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Vegetation Analysis and Association Species of Trees for Tropical Rainforest Highland in Cagar Alam Gunung Sigogor

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***Abstract* – One area that has chosen as a nature reserve in East Java is the Sigogor Mountain Nature Reserve, with mountain tropical rainforest types dominating this area. The composition of tree-level species and species that dominate the highland tropical rainforest area is the aim of this study. Data collection method uses the quadrant method (Point Center Quarter Method), while relationship analysis uses the 2 x 2 Contingency Table method. Based on the results of the study, it founded that the vegetation of Mount Sigogor Nature Reserve consisted of at least 42 species of trees including 21 families. The number of trees per hectare is 476 stems, with the total area of the base area per hectare is 86.2358 m^2. Sigogor Nature Reserve is dominated by Quercus sondaica BL Miq followed by Dodonea viscosa; Casuarina sp; Litsea glutinosa and Persea odoratissima (Nees) Kosterm with INP of 38.44% respectively; 35.90%; 28.21%; 27.11% and 16.29%. There is a tendency to live together between species of trees Quercus sondaica with Litsea glutinosa.**

***Keywords* – Vegetation, Association, Mountains Tropical Rainforest, Nature Reserve.**

I. INTRODUCTION

Indonesia has biodiversity high with various types forest ecosystem [1]. [2] The main constituents of forest areas in the form of trees have an essential role in regulating water management, germplasm reserves, supporting life, development resources and sources of foreign exchange. The task of trees in forest communities is increasingly difficult to maintain, given the increasing public pressure on plant groups.

Indonesia has the potential of abundant natural wealth, a high level of biodiversity and supported by a vast area with many islands and is located in the tropics [3] Geographically, Indonesia is between two continents, namely the continent of Asia and the continent of Australia. Besides, Indonesia also located around the equator where this condition causes Indonesia to have various types of forests. Tropical rainforests are a feature of natural forests where people grow their plants in climax formation. Another feature of tropical rainforests is the appearance of multi-layered tree canopies and the dominant tree canopy in the upper layers. [4].

The study which aims to determine the structure and composition of forests is called forest vegetation analysis [5], [6]. [7] States that the presence of vegetation will have a positive impact on ecosystem balance on a broader scale. For example in general, the plant will reduce a rate of soil erosion, regulate the balance of carbon dioxide and oxygen in the air, regulate groundwater, improve the physical, chemical and biological properties of the soil. The effect varies depending on the structure and composition of the plants that make up the vegetation formation of the area.

[8] One of the forms of interaction among the types of forest vegetation compilers is the association. [9] States that associations divided into positive associations and negative associations. Positive association occurs when a plant species is present simultaneously with other types of plants and will not be formed without the presence of these different types of plants. Negative associations occur when a plant species is not present simultaneously.

Nature protection and preservation in Indonesia is carried out, among others, by designating certain places like nature reserves, one of the places that have been named as a nature reserve in East Java is the Mount Sigogor nature reserve, with the broadest highland tropical rainforest ecosystem occupying this area [10].

II. MATERIAL AND METHODS

A. *Material*

This research was carried out in Mount Sigogor Nature Reserve, Ngebel Sub district, Ponorogo Regency, East Java Province, while the implementation of the study was in Mei 2018.

The material of this study is all types of trees with breast diameter (dbh)> from 5 cm in the forest area of Mount Sigogor Nature Reserve covering 190.5 ha which is the vast mountain tropical rain forest.

While the tools used in this study are: work maps 1: 10,000, compass direction, compass angle, rope off 20 meters, meter length 50 meters, meter 1.5 meters, Altimeter, mobile, calculator, camera and stationery.

B. *Methods*

B.1. *Sampling*

a. Establishing the pathway blocked by the Wates Line as the main route. Then every 250 m the main line is made of branch lines that are made perpendicular to the main line. The first branch path is formed to the left, second to the right, third to the left and so on.
b. At each branch line, the measurement points are determined. The distance between the measurement points with one another is 20 m, while the length of the branch path is dependent on the width of the block. So each branch line has not the same measurement point.
c. At each measurement point four quadrant lines are determined (in practice this line is only imagined).

Then in each quadrant is determined one type of tree that has the closest distance to the measurement point and> 5 cm in diameter. The selected tree then recorded for its kind, measured in diameter at breast height, and the distance of the tree to the measurement point. The recording of tree species is carried out with the help of a local tree identifier, then the name of the botanist is searched in the data and information on the potential of the conservation area [11].

B.1. *Data Processing*

a. Frequency is the distribution of a type which is expressing as a percentage of the presence of the species in the point of measurement of the total number of measurement points.
b. Relative Frequency (FR), is the value of the presence of a species divided by the total amount of the frequency of all species multiplied by 100%.
c. Relative Density (KR), is the number of individuals of a species divided by the total number of individuals (total individuals) multiplied by 100%
d. Dominance is the mastery of a species in vegetation or community against another species. In this study, dominance determined by calculating the area of the base area of each species.
e. Relative Dominance (DR), is the dominance of a species divided by the dominance of all species multiplied by 100%.
f. Important Value Index (IVI), is the sum of the Relative Frequency, Relative Density and Relative Dominance [12] [13] [14].

Data analysis to determine the association of tree species was made using the 2 x 2 Contingency Table method [15] [16]. In this study, only the main tree species (INP > 12%) included in the analysis. The table contingency form for associations between two species is as follows:

		Species A		
		+	-	Amount of
Species B	+	a	b	a + b
	-	c	d	c + d
	Amount of	a + c	b + d	a + b + c + d

Fig. 1. 2 x 2 Contingency Table

Note :

a = Observation of the number of measurement points containing species A and species B.
b = Observation of the number of measurement points that contain sp B only.
c = Observation of the number of measurement points that include sp A only.
d = Observation of the number of measurement points that do not contain species A and species B.

While to measure the magnitude of the deviation between the value of the observation with the expectation value is used "Chi-square test", the formula is as below :

$$\text{Chi-square } (X^2)_{count} = \frac{(ad-bc)^2\, n}{(a+b)(a+c)(c+d)(b+d)}$$

This value is compared with the chi-square (X2) table v-alue at a free rate equal to one at the test level of 10% and 5%. Based on these two chi-square values, a conclusion:

a. If the chi-square value is calculated to be higher than the chi-square table value, then the two associated species hold real associations at the test level.
b. If the chi-square value counts smaller than the chi-square table value, then the two species associated with holding unrealistic associations at the test level.

Determination of the level of association is used by the Association Coefficient [15] with the following conditions:

a. If ad ≥ bc, Then

$$C = \frac{(ad-bc)}{(a+d)(b+d)}$$

b. If bc> ad and d ≥ a, Then

$$C = \frac{(ad-bc)}{(a+d)(b+d)}$$

c. If bc> ad and a> d, Then

$$C = \frac{(ad-bc)}{(b+d)(c+d)}$$

Whereas C is the level of association between species.

III. Result and Discussion

A. *The Condition of the Observation Area*

The Mount Sigogor nature reserve designated as a nature reserve based on SK: Gb No 23 Stbl. 471, 4 September 1936 with an area of 190.5 ha. The Mount Sigogor nature reserve located in Pupus Village, Ngebel District, Ponorogo Regency. The length of the 19.71 Km area boundary line and has been realised as long as 19.71 Km during the reconstruction of the region in 1986. The number of borders is 364 pal limit. The geographical location of the Mount Sigogor CA is $07^{0}48$ '- $07^{0}50$' LS and 111^{0} 36 '- 111^{0} 38' BT.

Topography Mount Sigogor Nature Reserve is hilly (located on the western slope of Mount Wilis) with moderate to steep slopes in an altitude of 1,000 - 1,700 masl. The highest peaks include the southern part (Patok Banteng and Batu Blandar areas) and the eastern part (Cenger area). Sigogor CA has young volcanic rock geological formations with soil types that enter the Mediterranean complex, lithosol soil type. The climate type in the region categorised as C with a Q value of 57%. The average rainfall is 2,582 mm /year with the number of rainy days 142 days, the average temperature is 15-20o C at night and 30 - 35o C during the day. [17].

B. *Composition of Vegetation*

Based on the results of research in the location of mountain tropical rainforest, Mount Sigogor Nature Reserve found 42 species of trees included in 30 genera and 21 families. The number of trees per hectare is 476 stems, with the total area of the base area per hectare is 86.2358 m2.

Based on the results of medicinal plant exploration [17] found 12 types of medicinal plants. The difference in the number of species compositions is due to the different functions of the surveyed plants. The above discrepancies also caused by the determination of the minimum diameter of trees and the differences in sampling of forested areas surveyed.

A large number of species found at the study site showed that the composition of the forest vegetation composition was quite diverse. With this type of diversity, the stability of the ecosystem will be maintained, as stated by [18] [19]. [10] That the existence of species diversity will improve the stability of existing ecosystems because natural pest deterrence can be prevented. Whereas seen from the composition of mountain tropical rainforests Mount Sigogor Nature Reserve is a mixed forest with several species of plants more dominant than others.

C. *Relative Frequency (FR)*

The value of the relative frequency of a species indicates the spread of the species in its habitat. Broadly spread species will have a relatively high presence value, and vice versa, the species with a narrow range will have a relatively low presence value.

The distribution of the relative frequency of the tree species that comprise the Mount Sigogor nature reserve which has a corresponding frequency of more than 4% as in the figure below :

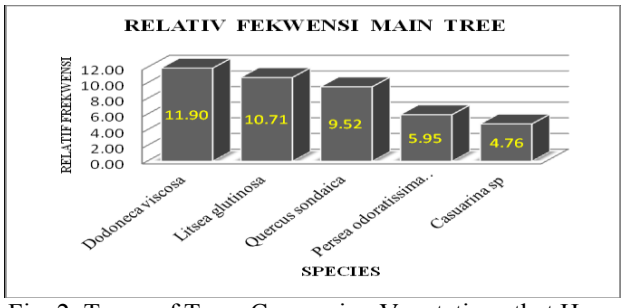

Fig. 2. Types of Trees Composing Vegetations that Have More than 4% Relative Frequency Value.

In Figure 1, it can seen that *Dodoneca viscosa, Litsea glutinosa and Quercus sondaica* have a high spread compared to others, with a relative attendance value of 11.90%; 10.71% and 9.52%. The widespread of this type is thought to be because this type has a broad tolerance for differences in existing soil moisture and other environmental factors. For plants that have a general understanding, they will be distributed very widely so that the value of their relative presence will be higher than others, such as what was stated by [20] [21] opinion that the spread of plant species in the community is a reaction (response) which are different from these types of microhabitat differences. Among environmental factors that influence the range of plants, soil moisture (water content) is the most influential factor.

D. *Relative Density. (KR)*

The relative density value calculated as the percentage of a species density for all types. Types of vegetation constituent trees that have a relative density value of more than 4% as shown in Figure 2:

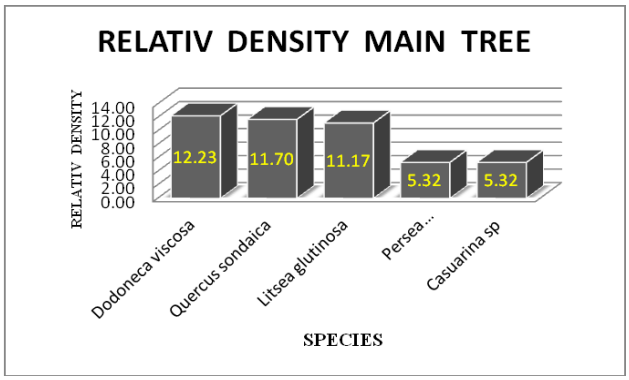

Fig. 3. Types of Vegetation Composers that Have Relative Density Value More Than 4%.

Figure 3 we can see the types of *Dodoneca viscosa*, *Quercus sondaica* and *Litsea glutinosa* having a relatively high-density value compared to others, with a relative density value of 11.70%; 11.17%; 10.64%. Sizeable relative density values of these types because this type is the types of winners in competition and has a broad tolerance so that the unity of the area will find in more significant individuals. - species of trees that have a sizeable Relative Attendance value will tend to have a considerable Relative Density value as well.

E. *Relative Dominance (DR)*

Dominance is a characteristic of the community that states the influence of the control of a species in the community on other species so that the population of other species will relatively reduce in the amount of power of life [22].

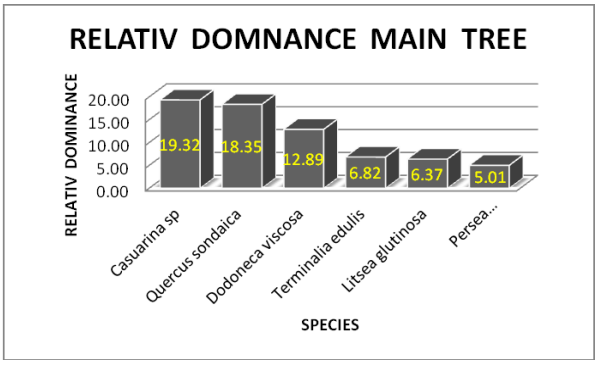

Fig. 4. Types of Tree Making Vegetation that Has a Relative Dominance Value of More Than 4%.

Figure 4 shows that the type *Casuarina sp; Quercus sondaica* and *Dodonea viscose* has a relatively high dominance value, each 18.66%; 18.34% and 12.89%. This high value is thought to be because these types can compete with other species in obtaining sunlight and nutrients in the soil. This is through the opinion of [23] [10] the mastery of a type against another type has to do with the growth of these types. The species that can grow strong and fast will get more light so that it will become thicker and can flow food well and be able to grow roots quickly. This condition causes a greater food supply, deeper penetration and spread more full than the roots so that these types will get better sources of life (water, light and nutrients) than their competitors.

F. *Important Value Index (IVI)*

A vital value index of a species in a plant community shows the level of importance or role of the species in the community. Species that have a significant (dominant) position in the community will have high IVI. IVI obtained by adding up the value of Relative Presence, Relative Density and Relative Dominance. Because the IVI determined by these three relative values, it ranges from 0 to 300 [12].

Table 1. Types of Trees Composing Vegetation that Have Important Value Indexes (IVI) More than 12%

No	*Species*	FR (*)	KR (*)	DR (*)	IVI (*))
1.	Quercus *sondaica*	8.93	11.17	18.34	38.44
2.	Dodoneca *viscosa*	11.31	11.70	12.89	35.90
3.	Casuarina sp	4.76	4.79	18.66	28.21
4.	Litsea glutinosa	10.12	10.64	6.35	27.11
5.	Persea odoratissima (Nees) Kosterm.	5.95	5.32	5.02	16.29

Data Source : Figure 2 , 3 , 4.

In table 1, it can see that the type of Quercus sondaica has the greatest IVI when compared to other species, meaning that this type has the most prominent role when compared to others. In table 1, it can also see that using only one relative value cannot be used to determine whether a species is higher than the others. So the dominance based on an important value index (IVI) provides more information when compared to the dominance that only uses one relative value. It is consistent with what is stated by [12], that the use of one parameter only provides limited information.

G. *Species Associations*

Associations between species were tested using the 2 x 2 Contingency table method, where the types proved had INP ≥ 12%, while the results were presented in table 1 for the chi-square table with a free degree of 1 (one) at level 10 % and 5% respectively were 2.71 and 3.84.

Table 2. Results of association calculations between tree species that have INP ≥ 12%,

No	Species Combination	C	X^2
1	*Quercus sondaica Vs Dodonea viscosa*	- 0.0771	0,2912
2	*Quercus sondaica Vs Casuarina sp*	0.1162	1.4512
3	*Quercus sondaica Vs Litsea glutinosa*	0.3816	6.8433**
4	*Quercus sondaica Vs Persea odoratissima*	- 0.2853	2.3397
5	*Dodonea viscosa Vs Casuarina sp*	- 0.1988	1.2174
6	*Dodonea viscosa Vs Litsea glutinosa*	0.0617	0.1956
7	*Dodonea viscosa Vs Persea odoratissima*	0.1160	0.3113
8	*Casuarina sp Vs Litsea glutinosa*	- 0.0958	0.7215
9	*Casuarina sp Vs Persea odoratissima*	- 0.0622	0.2340
10	*Litsea glutinosa Vs Persea odoratissima*	- 0.0253	0.0227

Data Source : Data processing

In table 2, it can be seeing that four types of combinations have a positive coefficient, namely *Quercus sondaica and Litsea glutinosa, Quercus sondaica* with *Casuarina sp, Dodonea viscosa* with *Persea odoratissima* and *Dodonea viscosa* with *Litsea glutinosa*. This means that between these types tend to live together, while other types of combinations have negative coefficient values, which means that there are no tendencies to live together. This is following the opinion of [23] who say, that certain types of plants usually grow together and some do not have the tendency to do so.

Table 2 shows that the combination of *Quercus sondaica* and *Litsea glutinosa* has a specific association at the 5% level. That shows that the joint occurrence between the pair of species is higher than expected [24]. Another possibility is that this pair does not negate one another, or that the type pair has the same reaction to environmental differences. [21]. Besides, the tendency to not issue each other between the two types is allegedly causing by the absence of competition between the two species. The lack of this competition is due to the species of life that have the same life needs while the sources that support life's needs themselves fulfilled

In table 2 it can be seen that various associative coefficient values are ranging from 0.3816 to - 0.2853. The difference in the association coefficient value is caused by:

a. Differences in the silvicultural properties of each type of plant, creating gaps in responses to variations in environmental factors.
b. Differences in the distribution patterns of each type
c. Difference between soil layers in each placed.
d. The difference in the area of land occupied by each type.

IV. CONCLUSION

The constituent vegetation of the mountain tropical rainforest area of the Sigogor Mountain Nature Reserve consists of at least 42 tree species, 30 genera and 21 families.

Based on the value of the Value Index, the importance is that *Quercus sondaica* is the type that plays the most role in the community with INP equal to 38.44%. Other species that are dominant are *Dodonea viscosa*; *Casuarina sp; Litsea glutinosa* and *Persea odoratissima (Nees) Kosterm* with INP 35.90; 28, 21; 27, 11 and 16, 29.

The type of couple who has a tendency to live together is *Quercus sondaica* with *Litsea glutinosa*.

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