The Group Of Understory Herbaceous Vegetation Stand At Tropical Lower Mountain Forest Of Mount Salak, West Java

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Abstract. This study aimed to determine the groups of herbaceous vegetation stands at tropical lower mountain forest of Mount Salak, Bogor, West Java. Hierarchical cluster analysis method was used for grouping herbaceous vegetation stands by Importance Value Index. The distance between stands was determined using Sørensen index while the grouping of stands made by the farthest distance method. The difference in stand's vegetation structure among the groups was tested with Kruskal-Wallis statistics. There were 4 stand groups (SG) formed at 80% distance of Sørensen index. The difference between SG was most visible through floristic composition. The most difference of SG was between SG 2 and SG 4, where the most dominant species that make up these SGs were *Nephrolepis exaltata*, *Isachne globosa* (family: Poaceae), and *Etlingera megalocheilos* (family: Zinggiberaceae) for SG 2 and *E. megalocheilos*, *N. exaltata* and *Dinochloa scandens* (family: Poaceae) for SG 4. Species *N. exaltata*, *Scleria purpurascens* (family: Cyperaceae), and *Selaginella plana* (family: Selaginellaceae) were found throughout the entire SG. There were no significant differences among the SG in the case of Shannon-Wiener's Diversity Index, Pielou's Evenness Index, Simpson's dominance index and the number of species ($P \geq 0.05$). There was a decreasing trend of vegetation structure's value from SG 2 to SG 1.

Key words: Groups of herbaceous vegetation stands, Importance Value Index, Mount Salak, Sørensen index, tropical lower mountain forest,

INTRODUCTION

Mount Salak is part of the Mount Halimun Salak National Park (MHSNP) based on the Minister of Forestry's decree No. 175 / Kpts-II / 2003 (Ekayani, *et al*., 2014). The MHSNP is the largest national park and contains largest mountainous tropical rainforest ecosystem on Java island, rich in biodiversity, beauty of the landscape and diverse of traditional culture (GHSNPMP-JICA, 2009). Administratively, the MHSNP covers two provinces of West Java and Banten as well as three districts, namely Bogor, Sukabumi and Lebak (Galudra *et al*., 2005).

The Mount Halimun Salak National Park is vulnerable because its location is very close to the residential area. According to Tapadebu *et al*., (2008), Java has experienced very fast rate of natural ecosystem conversion and it also is the most populated area in Indonesia.

Forests are the association of plants and animals communities which are dominated by trees and woody vegetation with a certain area that forms the micro-climate and specific ecological conditions (Simon,1993). The quality and quantity of forest ecosystems should be preserved, among others by conservation in which ecosystem utilization is carried out by considering the overall presence function. Forest management that only considers one function alone will lead to the destruction of forests (Ismaini *et al*., 2015). Undergrowth is one part of the forest functions (Prihantoro, 2013).

Most research on tropical forests vegetation has tended to focus on the tree component, and very few toward the understory vegetation (Lü *et al*., 2011). Herbaceous community in tropical rainforests is so little known, and it is less research on the structure quantitatively. On the other hand, underground herbaceous plants is a group of rich plant, comprising 14 to 40% of the species of the total species found in tropical rainforests. (Costa, 2004).

Understory vegetation layer is important for nutrient cycling (Hart & Chen, 2006), carbon cycling at an ecosystem (Larashati, 2010), and towards the plants of upper canopy layers (Hart & Chen, 2006). This layer is able to inhibit runoff on the forest floor to prevent erosion (Kinho, 2011), often used as indicators of soil fertility and litter producers in improving soil fertility (Hilwa & Masyrifina, 2015). One of the forest components that use by the society around the forest is an understory vegetation (Suharti, 2015), as food, medicinal plants, and as an alternative energy source (Hilwa & Masyrifina, 2015).

Studies on herbaceous vegetation understory, especially in lower mountain zone on Mount Salak still need to be increased, especially the ecology of understory vegetation considering the importance of this vegetation layer, beside that, it is also still rarely conducted. The comprehension on understory vegetation ecology is important for conservation activity of the MHSNP and also as a source of baseline data. This study aimed to determine the groups of herbaceous vegetation stands and how the floristic composition and structure of herbaceous vegetation on the group stands at tropical lower mountain forest of Mount Salak, Bogor, West Java.

METHODS

Study site

This research was conducted at the lower mountain forest of Mount Salak, at the MHSNP. Location of the study can be climbed from several places, and in this study through the village of Gunung Bunder Dua (S6^{o}41'484 "-E106^{o}42'234") and the village of Gunung Sari (Kawah Ratu) (S6^{o}41'.786"-E106^{o}42'. 006") subdistrict of Pamijahan, Bogor Regency. The research area is located from 1033 m asl - 1362 m asl.

Based on soil maps of West Java, the soil type in this area consists of the brown andosol association and brown regosol, the brown latosol association and yellowish brown latosol, brown latosol reddish and brown latosol, the brown latosol reddish association and laterite, complex brown latososl reddish and lithosol, brown latosol association and gray regosols (LP Tanah, 1966 *in* Larashati, 2010). According to the Schmidt & Ferguson's classification (1951), the climate at the MHSNP region including type A, with an annual rainfall of 4000-6000 mm.

Butterfly at Mount Salak mostly came from the Nymphalidae family. Butterfly species with the highest number of individuals is *Melanitis leda* (Tapadebu *et al*., 2008). Among others of Lucanid beetle that can be found in this mount are *Cyclommatus canaliculatus*, *Dorcus taurus*, *Prosopocoilus astocoides*, *Odontolabis bellicosa*, and *Prosopocoilus zebra* (Koneri *et al*., 2010). The endemic bird of Sumatra, Java, and Bali, the Walik Purple Head (*Ptilinopus porphyreus*) can be found on Mount Salak (van Balen & Nijman, 2004).

Sampling Method

Sampling was carried out in four places, namely on slopes facing toward the North, South, East, and West so that ecologically the entire region could be represented. At each location, we put 15 transects. The transect was placed cut perpendicular to the direction of elevation topography. Each transect has a size of 200m x 5m, and we considered it as 1 stand. The total number of stands were 60.

We made 10 observation plots with each has a size of 5m x 5m at every transect and the distance between the plot was 15m. Herbaceous plants in this study is a plant that does not have woody body parts above the soil surface. Fern was included in this study if it has a height at maturity $\leq$ 50 cm. Data was obtained by estimating the percentage of the herbaceous plants crown cover in each observation plot. Assessments carried out with reference to the Braun-Blanquet scale (Barbour *et al*., 1987).

Data Analysis

We determined species Importance Value Index (IVI) at each stand, where the IVI was obtained through the sum of the relative frequency with the relative dominance of each species (Cox, 1978; Hardjosuwarno, 1990; and Kusmana, 1997). We calculated the Shannon-Wiener's diversity index (Lalchhuanawma, 2008), the Pielou's evenness index, species richness (Omoro & Luukkanen, 2011), and the Simpson's dominance index (Barbour *et al*., 1987).

Data matrix of IVI was imported into R using read.csv ( ) function, then transformed so that the column part of the data matrix became the line in order to be processed with the vegan library (Oksanen *et al*., 2016). Hierarchical cluster analysis method was used for grouping herbaceous vegetation stands by IVI and calculated it using hclust ( ) function. The distance between stands was determined using Sorensen index (Kent & Cooker, 1992), and calculated with designdist ( ) function, which was part of the vegan library. Dendrogram graph is displayed to indicate the SG.

The most dominant species (tmds) in each SG was the species that have the most number of highest IVI of first and second order. If there are two or more species that have the highest IVI with the same number of stands, tmds will be decided based on the highest second ordered number of IVI from those species. The number of dominant species in SG were 3, where the first order of tmds was written first followed by the second and the third order of tmds in the next sequence.

Non-parametric test Kruskal-Wallis rank sum was conducted to determine whether there was a difference in vegetation structure among SGs (Lukiastuti & Hamdani, 2012). Data analysis and statistical tests performed by use the R version 3.2.2 (R Core Team, 2015).

RESULTS

Stand Groups

There were four SGs at 80% distance of the Sorensen's index. Every SG was composed with the different number of stands. The SG 1 was consisted with 17 stands which were stands 1, 4, 5, 17, 18, 19, 20, 24, 27, 30, 33, 40, 41, 46, 51, 52, and 60. The SG 2 consisted with 19 stands and was the highest number compared to other SG. This SG was made up of stands 2, 6, 8, 12, 13, 16, 21, 23, 31, 35, 36, 39, 45, 47, 49, 50, 54, 56, and 58.

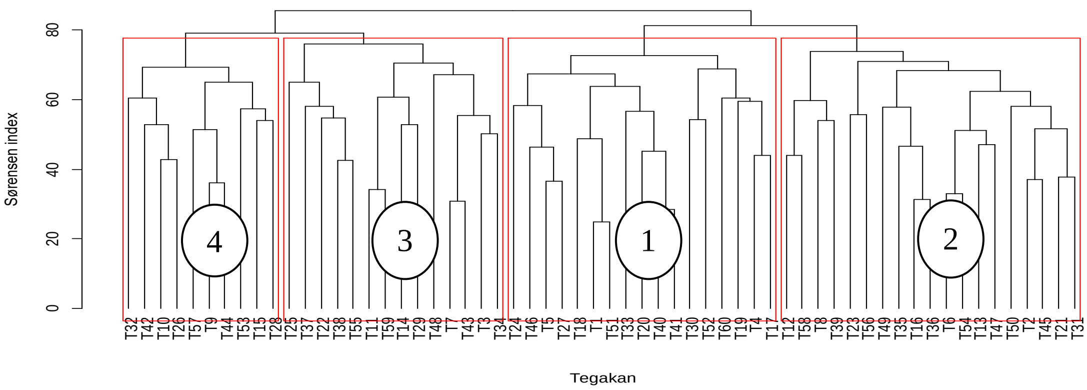

Figure 1. The Stand groups of herbaceous vegetation at lower mountain zone of Mount Salak. Each stand groups was confined within a box. Number 1,2,3, and 4 indicating stand group. T: Stand. Tegakan: Stand.

The SG 3 consisted with 14 stands, which were stands 3, 7, 11, 14, 22, 25, 29, 34, 37, 38, 43, 48, 55, and 59. The SG 4 was composed of 10 stands, which were stands 9, 10, 15, 26, 28, 32, 42, 44, 53, and 57. This SG has the lowest number of stands among the other stands (Figure 1).

The composition of species in Stand Groups

The most dominant species on the SG 1 is: *Nephrolepis exaltata* (family: Lomariopsidaceae), *Etlingera megalocheilos* (family: Zinggiberaceae), and *Scleria purpurascens* (family: Cyperaceae); on SG 2 is: *N. exaltata*, *Isachne globosa* (family: Poaceae), and *E. megalocheilos*; on SG 3: is *N. exaltata*, *E. megalocheilos* and *I. globosa*, and in the SG 4 is *E. megalocheilos*, *N. exaltata* and *Dinochloa scandens* (family: Poaceae). The *N. exaltata* was found as tmds in 16 stands (Table 1), in addition, the *N. exaltata*, *S. purpurascens*, and *Selaginella plana* (Family: Selaginellaceae) were found in all stands in the whole SGs.

Table 1. Species with highest Important Value Index

Stand Group	Rank I		Rank II		Rank III	
	Species	Number of stands	Species	Number of stands	Species	Number of stands
1	*Nephrolepis exaltata*	4	*Etlingera megalocheilos*	3	*Scleria purpurascens*	2
2	*Nephrolepis exaltata.*	6	*Isachne globosa*	4	*Etlingera megalocheilos*	3
3	*Nephrolepis exaltata*	6	*Etlingera megalocheilos*	3	*Isachne globosa*	2
4	*Etlingera megalocheilos*	3	*Nephrolepis exaltata*	2	*Dinochloa scandens*	1

The most different of SG in terms of species with the highest IVI and the most was SG 4. In this group, *N. exaltata* was not the first order of tmds, but *E. megalocheilos* and the third order of tmds was *D. scandens*. The first order of tmds in the other three groups was *N. exaltata*. The next group was SG 1, where of the third order of tmds was *S. purpurascens,* and this species was not tmds in the other SGs (Table 1).

At SG 2, *E. megalocheilos* and *E. punicea* were the third order of tmds. Both species have the highest IVI where each in three stands, however *E. megalocheilos* has more of the second order of tmds on more stands than *E. punicea*. The most dominant species on SG 2 and SG 3 were same but different in terms of the second and the third order of tmds, which for SG 2, those species were *I. globosa* and *E. megalocheilos,* while for SG 3 was the opposite (Table 1).

The species that only found in SG 2 was *Phragmites karka* (family: Poacea) and *Mussaenda frondosa* (Family: Rubiaceae), while in SG 4 was *Dipteris conjugata* (family: dipteridaceae). At SG 1 and SG 3, there was no species that can only be found in those of SGs. The total number of species found in this study was 58. Species *N. exaltata* is a plant with fern life form, *E. megalocheilos* is a plant with a ginger life form, *I. globosa* is a plant with grass life form, *S. purpurascens* is a plant with a grass life form and *D. scandens* is a plant with a climbing bamboo life form.

Species Diversity structure in stand groups

The mean range number of herbaceous vegetation species on each SG was 24.41 at SG 1 to 25.316 at SG 2 (Figure 1). The Kruskal-Wallis rank sum test showed that there was no different number of species in each SG (Kruskal-Wallis χ^2 = 0.66999, df = 3, P = 0.8802).

Shannon-Wiener's diversity index on each SG has a mean value that ranges from 2,910 at SG 1 which was the lowest value, while the other value was 2,959 at SG 4 which is the highest value (Figure 1). There were no differences of Shannon Weiner's diversity index among the four SGs (Kruskal-Wallis χ^2 = 0226, df = 3, p = 0.973).

Pielou's evenness index in four SGs has a mean value that ranges from 0,910 at SG 1 which was the lowest value and 0.927 at SG 4 which was the highest value (Figure 1). The Pielou 's evenness index among the four SG has no different (Kruskal-Wallis χ^2 = 1,652, df = 3, P = 0.6477). This species evenness values was closed to 1, which indicated that each species composing herbaceous vegetation in each SG has relatively equal of the individual number.

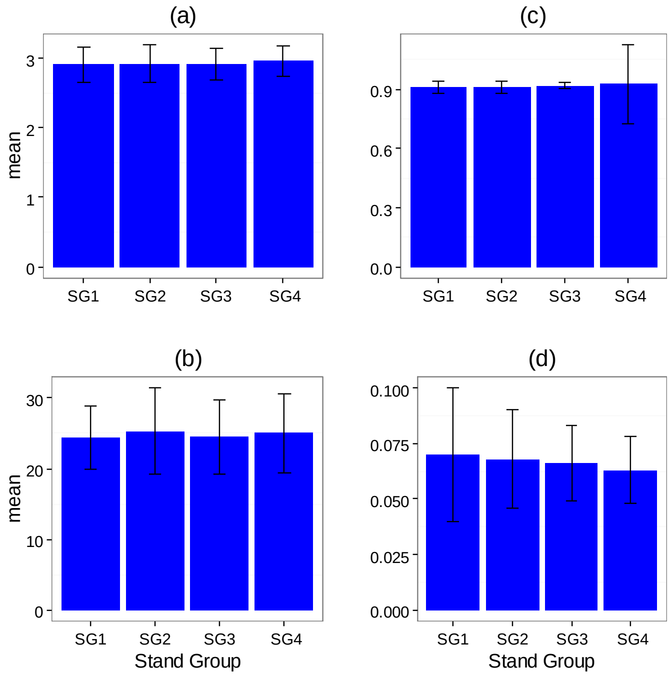

Figure 2. Mean and Standard Deviation of (a) Shannon Wiener's Diversity Index, (b) Number of Species, (c) Pielou's Evenness index, and (d) Simpson's index on four SG herbaceous vegetation. The y axis represents mean and standard deviation. Note: SG: Stand group.

The mean value of dominance species based on Simpson's index range from 0.063 at SG 4, which was the lowest value to 0,070 at SG 1, which was the highest value (Figure 1). There were no difference of Simpon's Index among the SGs (Kruskal-Wallis χ^2 = 0.29953, df = 3, p = 0.9601). These values were very small compared to 1, indicating that there were no species that relatively dominant in each SG.

The significant differences in terms of the number of species, diversity, evenness and dominant species do not appear in that of the four SGs. However, it appears that there is a tendency of SG 1 and SG 4 always has a value that is relatively different in terms of Shannon-Wiener's diversity index, Pielou's evenness index, and Simpon's index. SG 1 also appears to have the lowest mean value of species number (Figure 2). This probably indicating that SG 4 is more diverse than SG 1.

Discussion

The difference between the SGs is not very visible through the vegetation structure, but rather towards floristic composition. Indriyanto (2009) said that the species of lower plants depend on the species' ability adapting to a growing site and associated with other plants. According to Whitten *et al.*, (1996), the demarcation between the lowland and the mountain zones at 1000 m asl at Jawa Island determined mostly determined floristically. Furthermore, Larashati (2010) said that, the grouping of stand vegetation on Mount Salak especially related with canopy cover, which comprised with the area of closed canopy, open canopy, and very open canopy.

The species number, high diversity, high Evenness, and low Dominance Index probably because geographical position of Mount Salak, which is located at high altitude areas that support high precipitation. Most of the dominant species in the studied sites are members of fern life form. The abundance presences of fern species is an indicator of high precipitation. The similarity in terms of the structure of the vegetation may be caused by the location of the stands which at the zone of the tropical lower mountain forest at Mount Salak.

Espinosa *et al.*, (2011) in his research showed that the species composition of Tumbesian dry forests at the southern part of Aquador mainly determined by climate, topography, and soil. Water availability at that area significantly determined the species assemblage. Bai *et al.*, (2011) said that important factor in explaining the spatiotemporal trends within the vegetation were climatic factors.

CONCLUSION

The number of stands that make up the SG was different. The different among the SG was determined by the difference in floristic composition. Vegetation structure obtained through diversity, evenness, species richness and dominance of species did not differ significantly between the SG.

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