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Sustainable community forest management in West Kalimantan: A case study of the *Dayak Katab Kebahan* community

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Abstract. *West Kalimantan has a great potential for forest resources managed by indigenous people, such as the* Dayak Katab Kebahan *community. The study is aimed at analyzing the forest management carried out by the* Dayak Katab Kebahan *community and the condition of the forest ecosystem. The research area is in Melawi Regency, West Kalimantan. Data were collected through observations and in-depth interviews to explore the customs of managing forests. In addition, a vegetation survey using purposive sampling was performed, and the fauna study was conducted by the exploration method. Data analysis was conducted for vegetation data, which was carried out by calculating the importance value and diversity indices. In addition, a one-way ANOVA analysis was done to determine the presence of differences between the two forests. The findings showed forest managed by the* Dayak Katab Kebahan *community has a core zone which is a zone that should not be disturbed, and a utilization zone that can be utilized and can be intercropped with plantation crops; and the forest ecosystem managed by the* Dayak Katab Kebahan *community has a higher fauna richness, vegetation diversity index and the importance value index of each species. It is suggested that the government be involved in supporting the customary law of local communities in forest conservation.*

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INTRODUCTION

Forests are one of the most important natural resources due to their role in maintaining the ecosystem balance, as evidenced by the emergence of various natural disasters when deforestation occurs. In addition to acting as a source of raw materials in vital human facilities, forests also store the potential of germplasm and habitat for wildlife (Hari *et al*., 2012). Indonesia has abundant forests and high biodiversity, but due to political, social, and economic turmoil in recent years, long-term management of forests in Indonesia is facing challenges. In addition, there are many concerns about the impact of government policies on forest-dwelling communities (Colfer and Resosudarmo, 2002). Government policies frequently conflict with local forest

management principles and practices by local communities. On the other hand, local communities are able to manage forests sustainably based on their traditions. It is, therefore important to respect customary law, while the involvement of local communities must be protected by state laws (Nanang and Inoue, 2000). Recognition of the rights of indigenous people is important to be established in a government regulation, which must take into account the following: (a) the form of indigenous people association; (b) the form of customary rulers agreed upon and followed by indigenous people; (c) the clear territory in which customary law is applied; (d) existing legal institutions and tools recognized by indigenous people; and (e) the traditional way of life or livelihood of the indigenous people (Ardiansyah *et al*., 2015). Therefore, the recognition of indigenous forest rights in forest conservation as carbon reserves is very important in Indonesia (Saito-Jensen *et al*., 2015).

Traditional ecological knowledge of minority indigenous people must be considered in policymaking by the government and can be promoted in environmental conservations that bring benefits to the communities (Lau, 2010). There has always been a conflict of interest between the local communities, industry, and conservation of biodiversity in forest ecosystems, including in the forests of Kalimantan, which is one of the richest forest areas in the world (Moeliono *et al*., 2012). Since 2012, West Kalimantan Province has been increasingly active in the development of various sectors. Smallholder farmers and indigenous people must face opportunities and threats as forest clearing turns forests into monoculture crop plantations, especially rubber and oil palm plantations. Factors of poverty and economic pressure can be a threat to the success of such forest conservation (Langston *et al*., 2017). West Kalimantan is also an important province of forest degradation due to the conversion of forests into agrarian areas, thus triggering global climate change (Eilenberg, 2012).

In the face of the threats of deforestation and lack of human resources (forestry officers) in overall forest management, the government must grant community-based management rights that value local knowledge and indigenous systems (Asmin *et al*., 2019). *Dayak* is a large community group in West Kalimantan. In terms of numbers, this community reaches 30-40 percent of the total population of West Kalimantan, with 151 sub-tribes and 100 sub-tribes, while in terms of distribution, *Dayak* is spread across all districts, on the coast and inland. Many *Dayak* Tribes live in and with the forest of West Kalimantan, who live side by side with the forest nature (Yusriadi, 2018). Therefore, it is interesting to study how they regulate their relationship with natural resources, especially forests, within the framework of environmental management. This is based on the assumption that indigenous people have a system that has proven capable of protecting their environment from generation to generation since the time of their ancestors. One of the *Dayak* Tribes in West Kalimantan who live side by side with nature is the *Dayak Katab Kebahan* Tribe, who own a rule about the management of customary forests in their customary law. Due to regional autonomy and expansion of the region, Melawi Regency formed in 1994 to strengthen the local identity of the *Dayak Katab Kebahan* Ethnic community. They have also been affected by modern life in making ends meet (Prasojo, 2012). Therefore, the re-recording of local wisdom related to their forest management becomes an important aspect of doing.

Local wisdom can affect the behavior of indigenous people because, for them, forests are the storehouse of life. The destruction of nature will have a negative effect on themselves. One of the forms of local wisdom is customary law that has a coercive trait, i.e., there are sanctions if violated, so as to force them to behave in preserving the environment (Karhab and Setyadi, 2017). The existence of this customary law certainly has a positive impact on the sustainability of forest ecosystems. The condition of the forest ecosystem managed by indigenous people is evidently better than that not managed by customary law. However, research related to customary law in forest management so far has not linked it to evidence in the form of forest ecosystem conditions managed with customary law compared to the condition of a forest managed conventionally (without customary law). The novelty in our research is linking customary law with evidence of the customary forest compared to conventionally managed forest ecosystems. Therefore, the study is aimed to analyze; (1) the forest management carried out by the *Dayak Katab Kebahan* community; and 2) the condition of the forest ecosystem managed based on local wisdom.

METHOD

Study Area

The research was located in settlement of the *Dayak Katab Kebahan* community in Sebaju Hamlet, Nanga Kebebu Village, Nanga Pinoh District, Melawi Regency, West Kalimantan Province (Figure 1). This research is focused on forest management of the *Dayak Katab Kebahan* community. The *Dayak Katab Kebahan* community lives are spread and divided into eleven villages around the Melawi River and the Pinoh River.

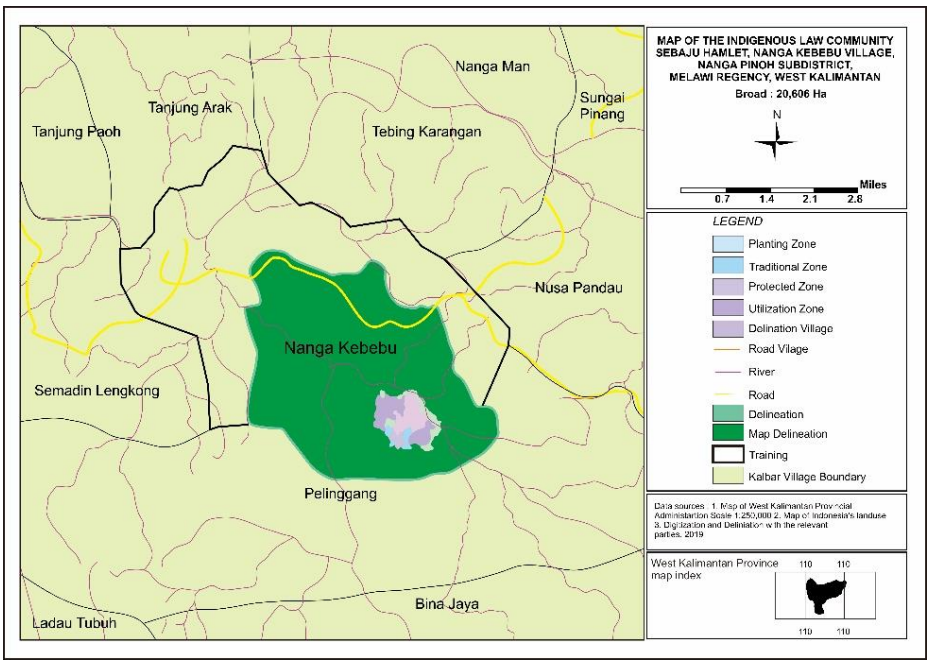

Figure 1 Study area of the forest managed by the *Dayak Katab Kebahan* Community

Data Collection

The research was conducted using the qualitative method. Observations, in-depth interviews, and a Focus Group Discussion were conducted to explore the customs and culture of the *Dayak Katab Kebahan* indigenous people related to forest ecosystem management. The in-depth interview process was done by collecting data from key informants and other supporting informants as well as other sources that support the research process in the field based on the research needs (Denzin and Lincoln, 1994). The 15 informants in this study were the elders and administrators in the *Dayak Katab Kebahan* indigenous community.

An analysis of forest vegetation was performed to find out the condition of the forest ecosystem managed by the *Dayak Katab Kebahan* indigenous people and compared to the conventionally managed forest ecosystem. The steps taken were as follows: (1) Preparing field equipment, namely: raffia ropes and stakes for plotting, a tree height measurement tool (hagameter or Christen altimeter), location and land cover maps, a 10-m roll-up tape measure for making the transect lines, a gauge meter for measuring the circumference of tree trunk, stationeries, documentation tools, compasses, tally sheets, and flora identification books; (2) Determining two forest ecosystems to be surveyed, one representing conventional forest and the other representing the *Dayak Katab Kebahan* customary forest; (3) Determining the location of the lanes to be surveyed (sample units) on the map, in which the length of each lane was determined based on the width of the forest (in this survey the lane length was 500 meters per shift), and the path was made in the direction perpendicular to the contour (cutting contour line); (4) Designing a line unit sample (Figure 2); and (5) Identifying the types and number of trees (for all growth stages, including seedlings and saplings) and measuring the diameters and heights (total height and free of branches) of poles and adult trees. Measurement data were recorded in a tally sheet.

The growth stages of trees are grouped as follows: (a) Seedlings range from sprouts to as high as <1.5 meters; (b) Saplings have a height of >1.5 cm and a diameter of <7 cm; (c) Poles are young trees with a diameter starting from 7 cm to <20 cm; and (d) Trees are adult trees with >20 cm in diameter. The survey was conducted using the plotting method. Two transect lines are made in each type of forest, and in each transect line, 10 sampling plots for each growth rate are laid. Therefore, for each type of forest, the total number of sampling plots for each growth rate is 20. The design of the vegetation sampling unit is presented in Figure 2.

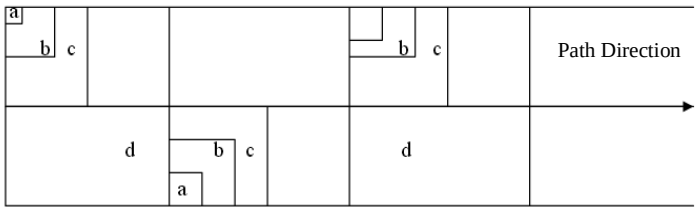

Figure 2 Vegetation sampling unit design

Description of Figure 2: a) Sampling plot of seedlings (2x2 m); b) Sampling plot of saplings (5x5 m); c) Sampling plot of poles (10x10 m); d) Sampling plot of trees (20x20 m). Specifically for mangrove forest, the size of the tree and pole sampling plot is 10x10 m.

Data Analysis Method

Data obtained from the fieldwork were then processed using the formulation of the quadratic plot method to calculate the density (number of individuals/ha), frequency and dominance (m^2/ha) and importance value index of each species (IVI), as follows:

a. Density

$$\text{Density (D)} = \sum \frac{\text{number of individuals}}{\text{sample plot area}} \quad (1)$$

$$\text{Relative Density (RD)} = \frac{\text{D of all species}}{\text{Totally D of all species}} \quad (2)$$

b. Frequency

$$\text{Frequency (F)} = \frac{\sum \text{species found in a subplot}}{\sum \text{All Sub-sample plots}} \quad (3)$$

$$\text{Relative Frequency (RF)} = \frac{\text{F of a species}}{\text{Totally F of all species}} \times 100\ \% \quad (4)$$

c. Dominance

$$\text{Dominance (Dm)} = \frac{\text{The basic area of a species}}{\text{Sample Plot Size}} \quad (5)$$

$$\text{Relative Dominance (RDm)} = \frac{\text{D of a species}}{\text{Totally F of all species}} \times 100\ \% \quad (6)$$

$$\text{IVI} = \text{RD} + \text{RF} + \text{RDm (for poles and trees)} \quad (7)$$

$$\text{IVI} = \text{RD} + \text{RF (for seedlings and saplings)} \quad (8)$$

The diversity of vegetations in the forest area is calculated using the Shannon-Wiener formula Index, as follows:

$$H' = -\sum Pi\ (\ln Pi) \quad (9)$$

H' = Shannon-Wiener Index
Pi = The proportion of individual numbers of each species divided by individual numbers of all species

Statistical analysis was performed using one-way ANOVA to test the difference in the richness of plant species between forests managed by indigenous *Dayak* Katab Kebahan people and conventionally managed forests. The H0 hypothesis is that the richness of indigenous forest plant types is the same as that of conventional forest and the H1 is that the richness of indigenous forest plant types is different from that of conventional forest.

RESULTS AND DISCUSSION

Forest Management Carried Out by the *Dayak Katab Kebahan* community

Based on observations and interviews, in the Rasau Sebaju Customary Forest there is sovereignty over customary land and natural resources as well as socio-cultural life regulated by customary law. These customary lands include *gupong/kelokak* (land managed for generations) and *rimba* (forest). Knowledge of the customary law is passed down across generations through stories from parents and indigenous figures (village elders), witnessed firsthand, as well as obtained from records from the predecessors. Activities that are usually used as media for transferring knowledge of the customary law from generation to generation are during daily interactions, *gotong royong* (mutual cooperation activities), and *rapat desa* (village meetings). The pattern of interaction between indigenous people and the forest environment can be seen from how they ensure protection through customary rules, participation in forest environment management, and taking economic benefits from the forest, which is summarized in Table 1.

Table 1 Pattern of indigenous forest management by the *Dayak Katab Kebahan* people

Protection with Customary Rules:	Participation in Forest Management:
1. *Langkah Lalu*: notify the tribe/ask permission when entering the forest area	1. Being a part of the *Lembaga Pasak Sebaju*
2. *Gunung timbul* (indemnity): in case of a fire caused by negligence, the individual must indemnify the burned area and pay a fine.	2. Participating in supervising the burning of land to open the land for farming
3. *Pemali nubak* (fishing rules): *nubak* or fishing is not allowed in clean water reserves and rivers without permission	3. Forming the *Katab Kebahan* Citizen Association
4. Prohibition of damaging the forest environment, The law applies against the perpetrators.	4. Helping maintain forest sustainability as a source of clean water, but may take the economic benefits of the forest, namely: a. Harvesting asam maram fruits to make asam maram sweets b. Harvesting honey from the forest and sell it c. Picking and selling the tengkawang fruits d. Weaving rattan and other materials from the forest such as fern
5. Customary regulations apply to farming (*berhuma*), burning land for farming, and determining which land can be used for farming. *Berhuma* should only be done in the utilization zone.	5. Serving as village officers
6. Nokap umuh: Plots of fields must be made communally. Customary sanctions apply if violated.	6. Deliberation and cooperation in making plots of fields

Protection with Customary Rules:	Participation in Forest Management:
7. Rules on replacement planting, replacement saplings and customary fines: a. For every tree cut down in the customary forest, 10 new seedlings must be planted. b. Local communities are able to manage forests sustainably based on their traditions in the form of planting new seedlings or giving a fine of 1 real (1 real= the price of 1 gram of gold on the market).	7. Obey and participate in the application of the rules

Source: *Potret Hutan Adat Rasau Sebaju* (Sukartaji *et al.*, 2015) cross-checked with interviews with indigenous *Dayak Katab Kebahan* (2020)

The compliance of the community to customary law is very high. The people dare not violate the law, and they believe that following the rules will bring safety and good returns. Indigenous people have traditionally made nature a source of life. Of the questions addressed to 15 informants about how their opinions and attitudes with the existence of customary law are, are useful and need to be preserved, 100 percent stated that customary law must be enforced, preserved, and obeyed because it has become part of the daily life of the *Dayak Katab Kebahan* community. This has a positive impact on forest sustainability.

The form of forest management by indigenous *Dayak Katab Kebahan* people is to divide the forest area into two zones, namely the core zone and the utilization zone. The core zone consists of mainly primary forests, which must be maintained because they are considered a source of water and livelihood, because they may take the economic benefits of the forest, such as: (a) harvesting *asam maram* fruits to make *asam maram* sweets; (b) harvesting honey from the forest and sell it; (c) picking and selling the tengkawang fruits; and (d) weaving rattan and other materials from the forest such as fern. While the utilization zone is located in secondary forests that can be used for farming or introducing local fruit crops, such as *durian* (*Durio zibethinus*), *lae* (*Durio kutejensis*), and *mawang/asam ambawang* (*Mangipera* sp.). The arrangement of forest zoning in regard to the forest condition in general, the purposes of the zones, and customary law related to forest management applied by the indigenous *Dayak Katab Kebahan* community are presented in Table 2.

Table 2 Forest zoning plan is based on the general condition of the forest, the purpose of the zoning area, and customary law in the forest management of the indigenous people of *Dayak Katab Kebahan*

No	Zone	Area (Ha)	Dot Name	Land Cover	Zone Setting Purposes	Customary Law/ Prohibited Activities
1.	Traditional	30.156	*Gandis*	Weeds, shrubs, secondary forests	The zone is designated for the protection of tombs, as well as historical, cultural, religious, and customary values, and can be used for supporting research, education, cultivation, and tourism.	1. Clearing land 2. Cutting down trees 3. Catching fish by poisoning the river
			Asam Maram	Secondary forest		
			Logging Location	Secondary forest, primary forest		
			Bekakang Wood Expanse	Primary forest		
			Labang Tihang	Shrubs, secondary forests		

			Munggu Pinang	Shrubs, secondary forests		
			Gupung Klansau	Shrubs, secondary forests		
			Labang Buhin	Shrubs, secondary forests		
			Labang Penyerahang	Secondary Forest		
			Pintas Doras	Shrubs, secondary forests		
2	Protected	54.234	*Logging Location*	Secondary forest, primary forest	The zone is intended for the protection of the environment, flora, fauna, seed sources and can be used for supporting research, education, cultivation, and tourism. This protected zone is located in the middle of Rasau Sebaju, far from people's economic activities. Most of the core zone area is still in the form of primary forests, although secondary forests also exist.	1. Clearing land 2. Cutting down trees 3. Catching fish by poisoning the river
			Logging Location	Secondary forest, primary forest		
			Logging Location	Secondary forest, primary forest		
			Hunting Road	Secondary Forest		
			Logging Location	Secondary forest, primary forest		
			Logging Location	Secondary forest, primary forest		
			Ramin	Secondary forest, primary forest		
			Kenyahuk	Primary forest		
			Logging Location	Secondary forest, primary forest		
			Kenyahuk tree	Primary forest		
			Asam Gandis	Secondary forest		
			Kenyahuk Wood	Primary forest		
			Ramin	Primary forest		
3	Planting	25.69	*Temau Wood Beds*	Secondary forest, primary forest	The zone is used to recover the ecological and economic functions of the region. This zone no longer has wood; only shrubs and wide leaf	1. It is forbidden to allow/release foraging animals in the planting zone. 2. Carrying woven items (wicker from
			Bekakang Wood Expanse	Secondary forest, primary forest		

			Jelutung Tree	Secondary forest, primary forest	weed. This area is used several times for farming activities.	rattan), carrying *dacing* (steelyard balance scale) and bushels, either intentionally or unintentionally 3. It is forbidden to steal other people's crops. 4. It is forbidden to catch fish by poisoning the river. 5. Before burning the fields, family members or neighbors who have gardens, plants, etc. must be notified. The following must also be prepared in advance: a boiler (fire safety road). Sacks, water, and other fire safety equipment.
			Logging Location	Secondary forest, primary forest		
			Temau	Secondary forest, primary forest		
4	Utilization	90.831	*Temau*	Secondary forest	The zone is intended for sustainable use in the form of wood and non-timber products. There are still economic activities in this zone, such as the processing of wood products, although so far, the products are more aimed to meet the needs of the Sebaju hamlet, such as house construction of the village community.	1. It is forbidden to cut down trees that have a sign.
			Kenyahuk Wood	Secondary forest		
			Jelutung	Secondary forest		
			Kenyahuk Wood	Secondary forest		
			Forest Boundaries	Secondary forest		
			Gandis	Secondary forest		
			Belian	Secondary forest		
			Kenyahuk Wood	Secondary forest		
			Logging Location	Secondary forest		

Source: *Potret Hutan Adat Rasau Sebaju* (Sukartaji *et al*., 2015) cross-checked the results of in-depth interviews with *Dayak Katab Kebahan* indigenous people affiliated with Suar Institute (2020)

To strengthen forest resilience, it is necessary to understand geographical variation in relation to vegetation, disturbance, regeneration, and human activities. At a time when disruption is increasing, it is necessary to expand protected areas and minimize secondary anthropogenic disorders (Guz and Kulakowski, 2020). This means that knowledge related to geographical variations will be very useful when there is an increase in disturbance of anthropogenic activities, so it is necessary to expand protected areas to prevent forest destruction. The zoning of protected areas can be based on geographical variations, especially in relation to the distribution of vegetation and human activities.

The division of zones (Table 2) in the customary forest shows that the primary forest areas in the protected zone are still wider than the secondary forests. From an area of 54 234 ha with 13 location points, there are 4 location points that are only primary forests, 2 location points are secondary forests, and 7 other location points are a mixture of primary and secondary forests. This shows that protected areas are still well maintained, and disturbed areas can still be tolerated by the existence of various customary rules in forest management (Table 1).

The division of zones into the core zone (traditional zone, protected zone, and planting zone) and utilization zone also allows for a succession of primary forests into secondary forests. Moreover, it is also still possible to conduct logging in the core zone with the condition of complying with the strict customs rules as mentioned in Table 1, which are: (1) for every tree cut down in the customary forest, 10 new seedlings must be planted; and (2) giving a fine of 1 real (1 real= the price of 1 gram of gold on the market). This addresses the statement of Arroyo-Rodríguez *et al*. (2017) on how tropical forests are currently deforested and fragmented extensively. The restoration of such tropical forests through successions has led to the expansion of human-modified secondary forests. These secondary forests are potential habitats for tropical biodiversity and an important source of ecosystem services.

Ecosystem services from secondary forests include providing food sources for local communities. In Table 1, it is mentioned that the *Dayak Katab Kebahan* people benefit economically from the customary forest in the form of harvesting honey from the *Meliponini* bee colony (stingless honeybee) and the fruit of *asam maram* (*Eleiodoxa conferta*). The *asam maram* fruit is then processed into *asam maram* sweets. These products generate income for the community. Sardeshpande and Shackleton (2019) and Chairullah *et al*. (2021) reported that wild edible fruits are the most widely used non-timber forest biological resources like food. This species also produces a lot of fiber and fuel and can be further processed into various products. Therefore, new strategies are needed to conserve wild edible fruits, taking into account ecosystem services, economic incentives, market innovation, and stakeholder synergies.

Economic valuations of ecosystems and biodiversity initially tend to focus on the instrumental value of ecosystem services, but today's development highlights a broader range, including local wisdom systems (Christie *et al*., 2019). Local knowledge and wisdom about forests as well as community involvement in forest management, will bring additional benefits in environmental and social aspects, such as poverty alleviation, forest fire reduction, and deforestation, and it can be assimilated into community forests (Meijaard *et al*., 2021).

The management of customary forests in the area of Rasau Sebaju Hamlet is handled by indigenous people through the establishment of the *Lembaga Pasak Sebaju* (Table 1) based in Sebaju Hamlet as an institution that oversees customary forest areas in the Rasau Sebaju Hamlet area. The *Lembaga Pasak Sebaju* is an institution that focuses on the protection, management, and sustainable utilization of Rasau Sebaju through the local wisdom of the people of Rasau Sebaju Hamlet. The structure of *Lembaga Pasak Sebaju* consists of the duties and functions of each managerial member, which is presented in Table 3.

Table 3 The structure of *Lembaga Pasak Sebaju* and the duties of each managerial position

No	Positions	Duties
1	Advisor	The advisor is the person to consult and coordinate with on the institutional affairs of Rasau Sebaju, customs that apply in Rasau Sebaju, and provide views on the management of the institution.
2	Chairperson	The chairperson holds the leadership in the institution with the task of coordinating and facilitating the implementation of institution activities. The chairperson is responsible for the forward/retreat of the *Dewan Pasak Sebaju* and serves as a delegate and representative for external affairs.
3	Deputy Chairperson	Substituting the role and responsibilities of the chairperson when the chairperson is unavailable and coordinating internal institutional meetings
4	Secretary	Carrying out administrative roles and institutional documentation

5	Treasurer	Managing the financial administration of the institution
6	Custom Division	Taking part in the strengthening of customs related to the management of Rasau Sebaju and the enforcement of customary law of Rasau Sebaju
7	Public Relations Division	Collecting and disseminating information related to the institutional affairs of *Lembaga Pasak Sebaju* and matters related to the Rasau Sebaju area, as well as promoting the region and building networks with external parties
8	Empowerment and Economic Division	Identifying the capacity building needs and facilitating capacity building meetings
9	Security Division	Possessing the authority to conduct supervision of Rasau Sebaju, such as early detection of matters that have the potential to interfere with the existence of Rasau Sebaju

Source: In-depth interviews with the elders and administrators in the *Dayak Katab Kebahan* indigenous community (2020)

The establishment of the management institution is also accompanied with a set of rules in the form of The *Lembaga Pasak Sebaju* Order. It consists of the principles that are firmly held by the *Lembaga Pasak Sebaju*, including deliberation (*hilang pokat beganti pokat*), mutual cooperation (*gotong-royong*), openness, mutual respect, responsibility, civility, discipline, and flexibility. The managerial system is also well regulated, for example, decision-making based on the principle of deliberation.

The Condition of The Forest Ecosystem Managed Based on Local Wisdom

The positive impacts of forest environment management conducted by indigenous *Dayak Katab Kebahan* people can be seen through the comparison of vegetation and wildlife diversity between the customary forest and conventional forest (pine forest) that are located within one village. The customary forest is a primary and secondary forest managed by the customary law of *Dayak Katab Kebahan* community, while the conventional forest is a monoculture pine forest managed by *Perhutani* (Indonesian State Forest Company). The composition of the vegetation in the two forest types is presented in Table 4.

Table 4 List of vegetations recorded in the customary forest and conventional forest

Customary Forest		Conventional Forest	
Family	Scientific Name	Family	Scientific Name
Apocynaceae	*Alstonia scholaris (pulai)*	Pinaceae	*Pinus Merkusii*
Euphorbiaceae	*Macaranga gigantifolia (merkubung)*	Dilleniaceae	*Dillenia indica*
Melastomataceae	*Bellucia axinantherea (jambu takalang)*	Fabaceae	*Pterocarpus indicus*
Clusiaceae	*Garcinia xanthochymus (asam kandis)*	Melastomataceae	*Bellucia axinantherea*
Dilleniaceae	*Dillenia indica (simpur)*	Primulaceae	*Ardisia pellucida*
Euphorbiaceae	*Macaranga (mahang)*	Euphorbiaceae	*Macaranga*
Moraceae	*Artocarpus integer (cempedak)*	Lamiaceae	*Gmelina Arborea*
Lamiaceae	*Gmelina Arborea (gamelina)*	Apocynaceae	*Alstonia Scholaris*
Euphorbiaceae	*Mallotus paniculatus (balik angin)*	myrtaceae	*Melaleuca leucadendra*
Malvaceae	*Durio zibethinus (durian)*	Moreceae	*Ficus Benjamina*
Myrtaceae	*Syzygium malaccense (jambu bol)*	Fabaceae	*Derris elliptica*
Altingiaceae	*Altingia excels (rasamala)*	Phyllanthaceae	*Bischofia javanica*
Fabaceae	*Archidendron pauciflorum (jengkol)*	Anacardiceae	*Gluta renghas*

Sapindaceae	*Dimocarpus longan (lengkeng hutan)*	Osmundaceae	*Osmunda angustifiola*
Arecaceae	*Arenga pinnata (enau)*	Blechnaceae	*Stenochlaena palustris*
Malvaceae	*Durio kutejensis (pekawai)*	Gleicheniaceae	*Dicranopteris linearis*
Moraceae	*Ficus racemose (loa)*	Arecaceae	*Caryota mitis*
Phyllanthaceae	*Baccaurea motleyana (rambai)*	Asplenium Nidus	*Aspleniaceae*
Meliaceae	*Lansium parasiticum (langsat)*	Osmundaceae	*Pteropsida*
Anacardiaceae	*Mangifera foetida (bacang/kemantan)*	Cyperaceae	*Scleria Sumatrensis*
Apocynaceae	*Dyera costulata (Jelutung)*	Phyllanthaceae	Phyllanthus amarus
Clusiaceae	*Garcinia mangostana (manggis)*	Smilacaceae	*Smilax anceps*
Arecaceae	Calamus rotang (rotan)		
blechnaceae	Stenochlaena palustris (pakis merah)		
Nepenthaceae	Nepenthes edwardsiana (kantung semar)		
Osmundaceae	osmunda angustifiola (pakis sejati)		
Lycopodiaceae	Licopodium Cerenuum (paku kawat)		
Menispermaceae	Sphatolobus littoralis (akar bajakah)		
Fabaceae	Mimosa pigra (mosai)		
Osmundaceae	Pteropsida (paku)		
Melastomataceae	Clidemia hirta (daun keduduk)		
Polypodiaceae	Pyrrosi piloselloides (sisik naga)		
Asparagaceae	Pandanus amarillifolius (pandan hutan)		
Selaginellaceae	Selaginella sp (paku rane)		
Zingiberaceae	Alpinia havilandi (jahe cangkrang)		
Pteridaceae	Taenitis pinnata (paku pinang)		
Aspleniaceae	Asplenium nidus (paku sarang burung)		
Lomariopsidaceae	Nephrolepis biserrata (paku pedang)		
Arecaceae	Caryota mitis (saray)		

Furthermore, the comparison between the conditions of the two forests can be seen from the comparison of vegetation community structure and wildlife diversity in both forests. Comparison of vegetation richness, vegetation diversity index, and evenness index between customary forests and conventional forests shows that the richness of vegetation in the customary forest is higher than that in the conventional forest (Table 5).

Table 5 Comparison of the diversity, richness, and evenness index values of each vegetation growth level between customary and conventional forests

Index	Conventional Forest				Customary Forest			
	Trees	Poles	Saplings	Seedlings	Trees	Poles	Saplings	Seedlings
Diversity Index (H')	0.256 (Low)	1.655 (Low)	1.499 (Low)	2.229 (Moderate)	2.625 (Moderate)	1.629 (Low)	2.055 (Moderate)	2.523 (Moderate)
Richness Index (R)	0.975 (Low)	1.731 (Low)	1.698 (Low)	3.501 (Moderate)	4.492 (Moderate)	2.076 (Low)	2.485 (Low)	4.908 (Moderate)
Evenness Index (E)	0.143 (Not Even)	0.850 (Nearly even)	0.837 (Nearly even)	0.721 (Somewhat even)	0.908 (Nearly even)	0.837 (Nearly even)	0.935 (Nearly even)	0.774 (Nearly even)

Description: The criteria for H' is according to Barbour *et al.* (1987); the criteria for R and E are according to Magurran and McGill (2011)

Based on the one-way ANOVA test result with a significance level of 5% to the plant species richness value, it is known that the value of F (9.117519) is greater than the value of F critical (4.098171731), and that the P-value (0.004507) is less than the significance value (alpha= 0.05). Therefore, H0 is rejected, which means that there is a significant difference in richness between customary forest and conventional forest.

Customary forest also has a higher diversity of wildlife than conventional forest. This study identified 3 types of aves, 5 types of mammals, and 1 type of fish protected by the law in the customary forest, and only 3 types of aves and 1 type of mammals protected by the law in the conventional forest. The total number of species is also higher in the customary forest than that in the conventional forest. The data is presented in more detail in the Table 6.

Table 6 Types of fauna observed in the customary forest and their protection status

No	Indonesian Name	Scientific Name	Family	Protection Status*)	Information	Customary Forest	Conventional Forest
A.	AVES						
1	Pipit	*Lonchura Punctulata*	*Estrildidae*	Unprotected	Finding	√	√
2	Ayam Hutan	*Gallus gallus*	*Phasianidae*	Unprotected	Interview	√	-
3	Murai	*Copsychus saularis*	*Muscicapidae*	Unprotected	Sound	√	-
4	Pelatuk	*Dinoplum javanense*	*Picidae*	Unprotected	Interview	√	-
5	Gereja	*Passer montanus*	*Passeridae*	Unprotected	Finding	√	-
6	Elang	*Hallaeetus leucogaster*	*Accipitridae*	Protected	Interview	√	√
7	Cicak Ujau	*Chloropsis sonnerati*	*Chloroseidae*	Protected	Interview	√	√
8	Kacer	*Copsychus saularis*	*Muscicapidae*	Protected	Interview	√	√
9	Merbah	*Pycnonotus golavier*	*Pycnonotidae*	Unprotected	Finding	√	√
10	Bondol	*Lonchura*	*Estrildidae*	Unprotected	Finding	√	√
B.	MAMMALS						
1	Tupai	*Tupaia javanica*	*Tupalidae*	Unprotected	Finding	√	√
2	Kera	*Macaca fascicularis*	*Cercopithecidae*	Unprotected	Interview	√	-
3	Klempiau	*Hylobates muelleri*	*Hylobatidae*	Protected	Interview	√	-
4	Berang – berang	*Lutra Paradoxurus*	*Mustelidae*	Unprotected	Interview	√	-
5	Musang	*Hermaphroditus*	*Viverridae*	Unprotected	Interview	√	-
6	Beruang madu	*Helarctos malayanus*	*Ursidae*	Protected	Interview	√	-
7	Trenggiling	*Manis javanica*	*Manidae*	Protected	Interview	√	-
8	Rusa	*Cervus unicolor*	*Cervidae*	Unprotected	Interview	√	-
9	Babi hutan	*Sus scrofa*	*Suidae*	Unprotected	Interview	√	-
10	Kijang	*Muntiacus*	*Cervidae*	Unprotected	Interview	√	-
11	Landak	*Hystrix javanica*	*Hystricidae*	Protected	Interview	√	-
12	Kesiduh	*Mydaus javanensis*	*Mephitidae*	Protected	Interview	√	√
C.	AMPHIBIANS AND REPTILES						
1	Ular weling	*Bungarus fasciatus*	*Elapidae*	Unprotected	Interview	√	√
2	Ular kadut	*Acrochordus granulatus*	*Acrochordidae*	Unprotected	Interview	√	-
3	Biawak	*Varanus salvator*	*Varanidae*	Unprotected	Interview	√	-

No	Indonesian Name	Scientific Name	Family	Protection Status*)	Information	Customary Forest	Conventional Forest
4	Kura – kura	*Testudo*	*Testudinidae*	Unprotected	Interview	√	-
5	Ular sawah	*Malaphython reticulatus*	*Pythonidae*	Unprotected	Interview	√	√
6	Krait kepala merah	*Bungarus flaviceps*	*Elapidae*	Unprotected	Interview	√	√
7	Ular sendok	*Naja*	*Elapidae*	Unprotected	Interview	√	√
8	Kodok sawah	*Fejerfarya cancrivora*	*Ranidae*	Unprotected	Interview	√	√
9	Kodok	*Fajerfarya limnocharis*	*Ranidae*	Unprotected	Interview	√	√
10	Kadal	*Mabouya multifasciata*	*Scincidae*	Unprotected	Interview	√	√
11	Bunglon	*Bronchocela jubata*	*Agamidae*	Unprotected	Interview	√	√
12	Cekibar	*Draco Volans*	*Agamidae*	Unprotected	Interview	√	√
13	Ular pucuk	*Ahaetulla*	*Colubridae*	Unprotected	Interview	√	√
D.	FISH						
1	Seluang	*Rasbora orgyrotaenia*	*Cyprinidae*	Unprotected	Interview	√	√
2	Arwana hijau	*Scleropages formosus*	*Osteoglossidae*	Protected	Interview	√	-
3	Sepat	*Trichogaster*	*Osphronemidae*	Unprotected	Finding	√	√
4	Mujair	*Oreochromis mossambicus*	*Cichlidae*	Unprotected	Finding	√	√
5	Wader	*Puntius binotatus*	*Cyprinidae*	Unprotected	Interview	√	√
6	Lele rawa	*Clarias batrachus*	*Clariidae*	Unprotected	Interview	√	√
7	Ulang uli	*Botia macrachanta*	*Cobitidae*	Unprotected	Interview	√	√
8	Gabus	*Channa striata*	*Channidae*	Unprotected	Finding	√	√
9	Lais	*Cryptopterus Spp.*	*Siluridae*	Unprotected	Interview	√	√

Description: *)Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.106/MENLHK/SETJEN/KUM.1/12/2018; (√)= present; (-)= absent

Management of forest ecosystem by humans can have a direct or indirect effect on the structure of communities and the diversity of organisms in the forest. Deforestation will affect the canopy area and change the composition of tree types that will ultimately affect the structure of the fauna communities associated with the ecosystem (Grevé *et al*., 2018). In this study, differences in management lead to differences in the composition of vegetation (Table 4) and fauna (Table 6) between the two forests.

Many forest lands in the tropics are displaced and undergo a succession process that changes the composition and structure of floristics. Therefore, there is a need for a study on the ecological impact of this land neglect. Ecological aspects that can be studied include the structure of the stand, floristic composition, and the diversity of types of tree stands (Karmini *et al.*, 2020). Biodiversity of both vegetation and fauna is also important to study, because biodiversity is one of the important factors in forest management (Martinho and Ferreira, 2021). For example, data collection on the diversity of flora and fauna in the Selangkau forest as a basis for developing management plan of cement industrial complex in East Kalimantan, where one plant species is protected, namely *Shorea glauca* King (*Meranti*), and there were 67 animal species consisting of 42 species of birds, 14 mammals, and 11 amphibians and reptiles. Of 67 recorded species, 12 are protected by the Indonesian Government laws, 63 are included in the IUCN Red List, and 10 species are regulated in CITES (Aminatun *et al*., 2021).

The condition of the forest ecosystem can be examined by looking at the parameters of vegetation community structure. The structure of the vegetation community becomes an important parameter in monitoring the ecological condition of an ecosystem (Trodd and Dougill, 1998). Therefore, this study conducted a comparative analysis of the vegetation structures between customary forests and conventional forests based on the richness index (R), the diversity index (H'), and evenness index (E) of the vegetations in the research locations (Table 5). Lower plant species are the most common type observed at the research site because it is a type of wild plant that is able to thrive in various conditions where it grows. In addition, this condition is also caused by old trees in the utilization area that is uprooted and dead, which opens the canopy and causes sunlight to enter the lower layer and make the initially depressed seedlings and saplings grow properly. According to Reni *et al*. (2015), changes in a plant community always occur due to competition and occupation of growing places.

The spread and growth of tree species in the customary forest are greater than that of the conventional forest. This is related to forest management by indigenous people, as seen in Table 1 and Table 2, which allows many primary forests to thrive. The distribution of trees affects the fauna that lives in the customary forest ecosystem. For example, there are 10 types of birds in the customary forest, while there are only 6 types of birds in the conventional forest. As a component of a bird's habitat, trees can serve as a cover or shelter from the weather and predators, as well as for nesting, playing, resting, and babysitting. In addition to providing parts (leaves, flowers, and fruit), trees can serve as the habitat of many other types of organisms that are a source of food for birds. Each type of tree and the composition of tree types in an ecosystem can create various environmental conditions and affect the availability of food specific to the fauna who live in the ecosystem (Noerdjito and Maryanto, 2001).

In understanding land conversion, this study obtained important data on land cover changes in the past from interviews with the local communities. Local communities are more aware of the changes associated with infrastructure development. These findings are useful in an ecosystem conservation approach, targeting areas that are vulnerable to changes in land use and spatial policies that are potentially a threat to ecosystems (Lukman *et al*., 2021). In this study, changes in land cover can be seen from the comparison between customary forest which consists of mostly primary forests, and conventional forest, which has turned what was once a primary forest into a pine forest. Land conversion will change the forest cover, forest structure, and tree demographics (Kulakowski *et al*., 2017). The introduction of pines into forest ecosystem can threaten the existence of native species of the forest. According to Gemechu *et al*. (2021) the introduction of foreign species to a landscape can threaten the existence of native species and biodiversity in an ecosystem.

Traditional ecological knowledge is very important to be applied in the conservation planning of forest plant types that have important cultural values for local communities (Benner *et al.*, 2021). Based on Table 1, indigenous people do forest clearing for agricultural land in the utilization zone by burning. Prior to burning the land, the area is first cleaned so that the fire can be controlled. This custom (known as "nunu") is supervised by customary officers. This is in accordance with a study by Long *et al*. (2021), which reported that indigenous communities often have a tradition of burning forests to protect their environment, and it is suspected to affect ecosystem services. Various species are collected from burned areas. However, they prefer burning more widely and frequently to promote resilience to wildfire and drought, conserve biocultural diversity, maintain traditional knowledge and spiritual values, and provide material goods such as foods, medicines, and fiber materials. The tradition turns out to improve the quality of the desired plants, including reducing pest attacks. However, the effect on the diversity of lower plants and wildlife needs to be evaluated.

The customary forest has a higher species richness than the conventional forest (Table 4). Based on the comparison of vegetation diversity index at each growth rate between customary and conventional forests, as well as the comparison of vegetation evenness index between indigenous forests and conventional forest (Tabel 5), the customary forest has higher diversity than conventional forest. The customary forest consists of various growth stages, including trees, poles, saplings and lower seedlings. From the characteristics of the customary forest, the forest can be classified as a primary forest. A primary forest is defined as a natural forest that is

largely undisturbed by industrial-scale land uses such as logging, mining, human-caused fires, or dam and road constructions. Primary forest is the result of ecological and evolutionary processes, including the full range of successional stages from new to an old forest with natural disturbance processes operating within historical bounds. It is also more likely to be inhabited by plant and animal species with complete characteristics with few exotics if any and dominated by a largely continuous tree canopy with unpolluted soil and water (Kormos *et al*., 2018).

Speech culture has been fused and passed down through generations in the *Dayak Katab Kebahan* community (Yusriadi *et al*., 2018). The preservation of the customary forest is due to the management of the customary forest by the *Dayak Katab Kebahan* community based on customary law that they have applied since ancient times, as it is part of the teachings of their ancestors to live side by side with nature. The high level of richness and diversity of flora and fauna in the customary forest at the research location, namely the Rasau Sebaju hamlet is in line with the customary law that they have applied from the past until now (Table 1 and Table 2).

CONCLUSIONS

There are two forest zones managed by the *Dayak Katab Kebahan* community, namely the core zone, which is a zone that should not be disturbed, and the utilization zone which can be utilized and intercropped with plantations. The pattern of interaction between the *Dayak Katab Kebahan* community and the forest environment in West Kalimantan aims to form a harmonious relationship with nature through customary regulations on forest management. This community relies on nature as the source of life. Traditionally, the compliance of *Dayak Katab Kebahan* people to customary law is very high. They believe that following the customs and the law will bring them salvation and good returns.

The forest managed by the *Dayak* Katab Kebahan community has a higher biodiversity than conventional forests, both in flora and fauna. Based on the vegetation analysis, the richness of species, diversity index, and the level of vegetation in the customary forest are higher than those in the conventional forest. This suggests that customary forest has a more stable ecosystem than conventional forest. Likewise, the richness of fauna species is higher in the customary forest than that in the conventional forest. There are 9 types of fauna protected by law observed in the customary forest (5 aves, 3 mammals, 1 fish), while there are only 4 protected types of animals in the conventional forest (3 aves, 1 mammal).

Based on the research results above, further research can be carried out regarding the type and area of harvest in the utilization zone of the customary forest as well as monitoring the population of protected animal species in the customary forest. The results of this research can then be an important consideration for Kalimantan's forest conservation policy.

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