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Vegetation composition and structure across land use types in a rotational cultivation system in Meratus Mountain, South Kalimantan, Indonesia

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Abstract. *Rezekiah AA, Ruslan M, Kadir S, Mahmud. 2022. Vegetation composition and structure across land use types in a rotational cultivation system in Meratus Mountain, South Kalimantan, Indonesia. Biodiversitas 23: 4234-4242.* The rotational cultivation system has become a local ecological knowledge of the Meratus Dayak community in South Kalimantan, Indonesia. This land management applies a cultivation system by dividing land into four types, namely *pahumaan* (cultivated area of annual crops), *balukar anum* (former cultivated field aged 3-6 years), *jurungan* (former field aged 7-12 years), and *kabun buah* (former fields aged more than 15 years). This study is aimed to investigate the floristic structure and composition of the vegetation in each land use type in the rotational cultivation system conducted by the Dayak Meratus community in three villages (i.e., Loksado, Lok Lahung and Haratai). Vegetation sampling was conducted purposively across four vegetation levels (i.e., seedlings, saplings, poles and trees) and the data was analyzed to calculate Important Value Index (IVI), Shannon-Wiener diversity index, species richness index and evenness index. The results showed that each land type had a certain vegetation structure and composition. In *pahumaan*, the dominant plant species were annual plants, especially crops. The *balukar anum* and *jurungan* were dominated by woody plants, while the *kabun buah* was dominated by fruit plants. The changes in vegetation structure and composition suggested that the succession process was in progress. The diversity index for each type of land use in the three villages was in the medium to high category. The species richness index was in the low to the high category, while the evenness index for all land uses in the three villages was at a high level. These findings suggest that traditional rotational farming activities carried out by the community did not damage the forest.

Keywords: Abundance index, diversity index, equality index, rotation, vegetation analysis

INTRODUCTION

Natural resources have many important aspects which are closely related to human life. Throughout centuries and millennia, humans have managed natural resources to fulfill their needs, one of which is land for agriculture. While in most parts of the world, modern and intensive agriculture are common nowadays, in many areas across the world, lands are still traditionally managed by several communities through shifting cultivation and/or rotational cultivation. These farming systems often exist in the tropics or in countries with important global biodiversity and carbon sequestration (Das et al. 2021; Mertz 2009), and are widespread in Southeast Asia such as Laos (Yirdaw et al. 2019). Another example of rotational system is in the northeast Himalayas conducted by the Indian community known as Jhum (Bhagawati et al. 2015).

Although rotational cultivation is almost the same as shifting cultivation, there are differences between both systems. In shifting cultivation, the same area is used for forestry and crop cultivation at different times (Das et al. 2022). On the other hand, the rotational cultivation system can be seen as a newer stage in the evolution of farming after shifting cultivation. It uses the planting cycle, which requires knowledge and connection with the environment and a perspective on conservation (Bhagawati et al. 2015). Rotational cultivation system is based on land clearing activities during the dry season and planting crops in the rainy season. Having the land cultivated with crops for few years, it is left to grow into the secondary forest (fallow) before the planting cycle is started all over again (Aththorick et al. 2012). The fallow period in an area generally can be around 5-20 years. The length of the fallow period can affect soil fertility and production potential (Kristian 2019; Yuliansyah et al. 2019). According to Susanto (2016), rotational farming is generally associated with three important stages: 1-3 years of opening, time of planting or growing and 10-20 years of fallow. The fallow period must be longer than the planting period to recover the abandoned area to its original state.

The Meratus Mountains is one of the areas in South Kalimantan, Indonesia that is rich in natural resources. These natural resources are used by the community to meet their daily needs, one of which is land for agricultural activities. The local tribe, the so-called Dayak Meratus, has long been carrying out agricultural activities around the forest in the mountains for their livelihoods. Traditionally, they do agricultural activities using a crop rotation system, and it has become the local wisdom of the Dayak Meratus community in land management (Kristian et al. 2019). The community uses the land for farming and then vacates it for a minimum of 7 years to experience a fallow period. During the fallow period, the community utilizes the land by planting rubber, fruit trees and other plants to restore the land conditions (Fahrianoor 2013). The community uses land inherited from their ancestors, which is usually divided into families with 7-10 cultivation areas per family (Muhaimin et al. 2021).

Loksado, Lok Lahung and Haratai are villages around the Meratus Mountains that are still carrying out traditional rotational cultivation systems. The land used by the community in the three villages can be categorized into four types namely *huma*/*pahumaan* (cultivation fields managed for 2 years maximum), *balukar anum* (former *huma* with an age of fewer than 7 years), *jurungan* (former *huma* with an age of 7-12 years), *kabun buah* or forests (former *huma* with an age of more than 15 years). The farmers only use land that has been cultivated before and *kabun buah* land that is no longer productive. Because this system is iterative, agricultural land is indirectly mapped and communities do not develop new agricultural land in primary forests (Kristian et al. 2019).

From the perspective of ecology, it is interesting to look at the state of vegetation of the land uses in the rotational cultivation system. Therefore, this study is aimed to investigate the floristic structure and composition of the vegetation in each land use in the rotational cultivation system conducted by the Dayak Meratus community in three villages (i.e., Loksado, Lok Lahung and Haratai). This knowledge can be used as the basis for whether the community's land management system has an impact on the vegetation.

MATERIALS AND METHODS

Study area and period

The data collection was conducted from September to October 2020 in three villages: Loksado, Lok Lahung and Haratai, in Loksado Sub-district, Hulu Sungai Selatan District, South Kalimantan Province, Indonesia (Figure 1). The geographic position of the study location is at 115°29’45.04” E and 2°47’40.90” S. Geographically, Loksado Sub-district is bordered by Kotabaru District to the east, Banjar District to the southeast, Padang Batung Sub-district to the west, and Telaga Langsat and Hulu Sungai Tengah sub-districts to the north. The location was chosen because the residents of the three villages mostly use the surrounding forest area for agricultural and gardening activities.

Data collection procedure

Vegetation data were collected on each land use type in the rotational cultivation system in Loksado, Lok Lahung, and Haratai villages, i.e., *huma*/*pahumaan*, *balukar anum*, *jurungan*, and *kabun buah.* In each land use of each village, we established 25 plots, resulting in total observation plot of 300. In each land use type, sample plots were established to collect vegetation data according to growth stages, namely plots measuring 2x2 m^2 for ground vegetation and seedlings, 5x5 m^2 for stakes/saplings, 10x10m for poles and 20x20 m^2 for trees. The data recorded were species name, number of individuals, diameter, and height.

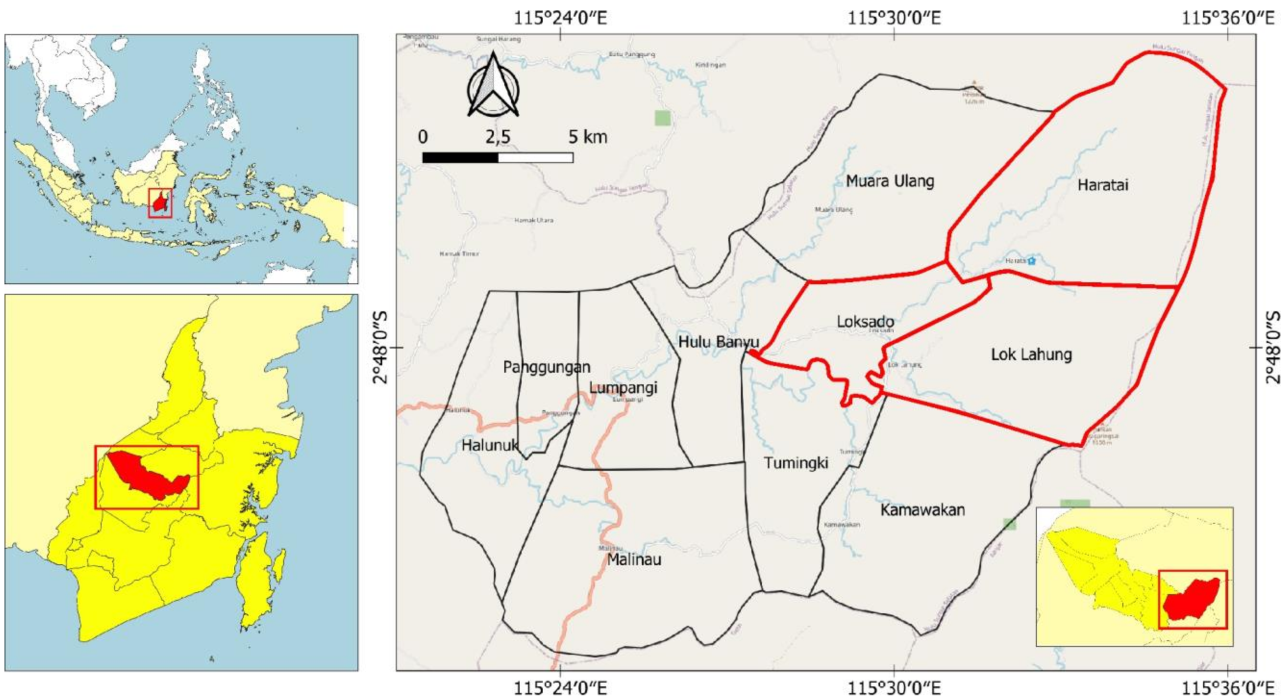

Figure 1. Map of the research location in Loksado, Lok Lahung and Haratai villages, Loksado Sub-district, Hulu Sungai Selatan District, South Kalimantan Province

Data analysis

Importance Value Index (IVI)

Importance Value Index (IVI) was obtained from the sum of Relative Density (KR), Relative Frequency (FR), and Relative Dominance (DR). The calculation of the Importance Value Index (IVI) (Mueller-Dombois & Ellenberg 1974) is as follows:

Density (K), with the following formula:

$$K = \frac{\Sigma\ individual}{plot\ area}$$

Relative Density (KR), with the following formula:

$$KR = \frac{K\ a\ species}{K\ total\ of\ all\ species} \times 100\%$$

Frequency (F), with the following formula:

$$F = \frac{\Sigma\ sub-plot\ found\ a\ species\ of}{\Sigma\ all\ sub-plots\ of\ sample}$$

Relative Frequency (FR), with the following formula:

$$FR = \frac{F\ of\ a\ species}{F\ total\ of\ all\ species} \times 100\%$$

Dominance (D), with the following formula:

$$D = \frac{base\ area\ of\ a\ species}{area\ of\ sample\ plot}$$

Relative Dominance (DR), with the following formula:

$$DR = \frac{D\ a\ species}{D\ total\ of\ all\ species} \times 100\%$$

For seedlings and saplings levels, the Importance Value Index (IVI) was calculated with the following formula:

IVI = KR + FR

While for poles and trees, the IVI was calculated as follows:

IVI = KR + FR + DR

Diversity index

The level of stability of vegetation was assessed using the Shannon-Wiener diversity index (Ludwig et al. 1988) as follows:

$$H` = -\sum [(ni/Nt) \ln (Ni/Nt)]$$

Where;

H' : Shannon-Wiener diversity index

Ni : Number of individuals of the i-th species

Nt : Total number for all individuals

The diversity index is categorized into three classes, namely: Low, if the H value < 1; Medium, if the H value is between 1 and 3; High, if the H value > 3.

Species richness index

The Margalef index is used to determine species richness (Ludwig et al. 1988) and was calculated as follow:

$$R1 = \frac{(S-1)}{\ln(N)}$$

Where;

R1 : Species Richness Index

S : Number of species found

N : Total number of individuals

The criteria for the Margalef species richness index are as follows: R1 < 3.5 is classified as low; R1 between 3.5 and 5.0 is classified as moderate; and R1 > 5.0 is classified as high.

Evenness index

Evenness index was used to determine the distribution pattern referring Ludwig et al. (1988) and was calculated as follows:

$$E = \frac{H'}{\ln(S)}$$

Where;

E : Species evenness index

H' : Species diversity index

S : Number of species

The criteria for the species equality index are as follows: E' < 0.3 is classified as low; E' between 0.3 and 0.6 is classified as moderate; and E' > 0.6 is classified as high.

RESULTS AND DISCUSSION

Vegetation structure of each land use

The result of vegetation analysis showed that each land use type had a different vegetation structure. In *huma*, the vegetation was mostly annual plants, and there was no pole and tree levels. The *balukar anum* and *jurungan* were dominated by woody plants, while the *kabun buah* was dominated by fruit plants. Figure 2 shows the structure and composition of vegetation on various land types in the three villages studied. Lok Lahung Village had more plant species than the other two villages. *Jurungan* had a higher number of species than the other three land uses. The higher the vegetation growth stage, the less the number of species found. Of the three villages surveyed, Lok Lahung Village had a higher number of species. There were 57 species at seedling levels in the *Jurungan*. Some species were wildly growing and some were plant species that were deliberately planted by the farmers when they farm in huma finished. The types that are usually planted are rubber, peronema, cinnamon, and several types of fruits.

The difference in the number of species can be influenced by environmental conditions where the species grows. These differences can be caused by rainfall, temperature, and altitude from where the species grows (Cowles et al. 2018; Tohirin et al. 2021; Xu et al. 2017). In addition, differences in the number of species can also be influenced by land management carried out by the community (Lestari et al. 2019). Differences in the composition of vegetation types can provide an overview of each type of plant that forms a community as a result of the interaction between biotic and abiotic components (Maridi et al. 2014).

Of the several species found, there were several local species typical of Kalimantan, such as kulidang (*Artocarpus lanceifolius)*, ramania (*Bouea macrophylla*), maharawin (*Durio oxleyanus*), tandui (*Mangifera rufocustata*), maritam (*Nephelium ramboutanake*), palipisan (*Mangifera sp.*), and kalanga (*Litsea angulata*). Local plants found in these areas can have an important role in increasing species abundance (Muhlisin 2021). According to Burghardt et al. (2009), the presence of local species affects the diversity of faunal species such as birds and butterflies. Based on Taylor et al. (2016), the abundance of individual species and species composition is more influenced by the presence of non-native plants than local plants. Therefore, local plant species must be preserved because they play an important role in biodiversity conservation (Muhlisin 2021).

Importance Value Index (IVI)

The sum of the relative values of density, frequency, and dominance is used to calculate the Important Value Index (IVI). Species with the highest IVI are presented in Table 1.

Table 1 above shows the three highest IVI for each vegetation level at each use land in three villages. Chili (*Capsium frutescens*) was species with a high IVI in *huma* at the seedling and sapling levels in Loksado and Lok Lahung. This is because local people plant secondary crops and vegetables in the fields to minimize attacks by wild animals and pests that can interfere with the staple crop (i.e., rice) (Soehadha 2018). Meanwhile, in Haratai, the highest IVI at seedling level was perennial vegetation which may have just been planted in a field that was no longer cultivated.

Rubber (*Hevea brasiliensis*), candlenut (*Aleurites moluccana*), sungkai (*Peronema canescens*) and cinnamon (*Cinnamomum burmannii*) were species with a high IVI at the sapling to tree levels in the *jurungan* and *balukar anum*. At the beginning of the fallow period after cultivation, vegetation composition is usually dominated by the same species (Karyati 2018). Therefore, such plant species became the dominant vegetation in Loksado, Lok Lahung, and Haratai. The high IVI was due to the fact that people in the three villages mostly used to economically help meet community needs (Astiani and Ripin 2016). Some vegetation such as rubber (*H. brasiliensis*) and candlenut (*A. moluccana*) have a long harvesting period. Sungkai (*P. canescens*) is a fast-growing tree so that the wood can be used by the community and the land used for sungkai planting can be re-cultivated. Cinnamon (*C. burmannii*) was used clear-cut after being harvested which enabled the community to re-cultivate the land.

The seedling level in the *kabun buah* in Loksado and Lok Lahung was dominated by rambutan (*Nephelium lappaceum*) and langsat (*Lansium domesticum*), while in Haratai it was dominated by durian (*Durio zibethinus*), gitaan, and tiwadak (*Artocarpus champeden*). At the sapling level, the highest IVI was Langsat (*Lansium domesticum*). At the pole level in Loksado Village, the *kabun buah* was not only dominated by fruit trees but also plants such as candlenut (*A. moluccana*) and cinnamon (*C. burmannii*). Meanwhile, in Haratai, sungkai (*P. canescens*) had the highest IVI at the tree level in the *kabun buah*. The species found in *kabun buah* were different with those in the *balukar anum* and *jurungan*. Besides being influenced by the preference of the local people, such difference was also influenced by the age of a land. This is in line with Karyati (2018) which states that there are similarities in the composition of vegetation in secondary forests aged 5 to 10 years, but at the age of 20 years, there are differences in vegetation composition. Therefore, the species composition on ex-cultivated land will change after 20 years of the fallow period.

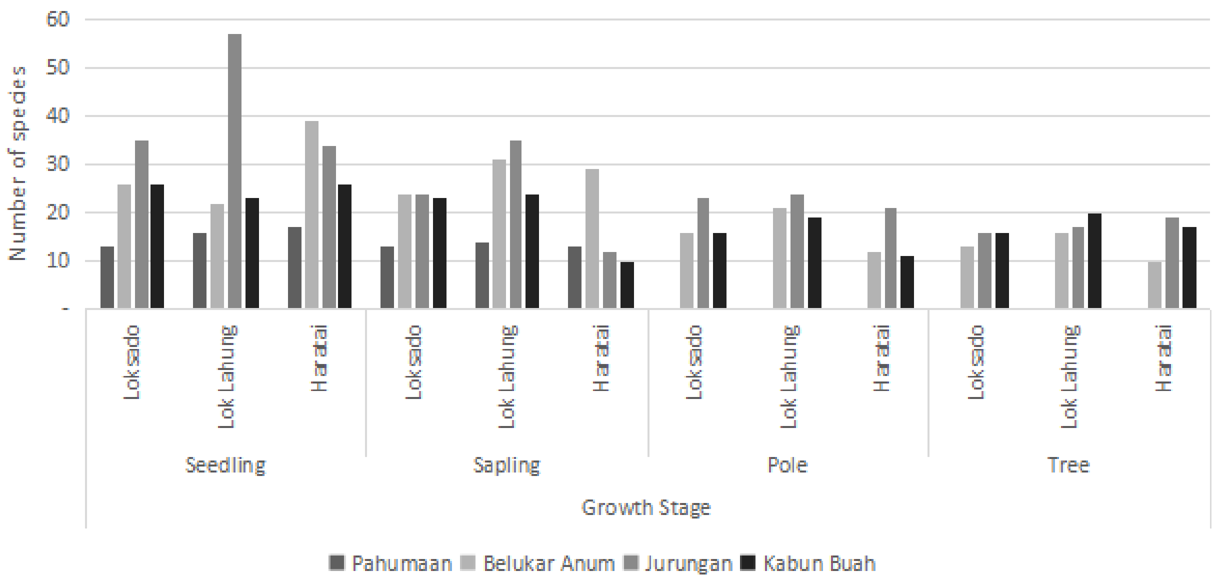

Figure 2. Vegetation structure of various types of land use of rotational cultivation system in three villages in Meratus Mountain, South Kalimantan, Indonesia

Table 1. Three species with the highest Importance Value Index (IVI) at each vegetation level of each land use type of rotational cultivation in three villages in Meratus Mountain, South Kalimantan, Indonesia

Land use type	Growth stage	Villages					
		Loksado		**Lok Lahung**		**Haratai**	
		Species	**IVI**	**species**	**IVI**	**species**	**IVI**
Pahumaan	Seedling	*Capsium frutescens*	38.59	*Musa paradisiaca*	32.05	*Dyera costulata*	28.7
		Coffea sp.	33.75	*Vernonia arborea*	26.12	*Peronema canescens*	28.2
		Karamihan	22.73	*Capsium frutescens*	25.97	*Nephelium lappaceum*	22.82
	Sapling	*Capsium frutescens*	43.58	*Capsium frutescens*	31.99	*Aleurites moluccana*	30.88
		Karamihan	29.59	*Manihot utilissima*	30.1	*Macaranga* sp	25.12
		Mallotus paniculatus	27.61	*Musa paradisiaca*	28.87	*Coffea* sp.	23.16
Balukar anum	Seedling	Awaling	13.59	*Cinnamomum burmannii*	70.82	*Anthocephalus chinensis*	14.57
		Uwarduhat	13.24	*Mangifera feotida*	20.74	*Hevea brasiliensis*	11.98
		Gigantochloa sp	12.9	*Vernonia arborea*	16.44	*Peronema canescens*	11.29
	Sapling	*Vernonia arborea*	31.49	*Vernonia arborea*	30.82	*Vernonia arborea*	26.88
		Cinnamomum burmannii	16.46	*Hevea brasiliensis*	18.26	*Cinnamomum burmannii*	19.04
		Mallotus paniculatus	16.46	*Pithecellobium lobatum*	15.69	*Vitex pinnata*	15.79
	Pole	*Mangifera foetida*	107.88	*Cinnamomum burmannii*	70.82	*Cinnamomum burmannii*	79.41
		Aleurites moluccana	44.05	*Aleurites moluccana*	54.67	*Aleurites moluccana*	70.03
		Cinnamomum burmannii	29.76	*Peronema canescens*	27.16	*Peronema canescens*	27.16
	Tree	*Hevea brasiliensis*	50.83	*Cinnamomum burmannii*	62.32	*Peronema canescens*	52.95
		Artocarpus champeden	41.49	*Hevea brasiliensis*	53.49	*Hevea brasiliensis*	47.4
		Aleurites moluccana	38.95	*Peronema canescens*	33.69	*Cinnamomum burmannii*	44.00
Jurungan	Seedling	*Artocarpus anisophyllus*	12.51	*Cinnamomum burmannii*	17.13	*Gigantochloa* sp.	16.9
		Calophyllum sp.	11.77	Kumut	15.8	*Anthocephalus chinensis*	16.2
		Zoysia japonica	11.56	*Peronema canescens*	15.32	*Baccaurea macrocarpa*	10.9
	Sapling	*Homalium caryophyllaceae*	22.13	*Peronema canescens*	21.95	*Vernonia arborea*	29.04
		Peronema canescens	21.56	*Vernonia arborea*	20.55	*Hevea brasiliensi*	20.22
		Hevea brasiliensis	20.57	*Hevea brasiliensis*	17.72	*Alstonia scholaris*	15.72
Kabun buah	Pole	*Cinnamomum burmannii*	52.4	*Cinnamomum burmannii*	57.05	*Aleurites moluccana*	58.57
		Peronema canescens	44.02	*Aleurites moluccana*	49.03	*Peronema canescens*	48.33
		Aleurites moluccana	41.59	*Mangifera foetida*	31.76	*Cinnamomum burmannii*	40.67
	Tree	*Peronema canescens*	64.94	*Mangifera foetida*	40.82	*Peronema canescens*	47.43
		Cinnamomum burmannii	37.08	*Peronema canescens*	40.43	*Artocarpus anisophyllus*	37.2
		Artocarpus elasticus	36.57	*Artocarpus anisophyllus*	34.02	*Mangifera foetida*	30.97
	Seedling	*Lansium domesticum*	12.53	*Nephelium lappaceum*	22.32	*Durio zibethinus*	21.79
		Nephelium lappaceum	12.53	*Melastoma malabathricum*	16.35	Gitaan	20.5
		Durio kutejensis	13.42	*Lansium domesticum*	16.21	*Artocarpus anisophyllus*	16.22
	Sapling	*Lansium domesticum*	23.77	*Lansium domesticum*	23.82	*Lansium domesticum*	33.59
		Nephelium lappaceum	23.42	*Durio zibethinus*	20.26	*Garcinia parvifolia*	21.9
		Artocarpus champeden	17.54	*Baccaurea motleyana*	16.33	*Artocarpus anisophyllus*	20.26
	Pole	*Cinnamomum burmannii*	39.1	*Durio zibethinus*	36.55	*Lansium domesticum*	65.79
		Aleurites moluccana	31.44	*Baccaurea motleyana*	35.4	*Durio zibethinus*	49.81
		Baccaurea macrocarpa	26.98	*Nephelium lappaceum*	32.81	*Artocarpus anisophyllus*	47.93
	Tree	*Lansium domesticum*	44.87	*Durio zibethinus*	44.04	*Peronema canescens*	47.636
		Garcinia parvifolia	25.57	*Artocarpus anisophyllus*	31.29	*Garcinia parvifolia*	23.102
		Durio zibethinus	24.61	*Lansium domesticum*	26.61	*Juniperus chinensis*	1336

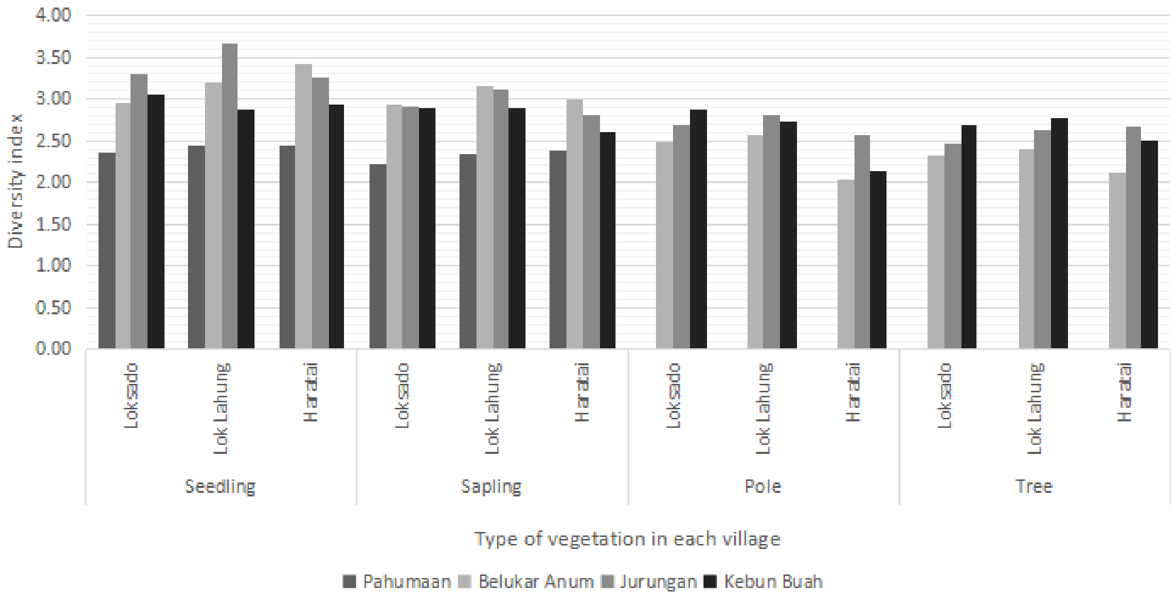

Figure 3. Shannon-Wiener diversity index of each vegetation level at each land use of rotational cultivation system in three villages in Meratus Mountain, South Kalimantan, Indonesia

Table 1 shows that there are several species that have a high IVI at the seedling to tree level. This is influenced by the adaptability of a type of vegetation from the seedling level to the next level. In addition, there are species found at the seedling level but not at the sapling to tree level. This is similar to the research of Maridi et al. (2014) which stated that there are differences in the type and number of individuals in understorey or tree-level vegetation. This difference can be caused by the survival rate of a species on ecosystem dynamics as well as external disturbances (Oktavia et al. 2021).

Diversity index

The Importance Value Index (IVI) was used for calculating the Shannon-Wiener diversity index with the results presented in Figure 3.

The species diversity index in the *balukar anum* for seedling and sapling levels in Lok Lahung and for the seedling in Haratai was more than 3, meaning that these lands had a high species diversity. A high species diversity index was also found in the *jurungan* for the seedling level in the three villages and for the sapling level in Lok Lahung. In addition, the seedling level in the *kabun buah* in Loksado also had a high diversity index. The diversity index other than the above-mentioned was in the medium category because it was in the range of 1≤H'≤3.

Species richness index

The species richness index is used to determine the number of species in a community, meaning that the more species found, the higher the species richness index. The calculation of the species richness index used the Margalef index with the results are shown in Figure 4. *Kabun buah* was land use with a high species richness index. The average species richness index in the *kabun buah* in the three villages was 3.38. In general, Loksado had a higher species richness index than Lok Lahung and Haratai.

Figure 4 shows that there are two land uses that had high species richness index, namely at the seedling level in the *jurungan* and *kabun buah* in Loksado with values of 5.18 and 6.09. On the other hand, land uses that had moderate richness were at the seedling level in the *balukar anum* of Loksado; seedling level in the *kabun buah* of Haratai; sapling level at the *balukar anum*, *jurungan*, and *kabun buah* in Loksado; as well as at the pole level in the *jurungan* and *kabun buah* in Loksado. The rest land use types had a low richness index.

Evenness index

The species evenness index is used to express the distribution/dispersion of each species. The results of the evenness index can be seen in Figure 5. The species evenness index of each land use in each village is categorized as high, which is more than 0.6, meaning that the species are equally distributed. The highest value of the species evenness index was found at the seedling level in the *balukar anum* area in Lok Lahung 1.03, while the lowest value was at the pole level in the *balukar anum* in Haratai. At the seedling level, *balukar anum* and *jurungan* had a high evenness index which is similar with the research by Oktavia et al. (2021), which found that *bebak* or ex-cultivated land had a higher evenness index when compared to burnt land (*padang*) or secondary forest.

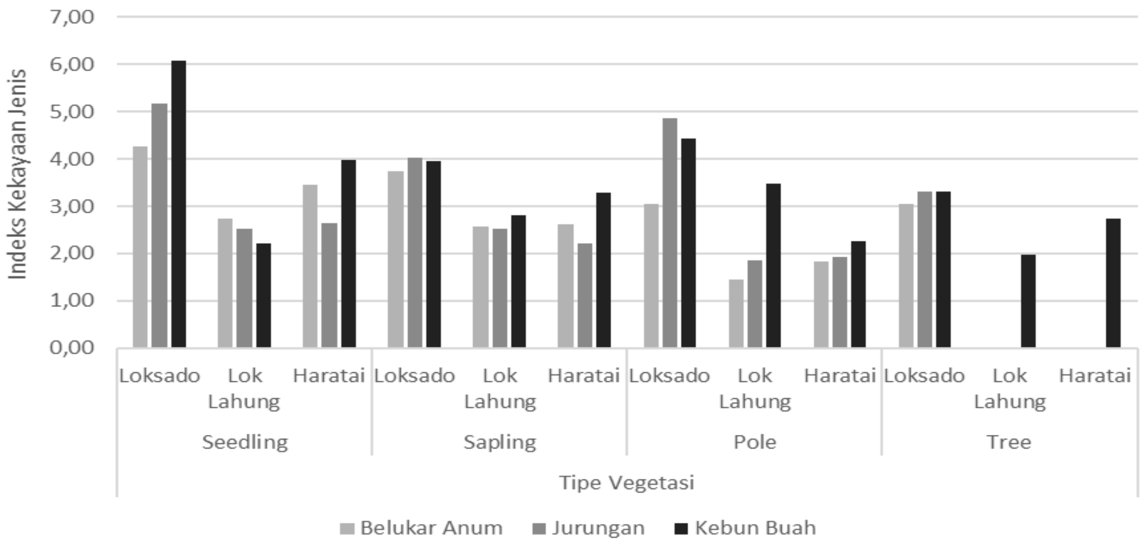

Figure 4. Margalef species richness index of each vegetation level at each land use of rotational cultivation system in three villages in Meratus Mountain, South Kalimantan, Indonesia

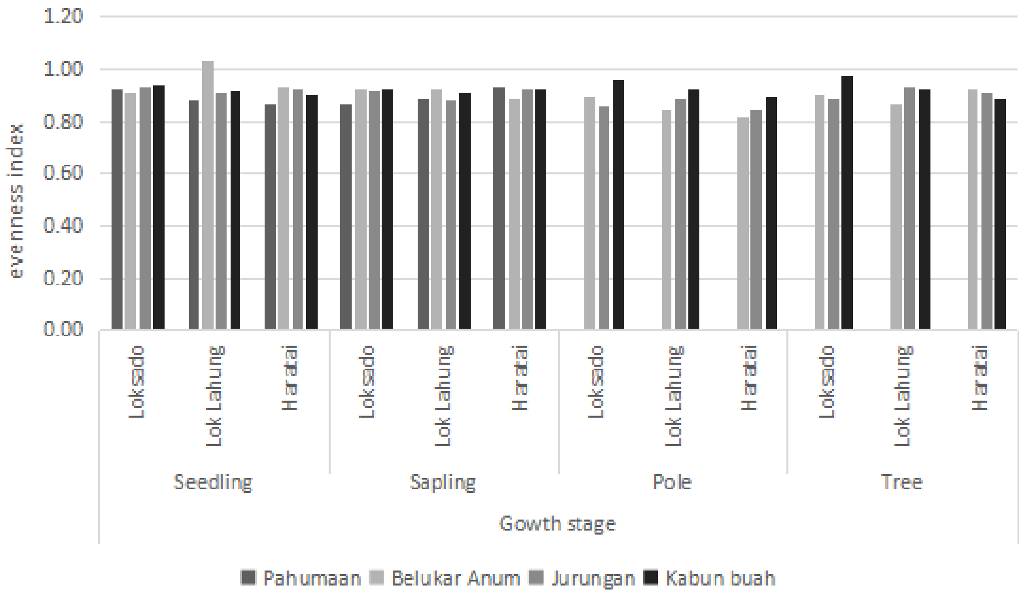

Figure 5. Species evenness index of each vegetation level at each land use of rotational cultivation system in three villages in Meratus Mountain, South Kalimantan, Indonesia

Discussion

Across the three villages studied, the vegetation found in the *pahumaan*, both at the seedling and sapling levels, had fewer species than those found in the other three land use types. This is because on the *pahumaan* the species were mostly intentionally planted by the community in the fields. The most common types of vegetation found in the *pahumaan* were chili (*Capsicum frutescens*), cassava (*Manihot utilissima*), banana (*Musa paradisiaca*), and coffee (*Coffea* sp.). In addition, perennial woody vegetation at the seedling and sapling levels was also found in this land type, such as sungkai (*P. canescens*), cinnamon (*C. burmannii*), rubber (*H. brasiliensis*), and candlenut (*A. moluccana*). Planting of perennial woody vegetation was usually done in fields that had just been used for cultivation so that they were only found at the seedling and sapling levels.

In *balukar anum* and *jurungan*, the vegetation was mostly dominated by several types of pioneer species such as sungkai (*P. canescens*), lua (*Ficus variegata*), and several species of *Artocarpus* such as tarap (*Artocarpus elasticus*) and tiwadak (*A. champeden*). This finding is in accordance with the research by Maulana (2019) which found that young fallow lands with an age of 9 years old are dominated by pioneer plants such as *Ficus* spp. and *Artocarpus* spp. from the Moraceace family. Types of *Artocarpus* spp. can dominate because they have a long life and fast growth rate and are found and spread in

Dipterocarpaceae forests. Similarly, in a study conducted in Sarawak by Karyati (2013), fallow lands aged 3 to 10 years were dominated by *Ficus aurata*, which is a member of the Moraceae family. Therefore, many pioneer species were found in the *balukar anum* and *jurungan*, which are the transition from agricultural fields to secondary forests. Another pioneer species that is often found across land use types was mahang (*Macaranga* sp.). According to Susanto (2016), mahang (*Macaranga* sp.) is a pioneer species that is commonly found in ex-cultivated areas. Mahang (*Macaranga* sp.) are also a pioneer plant species that is commonly found in areas of former shifting cultivation in Sabal, Sarawak (Karyati 2013).

The vegetation found in the *jurungan* area across the three villages tended to have a higher number of species than the other land use types. The fallow land with the age of 7-12 years allowed some pioneer vegetation to grow. The species number at pole level in the *jurungan* was the highest which is similar to the research of Oktavia et al. (2021) which stated that more species at pole levels were found than at seedling levels in the *bebak* area, which was a former cultivation area. In *kabun buah* with the age of 15 years or more, the species number was decreased. This is likely because the *kabun buah* was dominated by fruit plants, which were not too varied. This is in contrast to the *jurungan* area, where there were still some plants planted by the community, such as cinnamon (*C. burmannii*) and some wild vegetation that grew naturally.

In an older vegetation community, a higher number of species is found with a lower number of individuals of each species. Conversely, in young communities, there will be a few species with a large number of individuals per species. Cultivation areas (*huma/pahumaan*) in the three villages that were around 1 to 2 years old had fewer species compared to other areas. However, the *balukar anum* and *jurungan* had a higher number of species than the *kabun buah* although the age of the *kabun buah* vegetation was the oldest among the three other land use types. This might occur because in the *kabun buah*, there was competition among species to grow and most of the species were used by the community to produce fruits.

Based on an analysis of IVI, the vegetation structure across four land use types showed a change. This can be seen from the changes in the dominating species in each land use type. In the *pahumaan*, the vegetation was dominated with annual crops which in the *balukar anum* such species no longer dominated and in the *kabun buah* they were no longer found. This situation indicates the succession process is in progress. According to Bhagawati et al. (2015), most areas with high biodiversity are overlapped with areas with local wisdom in the cultivation system. Based on these results, it can be seen that farming activities carried out by the community were not damaging the forest ecosystems.

The diversity of vegetation found at the seedling and sapling levels in the three villages mostly increased from the *pahumaan* to the *jurungan* and then decreased in the *kabun buah*. This is similar to a study by Karyati (2013) which found that at the seedling and sapling levels, the diversity index increased according to the increase in the length of the fallow period and decreased in secondary forests aged 20 years. The decrease could be due to competition for the availability of nutrients in the soil as well as competition for growth space and light by each individual. Aththorick (2012) states that competition among vegetation increases in land aged 5 to 20 years and decreases in primary forest areas. The growth of saplings is limited on land aged 30 years due to the high coverage of the canopy.

The diversity index of tree level in Loksado and Lok Lahung increased from *balukar anum* to *kabun buah*. Meanwhile in Haratai Village, such index increased from *balukar anum* to *jurungan* and then decreased in the *kabun buah*. Across the three villages, the diversity index at tree level in the *balukar anum* was the lowest. According to Aththorick (2012), the low value can be caused by the fact the land has just experienced recovery from cultivation. The decrease in the number of species in the *kabun buah* can occur because the recovery process on land aged 10 years was more intensive than on land aged 20 years.

In general, the species richness index in the *kabun buah* area had a higher value than that in the *balukar anum* and *jurungan*. This is similar to the research on heath forests on Belitung Island by Oktavia et al. (2021) which states disturbances cause a low value of species richness across vegetation levels. The number of individuals of each species greatly affects the value of the richness index. The value of the richness index will increase if the number of species is high, and vice versa (Oktavia et al. 2021).

The composition and structure of the vegetation based on the vegetation analysis showed that each land type had certain vegetation characteristics. In *pahumaan*, most plant species were annual plants at the seedling and sapling levels. The *balukar anum* and *jurungan* were dominated by woody plants, while the *kabun buah* was dominated by fruit plants. Based on the results of the IVI analysis of the dominant species, the vegetation structure and composition across the four land use types changed, indicating that the succession process was in progress. The findings of this study suggest that traditional rotational farming activities carried out by the community did not necessarily damage the forest. High diversity index values were found in the *balukar anum* area for seedling levels in Lok Lahung and Haratai, sapling levels on *balukar anum* in Lok Lahung, seedling levels on *jurungan* in Loksado, Lok Lahung and Haratai, sapling levels on *jurungan* in Lok Lahung, as well as the seedling level of the *kabun buah* in Loksado. The high species richness index was found at the seedling level in the *jurungan* and *kabun buah* area of Loksado and most of the species richness index was at a low to moderate level. The evenness index for all land uses in the three villages was at a high level.

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