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"The Project for Producing Biomass Energy and Material through Revegetation of Alang-alang (*Imperata cylindrica*) Fields"

VEGETATION TYPES IN THE FOREST OF KATINGAN REGENCY, CENTRAL KALIMANTAN

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Abstract

The existence of land use by surrounding communities in forest areas indirectly affects the existence of biodiversity types, especially in vegetation located in Katingan Regency, Central Kalimantan. Six observation plots of 400 m^2 were carried out to determine the presence of vegetation types at various growth rates regarding to the Importance Value Index (IVI), namely the tree level (ø ≥ 10 cm) and poles (5 ≤ ø <10 cm), saplings (2 ≤ ø < 5 cm), and seedlings (ø < 2 cm), as well as observations on other vegetation types encountered during the research. The results showed that the tree level was dominated by agatis (*Nageia wallichiana*) and karet (*Hevea brassiliensis*); pole level in the form of karet (*H. brassiliensis*) and gerunggang (*Cratoxylum glaucum*); whereas sapling and seedling are generally in the form of a type of gerunggang (*C. glaucum*). The number of individuals at all growth rates shows an inverted "J-shaped" indicating a fairly high regeneration rate, with a tree to seedling ratio of 1: 5: 41: 184. Also, the estimated stand potential in the form of volume and above ground biomass was measured which reached 54.38 m^3 ha^{-1} respectively and above ground biomass was 2.91 tonnes ha^{-1} at the tree level, while 105.58 m^3 ha^{-1} and above ground biomass were 3.88 ton ha^{-1} at pole level. Information about these vegetation is important as material for recommendations on whether or not these lands need to be enriched during land rehabilitation, as well as information to maintain locations that still have good vegetation.

Keywords: biomass, gerunggang, growth rate, importance value, Katingan

1. Introduction

Indonesia is globally outstanding for its high diversity and endemism in many plant groups [1], [2]. The high levels of biodiversity are associated with tropical climates [3], [4]. The tropical peat forests have an important role in the ecosystem due to its rich biodiversity, rare and endangered species [5], and the composition of tree species varies with habitat [6].

Biodiversity of plant species in the intact, degraded and converted peat forest in Central Kalimantan has long been well investigated [7], [8], [9]. High-value natural landscapes are in decline, particularly forests, which can indirectly affect the tree biodiversity. Tree cover loss in Central Kalimantan decreased by 3.38Mha or equivalent to a 24% decrease in tree cover since 2000 and 1.32Gt of CO_2 emission from 2001 to 2019. Also, levels of deforestation varied in Central Kalimantan, and one of the top five in tree cover loss occurred in Katingan District. In 2016, the tree cover of Katingan was 197 kha or 11 % of intact forest, while the loss of primary forest reached 205 kha making up 64% of its total tree cover loss from 2002 to 2019 [10]. The degraded peat forests are all impoverished to some degree in terms of biodiversity, such as lower densities and surviving of pioneer species [11].

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Species diversity can drastically decline in the number of species that can be caused by natural destructive factors as well as by various human activities, such as forest fires. In the burnt area of peatland has a limited succession rate and regeneration, so the vegetation cover of the area reaches up to 30 ± 40%. Those factors also influenced the fairly drastic decrease of the diversity, density and similarity rate in the number of species [11]. Vegetation diversity can be considered as an indicator of land fertility, such as agricultural activities or forestry.

The ecological consequences for increasing degraded area in the tropics are far-reaching, including changes in forest composition and structure, that are potentially long-term in nature [12]. Changes in the species diversity occurring in clear cutting forests indicate changes in species structure and composition and potential value of plant species in the forest, they also indicate variation in plant density.

Based on the description above, it is certainly a problem in recognizing and knowing the diversity of peat forest remaining due to illegal logging and fires. One of the lowland tropical forest areas that has received considerable attention recently is peat forest. Peat forests with low soil fertility levels have been converted into agricultural and plantation lands, including those in Katingan area, which has an important meaning as a conservation area for natural conservation, especially flora. Therefore, the aim of this study was to know the species diversity of vegetation for ecological and conservation research of the peat forests so that it can provide data in an effort to maintain the existence of peatland forest, especially in the Katingan Regency, Central Kalimantan.

2. Methods

a. Study Site

The study area of peatland forest located in Katingan Regency, Central Kalimantan at latitude 1° 34' 14" LS - 1° 41' 41" S and longitude 113° 01' 09" - 113° 15' 06" E, at approx. 10 m above sea level, shown in Figure 1. According to classification, the climate in study area is belonged to type B or wet climatic condition [13] with annual rainfall was ca. 3,508 mm, 146 rain days, and highest in November reaching 475.5 mm, although the monthly rainfall was over 100 mm in most months. The soil types in the study area is mostly gley humus, and remaining covered by podsolic dan latosol soils.

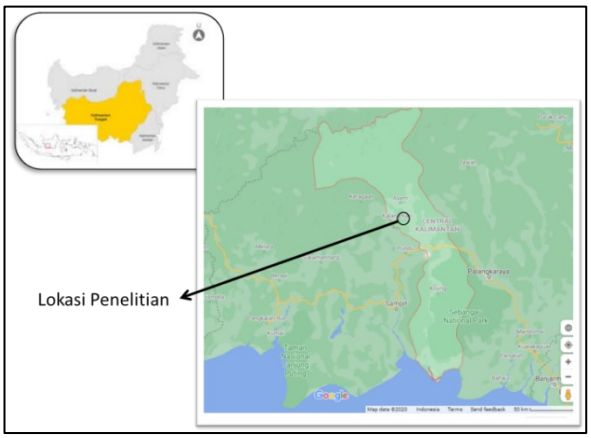

Figure 1. Study Site in Katingan Regency, Central Kalimantan

b. Vegetation Inventory

The characteristics of vegetation growth were obtained by species composition, structure and volume of vegetation. In six plots, each 20m x 20m (0.28 ha) plot was set up in

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representative areas. All vegetation in the plot were inventoried and recorded according to growth rate, namely trees, poles, saplings and seedlings. Trees were defined as having a DBH (Diameter at Breast Height) ≥ 10 cm and tree height larger than 1.3 m, poles with DBH ranging from 5 to <10 cm and larger than 1.3 m, sapling with 2 to <5 cm in DBH and seedlings with DBH < 2 cm. Tree measurement were in size 20 x 20m^2, while the plots of pole, sapling and seedling were, respectively, in size 10 x 10m^2, 5 x 5m^2 and 2 x 2m^2. Voucher specimens were taken for further species identification in Research Center for Biology-LIPI.

Tree structure described the distribution of tree species number (N/ha) based on the tree diameter in plot. Important Value Index (IVI) is utilized to figure out the dominance of a species in a community. The equation of IVI, as follows :

$$\text{Density (D; N/ha)} = \frac{\text{Number of individuals}}{\text{Unit area in plot}}$$

$$\text{Relative Density (RD; \%)} = \frac{\text{Number of individuals of a species}}{\text{Total number of individuals of all species}} \text{ x } 100\%$$

$$\text{Frequency (F)} = \frac{\text{Points occupied of a given species}}{\text{Distribution a species in plot}}$$

$$\text{Relative Frequency (RF; \%)} = \frac{\text{Frequency of a given species}}{\text{Frequency of all species}} \text{ x } 100\%$$

$$\text{Dominance } \left(\text{Dm}; \frac{\text{m}^2}{\text{ha}}\right) = \frac{\text{Basal area of a species}}{\text{Total basal area of a species per unit area}}$$

$$\text{Relative Dominance (RDm; \%)} = \frac{\text{Dominance of a species}}{\text{Dominance of all species}} \text{ x } 100\%$$

Important Value Index (IVI) = RD +RF + RDm, for tree and pole
Important Value Index (IVI) = RD +RF, for sapling

3. Result and Discussion

The results showed the species diversity in peat forest with different growth level, *i.e.* tree, pole, sapling and seedling.

a. Tree Level

The number of species found at the tree level were 8 species and 5 families, most of which were Dipterocarpaceae, the rest came from Podocarpaceae, Euphorbiaceae, Hypericaceae and Apocynaceae. Almost the found species were representing characteristics of peat forest, although there was non-indigenous species of peatland recorded, such *Nageia wallicianum*. Total density was 50 individu ha^{-1} and the basal area reached 0,50 m^2 ha^{-1}. Based on the Important Value Index (IVI), it showed that the species of *Nageia wallichianum* was the dominant species with 46.94 (IVI) compared to other species, or this species indicated as an important species in maintaining the balance of the ecosystem, see Table 1.

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Table 1. The species in the tree level according to Important Value Index (IVI)

No	Species name	Family	RDm	RD	RF	IVI
1	*Nageia wallichianum*	Podocarpaceae	17.78	16.67	12.50	46.94
2	*Hevea brasiliensis*	Euphorbiaceae	16.33	16.67	12.50	45.50
3	*Shorea parvistipulata*	Dipterocarpaceae	15.45	16.67	12.50	44.62
4	*Cratoxylum glaucum*	Hypericaceae	14.52	16.67	12.50	43.69
5	*Vatica rassak*	Dipterocarpaceae	13.64	8.33	12.50	34.47
6	*Dipterocarpus* sp.	Dipterocarpaceae	8.63	8.33	12.50	29.47
7	*Alstonia scholaris*	Apocynaceae	6.82	8.33	12.50	27.65
8	*Shorea bracteolata*	Dipterocarpaceae	6.82	8.33	12.50	27.65
Total			100.00	100.00	100.00	300.00

Note : RDm, RD, RF represented as Relative Dominance, Relative Density and Relative Frequency, respectively

The small number of basal areas indicated that this area is still in the secondary succession stage, because most of the research locations were burnt areas with burnt woody remaining. This is impossible considering that there are no trees with a diameter larger than 15 cm. Several species were commonly found in peat swamp forests, such as gerunggang (*C. glaucum*) and pulai (*Alstonia scholaris*). C. glaucum is categorized as a adapted species in burnt or open area forests, while A. scholaris is a species that is commonly found in peat swamp forest.

b. Pole Level

The species found at the pole level were 14 species and 8 families, most of which belong to the family of Dipterocarpaceae, although the largest number of individuals came from rubber (*Hevea brassiliensis*) of Euphorbiaceae. Rubber plants, which are found in tree level, are wild plants and sometimes claimed by the community as the boundaries of community ownership. The basal area reached 0.50 m^2 ha^{-}. According to IVI, it showed that there are four species with high IVI, in which the rubber is the dominant species of 61.21 (IVI), see Table 2.

Table 2. The species in the pole level according to Important Value Index (IVI)

No	Species Name	Family	RDm	RD	RF	IVI
1	*Hevea brassiliensis*	Euphorbiaceae	21.53	28.57	11.11	61.21
2	*Cratoxylum glaucum*	Hypericaceae	15.27	16.07	16.67	48.01
3	*Vatica rassak*	Dipterocarpaceae	12.79	14.29	11.11	38.19
4	*Shorea parvistipulata*	Dipterocarpaceae	17.67	12.50	5.56	35.73
5	*Aglaia* sp.	Meliaceae	5.98	5.36	5.56	16.90
6	*Dyera costulata*	Apocynaceae	6.49	3.57	5.56	15.62
7	*Syzygium rostratum*	Myrtaceae	2.37	5.36	5.56	13.28
8	*Macaranga triloba*	Euphorbiaceae	2.33	3.57	5.56	11.46
9	*Durio zibethinus*	Malvaceae	3.86	1.79	5.56	11.20
10	*Shorea* sp.	Dipterocarpaceae	3.86	1.79	5.56	11.20
11	*Koompassia malaccencis*	Leguminosae	3.13	1.79	5.56	10.47
12	*Chisocheton ceramicus*	Meliaceae	2.47	1.79	5.56	9.81
13	*Tristaniopsis merguensis*	Myrtaceae	1.39	1.79	5.56	8.73
14	*Macaranga costulata*	Euphorbiaceae	0.84	1.79	5.56	8.18
			100.00	100.00	100.00	300.00

Note : RDm, RD, RF represented as Relative Dominance, Relative Density and Relative Frequency, respectively

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c. Sapling Level

The number of species found at the sapling level were 11 species and 9 families, most of which came from the Dipterocarpaceae, whilst the rest of each other was from single family. Based on the IVI, it shows that the species of gerunggang (*Cratoxylum glaucum*) has the highest IVI, followed by rubber (*H. brassiliensis*) and laban (*Vitex pinnata*), as shown in Table 3. The highest IVI value due to environmental influences such moisture, temperature and not able to compete in its growth period, especially in the competition for nutrients, sunlight and growing space.

Table 3. The species in the sapling level according to Important Value Index (IVI)

No	Species Name	Family	RD	RF	IVI
1	*Cratoxylum glaucum*	Hypericaceae	41.94	20.00	61.94
2	*Hevea brassiliensis*	Euphorbiaceae	9.68	13.33	23.01
3	*Vitex pinnata*	Lamiaceae	9.68	13.33	23.01
4	*Shorea bracteolata*	Dipterocarpaceae	9.68	6.67	16.34
5	*Shorea parvistipulata*	Dipterocarpaceae	6.45	6.67	13.12
6	*Vatica rassak*	Dipterocarpaceae	6.45	6.67	13.12
7	*Durio zibethinus*	Malvaceae	3.23	6.67	9.89
8	*Ficus fistulosa*	Moraceae	3.23	6.67	9.89
9	*Nephelium rambutan-ake*	Sapindaceae	3.23	6.67	9.89
10	*Psychotria viridiflora*	Rubiaceae	3.23	6.67	9.89
11	*Syzygium lineatum*	Myrtaceae	3.23	6.67	9.89
Total			100.00	100.00	200.00

Note : RD, RF represented as Relative Density and Relative Frequency, respectively

The dominant species indicates that they have wide adaptability and tolerance to environmental conditions. A species considered dominant is indicated by high value of importance value index (IVI), which has a high frequency, density and dominance than other species [14]. The important value index of a species illustrates that the existence of this species is increasingly stable or has the opportunity to be able to maintain growth and sustainability of its species [14].

d. Seedling Level

The number of species found at the seedling level is 18 species and 13 families, most of which are Euphorbiaceae. It shows that the seedling level is filled with pioneer species, *i.e. C. longifolia, D. linearis, M. costulata, M. tanarius, M. malabathricum, N. biserrata, T. orientalis* and *V. pinnata* (Table 4). Number of species in the study location lower than those of in Barito Ulu. , Central Kalimantan [15], Chiang Mai, Thailand [16], Gogol Valley, Papua New Guinea [17], and Pasoh, Malaysia [18]. There is seedling of rubber because the fruit could not be dispersed quite far from the parent tree or the fruits have dispersal limitation, while the presence of oil palm could be influenced by the large number of oil palm plantations around the study location. The existence of oil palm shows that the expansion of oil palm trees has penetrated the forest area and needs attention for the species due to easy to grow through seed distribution.

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Table 4. The species in the seedling level

No	Family	Species Name
1	Arecaceae	*Elaeis guineensis*
2	Cannabaceae	*Trema orientalis*
3	Dipterocarpaceae	*Shorea bracteolata*
4	Euphorbiaceae	*Hevea brassiliensis*
5	Euphorbiaceae	*Macaranga costulata*
6	Euphorbiaceae	*Macarangan tanarius*
7	Gleicheniaceae	*Dicranopteris linearis*
8	Hypericaceae	*Cratoxylum glaucum*
9	Lamiaceae	*Callicarpha longifolia*
10	Lamiaceae	*Vitex pinnata*
11	Leguminosae	*Paraserianthes falcataria*
12	Malvaceae	*Sterculia coccinea*
13	Melastomataceae	*Melastoma malabathricum*
14	Myrtaceae	*Sysygium lineatum*
15	Myrtaceae	*Artocarpus integra*
16	Myrtaceae	*Syzygium rostratum*
17	Nephrolepidaceae	*Nephrolepis biserrata*
18	Rubiaceae	*Psychotria viridiflora*

The total basal area at tree and pole level is low compared to the basal area in the peat swamp forest in Klampangan and Lahei Regencies, Central Kalimantan [19]. The densities of vegetation in this study area were also low compared to that of other forest types in the lowland tropical area [20], [21], [22]. This study area still retained many of the structural characteristics typical of secondary forest such lower basal area and density difference of the density is mainly due to different age of forest [23]. The dominating species of the plant were the species that can efficiently utilize the environment against other plant species with the same conditions and places of growth.

The number of species is also categorized as low which was attributed to the habitat condition such as extremely acid soils, low nutrient, aneorobic and consisting mainly of organic materials [19]. Some species in study area are dipterocarps, *Shorea spp*. and *Vatica rassak*, in which the dipterocarps grow in 50-70% of full sunlight. The partial shade in the early stage of the development may be beneficial for height growth of the dipterocarp seedling [24], [25]. Furthermore, the occurrence of species composition of dipterocarps depends on the occurrence of seed-bearing mother trees in the vicinity [26]. The species were found in almost all growth levels *i.e C. glaucum*, *Shorea parvistipulata* and *S. bracteolata* that could be considered as long-lived species, similar finding of some species in different stages in secondary rain forest at Barito Ulu [27]. The presence of species diversity is attributed to the dynamic ecophysiological process and correlation with local climatic conditions, nutrients, tolerance in species, and biogeographic factors or species distribution and variations in forest ecological conditions

e. Growth Structure

The number of individuals in different growth levels were shown in Figure 1. It shows an inverted *J*-shaped curved indicating a fairly high regeneration rate in seedling level of study area, with seedling, sapling, pole and tree ratio reaching 184 : 41 : 5 : 1 Some species was even

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Bogor Nov 17, 2020
"The Project for Producing Biomass Energy and Material through Revegetation of Alang-Alang (Imperata cylindrica) Fields"

distributed in all growth level due to the growing vegetation structure that strongly supported the survival of various plant species at each growth level.

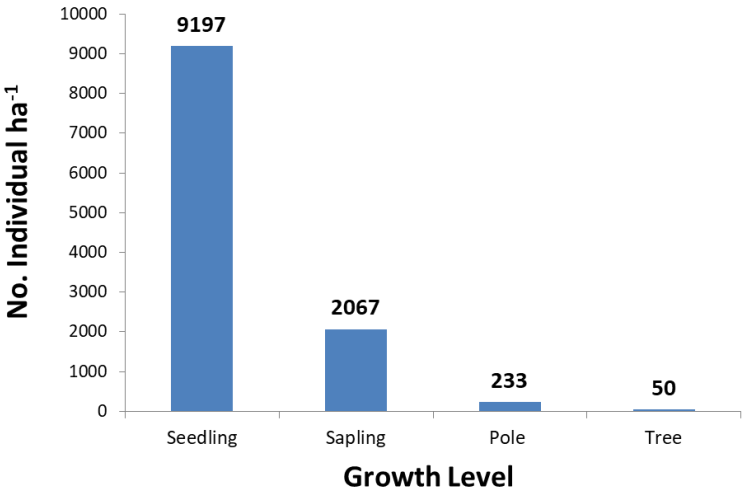

Figure 1. Number of individual per ha according Growth Level

The above ground biomass was calculated using both variables of basal area and height without branch. The estimated stand potential in the form of volume and above ground biomass was respectively reached 54.38 m^3 ha^{-1} and above ground biomass was 2.91 tonnes ha^{-1} at the tree level, meanwhile 105.58 m^3 ha^{-1} and biomass were 3.88 ton ha^{-1} at pole level or total above ground biomass (tree and pole levels) approx. 6,8 tonnes ha^{-1}. The estimated above ground biomass was lower than other studies [28], [29], and the that of was a bit higher than in burnt area plot in Klampangan Regency, Central Kalimantan [30], indicating that in the present study the tree size in diameter was smaller and previously the area was burnt. Above ground biomass accumulation in tropical secondary succession is usually approx. 5-10 tonnes ha^{-1}, and the above ground biomass is dependent upon the prior land history, with longer and more severe disturbances leading to a longer time to accumulate a given biomass [28], [31].

4. Conclusion

Vegetation types were representing characteristics of peat forest, for tree, pole, sapling and seedling growth level. Most of the family was Dipterocarpaceae for tree, pole and sapling, in contrast to seedling the family was fulfilled by Euphorbiaceae. Above ground biomass was characterized by tropical secondary succession forest.

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