

Analysis of sustainability factors underlying human-monkeys (*Macaca fascicularis*) conflict at IPB University

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Abstract. The proximity of the *Macaca fascicularis* habitat to locations of human activity, especially in the IPB University area, disrupts human activity, especially in the morning and evening. The act of *Macaca fascicularis* entering human territory increases the potential for human conflict with *Macaca fascicularis*. This research aims to identify the variables that cause conflict in the IPB Dramaga Campus environment by describing the intensity of influence and interdependent relationships between variables and grouping them from the most influential to the least influential. This research was conducted at IPB University, Bogor, Indonesia in 2021. The object of this research was the *Macaca fascicularis* group located at the IPB Dramaga Campus. Data collection was carried out by applying the Focus Group Discussion method to determine the influencing variables and human conflict with *Macaca fascicularis*. Data analysis was carried out using the Micmac Method. Based on the research results, there are factors that influence food, vegetation, culture, and the important role of human activity, land, population, and mitigation. The Primate Animal Study Center (PASC) in collaboration with the Bogor BKSDA is making efforts to overcome disturbances using the Trapping Cage method, which is a method carried out by storing iron cages filled with fruit such as bananas and others in several locations that are suspected to be frequently visited areas and Increase the active role of the community around the IPB campus which is affected by long-tailed monkeys by providing incentives for people who are able to catch long-tailed monkeys without causing harm.

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INTRODUCTION

Macaca fascicularis are found in several locations on the IPB University according to Mustari et al. (2014) at Dramaga IPB Campus, *Macaca fascicularis* can be found in bamboo arboretum and rectorate forests. *Macaca fascicularis* can be found in 3 locations, specifically in the bamboo arboretum and tropical forest, Al-Hurriyyah forest, and around the Information Resource Service (Abdullah 2017). There are 32 *Macaca fascicularis* with particulars, there were 7 individuals found in the bamboo arboretum and tropical forests,

23 individuals are found in Al-Hurriyyah Forest, and 2 in LSI (Abdullah 2017). In addition, Hidayat (2012) states that there are 41 individuals of *Macaca fascicularis* with particulars, specifically 4 tails are in the rectorate building, 2 tails are found in library and 23 of them are in the lecturer's house forest, and 12 of them are in deer captivity cikabayan. In addition, Suwarno (2014) stated that there were 39 individuals of *Macaca fascicularis* that spread over four locations, namely one library border area, one bamboo arboretum and tropical forest, 16 deer captive palm stands (Cikabayan Forest), and 16 deer captive bamboo stands (Cikabayan Forest) there were 21 individuals. Therefore, *Macaca fascicularis* has habitat distribution in locations with high levels of human activity.

Ganguly et al. (2018) stated that monkeys entering human areas to consume food require nutrition to perform their activities and survive. Monkey attacks usually occur during the day and late afternoon because at that time, there is a lot of used human food and for several reasons out of curiosity to revisit places found by long-tailed monkeys in the morning. Mendis and Ashoka (2016) stated that monkeys will keep returning to and stay around areas where human food is easy to find. According to Das and Mandal (2015), the conflict between humans and long-tailed monkeys will cause long-tailed monkey hunting to reduce the long-tailed monkey population, and humans can be considered predators of long-tailed monkeys to avoid population reduction (Hambali et al. 2012). They are also well-adapted to human-based food sources, such as garbage and food, which are provided directly to them (Gumert et al. 2011).

According to IUCN, the conservation status of *Macaca fascicularis* is endangered. The proximity of the habitat of *Macaca fascicularis* to the location of human activities can increase the interaction between *Macaca fascicularis* and humans, which will increase the potential for human-wildlife conflict. Based on the Regulation of Minister Forestry Number P.48/Menhut-II/2008, human-wildlife conflict is any interaction between humans and wild animals it had a negative effects on human social life, economy, culture, and on wildlife preservation and the environment. The occurrence of conflicts can be detrimental to both humans and *Macaca fascicularis*. According to Das and Mandal (2015), conflict between humans and long-tailed monkeys leads to their hunting. The long tail is decreasing in long-tailed monkeys, and humans can be considered predators for long-tailed monkeys.

However, one of the determining factors for the potential conflict of *Macaca fascicularis* in the Dramaga Campus area of the IPB is the loss of space and native habitat of *Macaca fascicularis* which must be considered by policymakers. To solve this problem, this research was conducted by identifying the variables causing conflict in the Dramaga IPB Campus area by describing the intensity of influence and the interdependence relationship between the variables, both direct and indirect, and stratifying them in the order of most influential to very insignificant. Based on the findings of this study, the researcher hoped to avoid problems that may arise in the future and encourage future thinking that is both successful and sustainable. Additionally, the results of this study are expected to provide information on the causes of *Macaca fascicularis* conflict. Hence, information from the data can also be considered in the management and development of *Macaca fascicularis* and its habitat at the Dramaga IPB Campus.

METHOD

Study Area

This research was conducted at the IPB University Dramaga, Bogor Regency, West Java Province, from 17 October 2021 to 7 November 2021. The habitat of *Macaca fascicularis* is adjacent to the IPB campus so that the home range of *Macaca fascicularis* reaches the IPB Campus. At the time of conducting the research, the temperatures in three research locations, namely Alhurriyah Forest 30 °C, Rectorate Forest 30.5 °C and Bamboo Arboretum 30.2 °C. A map of the research locations is shown in Figure 1.

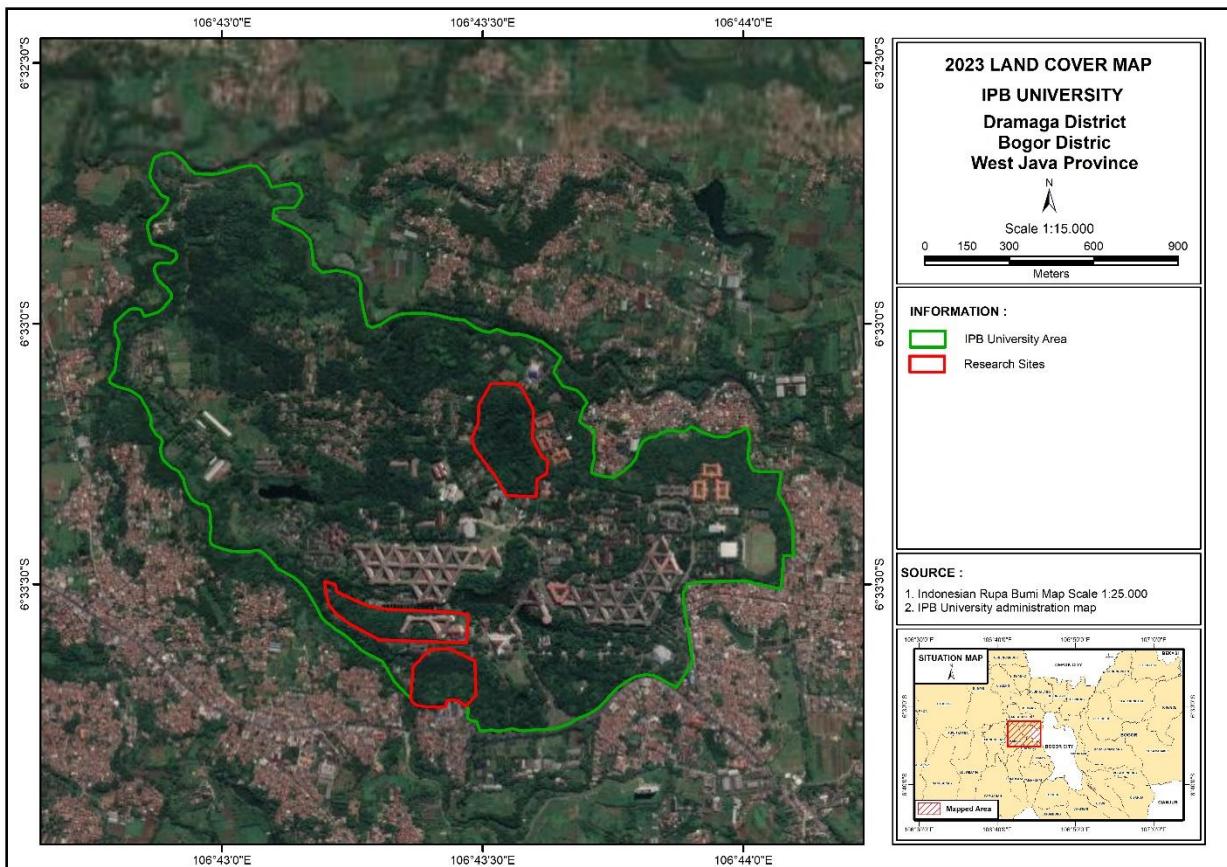


Figure 1 Map of the distribution of *Macaca fascicularis*

Data Collection

This research used a prospective structural paradigm to explore the structure, dynamics, and network of interrelationships between variables that are considered the most important in determining *Macaca fascicularis* conflict. Data collection was carried out using the Focus Group Discussion (FGD) Method to determine the influential variables and human conflict with *Macaca fascicularis*. Based on the FGD with local communities and related stakeholders, 14 elements or variables representing economic, social, technological, and institutional dimensions were identified. Direct observations in the field included natural and non-natural long-tailed macaque food, habitat carrying capacity, population demographics, population distribution, population movements, activities, and factors influencing conflict with long-tailed macaques.

Analysis Data

The researcher used conflict determination when filling out the software. Moreover, the discussions used the world café method to encourage interaction, shared knowledge, and transfer of experience with the participants. Fifteen FGD participants representing stakeholders in the Dramaga Campus Area of IPB came from IPB students, lecturers, local communities, and community leaders. In addition, the data analysis used the Micmac Method (cross impact matrix multiplication applied to classification). During its operation, Micmac applied the matrix property (Arcade et al. 1999; Godet et al. 2008). Micmac identifies and analyzes the main variables of the system. The advantage of Micmac over other structural methods is that it allows for grouping and determining the hierarchy of strategic variables of a system and knowing their mutual effects. This feature is very useful in the policy-making process because it directs the focus of the policy, considering that policy focus often leads to irrelevant variables, consequential in failure. The explanations presented by the

Micmac analysis will create greater confidence and trust in the issues raised and present various assumptions (Benjumea-Arias et al. 2016).

The operation of the Micmac Method consists of several stages: (1) Problem definition, identification of internal and external variables; (2) assessment of the relationship between variables based on the level of influence and dependence, which was assessed with a rating scale between 0 = none, 1 = weak, 2 = moderate, 3 = strong, and P = potential. The results of the assessment qualify the intensity of influence between variables into groups of direct influence, indirect effect, and potential influence. A direct effect occurs if variable A has an effect on variable B; Indirect effect occurs if variable A affects B and B affects variable C, and thus C is indirectly affected by A. Potential effect occurs if variable A should have an effect on B, whereas no direct effect occurs if a variable has no effect on the other variables (Delgado-Serrano et al. 2015); (3) analyzing the intensity of the influence and dependence of the variables determined by the location of the variables on the quadrant map of the influence and dependence of the variables (Figure 2).

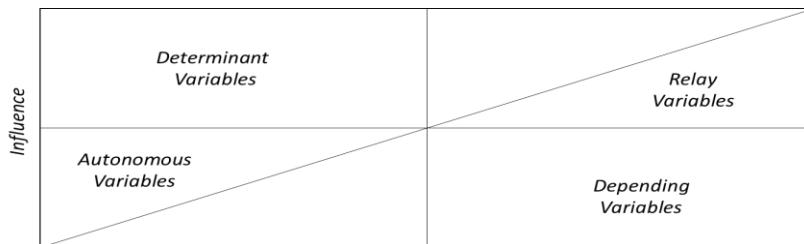


Figure 2 The results of the analysis of the intensity of influence and variable dependence

RESULT AND DISCUSSION

Results

Based on FGD with local communities and related stakeholders, 14 elements or variables representing economic, social, technological, and institutional dimensions were identified, resulting in a 14×14 matrix element. These 14 variables represent the concerns of the community and local authorities regarding livelihood sustainability in the area. However, the number of variables (variable sizes) is not evenly distributed between sustainability dimensions because of the overlapping measurements between variables in each dimension. For example, social role variables can be included in the institutional dimension and grouped in the social dimension. Similarly, "maintenance systems" can be grouped into the technological dimension and classified in the environmental dimension. Hence, for the purposes of this analysis and based on agreement from the focus group discussions, 14 variables were grouped, as listed in Table 1. The direct influence matrix of these variables can be seen in Figure 3. These variables were then included in the Micmac analysis.

Table 1 Variables identified as determinants of conflict list of variables

No	Long label	Short label	Description	Thema
1	Habitat characteristics	Character	characteristics of the habitat required by monkeys and areas that are rarely visited by humans or not adjacent to settlements	ecological aspect
2	Number of demographic	Demographic	demographics consisting of population size and density, birth and death rates, age structure, sex ratio, emigration and immigration	ecological aspect
3	Population growth model	Population	The <i>Macaca fascicularis</i> population growth model uses a density-linked model or also known as a logistic equation model	ecological aspect

4	Vegetation composition	Vegetation	The type of vegetation in the research plot in the Macaca Falcularis conflict area based on observations in the plot or research area	ecological aspect
5	Food percentage	Food	to find out the condition of macaca falcularis feed in conflict areas	ecological aspect
6	Habitat carrying capacity	Carrying	carrying capacity is also known in wildlife management. Estimation of the carrying capacity of a habitat can be done by measuring the amount of forage or feed productivity per hectare available and can be utilized by macaca Falcularis	ecological aspect
7	Community characteristics and activities	Activities	community activities observed include community activities in utilizing forest resources and specific factors in the form of crop damage caused by macaca falcularis behavior	socio-economic aspects of society
8	Type of land use	Land	This type of land use by the community will provide economic resources to the community but have an impact on reducing macaca falcularis habitat and being isolated in limited habitat	socio-economic aspects of society
9	Public perception index	Perception	Index of community perception of conflict mitigation with criteria agree is an alternative economic development for the community and implementing local wisdom in land use	socio-economic aspects of society
10	Community perception level	Level	This level of public perception is also supported by findings data in the field that in the village found lands that are used tigers to nest and find food	public perception index
11	Forms of local culture	Culture	Local wisdom is a cultural value that becomes part of community activities to survive in accordance with the conditions environment, according to needs, and deeply rooted beliefs hereditary	community local culture
12	Implementation in the tradition of using plants, animals	Benefit	see firsthand the form of tradition in the use of plants and animals around the conflict area	community local culture
13	Institutional aspects	Institution	institutions include institutions which is the basis for building community social behavior, norms of behavior rooted in society, regulations and enforcement rule of law	conflict mitigation model
14	Conflict mitigation model	Mitigation	see the conditions in the field and adjust to the appropriate model	conflict mitigation model

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	3	3	0	3	3	2	2	1	0	1	2	0	2		
1	0	0	3	2	3	3	0	0	1	1	0	1	2	3	
2	Demographi	3	0	3	3	3	1	2	1	3	0	1	2	3	
3	Population	3	3	0	3	3	2	2	3	2	2	3	3	0	
4	vegetation	3	3	3	0	3	3	2	2	3	3	3	3	0	
5	Food	3	3	3	3	0	3	3	3	3	3	3	2	3	
6	carrying	3	3	3	1	3	0	2	3	3	1	3	3	3	
7	activities	1	3	3	3	3	3	0	3	3	2	3	2	3	
8	land	3	3	3	3	3	3	3	0	2	2	3	3	P	3
9	perception	1	1	1	2	2	3	3	3	0	3	3	3	1	1
10	Level	P	P	P	2	2	2	3	3	3	0	3	3	0	2
11	culture	0	0	1	2	3	3	3	3	2	3	0	3	2	2
12	benefit	1	3	3	3	3	3	3	3	3	3	0	0	2	
13	Institutio	0	1	1	2	0	1	1	2	0	0	0	2	0	2
14	mitigation	2	2	2	1	3	3	2	3	3	3	0	1	2	0

Figure 3 Matrix of Direct Influence (MDI)

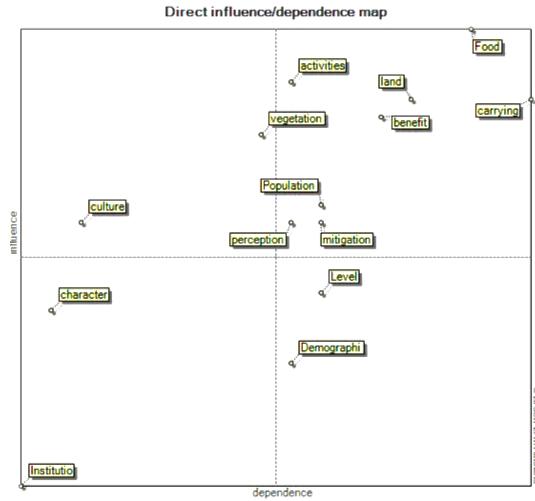


Figure 4 Influence-Dependence Map

Moreover, after the identification and construction of the MDI matrix, the next step in the MICMAC analysis is to define the relationship between variables. This correlation can be described in two ways: first, it describes the position of the variables through the Influence Dependence Map, and second, it describes the interconnections between variables. As shown in Figure 4, local wisdom variables and vegetation composition were placed on the map as driving or input variables. The Dependency Effect Map of the 14 variables is described in Figure 5. The results of filling in the MDI determine the position of variables on the direct influence and dependence map consisting of four typologies, as shown in Figure 4; specifically, the determinant variable, resulting from the Micmac analysis, includes two variables in the determinant quadrant, specifically, local wisdom and vegetation composition.

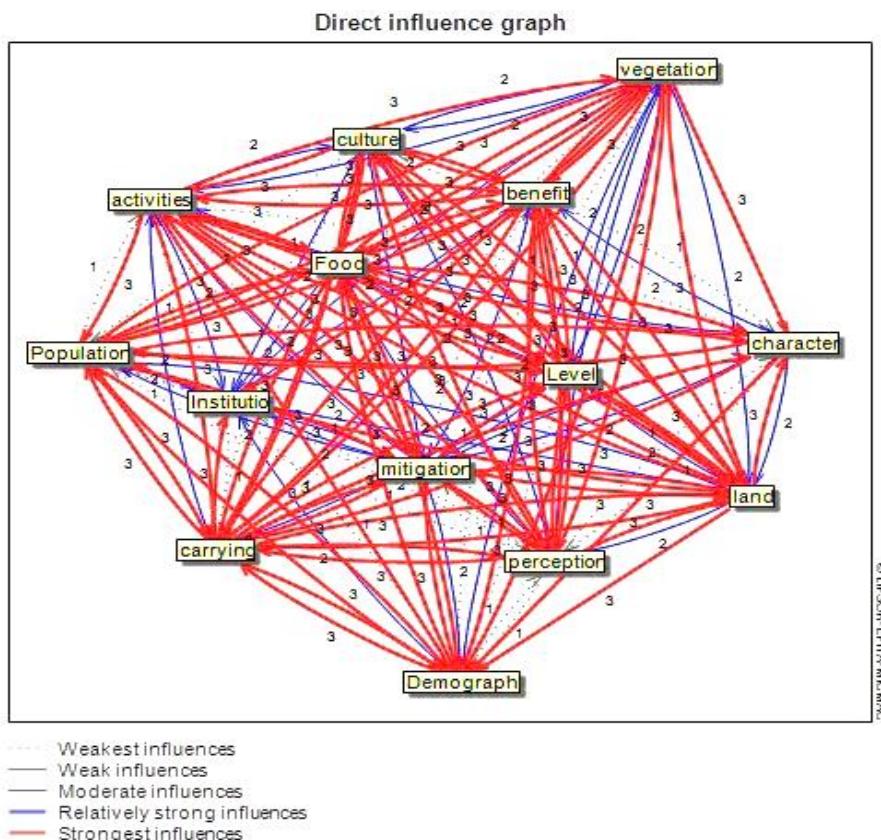


Figure 5 Direct influence graph for sustainable livelihood

Additionally, local wisdom and vegetation composition referred to in this study were local wisdom food and cultural values that are part of community activities to survive in environmental conditions, based on the needs and values that come from generation to generation. The types of vegetation in research plots in conflict areas, *Macaca fascicularis* were based on observations in the plot or study area. This is in line with the findings of Campbell et al. (2013), who found the importance of socioeconomic coherence and vegetation composition as key factors in the occurrence of *Macaca fascicularis* conflict. Similarly, the results of this study are also supported by findings from Kittinger et al. (2015), which emphasize the importance of social and ecological factors of vegetation for sustainability in overcoming conflict factors. Cultural values in society also affect perceptions of wildlife conflicts and, in turn, determine the effectiveness of mitigation efforts (Saraswat et al. 2015).

The second group of variables also plays an important role as relay variables. These variables were located in the top-right corner (northeast corner) of the map. There are two relay variables: influential and dependent. These variables can cause instability in *Macaca fascicularis* conflict in alternative livelihoods. Minor changes in these variables can cause conflicts to become unsustainable. The variables that have positions as relay variables are mostly in the ecological and socioeconomic aspects of the community, specifically activities, perceptions, mitigation, population, benefits, land, food, and support (carrying capacity).

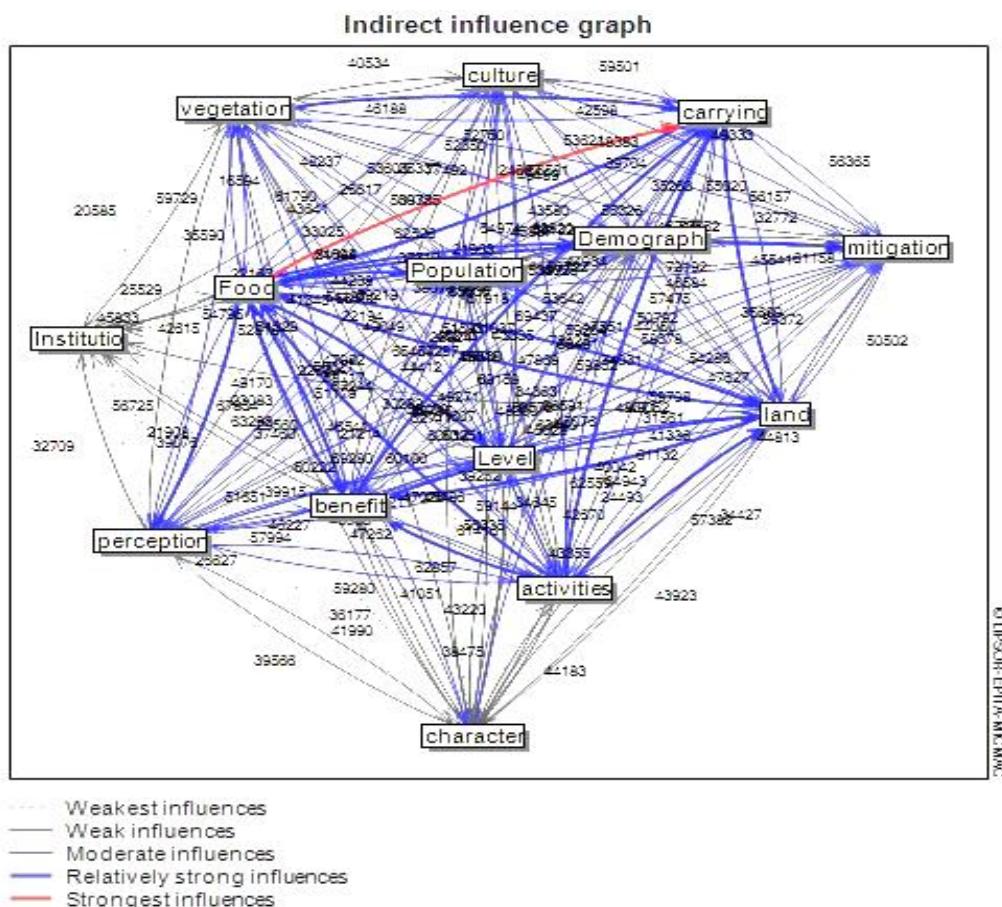


Figure 6 Map of indirect influence among variables

The correlation between variables from the direct influence perspective can be seen in Figure 5, where the variables influence each other. As shown in Figure 6, in terms of indirect influence, only the presence (support) of carrying capacity had the strongest indirect effect on food. There are several factors that influence the high prevalence of *Macaca fascicularis*, which may be due to the limited food availability of *Macaca fascicularis* in the forest. This research deals with the theory stated by Widyanti (2001), which states that

Macaca fascicularis will enter land and residential areas because of the lack of food in the forest. Figure 6 also shows that institutions had the weakest indirect effect among the other variables. This may be due to the fact that institutions are not a problem for the *Macaca fascicularis* conflict because they can survive to have no effect on the occurrence of the *Macaca fascicularis* conflict, where the institution usually exists because it determines obtainable problems, such as the *Macaca fascicularis* conflict on the Dramaga IPB Campus.

Figure 7 shows the rating of the comparison between variables based on their effects. The order of the MDI matrix variables on the left leads to the sequence of variables that have not been calculated, whereas the order of the matrix variables to the right leads to the calculated order of MDI matrix variables, which has an indirect effect. The red line indicates a decrease in the order of the variables, whereas the green line indicates an increase in the order of the variables after the calculation is carried out. It can be seen from Figure 7 that there was some displacement between variables after the calculation of the indirect effect. For example, the population and culture (local wisdom) have replaced each other. Previously, the total population was ranked as seven in the MDI matrix. However, these variables are now ranked 9 and have been replaced by culture (local wisdom) after indirect influences have been calculated. This also occurs in the supporting variables (carrying capacity), where the MDI matrix at rank 3 has now moved to rank 6.

Rating comparisons based on the above dependence are illustrated in Figure 8. As shown in Figure 8 the four conflict factor indicators are consistent in the big four as dependency variables, specifically carrying capacity (support), food, land and benefits. In addition, the population presence variable on conflict, however, has shifted from rank 5 under the MDI matrix to rank 6 after the indirect effect is calculated. Likewise, demographics and activities dropped to one level. This indicates that the variable has decreased or is prioritized less. The perception variable, however, has jumped from rank 10 as a dependent variable to rank 8 under the Matrix of Indirect Influence (MII). As a result, there was a significant role of public perception in the Dramaga IPB Campus area, in which other factors can influence the occurrence of human conflict with *M. fascicularis*.

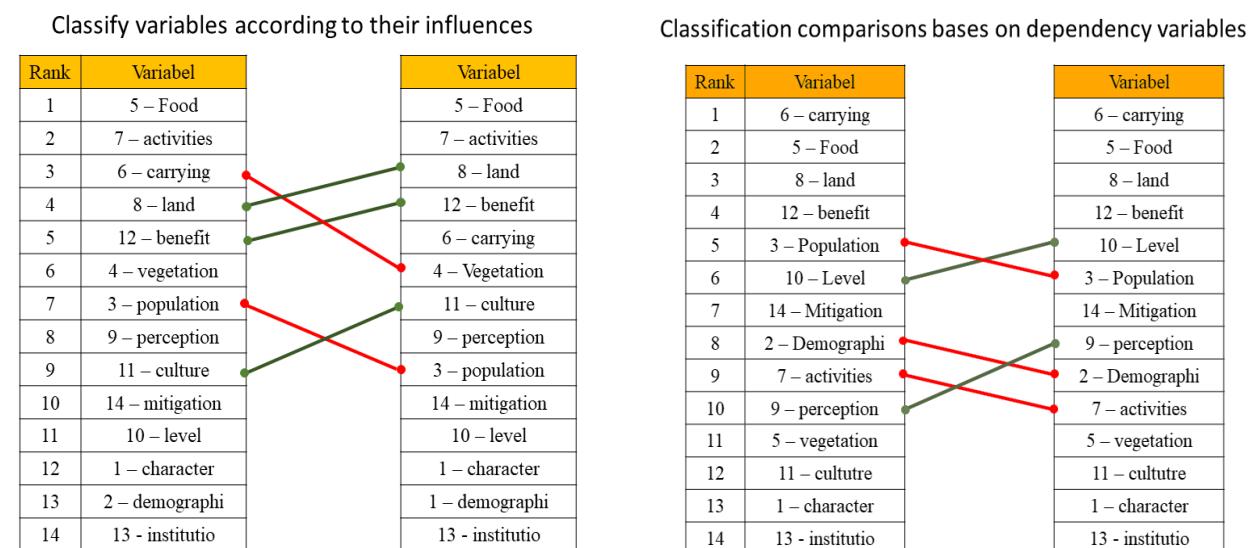


Figure 7 Rating comparisons based on the influences

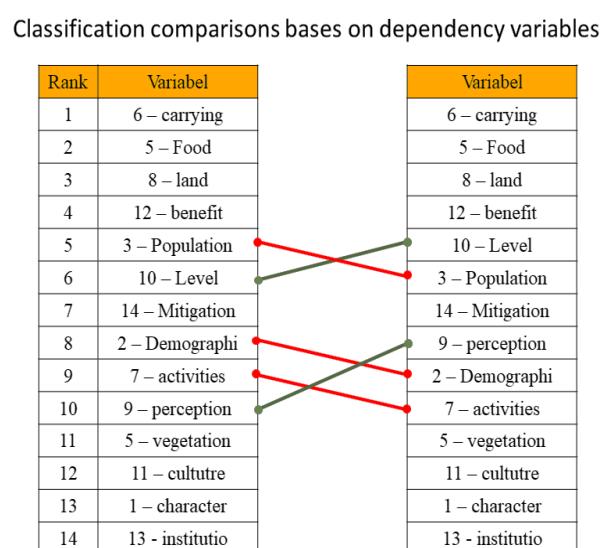


Figure 8 Classification comparisons based on the dependence

CONCLUSION

The *Macaca fascicularis* conflict at the Dramaga IPB campus is an important part of overcoming the uncertainty that arises from external and internal shocks in society. However, it is challenging to reduce the conflict of *Macaca fascicularis*, which is a sustainable alternative in which various variables can affect the sustainability of the *Macaca fascicularis* conflict within the Dramaga IPB Campus. Based on the results of the study, several factors that influence the high level of *Macaca fascicularis* disturbance, they are food,

vegetation, culture, and the important role of human activities, land, population, mitigation, forest resource benefits, carrying capacity and community perception around the Dramaga IPB campus area towards *Macaca fascicularis*. This study was the first to assess the factors that influence the occurrence of a never-ending human monkey conflict on the Dramaga campus of the IPB. This is the first study to use the MICMAC approach to address this issue. Based on the conditions that occurred during the disturbance period in long-tailed monkeys. The Primate Animal Study Center (PASC) in collaboration with the Bogor BKSDA (*Balai Konservasi Sumber Daya Alam*) made efforts to deal with disturbances using the trapping cage method, which is a method carried out by storing iron cages filled with fruits such as bananas and others in several locations that are suspected of being areas that are often visited. Visit the monkeys such as the IPB bus garage area, Postgraduate School Area, Lecturer residence and behind the Al-Hurriyah Mosque. Increasing the active role of the community around the IPB campus which is affected by long-tailed monkey disturbances by providing incentives for people who are able to catch long-tailed monkeys without causing harm.

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