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The Structure of Endangered Tree Stands Found on Gunung Sibela Wildlife Reserve



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ABSTRACT

The discussion of a plant community's structure which represents an organization of individuals in a stand comprises three primary elements that include growth form, stratification, and coverage. The main objective of this research was to investigate the composition, distribution pattern, and population status of endangered tree species found in Gunung Sibela Wildlife Reserve. This descriptive study employed the line transect method. On each observation point, a transect line (500m in length and 100m in width) was drawn at 20m intervals. Observation plots of 20x20m were randomly created along the transect lines. Observation parameters consisted of the number of species and the number of individuals contained in each of the species group. These vegetation parameters were analyzed based on the IUCN Red List to determine the distribution pattern and category of nine targeted species. The findings of the current study suggest that of the nine plant species examined, five of them (i.e. *Duobanga moluccana* Bl., *Drancoto melondao* (Blanco.) *Agathis dammara* (Lamb.) Rich & Rich., *Pometia pinnata* J.R. Forts., and *Syzygium ampliflorum* Merr. & Peery.) have a random distribution pattern and the other four are clustered in groups (*Intsia bijuga* (colebr) J. Kuntze., *Vitex parviflora* Juss., *Dryobalanops aromatica* Gaertn .f., and *Tectona grandis* L). The results also indicate that the existence of five species, namely *Agathis dammara* (Lamb.) Rich & Rich., *Intsia bijuga* (colebr) J. Kuntze., *Vitex parviflora* Juss., *Dryobalanops aromatica* Gaertn .f., and *Syzygium ampliflorum* Merr. & Peery, has been threatened but the other four species, namely *Duobanga moluccana* Bl., *Drancoto melondao* (Blanco.), *Pometia pinnata* J.R. Forts., and *Tectona grandis* L are not listed under the endangered species.

INTRODUCTION

The term “vegetation structure” may vary based on its use and purpose Istomo [6]. Armizon [2], for example, applies this term to explain the distribution of plant individuals under a particular canopy layer while Dansereau in Telangana [12] refers this structure as a community that contains individuals that are organized in a space called stand. A tree stand may be comprised of the following primary elements: growth form, stratification, and coverage. The other distinctive components that can also characterize a vegetation structure Tolangara [13] include vertical structure (e.g. stratification of layers), horizontal structure (describing the spatial distribution of species and individuals), and quantitative structure (depicting the abundance of every species in a community).

Importance Value Index (IVI) is a measure of how dominant a species is in a vegetation community. IVI is calculated from adding the relative frequency to the relative density of a plant species. To determine the Important Value Index (IVI) of what constitutes a plant's community, data on plant's type, stem diameter and height must be collected Odum [9]. Through the vegetation analysis, quantitative information about the structure and composition of the plant's community which covers the stand's vertical components (trees, poles, saplings and seedlings) can be obtained.

Stem diameter, branching, tree height and canopy condition are the parameters of a stand's measurement. The structure of a tree stand, according to Istomo [6], can provide useful information on population dynamics. In fact, of all plant's levels (trees, poles, saplings and seedlings), a tree stand is more prone to damage. When the damage lasts for a long time, the existence of the tree species that form the stand can be threatened. The endangered status of the plants may be indicated by their inclining population and limited distribution pattern Tolangara, [13].

Gunung Sibela Wildlife Reserve is located on 2.118 meter above the sea level. It was appointed as a conservation area by the Decree of the Minister of Treery No.32/6/kpts-II/1987 on 14 October [14]. Based on survey results, some plant species in Gunung Sibela Wildlife Reserve have been categorized as very likely to become extinct. It was also reported that the extinction of these groups of species can be accelerated by activities performed by nearby society, such as exploiting the tree without the consent of the conservation management. To address this issue, it is thus necessary to conduct a study that can identify

the structure of tree stands on Gunung Sibela Wildlife Reserve. This study, in particular, aimed to investigate the composition, distribution pattern, and population status of endangered tree species found in this conservation area.

MATERIALS AND METHODS

There were two exploration techniques used in this study. The first one was the field survey and the second was the measurement of the stem diameter of a tree to determine the level of the tree. The survey was conducted on the endangered species deployment centers on Gunung Sibela Wildlife Reserve. The survey data were then used in the process of identifying the population status of the plants. The results of the survey and the measurement of the stem diameter of the trees were thoroughly examined, verified, and interpreted.

A road stub was initiated. Then, parallel transect lines (500m in length and 100 in width) were created on both sides of the stub. The lines were set 20m apart. Observation plots (20x20m) were put along the lines. Equipment used in this study included an altimeter, a diameter tape, a global positioning system (GPS), garden scissors, herbarium labels, plastic bags, newspaper, and alcohol (70%). At the tree level, the species were supposed to have a stem diameter of ($\varnothing > 20$ cm) and a height of ± 130 cm above the ground or 20 cm from the flood starting point. Observed vegetation parameters consisted of the number of species, the density (the number of individuals contained in a group of species), and the stem diameter (dominance) Hilton-Taylor [4].

To determine the stand structure, data on the vegetation parameters were analyzed by calculating the density, dominance, frequency, and Importance Value Index (IVI) of each species, using the formula suggested by Cox ; Mueller-Dombois and Ellenberg, *in*Tolangara[15]. $IVI = Kr (\%) + Dr (\%) + Fr (\%)$. Endangered species were then listed by referring to the IUCN Red List [10]. The distribution pattern, basal area, and IVI of each stand were stipulated according to Hilton-Taylor [4].

RESULTS

Research Findings

The survey results indicated the existence of nine tree stands on Gunung Sibela Wildlife Reserve. These nine tree species were presented in Table 3.1.

Table 1: The Composition of Tree Stands Found on Gunung Sibela Wildlife Reserve

No	Local Name	Indonesian Name	Scientific Name
1.	Binuang Tree	Kayu Binuang	<i>Duobanga moluccana</i> Bl.
2.	Bua Rau Tree	Kayu Bua Rau	<i>Drancoto melumdao</i> (Blanco)
3.	Damar Tree	Kayu Damar	<i>Agathis dammara</i> (Lamb.)
4.	KayuBesi Tree	Kayu Besi	<i>Intsia bijuga</i> (Colebr)
5.	Matoa Tree	Kayu Matoa	<i>Pometia pinnata</i> J.R. Forst
6.	Gufasa Tree	Kayu Gufasa	<i>Vitex cofassus</i> Reinw. exBlume.
7.	Kapur Tree	Kayu Kapur	<i>Dryobalanops aromatica</i>
8.	Jati Tree	Kayu Jati	<i>Tectona grandis</i> L.
9.	Gosale Tree	Kayu Gosale	<i>Syzygium malaccense</i> (L.) Merr. & Perry

Source: A.R. Tolangara, 2018

The data presented in the table above were analyzed and used to determine the distribution pattern, basal area, and Importance Value Index (IVI) of each of the tree stands. The results were summarized in Table 2.

Table 2: The Distribution Pattern, Basal Area, and IVI of Each Tree Stand Found on Gunung Sibela Wildlife Reserve

No	Indonesian Name	Scientific Name	Distribution Pattern (Id)	Basal area (m ²)	IVI (%)
1.	Binuang Tree	<i>Duobanga moluccana</i> Bl.	0.08 (random)	2.82	16.8
2.	Buah Rau Tree	<i>Drancotomelum dao</i> (Blanco)	0.05 (random)	1.52	13.6
3.	Damar Tree	<i>Agathis dammara</i> (Lamb.) Rich& Rich	0.06 (random)	1.38	14.7
4.	Kayu Besi Tree	<i>Intsia bijuga</i> (Colebr)	2.62 (clumped)	1.61	45.2
5.	Motoa Tree	<i>Pometia pinnata</i> J.R. Forst	0.07 (random)	0.12	13.3
6.	Gufasa Tree	<i>Vitex parviflora</i> Juss.	1.15 (clumped)	2.07	35.2
7.	Kapur Tree	<i>Dryobalanops aromatica</i> Gaertn.f.	2.12 (clumped)	1.38	53.4
8.	Jati Tree	<i>Tectona grandis</i> L.	2.44 (clumped)	2.24	50.2
9.	Gosale Tree	<i>Syzygium ampliflorum</i>	0.05 (random)	1.84	4.5

Source: A.R. Tolangara, 2018

Notes: $Id < 0$, a uniformed distribution pattern, $b = 1$, a random distribution pattern, $b > 1$, a clumped distribution pattern. Basal area = area of occupancy of a species, IVI (%) = Importance Value Index.

These data (the distribution pattern, basal area, and IVI of the species) were compared to the endangered species criteria set in the IUCN Red List [10]. As a result, the population status and conservation state of each stand could be determined (Table 3).

Table 3: The Conservation Status of Each Tree Stand Found on Gunung Sibela Wildlife

No	Indonesian Name	Scientific Name	Conservation Status	Source
1.	Binuang Tree	<i>Duobanga moluccana</i> Bl.		
2.	Buah Rau Tree	<i>Drancotomelum dao</i> (Blanco)		
3.	Damar Tree	<i>Agathis dammara</i> (Lamb.) Rich & Rich	Vulnerable (Vu A4cd)	IUCN
4.	Kayu Besi Tree	<i>Intsia bijuga</i> (Colebr) J.Kuntze	Vulnerable (Vu A1cd)	IUCN
5.	Motoa Tree	<i>Pometia pinnata</i> J.R. Forst		
6.	Gufasa Tree	<i>Vitex parviflora</i> Juss.	Vulnerable (VuA1cd)	IUCN
7.	Kapur Tree	<i>Dryobalanops aromatica</i> Gaertn.f.	Critical (A1cd+2cd,B1+2c)	IUCN
8.	Jati Tree	<i>Tectona grandis</i> L.		
9.	Gosale Tree	<i>Syzygium ampliflorum</i> Merr. & Perry	Critical (B1+2c,c2b)	IUCN

Note: IUCN Red List of Endangered Species[10].

DISCUSSION

A great diversity of tree stands has been found on the Gunung Sibela Wildlife Reserve area (Table 1). This finding indicates that Indonesia is rich with biodiversity that has been equally spread throughout the country. Sakura [11] points out that the world is crowded by millions of plants, animals, and microorganisms that inhabit different natural communities or ecosystems. Some of the diverse species are being in an endangered status because their existence has been threatened under some circumstances, such as an incline in a species population, poor regeneration abilities, and lack of adaptation skills Tolangara [13]. Gunung Sibela Wildlife Reserve provides a sanctuary for several endangered plant species of which actuality is also being at risk due to human activities. The nearby community keeps exploiting the tree without consent of the conservation management and without any effort of greening.

Distribution Pattern

The distribution pattern of each of the tree stands highly depends on the condition of the space in which the species grow (Table 2). A plant's distribution pattern suggests an interaction motive of a species. The most common interaction that is established among plant species is a competition Tolangara [12]. Every plant individual would compete for water, daylight, space, and nutrients May [7]. The availability of living resources may affect the plant individuals' way of life; thus, they can be distributed randomly or in groups.

Some parts of Gunung Sibela Wildlife Reserve have been cultivated for agricultural lands and some others are dominated by secondary vegetation, such as *Piper aduncum*, *Anthocephalus macrophyllus*, *Ficus spp.*, *Pipturus sp.*, *Duabanga moluccana*, *Timonius sp.* and *Pertusadina sp.* Reed (*Imperata cylindrica*) can be easily found on the open areas. There are also *Nephrolepis biserrata* and *Merremia peltata*. These two plant species belong to the vines category which is known for its ability to harm nearby trees. The number of tree individuals in Gunung Sibela Wildlife Reserve keeps declining due to human activities. Their existence has been threatened and even being endangered to extinction. The Management of Gunung Sibela Wildlife Reserve Bacan Island [3].

As is stated by Shigesada and Kawasaki in van Steenis [15], a habitat disruption may lead to the possibility of a new species to replace native plants. It, in other words, provides a space for the new species to grow and reproduce. To maintain their existence, the native plants will establish a random distribution pattern and those that live near the parents will attempt to live in groups Abiwijaya [1].

The findings of the present research indicate that the average Importance Index Value (IVI) of tree stands in Gunung Sibela Wildlife Reserve is categorized low. This index value is strongly associated with the ability of the plants to win a competition over environmental aspects such as humidity, temperature, nutrients, and daylight. IVI can be measured from the diameter and the age of a tree Tolangara [12]. The dominant plant species which possess high IVI will also have high productivity and bigger stem diameter Odum [9]. The existence of the dominant individuals is one of the indicators that the plant's community belongs to its right habitat.

Population Status

Heavy situations can be a threat to a species existence Hilton-Taylor [4]. Individuals which live separately or relatively isolated from their environment can lose an opportunity to struggle together with their group. The results of the current study presented in Table 3 show that there are five endangered species that can be found in Gunung Sibela Wildlife Reserve. These plant species include damar tree (*Agathis dammara* Lamb.) Rich & Rich., kayu besi tree (*Intsia bijuga* Colebr.) J. Kuntze., gufasa tree (*Vitex parviflora* Juss), kayu kapur tree (*Dryobalanops aromatic* Gaertn.f.), and kayu Gosale tree (*Syzygium ampliflorum* Merr. & Perry). This status is threatened with extinction referring to the IUCN Red List [10].

Agathis dammara (Lamb.) Rich & Rich or damar tree (Ind.) live with a random distribution pattern on 0°44'3"S and 127°32'9"E. This plant species belongs to the vulnerable category (Vu: A1cd). The plant community consists of 6 individuals per 10.000 m². Compared to the area of Gunung Sibela Wildlife Reserve (23.024 Ha) and basal area of 1.38 m², this plant species has a low Importance Value Index (IVI) (14,7% = 5.998 m²). These figures suggest that the risk of the plant's extinction is high in nature in the near future, the population is very small or limited in number, and the population is characterized by the limited area occupied which is less than 100 km² and a random distribution pattern.

Intsia bijuga (Colebr.) J. Kuntze or kayubesi tree are distributed in groups on 0°45'3"S and 127°33'9"E. This species is vulnerable (Vu: A1cd) with 7 individuals per 10.000 m². Compared to the area of Gunung Sibela Wildlife Reserve (23.024 Ha) and basal area of 1.61 m², this plant species also has a low Importance Value Index (IVI) (45,2% = 6.997 m²). Similar to damar tree, the risk of this plant's extinction is high in nature in the near future, the population is very small or limited in number, and the population is characterized by the limited area occupied which is less than 100 km² and a clumped distribution pattern.

Vitex parviflora Juss. or gufasa tree (Ind.) has a clumped distribution pattern (0°45'3"S and 127°33'9"E). This plant's category is vulnerable (Vu: A1cd). There are nine individuals living per 10.000 m². Converted into 8.999 m² (based on the conservation area and basal area of 2.07 m²), the IVI of this plant is also categorized small (35.2%). *Dryobalanops aromatic* Gaertn. f. orkayukapur tree (Ind) also lives in groups on Gunung Sibela Wildlife Reserve (0°46'4"S and 127°32'11"E). The basal area is 1.38 m² and the conversion of the area where the species grow is 5.998 m²; thus, the Importance Value Index (IVI) of the plant is also

categorized low (53.4%). The number of individuals has declined by 80%. Therefore, this plant species is classified into the critical category (CR: A1cd+2cd,B1+2c) with the extent of occurrence less than 5000 km².

Unlike gufasa tree and kayukapur tree, *Syzygium ampliflorum* Merr. & Perry or gosale (Ind.) are distributed randomly on Gunung Sibela Wildlife Reserve (0⁰44'4'S and 127⁰33'13'E). This type of plants belongs to the vulnerable group (Vu: A1cd). The basal area is 1.84 m², thus the conversion value is 7.996 m² and the Importance Value Index (IVI) reported is 4.5% (very small). Gufasa tree is categorized into critical (CR: B1+2c,c2b). The extent of occurrence of this species is no more than 5000 km² and after a careful observation, it can be concluded that the population of this species keeps declining and the area on which the individuals are living keep shrinking.

These endangered tree stands contain plant individuals that normally have a small population number, slow regeneration processes, and limited distribution. The high economic value of the trees has also invited irresponsible people to keep exploiting them. The plants have been sold in the public market or used for human personal needs fulfillment Tolangara [13]. Therefore, in order to prevent these endangered species from extinction, conservation efforts need to be conducted Mogeia [8]. Otherwise, the population of the species can diminish in a very short time.

CONCLUSIONS

The results of the current study suggest that:

1. There are nine tree stands found on Gunung Sibela Wildlife Reserve (*Agathis dammara* (Lamb.) Rich & Rich., *Intsia bijuga* (colebr) J. Kuntze., *Vitex parviflora* Juss., *Dryobalanops aromatic* Gaertn .f., *Syzygium ampliflorum* Merr. & Peery., *Duobanga moluccana* Bl., *Drancoto melondao* (Blanco.), *Pometia pinnata* J.R. Forts., and *Tectona grandis* L).
2. Five of the nine species have a random distribution pattern. These plant species include *Duobanga moluccana* Bl., *Drancoto melondao* (Blanco.) *Agathis dammara* (Lamb.) Rich & Rich., *Pometia pinnata* J.R. Forts., and *Syzygium ampliflorum* Merr. & Peery., while the four others, namely *Intsia bijuga* (colebr) J. Kuntze., *Vitex parviflora* Juss., *Dryobalanops aromatic* Gaertn .f., and *Tectona grandis* L, have a clumped distribution pattern.

3. The existence of five species, namely *Agathis dammara* (Lamb.) Rich & Rich., *Intsia bijuga* (Colebr) J. Kuntze., *Vitex parviflora* Juss., *Dryobalanops aromatic* Gaertn .f., and *Syzygium ampliflorum* Merr. & Peery, has been threatened but the other four species, namely *Duobanga moluccana* Bl., *Drancoto melondao* (Blanco.), *Pometia pinnata* J.R. Forts., and *Tectona grandis* L are not listed under the endangered species. The conservation status of the five endangered species may possibly change, such as *Dryobalanops aromatic* Gaertn .f. and *Syzygium ampliflorum* Merr. & Perry. (from vulnerable (VU) to critical (CR)), due to an incline in their population and a provided limited area that is inhabited with a random distribution pattern.

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