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## **Species and Structure Compositon of Nature Disturbed Forest Stand in Papandayan Mountain, West Java Indonesia**

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### **Abstract**

Papandayan Mountain is one nature reserve in Garut, West Java province, Indonesia's forest ecosystems disturbed. Form of disturbance to the ecosystem is the eruption of the Papandayan mountain in 2002 (natural) and disruption due to encroachment and illegal logging (anthropogenic). The purpose of this study was to assess the species composition and structure of forest stands disturbed, either by natural or anthropogenic. Determining the location of the observations done by using purposive sampling method, ie on undisturbed forest sites. Analysis of the data used is the analysis of vegetation to find a picture on the species composition and structure of forest stands. The results showed that the diversity and richness of the forest site types disturbed by anthropogenic higher than the undisturbed forest sites by nature. The dominant type in the affected areas and in areas disturbed eruption illegal logging is *Distylium stellare*, whereas the encroachment area is *Castanopsis javanica*. Canopy stratification patterns in all forest areas are disturbed stratum B (20-30 m) and stratum C (4-20 m). Stand structure for all areas of undisturbed forest in the form the letter "J" upside indicating guarantee for forest succession towards forest conditions as before.

**Keywords:** disturbed forest; nature reserve papandayan; species composition; stand structure.

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## 1. Introduction

Papandayan mountain is a mountain forest ecosystem with very rich floristic [24]. Forest ecosystems Mount Papandayan get interference due to exposure to the eruption of the Papandayan Mountain in 2002 (natural) and disturbed by humans in the form of illegal logging and encroachment (anthropogenic). Nuisance this disturbance can cause damage to the forest ecosystem is [13,31]. The disturbance in tropical forests would lead to changes in plant species diversity [3,7,8,9,14, 29].

Research related to high plant diversity and ecological flora been done by some researchers, such as by [26] on the stand structure and diversity and by [16] concerning the succession of vegetation after the eruption in 2002. However, research on the species composition and stand structure in disturbed forest sites has never been done.

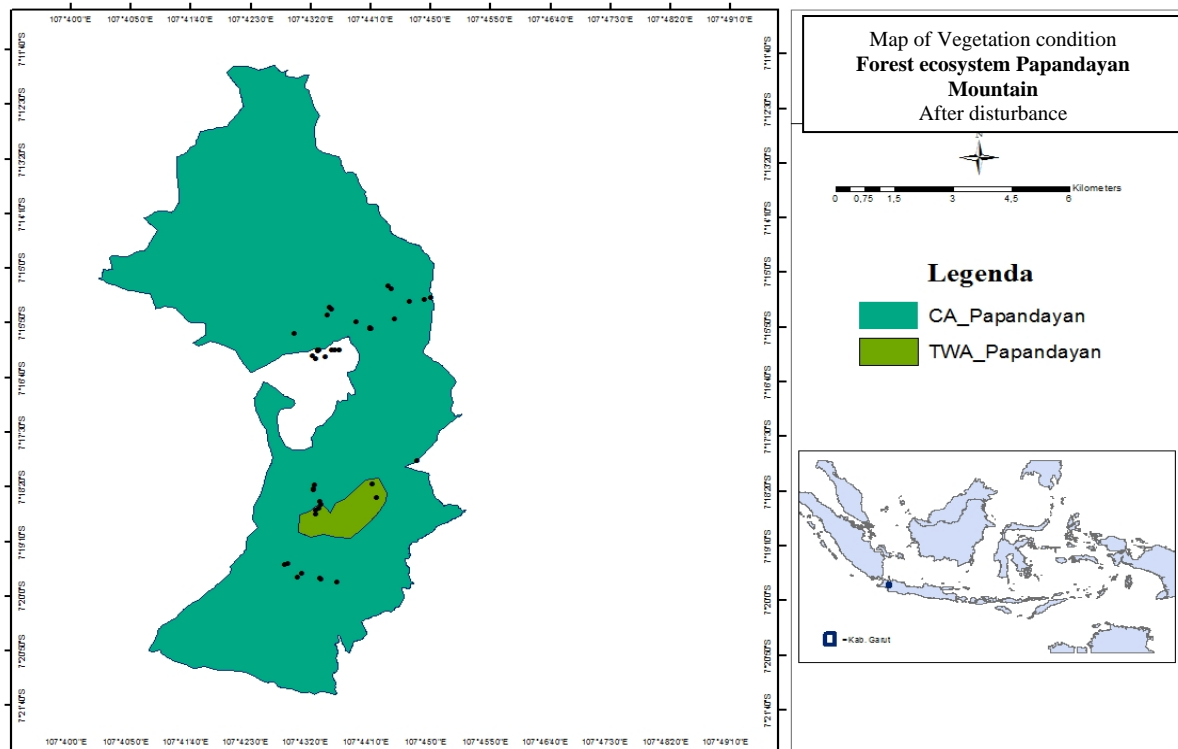
The purpose of this study was to assess the species composition and structure of forest stands disturbed, either by natural or anthropogenic. Results of this research would be useful to provide information about the condition of vegetation in disturbed forest. It also can be used as a baseline in the management or preservation in the nature reserve area of the Papandayan Mountain.

## 2. Material and Method

### 2.1. Study Area

Nature reserve area of the Papandayan Mountain designated as a conservation area by the Forestry Ministerial Decree No. 226 / Kpts - II / 1990 date. May 8, 1990 covering an area of 7032 hectares, consists of a nature reserve area: 6807 Ha, TWA area: 225 ha. Nature reserve area has a climate type B, the data showed annual rainfall of 2077 mm<sup>-1</sup>, monthly rainfall ranges between 54-276 mm month<sup>-1</sup>, evaporation 76-85 mm month<sup>-1</sup> and 77.2% relative humidity. Temperature at Nature reserve area ranging between 14<sup>0</sup>C - 22<sup>0</sup>C. The temperature pattern in the fourth study area is the same although the temperature range that is wide enough to 8<sup>0</sup>C. The highest temperature in the four regions in May and November, while the low temperatures occur in July and August [1].

Nature reserve area including mountainous rain forest with Oak-laurel type associations are usually dominated by lauraceae. Flora which are generally dominated by trees Suagi (*Vaccinium Valium*) and Edelweiss (*Anaphalis javanica*), while other kinds of vegetation is Puspa (*Schima walichii*), saninten (*Castanopsis argentea*), Kihujan (*Engelhardia scipata*), Jamuju (*Podocarpus imbricatus*), Replac ( *Quercus sp.*), Manglid (*Manglieta glauca*). Species in the area of the Papandayan mountain which is easily found directly generally various kinds of birds, monkey (*Presbytis phyrus*), Surili (*Presbytis angula*), Weasel (*Paradoxurus hermaproditus*), Long-tailed monkeys (*Macaca fascicularis*), Pig (*Sus scropa*), Deer ( *Indian muntjac*), Porcupine (*Histrix sp*), hare (*Tragulus javanicus*), jungle cat (*Felis bengelensis*), leopard (*Panthera pardus*), pythons snake (*Python sp.*), Londok (*Callotes jubatus*), Lizard (*Mabouia multifasciata*), Frogs (*Bufo melanotictus*) and various types of birds [1]. Figure 1 shows the location of research.



**Figure 1:** study area

## 2.2. Tools and Materials

The materials used in this study is a Landsat image of 2012, the entire tree and its renewal, as well as other habitus which is in the path of observation; transect soil samples; materials for the manufacture of herbarium and vegetation analysis, specimen plants, mines plastic, rope rapia and alcohol. The tools used in this study include: GPS, compass, haga Hypsometer, phiband, altimeter, and tree species identification book.

## 2.3. Research Procedure

Data retrieval research conducted during the month of April 2013 - May 2015 in the Nature Papandayan Mountain in West Java province of Indonesia on the location of forests damaged by the eruption of 2002, are degraded through encroachment and forest damaged by illegal logging. In each forest area made the observation plots terraced line method [11] combined with path method [6]. The observation plot measuring 20 × 20 m to the minutes of the tree and placed inside the sub-sub plot observations measuring 2 × 2 m to the minutes of seedlings, 5 x 5 m for the minutes of the stake, and the 10 x 10 m for the minutes of the pole. Canopy stratification is done by using the profile diagram canopy with plot 20 mx 60 m were taken from half of the pilot, the plot observation that if it can represent.

Analysis of the data used in this research is the analysis of vegetation to pictured on composition of the species and structure of forest stands. The calculation is performed on parameters which include important value index, dominance index, species diversity index, index of species richness and evenness index and made a graph which

shows the structure of the stand. Data processing results of the analysis of vegetation cover: Importance Value Index (IVI), Dominance Index, Index Type Diversity, Community similarity coefficient, Wealth Index Type, and Evenness index type

### 3. Result

#### 3.1. Species Composition

Based on observations, the location of the damaged because of the eruption of 2002 had the fewest number of species at all stages of growth when compared with the location of damaged because of encroachment and logging. Meanwhile, the location of the damaged because of logging the number of species is relatively more when compared with the location of damaged because of encroachment. Result presented in table 1.

**Table 1:** Number of species are found at every level of growth in the research area

No.	Damage types	Number of Species			
		Seedling	Sapling	Pole	Trees
1	Area affected by volcanic eruption	11	15	12	9
2	Territory encroachment	25	40	27	30
3	Illegal logging area	21	35	34	32

#### 3.2. Dominant Species

Species composition and dominant species in three types of location of damage varies greatly. At the location of the damaged since the eruption of the type of dominance is kendung (*Helicia serrata*) at a rate of seedlings and saplings, Suwagi (*Vaccinium varingifolium*) at the level of the pole, and angrit (*Distylium stellare*) at tree level. At the location of the damaged because of the encroachment of the type of dominance is Puspa (*Schima walichii*) at a rate of seedlings, saplings and poles, and Hiur (*Castanopsis javanica*) at tree level. At the location of the damaged due to logging are the dominant type of Ki Salam (*Eugenia operculata*) at a rate of seedlings and saplings, and Angrit (*Distylium stellare*) on pole and tree level. Result presented in table 2.

#### 3.3. Index of Species Diversity

According to the Shannon-Wiener, the value of diversity Index is generally in the range between 1.0-3.5 where the closer the value of 3.5 then describe the level of high diversity.

The values of diversity index for all levels of growth in the overall type of location of damage is high, because the species diversity index value greater than 2, except at the level of a tree in a location that is damaged due to the eruption, the diversity of species classified as being due to value diversity index ranged between 1 and 2. Result presented in table 3.

**Table 2:** Dominant and codominant species of vegetation at every level of growth in any types of damage in the mountain forest ecosystem at Papandayan Nature Reserve

Damage Types	Growth Rate and Dominant and codominant types	Family	Density (N ha <sup>-1</sup> )	Frequency	Dominansi (m <sup>2</sup> ha <sup>-1</sup> )	Importance Value Index (IVI) (%)
Area affected by volcanic eruption	Seedling					
	Helicia serrata	Proteaceae	4038	0,54		52,01
	Wormia excelsa	Dilleniaceae	2692	0,42		37,60
	Sapling					
	Helicia serrata	Proteaceae	1138	0,58		46,46
	Distylium stellare	Hamamelidaceae	446	0,42		24,16
	Pole					
	Vaccinium varingifolium	Ericaceae	81	0,27	0,43	73,86
	Distylium stellare	Hamamelidaceae	10	0,19	0,58	47,89
	Trees					
Distylium stellare	Hamamelidaceae	10	0,19	0,59	93,70	
Wormia excelsa	Dilleniaceae	7	0,19	0,24	60,79	
Territory encroachment	Seedling					
	Schima walichii	Theaceae	1437	0,23		27,32
	Eugenia operculata	Myrtaceae	937	0,20		20,86
	Sapling					
	Schima walichii	Theaceae	1030	0,68		39,37
	Eugenia operculata	Myrtaceae	590	0,48		24,67
	Pole					
	Schima walichii	Theaceae	63	0,29	1,04	67,80
	Castanopsis javanica	Fagaceae	29	0,14	0,58	34,28
	Trees					
Castanopsis javanica	Fagaceae	34	0,39	2,92	63,34	
Schima walichii	Theaceae	15	0,46	1,19	37,56	
Illegal logging area	Seedling					
	Eugenia operculata	Myrtaceae	1454	0,25		52,35
	Distylium stellare	Hamamelidaceae	1136	0,20		41,01
	Sapling					
	Eugenia operculata	Myrtaceae	749	0,49		42,38
	Distylium stellare	Hamamelidaceae	283	0,25		18,24
	Pole					
	Distylium stellare	Hamamelidaceae	67	0,40	1,18	58,31
	Eugenia operculata	Myrtaceae	44	0,29	0,76	39,13
	Trees					
Distylium stellare	Hamamelidaceae	68	0,65	6,97	74,32	
Engelhardia spicata	Fagaceae	23	0,53	7,05	50,47	

**Table 3:** Index of species diversity ( $H'$ ) at each level of growth in the research sites

No.	Damage Types	Index of species diversity ( $H'$ )			
		<i>Seedling</i>	<i>Sapling</i>	<i>Pole</i>	<i>Trees</i>
1	Area affected by volcanic eruption	2,02	2,34	2,08	1,88
2	Territory encroachment	2,89	3,03	2,80	2,68
3	Illegal logging area	2,49	2,93	3,01	2,58

### 3.4. Index of Species Richness

The values of Species richness index at the location which was interrupted by the eruption of 2002 (nature) is smaller than the sites disturbed by encroachment and illegal logging (anthropogenic). Result presented in table 4.

**Table 4:** Value of species richness index ( $R_1$ ) at each level of growth in the research sites

No.	Damage Types	Species richness index ( $R_1$ )			
		<i>Seedling</i>	<i>Sapling</i>	<i>Pole</i>	<i>Trees</i>
1	Area affected by volcanic eruption	1,98	2,52	2,03	2,33
2	Territory encroachment	4,73	6,39	5,64	5,39
3	Illegal logging area	4,19	5,71	6,34	5,03

### 3.5. Evenness Index of species

Evenness index values for all growth rates on any type of location is interrupted, is high, which means the number of individuals per species at all locations evenly. Result presented in table 5.

**Table 5:** Value evenness index ( $E_H$ ) at each level of growth in the research sites.

No.	Damage Types	Value Evenness Index ( $E_H$ )			
		<i>Seedling</i>	<i>Sapling</i>	<i>Pole</i>	<i>Trees</i>
1	Area affected by volcanic eruption	0,85	0,87	0,84	0,86
2	Territory encroachment	0,89	0,82	0,85	0,79
3	Illegal logging area	0,82	0,82	0,88	0,75

### 3.6. Index of dominance

Dominance index value describes the pattern of dominance in a kind of stand. Dominance index of species at all disturbed area is low, because there is no dominance index value equal to or close to one. This indicates that the dominance of species at study sites scattered in many types, this is a reflection of tropical forests even though the location of the research conducted on undisturbed forest sites. Result presented in table 6.

**Table 6:** Index of dominance at every level of growth in the research sites.

No.	Damage Types	index of dominance			
		<i>Seedling</i>	<i>Sapling</i>	<i>Pole</i>	<i>Trees</i>
1	Area affected by volcanic eruption	0,16	0,12	0,15	0,19
2	Territory encroachment	0,07	0,08	0,09	0,10
3	Illegal logging area	0,13	0,08	0,08	0,12

### 3.7. Structure of Vegetation

The Structure of Vegetation at Natural forest can be seen from the relationship between the diameter classe density. The results showed the highest density value types contained in the seedlings and the density of the lowest kind are at the level of the tree. The highest density of seedlings is at location that is damaged due to the eruption, to the level of stake is at a location that is damaged due to encroachment, while the level of the highest density poles and trees are at locations damaged by logging. Result presented in table 7.

**Table 7:** Vegetation density at every level of growth at the sites

No.	Damage Types	Density (N ha <sup>-1</sup> )			
		<i>Seedling</i>	<i>Sapling</i>	<i>Pole</i>	<i>Trees</i>
1	Area affected by volcanic eruption	14712	3923	215	30
2	Territory encroachment	9938	4440	244	132
3	Illegal logging area	5318	2807	333	213

### 3.8. Stratification of Canopy

Stratification is a pattern plating canopy , in Papandayan Mountain can be grouped into two strata, the stratum B (high trees between 20-30 meters), and stratum C (tree height between 4-20 meters). But no one reaches the stratum A (high trees over 30 meters). To reach the stratum A, only the old-old trees of climax tree species are capable of, so the number of trees a little and appear discontinuous.

At the location of the damaged because of the eruption and encroachment stratification canopy is still in the

stratum C and concentrated on the canopy with a high grade of 4-10 m, this is due to the location of the damaged because of the eruption and illegal encroachment at the beginning of the damage, the condition of the vegetation destroyed and become areal open. As for the location of the damaged because of logging, although stratification of the canopy is still in the stratum C, but the concentration of the population are in the canopy of trees with a high class of 11-20 m. In addition, based on calculations by class tree density and height of trees in the stratum B, the location is damaged due to logging has the highest density value. This is because the location is damaged by logging an intact forest which is then subjected to human disturbances such as illegal logging, so that the condition of the vegetation is not exhausted as on the location of the damaged because of the eruption and encroachment.

The number of species in each study location varies. In the area destroyed by the eruption in 2002 had the fewest number of species at all stages of growth when compared with the location of damaged because of encroachment and logging. The results are consistent with the results of earch [4] which explains that the condition of Sri Lanka Sinharaja forest conservation that have been impaired are likely to experience significant changes, where the influx of pioneer plant species will increase the number of plant species in the area.

The dominant of species are different at every disturbed area. Dominan species at the area affected by the eruption of 2002 is *Distylium stellar*, and at encroachment area, illegal logging while at the acreage *Castanopsis javanica*. According to [19]; the disturbed tropical forests changes dominance very different species with primary forest in the vicinity.

Diversity index type at any level of growth in the area of encroachment has the highest value rather than on illegal logging areas and areas affected by the eruption. This is because the type of vegetation at the site is already mixed with species planted by the community because of the location of an abandoned former agricultural land. In the area affected by the eruption has the most value diversity index lower. This is because the type of vegetation growing on the site are still in the process of succession. Reference [30] states in an environment that does not indicate the presence of specific factors, the environmental community that occupied the question will demonstrate a high level of species diversity. In this study, forest disturbance is a special factor in any location, where the diversity in human-disturbed location higher than the location which is violated by nature. High diversity in the location indicated disturbed by humans because of some kind is not an original type in that location. The highest density is in the area kind of illegal logging, while the density of the lowest kind is in the area affected by the eruption

#### **4. Conclusion**

Species composition and dominant species at the level of the pole and trees in the area affected by the eruption is Suwagi (*Vaccinium varingifolium*), Angrit (*Distylium stellare*) and Segel (*Wormia excelsa*). In the area of encroachment is Puspa (*Schima walichii*) and Hiur (*Castanopsis javanica*). In the areas where illegal logging is Angrit (*Distylium stellare*). Forest disturbance is a special factor in any location, where the diversity in human-disturbed location higher than the location which is violated by nature. Editorial coating pattern on all disturbed



areas are located in the stratum B (20-30 m) and stratum C (4-20 m).

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