e-ISSN: 2655-8777 http://journals.itb.ac.id/index.php/3bio

Community Dependency and Vulnerability to Natural Resources: Case Study Mount Geulis University Forest

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Received: 2022-05-18
Accepted for publication: 2022-09-22

Abstract

Mount Geulis University Forest (MGUF) is a university forest area surrounded by eight villages and has close relationships with the surrounding community. With a very strategic position, MGUF is vulnerable to various pressures, especially anthropogenic ones. Other studies have shown that population, development, and the economy have an essential role in environmental degradation. Thus, understanding these three things becomes essential to determine the right strategy to reduce the level of vulnerability around MGUF. This study aims to analyze the level of community dependency on MGUF and the level of vulnerability of the community around MGUF. Community dependency was analyzed using perceived value dependency on livelihood, perceived value dependency on income, and perceived value dependency on participation level. Community vulnerability was analyzed based on the population growth index, built-up land index, and economic openness index. The results showed that the farmer community had a relatively high dependency on MGUF. The lower the income, the higher the dependency on MGUF, and the participation rate increases as the dependency on MGUF increases. Raharja Village has the highest population growth index of 123.75, Mangunarga Village has the highest built-up land index with a value of 75.11, and Jatimukti Village has the highest economic openness index with a value of 33.52. In general, the village with the highest composite vulnerability index is Cikahuripan Village, with a value of 0.71, and the lowest is Jatiroke, with a value of 0.20. Based on the value of the vulnerability index and the level of security, the level of vulnerability can be reduced by carrying out collaborative management to run programs with every stakeholder in the MGUF management system.

Keywords: *Community dependency, community vulnerability, population growth, built-up land, economic openness*

1. Introduction

Mount Geulis University Forest (MGUF) is one of 16 Special Purpose Forest Areas (SPFA) whose management is given to universities by the government, with a total area of 338.31 hectares. MGUF is a protected area within the administrative boundaries of eight villages and three sub-districts, so MGUF has a very close relationship with the surrounding community. This close relationship can be seen from several aspects. From an economic perspective, people are still working on land for agricultural commodities in the MGUF area [1]. MGUF is a community liaison from a social perspective, mainly through the Forest Farmers Group (FFG). The community needs MGUF ecosystem services as a water provider in terms of the environment.

MGUF's strategic position causes various pressures to threaten MGUF, mainly anthropogenic pressure. Multiple studies suggest that population problems cause half or more of deforestation in the world [2]. The area of agricultural land in the MGUF area is quite extensive. Agricultural land created to cross the boundaries of protected areas will impact ecological functions in the long term [3]. In addition to agricultural land, settlements are overgrowing around the MGUF to press the slopes. Increased anthropogenic pressure that is not accompanied by adequate planning and improper land use can trigger landslides [4].

Only 79.65% of community members in areas surrounding MGUF graduated from elementary-junior high school [1]. Their income is low [5], with their main livelihoods dominated by entrepreneurs and laborers. Other common occupations are traders and farmers [5]. The low education level in a large population, such as the ones in

DOI: 10.5614/3bio.2022.4.2.4

MGUF, is the cause of the lack of innovation performance [6]. This condition causes communities around MGUF to depend on ecosystem services and resources from MGUF. In addition, the lack of academic qualifications is an essential determinant of people's vulnerability [7].

Conditions related to population, development, and economy around the MGUF community contribute to the MGUF system's vulnerability to external pressures. It is crucial to understand and measure the level of dependency and vulnerability to reduce the vulnerability level of the community around the MGUF. In determining the level of dependency, data related to income, livelihoods, and community participation [8] related to MGUF are needed. Furthermore, analyses of population growth, degradation of built-up land, and economic openness [8] around the MGUF are also required. This study aims to analyze the level of community dependency and vulnerability of the community around the MGUF.

2. Methodology

2.1. Time and Location

This research was conducted from January to May 2021 at MGUF, Sumedang, West Java (Figure 1). MGUF is located in three sub-districts, i.e., Tanjungsari, Jatinangor, and Cimanggung, Sumedang Regency, West Java Province. Specifically, MGUF is surrounded by eight villages, namely Jatiroke Village, Jatimukti Village, Cisempur Village, Mangunarga Village, Sawahdadap Village, Cikahuripan Village, Raharja Village, and Cinanjung Village. This research was conducted in three stages, i.e., a preliminary survey, data collection, and data analysis. The preliminary survey was carried out from November 2021 to January 2022, while data collection for both community dependency and community vulnerability was carried out from February to April 2022.

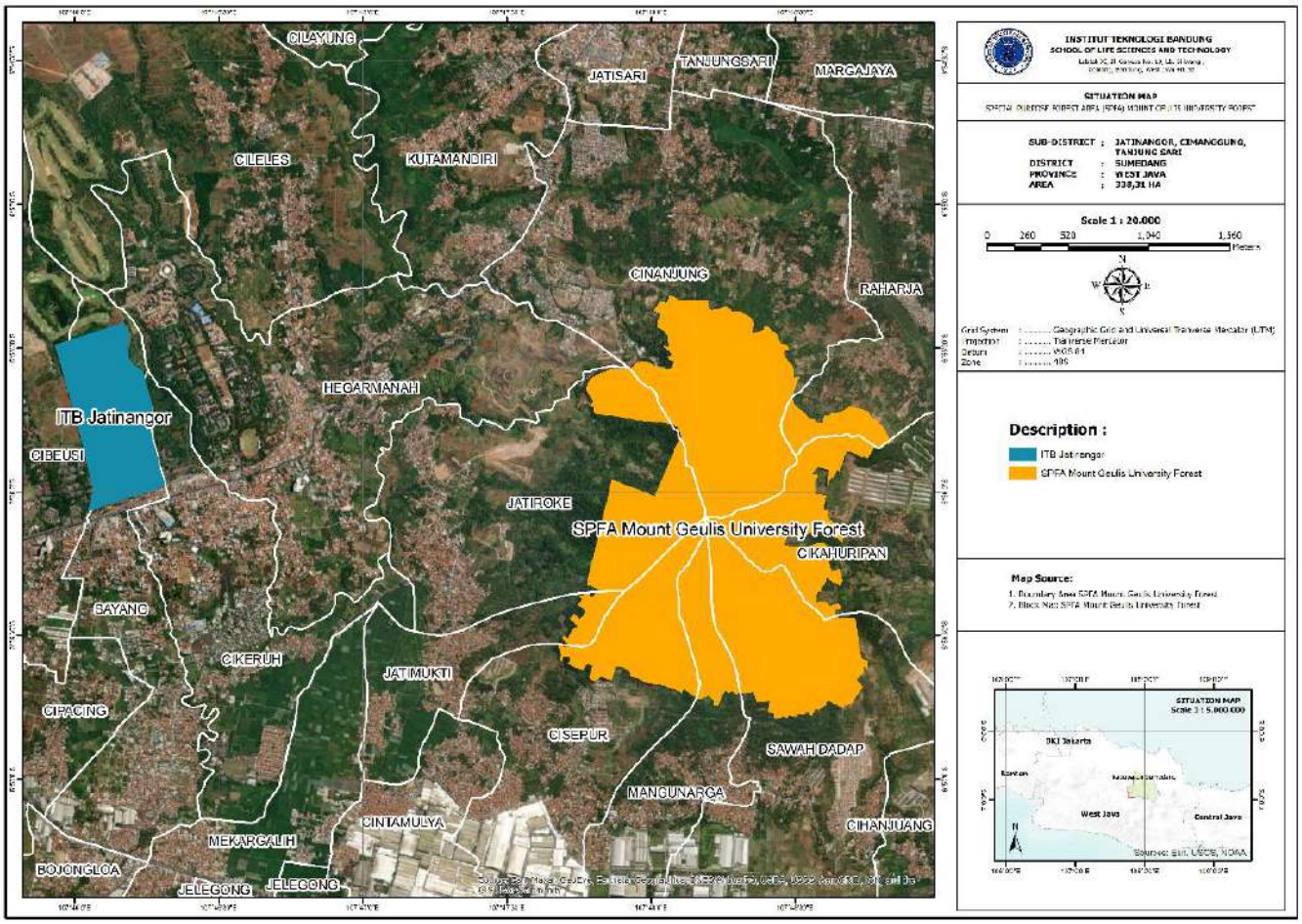

Figure 1. The location of Mount Geulis University Forest

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2.2. Data Collection

2.2.1. Community Dependency

The level of community dependency on MGUF in this study was measured using several variables, i.e., perceived value dependency on livelihoods, perceived value dependency on community income, and perceived value dependency on community participation [8]. These data are obtained by taking data directly (primary data). Data collection was carried out by stratified random sampling of people in eight villages. The eight sample areas were determined by purposive sampling based on the villages owning land within the MGUF area, namely Cisempur Village, Mangunarga Village, Sawahdadap Village, Cikahuripan Village, Raharja Village, Cinanjung Village, Jatiroke Village, and Jatimukti Village. Data were collected by filling out questionnaires by researchers related to the results of structured interviews with the community. The number of samples is 100 people. The number of samples is determined based on the following formula [9]:

$$n = \frac{N}{Ne^2 + 1}$$

n : sample size
N : population size
e : percent allowance for inaccuracy due to tolerable or desirable sampling errors

2.2.2. Community Vulnerability

The variables used in measuring the level of community vulnerability in this study were the population growth index, the built-up land index, and the economic openness index [8]. The population growth index used secondary data, population data sourced from BPS and the official website of the Sumedang Regency Government, and village area data sourced from the Geospatial Information Agency (BIG). The built-up land index uses primary data, field baselines for validation taken at random points for each village, and secondary data, Landsat 8 imagery, sourced from Google Earth Engine. As for the economic openness index, secondary data was used, i.e., population and percentage of the working population sourced from BPS and the official website of the Sumedang Regency Government; Gross Regional Domestic Product (GRDP) and total trade value, sourced from BPS.

2.3. Data Analysis

2.3.1. Community Dependency

The primary data on community dependency on MGUF were subjected to descriptive analysis. This method was employed so that problems and ways of working that apply in society (e.g., relationships, activities, and attitudes) to the influence of a phenomenon can be clearly described [10]. After the data on perceived value dependency on livelihoods, community income levels, and community participation levels were obtained, they were visualized as a bar graph (dependency of livelihoods) and point graphs (dependency of the community's income level and the level of community participation).

2.3.2. Population Growth Index

The Population Growth Index represents a measure of the pressure of the population on the environment at a specific time [10]. The population calculated in this study is the population of each village that administratively surrounds the MGUF. The Population Growth Index calculation uses the formula [10].

$$PP_{it} = \left\{\left(\frac{AP_{it}}{50}\right) x \left(\frac{Trend_{i,t-l}}{2}\right)\right\}$$

PP_{it} : population pressure of village *i* in year *t*
AP_{it} : average population per km^2 of village *i* in year *t*
$Trend_{i,t-l}$: population growth per year in village *i*

2.3.3. Built-up Land Index

The built-up land index represents the level of land degradation caused by anthropogenic activities, especially activities related to the construction of settlements or other facilities [10]. The built-up land index was calculated in each village surrounding the MGUF. The built-up land index was calculated using the following formula [10].

$$BL_i = \left(\frac{BA_i}{VA_i}\right) x\, 100$$

BL : built-up land index (%)
BA : built-up area (km^2)
VA : village area (km^2)
i : village name

CART was applied to divide the image into forest and built-up classes. The classification results are then verified through an accuracy test using one algorithm for the and direct observation. The algorithm used for the accuracy test is random forest. Random forest is a classification algorithm consisting of a combination of classification trees. Each classification is generated using a random vector sampled independently of the input vector. Each tree votes for the most popular class for classifying the input vector [11]. Meanwhile, direct observation is carried out by comparing the classification results with field observations. Then the

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confusion matrix is used to get the overall accuracy and kappa coefficient values.

2.3.4. Economic Openness Index

The economic openness index in this study is calculated using the total value of trade in village *i* to the total GRDP of village *i* at time *t*. The following is the formula for the economic openness index [10].

$$EO_{it} = \left(\frac{TV_{it}}{2GRDP_{it}}\right) x\ 100$$

EO_{it} : economic openness index of village *i* in year *t*
TV_{it} : trading value of village i in year t
$GRDP_{it}$: Gross Regional Domestic Product of village *i* in year *t*

The value of the village GRDP is obtained from the estimated GRDP of each sub-district. The GRDP of each sub-district is obtained from estimates based on the GRDP of the Sumedang Regency. The following is a formula for estimating sub-district and village GRDP.

$$GRDP_{sub-districts} = \frac{WP_{sub-districts}}{100}\ x\ PDRB_{districts}$$

$$GRDP_{village} = \frac{WP_{village}}{100}\ x\ GRDP_{sub-districts}$$

WP : workers percentage from sub-district/village in district/sub-district
GRDP : Gross Regional Domestic Product

2.3.5. Community Vulnerability

After all variables from the vulnerability index have been obtained, standardization is carried out on all these variables so that the units used are the same and there is no bias when measuring the vulnerability index. The following is a standardized formula for each vulnerability index [12].

$$SV_{ij} = \frac{X_{ij} - Min\ X_j}{Max\ X_j - Min\ X_j}, 0 \le SV_{ij} \le 1$$

SV_{ij} : standardized variable *j* of village *i*
X_{ij} : variable value *j* of village *i*
Min X_j : the minimum value of variable *j* for all villages in the index
Max X_j : the maximum value of variable j for all villages in the index
j : PP, BL, and EO

This vulnerability index is represented by the Composite Vulnerability Index (CVI), which ranges from 0 to 1 [12]. The closer the CVI value is to 0, the lower the level of vulnerability, while the closer the CVI is to 1, the higher the level of vulnerability. The following is the formula for the adjusted CVI [12].

$$CVI_i = (EO_i\ x\ 0.4) + (BL_i\ x\ 0.3) + (PP_i\ x\ 0.3)$$

CVI_i : the composite vulnerability index value of village *i*
EO_i : the economic openness index value of village *i*
BL_i : the built-up land index value of village *i*
PP_i : the population pressure index value of *i*

3. Results and Discussion

3.1. Community Dependency

The questionnaire results distributed to the community of eight villages around the MGUF (Figure 2) show that farmers' livelihoods are in a fairly high dependency category, while breeders are in a low category but tend to be relatively high. Farmers' dependency condition is because many feel they need arable land in the MGUF area. After all, they do not have arable land outside the MGUF area, while breeders tend to be relatively high because many breeders need feed from the MGUF area for their livestock, such as honey bee breeders and goat or cattle breeders. This condition follows the opinion of other studies that forests and other environmental products are precious for marginal communities who live around them [14].

The questionnaire results obtained show that the livelihoods around the MGUF can be grouped into two categories, i.e., natural resource-based livelihoods and non-natural resource-based livelihoods. Four main ecosystem functions are related to the dependency on community livelihoods [13], i.e., services that provide products from ecosystems (e.g., providing fruit), life support services (e.g., carrying out the photosynthesis process), life regulatory services (e.g., carrying out the decomposition process), and cultural or cultural services (e.g., recreational facilities).

Various ecosystem services provided by MGUF can be used as a source of livelihood, mainly providing services. Farmers commonly use ecosystem services to produce several products, such as coffee and papaya. The condition in the community around the MGUF is that the land cultivated outside the MGUF area is decreasing over time. The main driver of this condition is the people selling their land to companies around the MGUF. Thus, the community is looking for alternative livelihoods to maintain their lives, including switching from breeders, and traders, to construction workers. The relationship between the level of community's dependency on the MGUF on their livelihoods is presented in Figure 2.

Livelihood is also related to income. Therefore the influence or relationship between community dependency on income is necessary to identify the right target for managing

DOI: 10.5614/3bio.2022.4.2.4

people with certain income classes. The relationship between dependency and income level can be seen in Figure 3.

Results showed that the higher the income level of the community, the lower the dependency on MGUF, or there is a negative relationship between the level of community dependency and income (Figure 3). People with low-income levels are dominated by farmers, laborers, and traders. However, some farmers feel they are not very dependent on the MGUF because they have never worked on land within the MGUF area. Similar condition also applies to high-income communities. On the other hand, some people have high incomes but feel very dependent on MGUF. For instance, a farmer has a high income because he has relatively sizeable agricultural land outside the area bordering the MGUF.

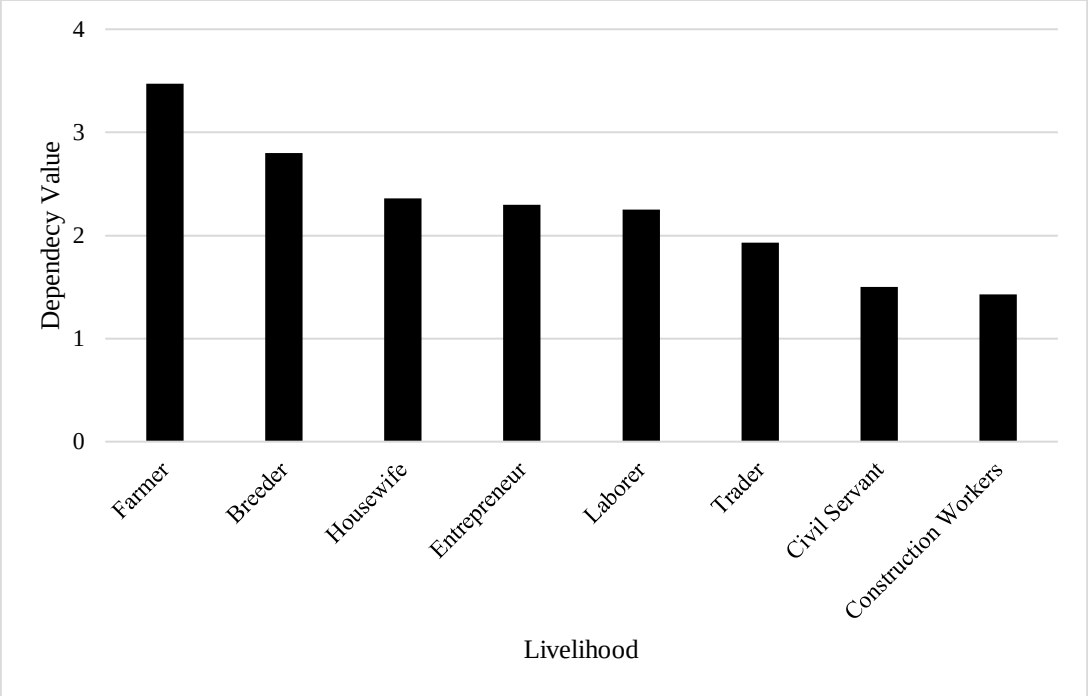

Figure 2. Perceived value dependency on livelihood

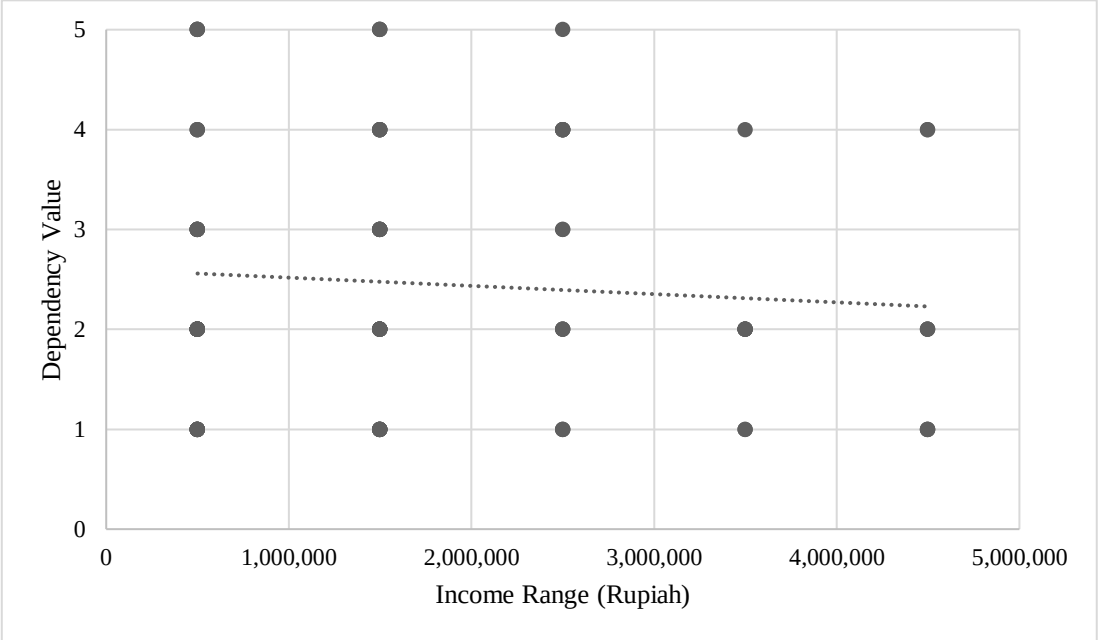

Figure 3. Perceived value dependency income level; y-axis shows value between 1 and 5, with each number described as follows: (1) Very Low, (2) Low, (3) High Enough, (4) High, and (5) Very High

DOI: 10.5614/3bio.2022.4.2.4

Livelihoods and income levels are also closely related to the community's intensity in activities or participation in MGUF. Participation in this context is the intensity of community involvement in MGUF management, whether with the manager or not. The relationship between dependency and level of participation can be seen in Figure 4.

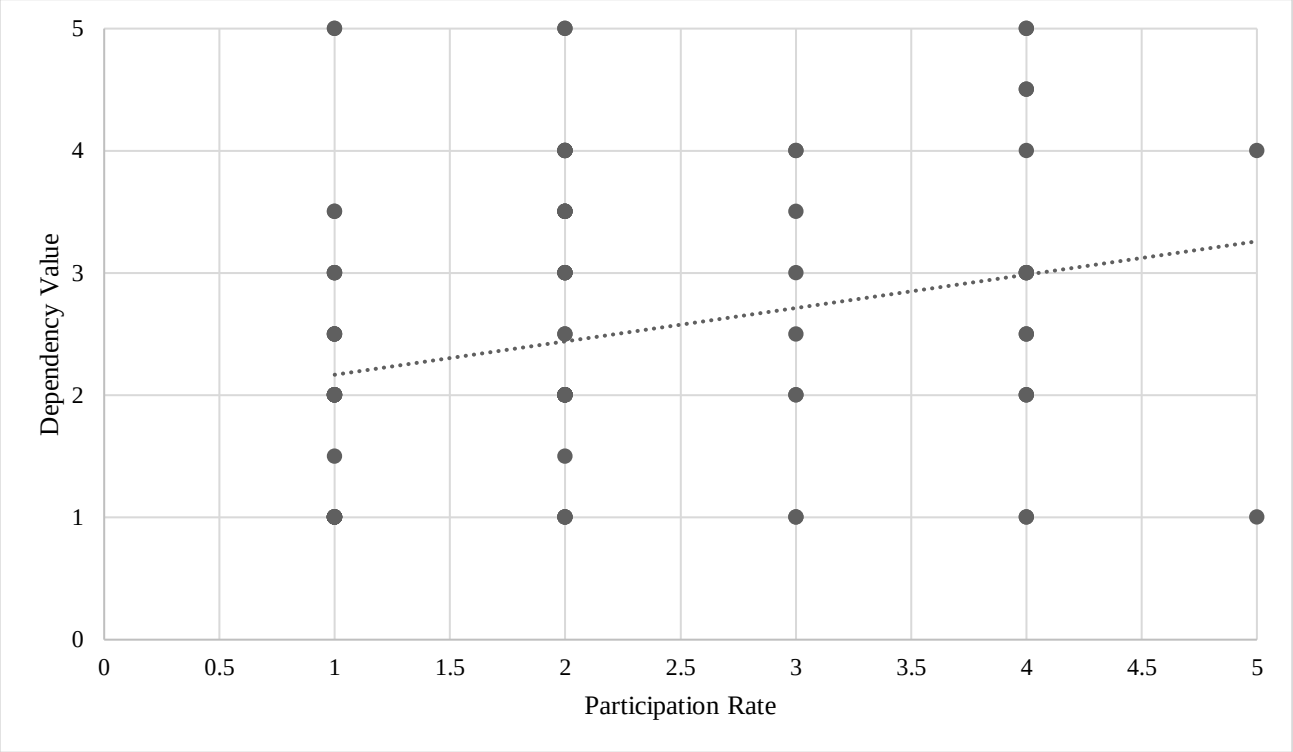

Figure 4. Perceived value dependency participation rate. y-axis shows value between 1 and 5, with each number described as follows: (1) Very Low, (2) Low, (3) High Enough, (4) High, and (5) Very High

The questionnaire results showed a positive relationship between the level of community dependency on MGUF and community participation (Figure 4). The higher the level of participation, the higher the community's dependency on MGUF. On the other hand, the lower the level of participation, the less dependent the community is on MGUF. This result is in line with the opinion expressed by other studies [15] that when resource users feel very dependent on the resource, they will tend to give their time and energy to manage it. This high involvement is reflected in one farmer of the FFG Cisempur Village, which is quite intensive and proactive in inviting the management to discuss developing a forest farmer group in their village.

Apart from the existence of parties with a high level of participation, many parties still do not actively participate in the management. Communities who do not actively participate in the management of MGUF generally feel that MGUF does not have a direct impact on their lives. Furthermore, the community has become less proactive in knowing how to manage MGUF. This condition is illustrated by the public's ignorance of the current MGUF management. From a sample of 100 respondents, 66% did not know that MGUF was currently managed by ITB, even though during the management of ITB, it was pretty often socialization of management to the community around MGUF. More proactive management requires directing the community to get more significant benefits in protecting the forest than working on land in the forest, especially the economic benefits [16].

3.2. Community Vulnerability

3.2.1. Population Growth Index

Based on the population data processing (Table 1), the village with the highest population growth index is Raharja Village (123.75), followed by Cikahuripan Village (112.76). Meanwhile, the lowest population index value was shown by Mangunarga Village (-45.09). The high population growth rate in Raharja Village is the main factor causing its high population growth index.

Population growth is one of the factors that determine vulnerability in an area. The Population Growth Index measures the population's pressure on resources or the environment [10]. The high population also causes an increase in population density in a fixed area. The high population density in an area can lead to increased criminal acts,

DOI: 10.5614/3bio.2022.4.2.4

especially if the economic conditions in the area are also low [17].

Cisempur village has the highest population density per km^2 of than other seven villages. However, the population growth index value of the population of Cisempur Village is ranked second lowest of all villages due to its low percentage of population growth. The population growth rate in Cisempur Village is meager, at -0.25%. A negative population growth rate means that the population in Cisempur Village tends to decrease over time, not increase. The mentioned explanation is evidence that population growth is the main factor determining the high or low value of the population growth index.

The high population growth causes pressure on the environment also to increase. Thus, it is necessary to control population growth in an area. Factors that affect the population growth rate include the sex ratio, the level of urbanization, employment and income, government policies, and other factors such as disasters [18]. The high population growth rate in Raharja and Cikahuripan villages is likely due to urbanization. The high level of urbanization in the two villages is also possible because of the low population density and easy accessibility with the construction of toll roads [19].

3.2.2. Built-up Land Index

Of the eight villages surrounding the MGUF, Mangunarga Village has the highest built-up land index (Table 2) due to its built-up land area that has almost filled the entire village. Apart from the large number of settlements being built, most of the area of Mangunarga Village is also occupied by factory buildings. The remaining forest area of Mangunarga Village is only the part of the village that is included in the MGUF area. Built-up land is anything that can help meet human needs that are created, maintained, and arranged by humans [20]. In the context of this research, built-up land includes buildings, yards, roads, public facilities, and other facilities. The built-up land index describes the percentage of built-up land area in an area to the area's total area.

Table 1. Population Growth Index

No.	Village	Population Density (person/km^2)	Population Growth (%)	Population Growth Index
1	Cisempur	5213	-0.25	-12.84
2	Mangunarga	3773	-1.20	-45.09
3	Sawahdadap	3008	2.97	89.45
4	Cikahuripan	2127	5.30	112.76
5	Raharja	2259	5.48	123.75
6	Cinanjung	3004	1.79	53.83
7	Jatiroke	3030	2.14	64.94
8	Jatimukti	2779	-0.17	-4.83

Table 2. Built-up Land Index

No.	Village	Village Area (km^2)	Built-up Area (km^2)	Built-up Land Index
1	Cisempur	2.06	1.16	56.22
2	Mangunarga	1.46	1.10	75.11
3	Sawahdadap	1.87	0.93	49.73
4	Cikahuripan	3.44	1.76	51.24
5	Raharja	3.89	2.02	51.96
6	Cinanjung	3.88	1.32	34.01
7	Jatiroke	2.43	0.69	28.57
8	Jatimukti	0.80	0.28	35.10

The village that has the second-highest degradation index value after Mangunarga Village is Cisempur Village. Not much different from Mangunarga Village, the high value of the built-up land index in Cisempur Village is caused by built-up land that covers more than half of the village. Of the total built-up area, half is occupied by factory buildings. The area of land that does not become built-up land is only village land included in the MGUF, such as Mangunarga Village. The

DOI: 10.5614/3bio.2022.4.2.4

conditions in Mangunarga and Cisempur villages follow the opinion of other research, which states that industrialization encourages the conversion of land functions into industrial land, especially on land with a flat topography [21].

Jatiroke Village has the lowest built-up land index value among other villages due to three possible explanations. First, the area of Jatiroke Village tends to be quite extensive, at 2.43 km^2. Second, before entering the MGUF area, there is land owned by PT. Kahatex, which PT. Kahatex maintains an open space. Third, the MGUF land is far from the reach of the community and is still lush because if people want to enter the MGUF from Jatiroke Village, people have to go through land owned by PT. Kahatex, which is quite extensive.

Minister of Forestry Regulation P.15/MENLHK/SETJEN/KUM.1/5/2018 concerning Special Purpose Forest Areas (SPFA) states that the determination of SPFA does not change the primary function of forest areas and does not change the landscape in protected forests. The status of the MGUF area was initially a Protected Forest area. However, the enactment of the Decree of the Minister of Environment and Forestry of the Republic of Indonesia Number SK. 633/Menlhk/Setjen/PLA.4/11/2017 changed the area's status to SPFA. However, its primary function remains as a protected forest. Thus, if we look at the value of the built-up land index for each village, MGUF plays a role in maintaining the value of the built-up land index in each village remains low. A possible explanation is that ITB, as MGUF manager, has managed to keep the MGUF from being degraded by the built-up land.

3.2.3. Economic Openness Index

The village with the highest economic openness index value is Jatimukti Village, with a value of 33.52 (Table 3). Besides Jatimukti Village, Cinanjung Village is the village with the second-highest economic openness index value, with a value of 31.27. The high value of the economic openness index in these two villages is due to the large proportion of trade value from the total village GRDP value. The more significant the proportion of trade value from the GRDP value coincides with the vulnerability index value increase. Conversely, the lower trade value proportion from the GRPD value corresponds with a decrease in the vulnerability index value. Economic openness is essential in assessing vulnerability because the higher the economic openness, the more development in an area will be influenced by external conditions or outside the village [12]. The strong influence of external conditions in development will cause a decrease in the internal capacity of a region to determine the direction of development. The economic openness index in this study was carried out by comparing the total trade value with the GRDP of each village.

Table 3. Economic Openness Index

No.	Village	Trade Value	GRDP	Economic Openness Index
1	Cisempur	Rp85,595,342,000	Rp197,691,442,028	21.65
2	Mangunarga	Rp61,520,690,000	Rp105,127,434,144	29.26
3	Sawahdadap	Rp66,990,336,000	Rp133,399,435,421	25.11
4	Cikahuripan	Rp91,680,708,000	Rp156,581,210,837	29.28
5	Raharja	Rp85,800,582,000	Rp153,188,672,905	28.00
6	Cinanjung	Rp114,144,226,000	Rp182,539,943,293	31.27
7	Jatiroke	Rp64,978,984,000	Rp172,217,637,539	18.87
8	Jatimukti	Rp54,193,622,000	Rp80,825,933,852	33.52

Many things cause a large proportion of trade value to the value of GRDP in the villages around the MGUF. One of the main reasons is the ability to create added value in the internal village. Villages whose communities do not have the independence to create added value will depend on external village parties and create more excellent trade value. Unfortunately, few villages around MGUF can create added value from their products. This increasing dependency causes progress toward becoming self-reliant in rural communities slow [22]. Thus, creating added value is essential to be developed in the villages around the MGUF.

In general, the rural economy around the MGUF is still oriented towards the upstream economy, which means that it only focuses on raw material producers. Especially for the people of Cinanjung Village, whose land for agricultural production tends to be small compared to other villages. However, one example of the success of creating added value in villages around MGUF can be seen in Jatiroke Village. One of the commodities that are given added value is coffee. Jatiroke village produces coffee to be roasted beans which have a much higher value than freshly picked coffee beans, as seen in the value of the economic openness index. Jatiroke

DOI: 10.5614/3bio.2022.4.2.4

Village is the village with the lowest economic openness index value compared to other villages. The creation of added value in rural areas increases direct income for farmers, artisans, and entrepreneurs to rural communities in general and makes villages able to meet their own needs [23].

3.2.4. Composite Vulnerability Index

Cikahuripan and Raharja are villages with the highest composite vulnerability index (CVI), with values of 0.71 and 0.70, respectively (Table 4). The population growth index, the built-up land index, and the economic openness index in this section will be integrated into a composite vulnerability index so that this composite vulnerability index will be able to assess the level of external disturbances that exist in a system. As a result, the increasing level of vulnerability is represented by CVI [10]. The high composite vulnerability index in Cikahuripan and Raharja is caused by the population growth index and the high index of economic openness. The village with the lowest composite vulnerability index around the MGUF is Jatiroke Village, with a value of 0.20. The cause of the low composite value of the vulnerability index in Jatiroke Village is the low value of the built-up land index and the index of economic openness. The following is a diagrammatic illustration to illustrate the composite position of the vulnerability index of each village surrounding the MGUF (Figure 5).

Table 4. Composite Vulnerability Index

No.	Village	Population Growth Index	Built-up Land Index	Economic Openness Index	Composite Vulnerability Index
1	Cisempur	0.19	0.59	0.19	0.31
2	Mangunarga	0.00	1.00	0.71	0.58
3	Sawahdadap	0.80	0.45	0.43	0.55
4	Cikahuripan	0.93	0.49	0.71	0.71
5	Raharja	1.00	0.50	0.62	0.70
6	Cinanjung	0.59	0.12	0.85	0.55
7	Jatiroke	0.65	0.00	0.00	0.20
8	Jatimukti	0.24	0.14	1.00	0.51

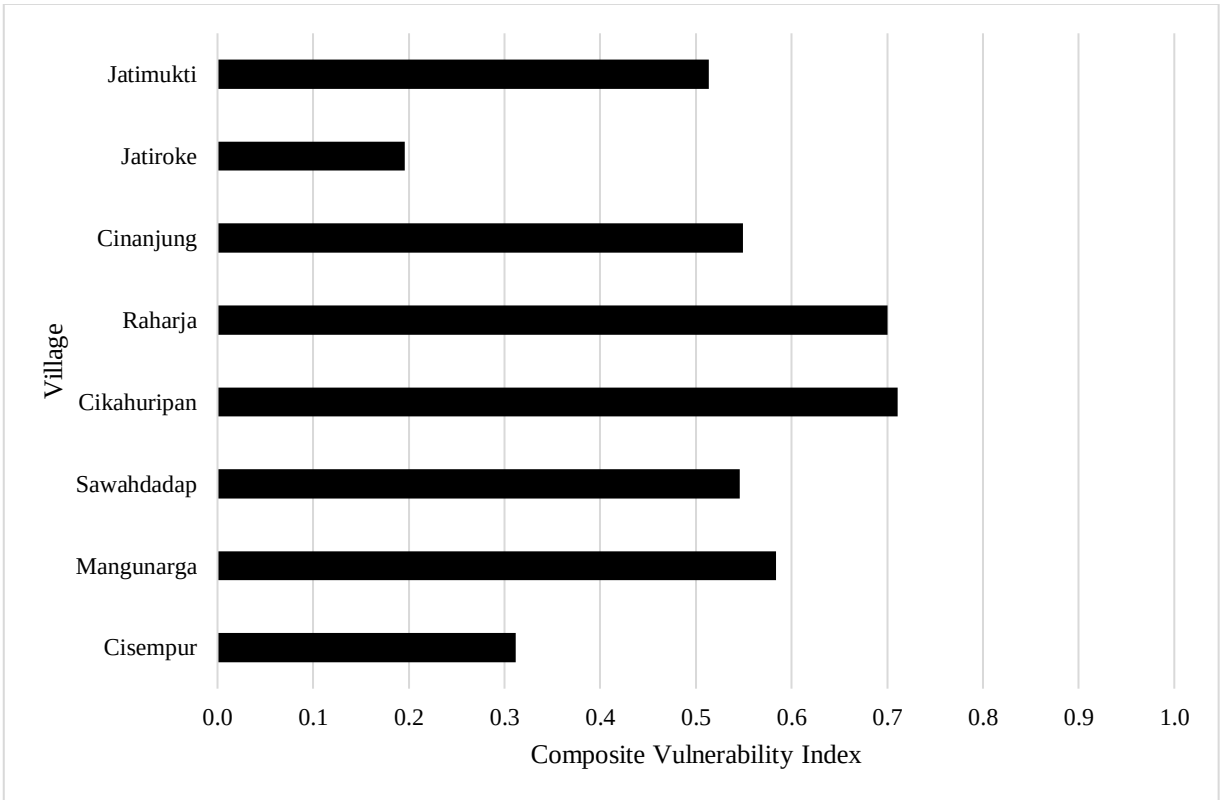

Figure 5. Composite Vulnerability Index comparison

DOI: 10.5614/3bio.2022.4.2.4

Vulnerabilities in villages surrounding the MGUF were assessed to identify the villages most vulnerable to external hazards and actions to reduce vulnerability. The composite value of this vulnerability index is in the range of 0 to 1 [24]. The composite value of the vulnerability index close to 0 indicates that an area has a low level of vulnerability; on the other hand, a composite value of the vulnerability index close to 1 indicates that the area has a high level of vulnerability. A moderate vulnerability level is around the composite value of the vulnerability index of 0.5.

By referring to the assessment criteria, villages with a high level of vulnerability are Cikahuripan and Raharja villages because they have a composite vulnerability index value of > 0.70. On the other hand, the villages of Mangunarga, Sawahdadap, Cinanjung, and Jatimukti have a moderate level of vulnerability because they have a composite vulnerability index value in the range of 0.5. Finally, Jatiroke and Cisempur villages have a low level of vulnerability because they have a composite vulnerability index value lesser than 0.35. Therefore, MGUF is dominated by villages with a moderate level of vulnerability.

Villages with a high level of vulnerability, such as Cikahuripan and Raharja villages, need further attention, especially from the index, which causes a high level of vulnerability. In this case, the population growth index strongly influences the high level of vulnerability in the Cikahuripan and Raharja villages. Another example, the moderate level of vulnerability in Mangunarga Village is strongly influenced by the built-up land index. Likewise, with other villages, the level of vulnerability needs to be addressed by looking at the constituent indices that lead to the high composite value of the vulnerability index.

4. Conclusion

Communities with farmers' livelihoods are pretty dependent on MGUF. People with low-income levels also tend to have a high dependency on MGUF. The higher the level of dependency on MGUF, the community will tend to participate in the management of MGUF actively. In addition, Cikahuripan and Raharja villages have a high level of vulnerability, mainly influenced by high population growth and high levels of economic openness. While Jatiroke Village has a low level of vulnerability, it is strongly influenced by the low openness of the economy, which is supported by the ability of the Jatiroke Village community to create added value. Thus, this study recommends carrying out collaborative management among all stakeholders. Collaborative management programs focusing on increasing the ability to create added value to reduce vulnerability can solve problems related to population growth, environmental degradation, and economic conditions.

Acknowledgements

The authors would like to thank the management of MGUF ITB, who has given permission, provided various information, and assisted in the data completion process. The authors would also like to thank Najwa Diwanty Tasyabita, Ratu Ayu Agung Ashakirana, Laurencia Larasati, Fardan Muhammad, Rafli Hendro Witjaksono, Ramadhoni Hilmy, Andika Putra Kunigara, Aditya Abdi, Giovani Rahadian Arif, and Aswien Ahmad Irfani. In addition, they have assisted in filling out the questionnaire from the community around MGUF.

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