village to volcanic eruption disasters using scoring and weighting methods with AHP. Vulnerability assessments are often carried out as a whole without delving into specific subjects or professions such as farmers. In fact, farmers have various characteristics that have different levels of vulnerability, so assessing farmer vulnerability is important. The scoring and weighting method using AHP (Analytical Hierarchy Process) to measure vulnerability has been widely used in previous research which used AHP and scoring as a tool for measuring vulnerability. The AHP method was chosen for weighting because of its sensitivity, ease of use and interpretation and is widely used in research related to disaster vulnerability. AHP offers a useful method allowed incorporating experts' judgments of each decision element into a hierarchical structure and processed it mathematically (Dano, 2022). Apart from that, AHP compares variables, so that the process of comparing each criterion and sub-criteria can be more focused and directed.

There are several previous studies that examined the Kelud Volcano disaster. Sejati et al., (2019) researched the level of community participation in Kelud disaster mitigation efforts and Windiani et al., (2019) analyzed the role of social capital in community development in the region disaster-prone in Sempu Village, Kediri Regency. There has been no research regarding disaster vulnerability specifically in Sempu Village. Research from Hizbaron et al., (2018) examined vulnerability in Kelud disaster-prone areas and included the number of farmers, agricultural land area and poor families as variables that increase the vulnerability index and reduce resilience. This research tries to analyze farmers specifically as the main subject with the assumption that farmers have different economic conditions. There is a possibility that farmers are economically strong, but there is another possibility that farmers are also from poor families, which further increases the level of vulnerability. In the end, results will be obtained in the form of variations in the level of farmers' economic and social vulnerability. This research aims to identify the level of socio-economic vulnerability of farmers in the Kelud volcano disaster-prone area especially in Sempu Village using scoring method with weighting using AHP. Vulnerability analysis aims to understand the weaknesses and strengths as well as various aspects that cause community vulnerability so that it can be used as a basis for designing appropriate disaster mitigation measures.

Methods

Variable Identification

The vulnerability variable was adapted from previous research. Economic variables to assess economic vulnerability in this study are arranged in Table 1. Economic vulnerability is measured based on the economic conditions of society (Marfai et al., 2019). In the economic field, vulnerability is defined as the risk of a household's economic level declining or remaining in poverty, one of which is due to dangers originating from outside or the environment. The vulnerability variable was adapted from previous research. There are 4 economic variables and 9 sub-variables in this study. The income variable consists of the amount of income from agriculture (Savari et al., 2022) and the amount of income outside of agriculture (Chombo et al., 2018; Hujianto, 2022). The farming business characteristics variable consists of 4 sub-variables that can indicate the economic conditions of farming businesses including land area (Hujianto, 2022; Savari et al., 2022), land ownership status (Chombo et al., 2018), capital sources (Musa et al., 2024; Zhang et al., 2020) and the number of types of commodities (Ijaz et al., 2019). The social safety net variable shows the level of financial security of farmers in crisis conditions including savings and insurance ownership (Hujianto, 2022; Savari et al., 2022). The last is the variable number of dependents showing the number of members who are economically dependent on farmers as heads of families (Dewi et al., 2021; Unzila et al., 2021). Economic variables to assess economic vulnerability in this study are arranged in Table 1.

Table 1. Variable of Economic Vulnerability.

Variable	Criteria	Source
Income	Total income from agriculture	(Savari et al., 2022)
	Total income from non-agriculture	(Chombo et al., 2018; Hujianto, 2022)
Characteristics of farming businesses	Total land area	(Hujianto, 2022; Savari et al., 2022)
	Land ownership status	(Chombo et al., 2018)
	Source of capital	(Musa et al., 2024; Zhang et al., 2020)
	Diversification of commodities	(Ijaz et al., 2019)
Social Safety Network	Ownership of savings	(Hujianto, 2022; Savari et al., 2022)
	Insurance ownership	(Hujianto, 2022)
Number of Dependents	Number of member family who unemployed	(Dewi et al., 2021; Unzila et al., 2021)

The social conditions of society consist of several different factors, thus forming characteristics that are also different for each individual or society. Social vulnerability refers to the characteristics and resilience of individuals or groups in facing the threat of disaster (Musa et al., 2024). During a disaster, social vulnerability is defined as a condition where society with its various institutions and social structures is unable to face the impact of a disaster. Social vulnerability is assessed from several variables. The selection of variables in this research is based on previous research which is suitable for assessing farmers' socio-economic vulnerability and types of volcanic disasters. There are 4 social variables and 8 sub-variables in this study. The variable of knowledge related to disasters shows the readiness of farmers in facing disasters in terms of knowledge assessed by the sub-variable of disaster experience (Kartika et al., 2022) and participation in disaster mitigation training (Hujianto, 2022; Indyastuti et al., 2023). Institutional variables show the strength of farmers' social networks as social capital in facing disasters consisting of farmer participation in farmer communities (Hujianto, 2022) and participation in community institutions (Abidin & Handayani, 2022; Lottering et al., 2021). Demographic variables show the absolute vulnerability of farmers because this variable cannot be changed consisting of gender (Abdullah et al., 2019; Lottering et al., 2021) and age (Crowley, 2021; Lottering et al., 2021). The next variable is health conditions consisting of chronic disease sufferers (Hujianto, 2022) and people with disabilities (Sricharoen, 2019). These social variables are then arranged in Table 2.

Table 2. Variable of Social Vulnerability.

Variable	Criteria	Source
Disaster Knowledge	Disaster's experience	Kartika et al., (2022)
	Participation in disaster training	(Hujianto, 2022; Indyastuti et al., 2023)
Institution	Participation of farmers' associations	Hujianto (2022)
	Participation in social organization	(Abidin & Handayani, 2022; Lottering et al., 2021)
Demography	Gender	(Abdullah et al., 2019; Lottering et al., 2021)

Variable	Criteria	Source
	Age	(Crowley, 2021; Lottering et al., 2021)
Health condition	Chronic disease sufferers	(Hujianto, 2022)
	People with disabilities	(Sricharoen, 2019)

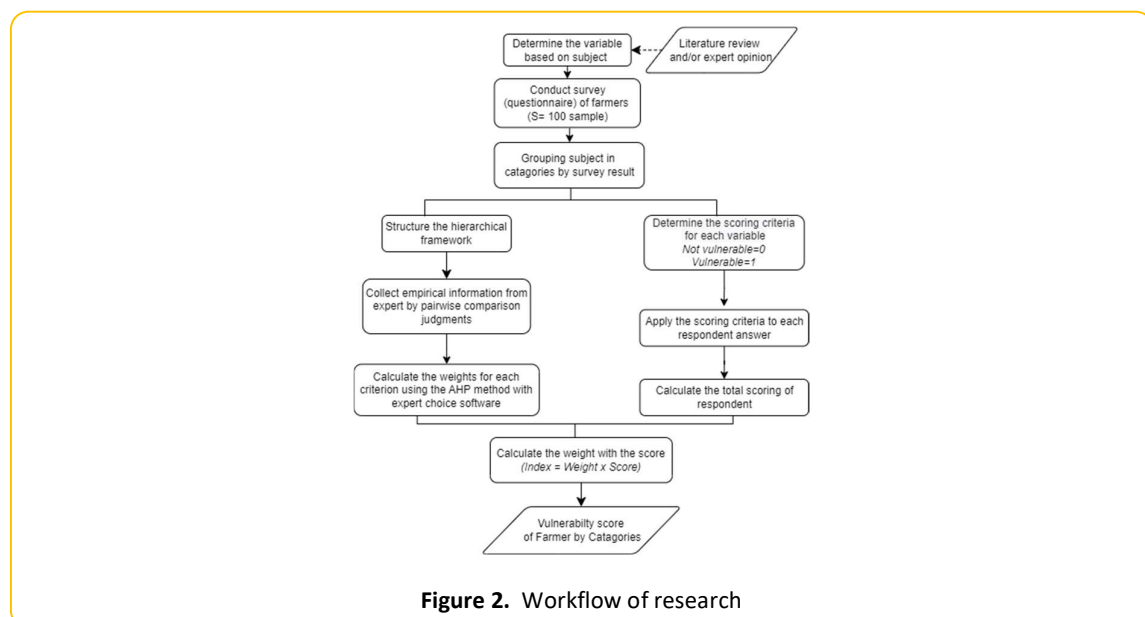
Participant Selection

Primary data was obtained from a survey of farmers in Sempu Village. The method for determining the number of samples in this study employed the Yount sampling method. Yount's sample method involves calculating the sample size by multiplying the total population by a predetermined percentage based on the population size (Anggraini, 2022; Silaen et al., 2022). Specifically, for populations of less than 100 individuals, a 100% sampling rate is applied, meaning the entire population is included in the study. The population of farmers in Sempu Village is 1009 farmers. For populations ranging between 100 and 1000 individuals, a 10% sampling rate is utilized to determine the sample size. This is reinforced by Gay & Diehl's theory which also uses a sample size from the result of multiplying the total population by a percentage of 10% for descriptive research (Fahlevi et al., 2020; Irianto, 2019). This study uses a descriptive approach, so the number of informants used is 10% of the collection of informants. The number of samples in this research is 100 sample. The results were obtained by multiplying the total farmer population of 1009 by 10%. The sample selected had several requirements, namely that the main occupation was farmer, the head of the family, had agricultural land in Sempu Village and lived in Sempu Village. Sampling was carried out using a purposive sampling method.

In determining the sample size, the researcher did not initially group the subjects by categories, as the grouping was conducted post-data collection. This approach allowed for a more accurate representation of the farmers in Sempu Village, as the categorization was informed by the actual data collected. By deferring the categorization, the research ensured that the groups reflected the true characteristics of the farmers, rather than being constrained by pre-defined categories.

Research Procedure

The research stages are depicted with a flowchart in Figure 2 and are explained for each stage.



There are several stages in the research which will be explained as follows:

1. Determine the score for each parameter

The scoring of each response to these parameters is based on the assumed contribution to the level of socio-economic vulnerability of the community. The assessment of each parameter uses a score range between 0-1 where the higher the score, the greater the level of vulnerability of the parameter. For example, in the age variable, farmers aged under 45 years will get a score of 0, farmers aged 46-64 years will get a score of 0.5 and elderly farmers or over 64 years will get a score of 1. The scoring is based on the assumption that the elderly are more vulnerable than young age so the score will be higher

2. Determine the weight of each variable

Each vulnerability variable has a different contribution to total vulnerability. The level of the influence on vulnerable conditions is determined by the amount of weight on each different parameter. The process of determining the weight will be carried out using the AHP (Analytical Hierarchy Process) method with expert choice software. Determining the weight of each parameter using the AHP method uses comparative judgment by creating a pairwise comparison matrix. Comparative judgment is carried out by asking for expert opinions. The experts who contributed to weighting parameters in vulnerability were 3 practitioner experts in disaster and agriculture. Calculate the weight and the score of each parameter

4. Calculate the index of vulnerability

The results of the AHP calculation in the form of a weighted value will be multiplied by the survey result score to form a vulnerability formula. The formula used to calculate vulnerability with each weight is shown in Figure This research uses an equal scenario so that social vulnerability and economic vulnerability have the same weight. After obtaining the results of the vulnerability in the form of a vulnerability index, the next step is to classify the index into vulnerability classes using the following formula.

The formula for calculating the social and economic vulnerability index is as follows:

$$\text{Weight of Variable} \times \text{Score Variable}$$

5. Determine the classification of vulnerability

The vulnerability class is divided into three classes, namely high, medium and low vulnerability. Class determination is based on the results of calculating the vulnerability index in the previous stage. The classification was shown in table 3. The range of scores for each classification is determined by first establishing the desired number of categories for the study. Subsequently, this is calculated by dividing the maximum score by the number of classes. In this context, the maximum vulnerability score is set at 1, representing the highest level of vulnerability among farmers, while the minimum score is 0, indicating the least vulnerable farmers.

Table 3. Classification of Vulnerability.

Index	Classification
0-0,33333333	Low
0,3334- 0,666	Medium
0,6667 -1	High

Tuccillo & Spielman (2022) analyzes the topology of social vulnerability which considers assessments of individuals, communities and populations simultaneously. This research will describe the condition of socio-economic vulnerability of farmers using two methods, namely individually and in groups grouped based on socio-economic characteristics. The results of the vulnerability calculation will be analyzed using different scales. The first way is to calculate the overall average total vulnerability.

Results

The weighting results can be seen as follows in table 4 for social variables and table 5 for economic variables. The total calculation for all weight variables is 100% or a value of 1. This score shows that a farmer's score that is close to 1 is the most vulnerable and one that is close to 0 is the least vulnerable. The result of vulnerability assessment by the group can be seen in Table 4 for social vulnerability and Table 5 for economic vulnerability. The results of the AHP analysis method show that the most influential social vulnerability variable is health conditions consisting of people with disabilities and chronic disease sufferers

Table 4. The weight of social vulnerability variable result using AHP.

Variable	Weight of Variable	Sub- variable	Weight of Sub-variable
Knowledge	0.137	Disaster experience	0.442
		Disaster knowledge	0.558
Organization	0.106	Farmer's organization	0.304
		Social organization	0.696
Demography	0.339	Age	0.752
		Gender	0.248
Health condition	0.418	Chronic disease	0.442
		Disability	

Table 5. The weight of economic vulnerability variable result using AHP.

Variable	Weight of Variable	Sub- variable	Weight of Sub-variable
Characteristics of agriculture business	0.538	Commodity diversification	0.097
		Total Land area	0.248
		Land ownership	0.163
		Source of capital	0.492
Income	0.183	Income from agriculture	0.409
		Income from non-agriculture	0.591
Social Safety Network	0.146	Insurance	0.134
		Saving	0.866
Number of family dependents	0.134	-	-

The survey results show that the majority of farmers in Sempu Village are male farmers aged 45-64 years. There are no farmers with disabilities, but some farmers have chronic diseases. In the disaster variable, almost all farmers have experienced the eruption of Mount Kelud but not all of them have received training or socialization on disaster mitigation. Based on institutions, most farmers are members of farmer groups, but not all members are active members. All farmers tend to be more active in community activities in general, not specifically for the farming community. The results of the survey related to the economy show that the majority of farmers in Sempu Village have small plots of land of less than 0.5 Ha, but they cultivate more than one commodity to plant. The types of commodities most widely planted are pineapple, chilli, corn and sugar cane. Although insurance ownership is still low, most farmers have savings in the form of money, livestock or ownership of assets such as gold. Almost half of farmers in Sempu Village have loans that are used as sources of business capital. Land ownership status is dominated by private land ownership, but most of it is also owned by the government and farmers only have use rights, not ownership rights.

The results of the social vulnerability analysis in Sempu Village show that the majority of respondents have low to moderate vulnerability conditions. The range of farmers' social vulnerability index values in Sempu Village is 0.016 – 0.631. The results of the economic vulnerability analysis show that farmers have low to high vulnerability conditions. The percentage of respondents with moderate economic vulnerability was 46% of the total respondents, 13% of farmers were in the high economic vulnerability class and 41% were in the low vulnerability class. Based on this index range, the economic vulnerability of farmers in Sempu Village ranges from 0.159 – 0.766. The average economic vulnerability index is 0.457. The total vulnerability calculation consists of economic and social vulnerability. The calculation results show that 63% of farmers in Sempu Village are in the medium socio-economic vulnerability class and 37% are in the low socio-economic vulnerability class. Even though there are farmers who have high economic vulnerability, when combined with social vulnerability the results are lower

The community in Sempu Village shows several characteristics that are almost similar so that they can be grouped into several groups. These groups are arranged based on similarities or consistency in each variable that forms the characteristics of the group. This grouping aims to provide a deeper picture of the characteristics of the community in Sempu Village and simplify the research variables. The purpose of grouping is also intended so that the programs or solutions offered for vulnerability reduction efforts can be more targeted and according to needs. Variables that differentiate each group are shown in Table 6.

Table 6. The Farmer Grouping based on Characteristic of vulnerability.

Variable	Group 1	Group 2	Group 3	Group 4	Group 5
Age	> 64 years or elderly	<64 years	<64 years	<64 years	< 64 years
Gender		Woman	Man	Man	Man
Active in organization			Not joining in any organization	Joining in organization	Joining in organization
Source of capital				Capital from loan	Capital from saving

Variable	Group 1	Group 2	Group 3	Group 4	Group 5
Land Area				Total land area smaller than 1 Ha	Total land area more than 1 Ha
Total farmer of each group	24 farmer	13 farmers	25 farmers	24 farmers	14 farmers

Based on the results in the field, information was obtained regarding the characteristics of each group which are explained as follows:

1. Group 1 or elderly farmers

Group 1 consists of farmers aged over 64 years. BPS states that the productive age limit is 64 years, which also assumes that at that age productivity will decline. At this age, farmers are included in the elderly age group. The source of capital for elderly farmers is from personal sources and not loans because there is an age limit for applying for a loan. In addition, elderly farmers have one dependent or no dependents at all. Because their children already have their own families. Farmers who suffer from chronic diseases are mostly elderly farmers. The land area owned by elderly farmers tends to be narrower, namely mostly less than 0.5 hectares. Some elderly farmers said that the land they owned had been distributed to their children to inherit. Elderly farmers tend not to have other jobs and only work as farmers because age also influences productivity.

2. Group 2 or female farmers

Group 2 consists of a group of women farmers. The key variable in this group that differentiates it from other groups is gender. Women farmers in Sempu Village show almost the same socio-economic characteristics regarding land area and farmer group activities as well as regular participation in disaster training. Women farmers in Sempu Village tend to have small plots of land of less than 0.5 Ha. However, unlike elderly farmers, most female farmers with limited land have other alternative jobs. Women farmers are less active in farmer groups and disaster training. Several female farmers also belong to farmer groups, but admit that they are not active in any routine activities or meetings. There is not a single female farmer in Sempu Village who regularly takes part in disaster training because the training is only intended for the village disaster volunteer team. Women farmers are not included in the disaster volunteer team because they are a vulnerable group that must be prioritized when a disaster occurs.

3. Group 3 or farmers with low social participation

Group 3 is a group of farmers who did not receive disaster training. Farmers who have never attended disaster training are mostly not members of associations or community organizations. Participation in disaster training is related to being active in community activities and farmer groups. Group 3 is less active in social activities which can increase social vulnerability.

4. Group 4 or farmers with low economic resources

Group 4 consists of farmers whose source of capital comes from loans and farmers whose land area is less than 0.5 Ha. Capital sources are the biggest burden on economic vulnerability. This variable is related to

participation in farmer organizations. The government through the BPP (Agricultural Extension Center) simplifies loan application procedures for members of farmer organizations.

5. Group 5 or farmers with high economic resources.

Group 5 consists of farmers who have land area of more than 0.5 Ha and source of capital from individuals. This group is expected to have a low level of vulnerability both social and economic, so that other groups can compare the index deviation.

The calculation of socio-economic vulnerability is done by considering the average value in each group. This is intended to generally be able to know which groups have the highest and lowest vulnerability. The results of the social vulnerability assessment based on groups are shown in table 7. The farmer group with the highest social vulnerability is the elderly farmer group with a social vulnerability index of 0.42. This is because most elderly farmers also suffer from chronic diseases and are less active in community activities. The female farmer group also has a higher index value when compared to the other three groups. The majority of female farmers in Sempu Village are less active in participating in farmer communities and do not participate in disaster training.

Table 7. The result of Social vulnerability assessment based on group.

Group	Member of Group	Social Vulnerability Index	Social Vulnerability Class
Group 1	Elderly Farmer	0.42	medium
Group 2	Woman Farmer	0.28	Low
Group 3	Farmer with low participation in social community	0.18	Low
Group 4	Farmer with low resource of economy	0.16	Low
Group 5	Farmer with good participation of social activities and good resource of economy	0.15	Low

Table 8. The result of Economic vulnerability assessment based on group

Group	Member of Group	Economic Vulnerability Index	Economic Vulnerability Class
Group 1	Elderly Farmer	0.34	Low
Group 2	Woman Farmer	0.54	Medium
Group 3	Farmer with low participation in social community	0.46	Medium
Group 4	Farmer with low resource of economy	0.67	High
Group 5	Farmer with good participation of social activities and good resource of economy	0.26	Medium

The results of the economic vulnerability assessment are shown in Table 8. The highest economic vulnerability is farmer groups with low economic resources, women farmer groups, farmer groups with low social participation

and farmer groups with low social participation. As expected, the group with limited land has the highest economic vulnerability value. In addition, female farmers also have high vulnerability due to the limited amount of land and dependence on a single commodity.

Overall, there is a relationship between economic and social vulnerability. Female farmer groups have higher social and economic vulnerability than all farmers. Elderly farmer groups have the highest social vulnerability, but their economic vulnerability is quite low compared to other groups. This is because the elderly farmer group does not rely on loans because they have passed the maximum age limit for applying for loans.

Discussion

Weighting Variables using AHP

Based on the results of weighting social vulnerability using the AHP method, experts agree that the health variable has the highest weight. The health variable includes people with chronic diseases and people with disabilities. Health factors are basic human conditions that contribute to increased vulnerability because they hinder individuals' ability to protect themselves and there is a risk of worsening health conditions during a disaster. Chronic illness, as a long-term condition, results in increased dependence on others, thereby increasing vulnerability. Likewise, individuals with disabilities require special assistance due to physical limitations, making them a potentially vulnerable group (Sricharoen, 2019). The literature often categorizes people with disabilities, the elderly and pregnant women as part of the vulnerable population.

Demographic variables consisting of age and gender also have quite a large weight in assessing vulnerability. When a disaster occurs, the elderly are very vulnerable due to several factors: higher dependence on other people for assistance and limited access to community resources (Maltais, 2019). Apart from that, women's vulnerability to disasters is also exacerbated by a lack of education about disasters, lack of protection efforts, and cultural problems. In addition, factors such as coordination between disaster risk reduction stakeholders and economic and financial challenges also contribute to the increased vulnerability of women during disasters (Hamidazada et al., 2019).

The variables of disaster knowledge and institutional participation have the smallest vulnerability weight. Several literatures reveal the importance of these two factors. The knowledge variable related to disasters consists of participation in disaster training and disaster experience. Disaster mitigation training is a key strategy for reducing disaster vulnerability in the long term (Indyastuti et al., 2023). Learning based on experience from disaster events provides practical knowledge that can be applied repeatedly in mitigation efforts (Kartika et al., 2022). Farmers who do not have knowledge related to disasters are more vulnerable to the impacts of disasters due to a lack of preparedness and self-rescue skills.

Institutional variables include farmer participation in community activities and agricultural communities. Community participation is an effort to build strong social networks between individuals and the wider community. In disaster contexts, strong social networks within communities facilitate mutual support, protection, and access to critical information. Participation in farmer groups is also important to mitigate social vulnerability and increase the social resilience of farming communities. Through this participation, farmers can interact, share knowledge, information and experience, collaborate and work together to facilitate the post-disaster recovery process.

Internal factors that are innate, such as demographics and health, have quite a high weight because the obstacles experienced will be greater than the lack of external factors such as institutional participation and disaster knowledge. However, it is important to include external factors because the intervention of policy makers is to regulate external factors, not internal factors.

The results of weighting economic vulnerability using AHP show that the variable with the highest weight is the characteristics of agricultural businesses which include land area, number of types of commodities, sources of capital, and land ownership status. Farmers with limited land are generally more economically vulnerable. Limited land results in low income, making farmers' livelihoods increasingly vulnerable (Wiyata et al., 2019). The number of types of commodities cultivated also influences economic vulnerability, because dependence on one type of crop increases vulnerability to various environmental constraints, thereby impacting farmers' income (Arsyad et al., 2020). Apart from that, vulnerability is also influenced by land ownership status and sources of capital. The nature of ownership and land management practices determine the reliability of farmers' household income sources, thereby contributing to economic vulnerability (Fitriani & Kuswadi, 2022). Farmers who rent land are more vulnerable than land-owning farmers, especially if they rely on loans as a source of capital. Loans are an indication of fragile conditions, and the need for loans indicates vulnerability (Musa et al., 2024). Apart from that, special loans for the agricultural sector also contribute to large risks, especially in disaster-prone areas.

The next economic vulnerability variable is income which includes income from both the agricultural and non-agricultural sectors. Research by Wiyata et al., (2019) explains that low income can directly worsen farmers' economic vulnerability. Apart from income from the agricultural sector, income from non-agricultural work must also be considered to measure vulnerability. The agricultural sector is very vulnerable to disruption during disasters, causing farmers to temporarily lose their jobs. Farmers who do not have alternative jobs or additional sources of livelihood outside of agriculture will be economically vulnerable when a disaster occurs.

Social vulnerability variables include insurance ownership and savings. If a disaster occurs that destroys property, individuals who have insurance and savings can recover more quickly and efficiently. Insurance provides financial protection, mitigates losses, safeguards assets, and covers medical costs. Savings are liquid assets that can be immediately utilized in post-disaster emergencies. However, the absence of insurance and inadequate total assets or savings can significantly increase farmers' economic vulnerability (Wiyata et al., 2019)

Another factor that contributes to economic vulnerability is the high number of household dependents who are not working. Farmers with large households may face greater vulnerability due to high dependency ratios, which are associated with increased pressure on consumption needs imposed by larger families. The number of dependents refers to family members who do not work and are supported by the head of the household. The more dependents there are, the more vulnerable the household is. Household expenses increase in proportion to the number of dependents. In addition, a larger number of dependents makes evacuation efforts difficult when a disaster occurs.

Social and Economic Vulnerability Index

The results show that group 4 is the most economically vulnerable group. Consisting of farmers whose capital comes from loans and land area of less than 0.5 Ha. This shows the high level of economic vulnerability. Although loans are correlated with farmer group participation, they have little impact on total vulnerability. Small agricultural land will reduce the number of commodities planted and reduce the income received. A small income can reduce the opportunity for farmers to set aside money to save or pay insurance. This will increase the level of economic vulnerability in particular. Farmers apply for loans due to lack of economic capital. Lack of economic capital is also related to income and savings, so farmers have to apply for loans as business capital

Gender shows significant results regarding social and economic vulnerability. The second highest vulnerability class analysis is group 2 with an average score of 0.41 and greater than the overall average score. This group consists of female farmers. Women farmers in Sempu Village are disadvantaged from a social and economic perspective. Even though female farmers are active in community organizations such as PKK, Islamic studies or social gatherings, female farmers are less active in farmer groups and disaster training. Women farmers experience limited access to disaster-related training. This is because routine disaster-related training is only

intended for village alert teams and several communities selected to represent them. There are no female farmers who are members of the village alert team. This is also because women's position in disasters is a vulnerable group that must be saved. Meanwhile, women farmers are less active in farmer groups due to the dual role of women who are not only heads of families but also housewives. After working, women farmers still have to do domestic work at home so they have limited time to be active in farmer groups.

Elderly farmers (Group 1) has the highest social vulnerability score but has quite low economic vulnerability. Even though age has a fairly high weight in the calculations, the age variable alone is not enough to place farmers in moderate social vulnerability. This is proven by the fact that not all elderly farmers have moderate vulnerability. Another factor that increases the value of social vulnerability is the level of health and participation of farmer groups. Elderly farmers are vulnerable to health problems. Most of the farmers who suffer from chronic diseases are elderly farmers. From the economic vulnerability assessment, elderly farmers tend to be less vulnerable than other groups. This is because they do not have loans. Because, there is an age limit when applying for a loan. Farmers aged 60 years and over cannot apply for loans through banks or cooperatives. Most elderly farmers also have few or no dependents because their children already have families of their own. Even though they have a high vulnerability due to suffering from an illness, this is offset by having health insurance. Awareness of having health insurance often arises simply because there is a need for health facilities. The results of group socio-economic vulnerability analysis show that elderly farmers are more socially vulnerable but have low economic vulnerability, while farmers with loans and small land areas are more economically vulnerable and less socially vulnerable. However, there are findings that show that female farmers consistently have higher social and economic vulnerability compared to other groups, although not the highest.

This finding is in line with previous studies (Naz & Saqib, 2021) which show that women have limited access to important resources (land, labor, farming experience), thereby increasing their vulnerability to undertake farming livelihood activities. Efforts to reduce vulnerability can be focused on vulnerable groups, namely farmers with loans and small land areas, elderly farmers and women farmers

The group with the lowest vulnerability is shown by group 5, namely the group of farmers with a land area of more than 1 Ha. This group has a low level of vulnerability because land area is related to income and savings. So economically, this group has low vulnerability compared to other groups. Resilience in the economy also has an impact on social society. Most farmers are members of community groups and are members of farmer groups.

Based on the analysis results, the variables that have the most influence on vulnerability are age, gender and source of loan capital. After a volcanic eruption, farmers not only bear losses due to disasters, but also have to think about the costs of repairing land and capital to replant. Farmers with high economic vulnerability will find it increasingly difficult to recover after a disaster. The Kediri Regency Government, through the agriculture department, is helping farmers by distributing plant seeds, fertilizer and agricultural tools to affected farmers in disaster-prone areas. After the disaster, farmers with capital sources from loans had difficulty paying off the loans. One of the efforts made by the government through the agricultural and village services is to negotiate with lenders. These negotiations are carried out so that the loan payment schedule can be postponed without incurring fines or interest. Postponement of loan payments is carried out for one year with the assumption that farmers can recover after a disaster occurs

The government's efforts to empower women farmers is by organizing women farmer groups. The women's farmer group is a special institution under the auspices of the BPP and farmer groups. Women farmer group activities include processing agricultural products so that they can increase selling value. The Village-Owned Enterprises (BUMDes) of the Sempu Village government are holding an agricultural product processing program to increase the added value of commodities. The Sempu Village government facilitated the location, trainers and

tools used such as oil draining machines and syrup makers. Processing training utilizes harvests that do not meet quality standards to be sold as fresh fruit. Lower quality harvests can be processed into other products such as pineapple pie, pineapple jam, pineapple juice. These products are sold as typical souvenirs from Kediri Regency which are marketed at Mount Kelud Tourism outlets and several souvenir centers in Kediri Regency. These processed products increase their selling value because the selling price is higher than if they were sold in the form of fresh fruit.

The village government has special priorities for vulnerable groups such as the elderly, children, pregnant women and women when a disaster occurs. Before the disaster occurred, the Sempu Village Government had collected data regarding the number and personal data of vulnerable groups. The Sempu Village also conducted an assessment through the RT head regarding the elderly's ability to save themselves, the availability of companions, the ability to obtain information related to disasters. For elderly people who have limited mobility to evacuate independently and do not have a family or live alone, the village government will create a special scheme and appoint volunteers to assist in the evacuation process. Elderly farmers who also have chronic illnesses will be provided with health posts with medicines and medical teams at refugee camps. The Health Service has coordinated with all medical institutions in the Kediri Regency area, including hospitals, health centers and health clinics so that refugees who have chronic diseases can be taken to better health facilities.

The choice of the AHP method for weighting was due to its advantages in providing assessments based on the knowledge and experience of decision makers who have a better understanding of the research subject. This implies that AHP is a decision-making approach that is based on people's genuine abilities to make important decisions. Another advantage of AHP is that it allows a hierarchical structure of criteria, so that the process of comparing each criterion and sub-criteria can be more focused and directed. In this way, the decision maker determines the hierarchy in the solution of a complex problem and selects the results that provide suitability values when allocating weights (Erdin, 2020). The disadvantages of the AHP method is in maintaining consistency. In pairwise comparisons, the number of comparisons increases exponentially, and it is very difficult to maintain consistency of responses. If there are too many items being compared, the hierarchical structure and comparison matrix will become more complicated, and the number of calculations will be too large. This certainly makes it difficult for experts to compare consistently. This research used a total of 16 socio-economic variables which were compared between variables, resulting in a very large number of comparisons. The potential for inconsistent AHP results in this research was overcome by increasing the number of experts who carried out the assessment so that the assessment was not only carried out by one expert. Apart from that, the validity of the results is proven by the inconsistency ratio figure which is less than 0.1, indicating that the AHP results are consistent

Limitations and Future Research

This study is limited to 9 economic variables, namely characteristics of farming businesses, farmer income, social safety nets and number of dependents and 8 social variables, namely demographics, health, disaster knowledge, institutions. There are other variables that can also describe the level of socio-economic vulnerability, but this study does not involve all variables to be more effective and efficient. Variables related to agriculture in the study also do not involve all variables and only partially such as land area, income in agriculture, type of commodity. It is hoped that further research can develop variables that have not been applied in this study. The findings in this study indicate that vulnerable groups such as women and the elderly show higher socio-economic vulnerability than others. The limitation in this study is that it has not discussed in depth the vulnerability of these vulnerable groups. It is hoped that in further research, it can focus on vulnerable groups to further examine the level of vulnerability and solutions to reduce vulnerability.

Conclusions

The Sempu Village vulnerability study highlights the complex interactions between various factors that contribute to the vulnerability of farmers in disaster-prone areas and farmer characteristics. By addressing knowledge gaps through disaster training, improving health and social services, increasing capacity for women farmers, encouraging farmer regeneration, encouraging economic diversification, and strengthening institutional support, policymakers can help reduce farmers' socio-economic vulnerability. These steps will not only increase their resilience to disasters but also contribute to the stability and development of the region as a whole.

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