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Distribution of Tree Canopy-Level Vegetation in Mandiangin Hill, Banjar Regency

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ABSTRACT

The high diversity of tree species at various height levels indicates that there may still be many unidentified tree species, making it unclear how the distribution and abundance of the tree community's structure are. The ULM Special Purpose Forest Area (KHDTK ULM) covers an area of 1,617 hectares. The KHDTK ULM includes several regions such as Bukit Besar, Bukit Mandiangin, Bukit Pamaton, and Bukit Pandamaran, each with different elevations. Research on the structure of the tree community at Bukit Mandiangin is necessary for the preservation of germplasm in the KHDTK ULM. The objectives of this research are (1) to assess the presence of tree species at different elevations, (2) to analyze the distribution and abundance of tree species at different elevations, and (3) to analyze the diversity, evenness, and similarity of tree species communities at different elevations

Introduction

Forests are highly complex natural ecosystems that serve various functions, including being a source of germplasm, water storage, ecosystem stability, oxygen production, erosion prevention, livelihood support, natural resource provision, and meeting the needs of communities. Forests also have the potential to be natural tourist attractions, research facilities, and a means to witness the greatness of the Almighty Creator. Vegetation in forests varies from the undergrowth, saplings, and poles to trees. The presence of tree canopy levels, apart from being a source of biodiversity, also plays a role in soil and soil organism protection, microclimate creation within the forest floor, safeguarding the soil from erosion, and maintaining soil fertility.

Tree canopy-level plants have extensive root systems that result in dense clumps, capable of preventing soil erosion and protecting the soil from rainfall and surface runoff. They also contribute to the increase of organic matter in the soil, serving as green manure or mulch (Erna, 2017). Besides their ecological functions, certain canopy levels have been identified as plants that can be utilized as food sources, medicinal plants, and alternative energy sources. However, it is not uncommon for tree canopy levels to also act as weeds that hinder the growth of tree saplings.

The high diversity of tree canopy-level plants suggests that there are likely many unidentified species, making it unclear the actual diversity and community structure. The Lambung Mangkurat University has been entrusted by the Ministry of Environment and Forestry to manage a forest area spanning 1,617 hectares located in Karang Intan District, Banjar Regency. This location is adjacent to the Sultan Adam Grand Forest Park (Tahura). Bukit Mandiangin falls within the KHDTK area, with an elevation of approximately 275 meters above sea level. The hill still boasts a significant expanse of natural forest vegetation. The main issue at hand is the distribution and abundance of tree canopy-level species at different elevations within the Bukit Mandiangin area. Specifically, the study aims to identify the species present at different elevations, analyze their distribution and abundance, determine their importance value index, assess diversity, evenness, and similarity of plant communities, and investigate whether different elevations significantly influence the number of species encountered. Information on the distribution, abundance, and dominance of tree canopy-level species, and other aspects investigated will be invaluable for KHDTK managers in planning and implementing advanced silvicultural techniques to facilitate the regeneration of natural forest vegetation in the KHDTK ULM.

Materials and Methods

Tools and Materials

The research conducted at Bukit Mandiangin, KHDTK ULM, utilized various tools and equipment such as research location maps, Global Positioning System (GPS), raffia ropes, Phiband or measuring tape, machetes, cameras, light meters, tally sheets, Thermo hygrometers, white bond paper, whiteboards, wooden stakes, plastic bags, and laptops. The focus of the study was on tree canopy-level vegetation.

The research location was determined using the purposive sampling method, which involved examining satellite images. Data collection employed sampling techniques through the establishment of randomly located sample plots that represented the entire population of trees. The addition of sample plot area was done until the addition of individuals ≤ 10%, which served as the size of the sample plot (Oosting, 1973 in the Ministry of Forestry, 2004). Based on the final presentation results, the minimum plot area for vegetation analysis can be determined.

Research Methods

The Importance Value Index (IVI)

The data collected in the field consists of recording various vegetation types, which are then calculated and expressed as the Index of Importance Value (IIVI. The IIV is determined by summing the relative density, relative frequency, and relative dominance.

The Index of Species Diversity (H')

To assess the stability of a community, the calculation of species diversity is performed. The Index of Species Diversity can be determined by calculating the species diversity according to Shannon-Weiner index (Umar, 2013).

The Index of Species Evenness (E)

To determine the community structure of plants within the research plot, the Index of Evenness between species is calculated as proposed by Odum (1993).

The Index of Community Similarity (IS)

The Index of Community Similarity is used to determine the relative similarity of species composition between two compared stands at each growth level. The Index of Community Similarity between habitats, according to Suin (2002), can be calculated using the Sorensen formula.

The Complete Randomized Design (CRD)

This study employed a Complete Randomized Design (CRD) to investigate the differences in the number of species and individuals at each elevation level, consisting of three elevation categories. Each elevation category was replicated six times. The elevation categories used in this study were as follows: A) Elevation 125 - 150 meters above sea level (masl), B) Elevation 150 - 175 masl, and C) Elevation 175 - 200 masl

Results And Discussion

The Complete Randomized Design (CRD)

The vegetation composition indicates the potential and diversity of plant species in the area (Wibisono and Azham, 2017). The composition of tree canopy-level species at lower elevations can be seen in Table 1.

Table 1. Composition of Tree Canopy-Level Vegetation at an Elevation of 125-150 masl

No	Species Names	Scientific Names	Number of Individuals	Family
1	Alaban	*Vitex pinnata*	4	Verbenaceae
2	Bangkal gunung	*Nauclea subdita*	1	Rubiaceae
3	Bati-bati menjangan	*Eugenia spicata*	4	Myrtaceae
4	Damar kumbang	*Agathis* sp	3	Araucariaceae
5	Jamai	*Instia* sp	6	Fabaceae
6	Kamalaka	-	2	-
7	Lalangsatan	*Lansium* sp	2	Meliaceae
8	Madang puspa	*Schima wallichii*	1	Theaceae
9	Mahoni	*Swietenia macrophylla*	3	Meliaceae
10	Marsihung	*Alseodaphne* sp	1	Lauraceae
11	Medang puspa	*Schima wallichii*	2	Theaceae
12	Tengkook ayam	*Nephelium massoia*	3	Sapindaceae
	Total		32	

Data source: Primary data collected in the field, 2022.

Based on Table 1, which shows a total of 12 plant species, it can be observed that the species with the highest number of individuals in the tree canopy-level vegetation is Jamai from the Fabaceae family, with 6 individuals. Following that, Alaban and Bati-Bati menjangan have 4 individuals each. Damar kumbang, Mahoni, and Tengkook ayam have 3 individuals each. Kamalaka, Lalangsatan, and Madang puspa each have 2 individuals, while Bangkal gunung and Marsihung have the lowest number of individuals, with only 1 individual each. For the composition of tree canopy-level vegetation at mid-elevations (150-175 meters above sea level), please refer to Table 2.

Based on Table 2, which displays a total of 4 plant species, it can be observed that the species with the highest number of individuals is Madang puspa from the Theaceae family, with 8 individuals. Following that, Jamai has 3 individuals, while Alaban and Bati-Bati Menjangan have the lowest number of individuals, with 1 individual each. At this elevation, there is a significant decrease in the number of species compared to the previous elevation. For the composition of tree canopy-level vegetation at higher elevations (175-200 meters above sea level), please refer to Table 3.

Table 2. Composition of Tree Canopy-Level Vegetation at an Elevation of 150-175 masl

No	Species Names	Scientific Names	Number of Individuals	Family
1	Alaban	*Vitex pinnata*	1	Fabaceae
2	Bati-bati menjangan	*Eugenia spicata*	1	Myrtaceae
3	Jamai	*Instia* sp	3	Fabaceae
4	Madang puspa	*Schima wallichii*	8	Theaceae
	Total		13	

Data source: Primary data collected in the field, 2022.

Table 3. Composition of Tree Canopy-Level Vegetation at an Elevation of 175-200 masl

No	Species Names	Scientific Names	Number of Individuals	Family
1	Akasia	*Acacia mangium*	4	Fabaceae
2	Bangkal gunung	*Nauclea subdita*	1	Rubiaceae
3	Bintangur	*Calophyllum inophyllum*	1	Clusiaceae
4	Jamai	*Instia* sp	5	Fabaceae
5	Madang puspa	*Schima wallichii*	5	Theaceae
	Total		16	

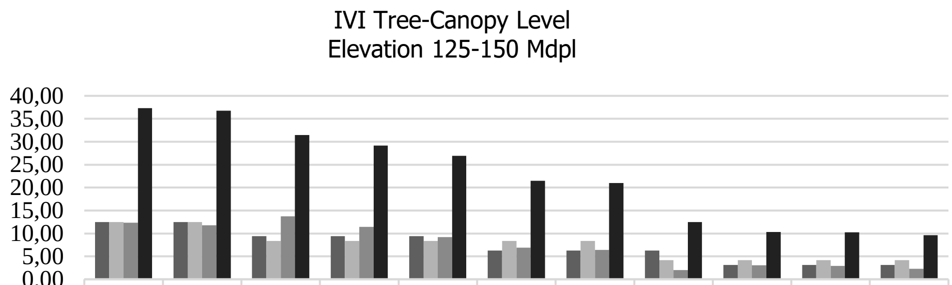
Data source: Primary data collected in the field, 2022.

Based on Table 3, which displays a total of 5 plant species, it can be observed that the species with the highest number of individuals in the tree canopy-level vegetation is Jamai from the Fabaceae family and Madang puspa from the Theaceae family, both with 5 individuals. Following that, Akasia has 4 individuals, while Bangkal gunung and Bintangur have the lowest number of individuals, with only 1 individual each. If we compare the number of species with the previous two elevations, it can be seen that there is a decrease in the number of species from the lower to upper elevations, although there is an addition of 1 species between the mid and upper elevations. Besides internal factors, external factors such as the environment or plant habitat, especially under the canopy, are closely related to sunlight intensity and shade (Dahlan, 2011), which also influence the growth of forest vegetation.

According to Maisyaroh (2010), differences in environmental conditions lead to variations in the number of plant species that grow in an area. Sunlight in open areas is more abundant compared to closed canopy areas, causing plant species in those areas to compete for sunlight, resulting in some species not being able to grow well. In addition to competition for sunlight, the decrease in the number of species may also be caused by the loss of nutrients in the upper soil layer due to continuous surface erosion, leading to soil fertility loss in a forest stand.

The Importance Value Index (IVI)

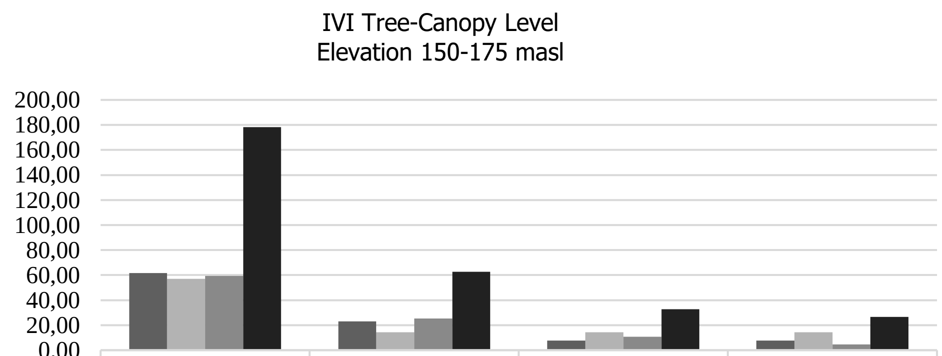
According to Soerianegara and Indrawan (1982) as cited in Yesse (2011), plant species that play a significant role in a forest area are characterized by their high Importance Value Index (IVI), which is the sum of their Relative Density (RD), Relative Frequency (RF), and Relative Dominance (RD). The higher the IVI of a species, the greater its dominance within the community where it grows. The Importance Value Index (IVI) for the tree canopy-level vegetation can be seen in Figure 1.



	Bati-bati menjangan	Alaban	Damar kumbang	Mahoni	Tengkook ayam	lalangsatan	Medang puspa	kamalaka	Bangkal gunung	Marsihung	Madang puspa
KR (%)	12,50	12,50	9,38	9,38	9,38	6,25	6,25	6,25	3,13	3,13	3,13
FR (%)	12,50	12,50	8,33	8,33	8,33	8,33	8,33	4,17	4,17	4,17	4,17
DR (%)	12,34	11,75	13,75	11,42	9,19	6,93	6,39	2,03	3,05	2,92	2,31
INP (%)	37,34	36,75	31,46	29,13	26,90	21,51	20,98	12,45	10,34	10,21	9,60

Figure 1. Importance Value Index of Tree Canopy-Level Vegetation at Lower Elevations

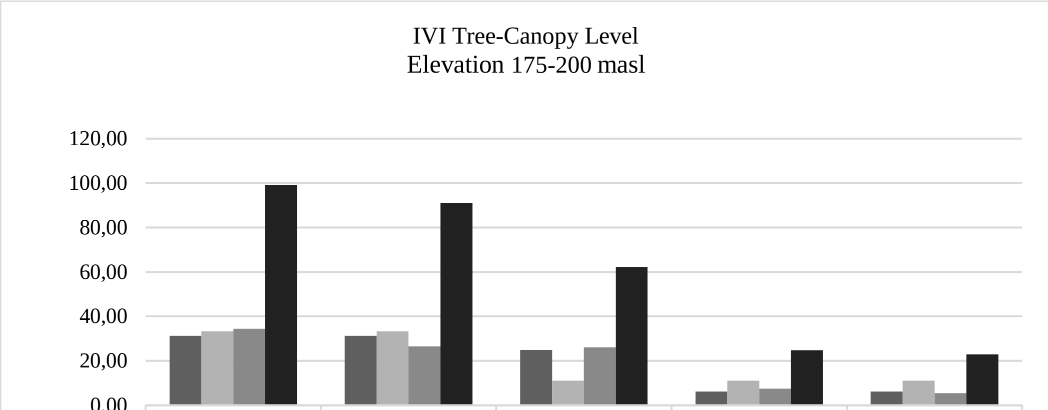
Bati-Bati Menjangan (*Eugenia spicata*), Alaban (*Vitex pubescens*), Damar kumbang (*Agathis* sp), Mahoni (*Swietenia macrophylla*), Tengkook ayam (*Nephelium massoia*), Lalangsatan (*Lansium* sp), Madang puspa (*Schima wallichii*), Kamalaka, Bangkal gunung (*Nauclea subdita*), Marsihung (*Alseodaphne* sp), and Madang puspa (*Schima wallichii*). The highest IVI value is attributed to Bati-Bati Menjangan at 37.34%, obtained by summing the RD (Relative Density) of 12.50%, RF (Relative Frequency) of 12.50%, and RD (Relative Dominance) of 12.34%. Meanwhile, the lowest IVI value is associated with Madang puspa at 9.60%. The difference in IVI values between Bati-Bati Menjangan and Madang puspa is 27.74%. The IVI values for the middle elevation (150-175 masl) can be seen in Figure 2.



	Madang puspa	Jamai	Alaban	Bati-bati menjangan
KR (%)	61,54	23,08	7,69	7,69
FR (%)	57,14	14,29	14,29	14,29
DR (%)	59,43	25,34	10,66	4,57
INP (%)	178,11	62,70	32,64	26,55

Figure 2. Importance Value Index of Tree Canopy-Level Vegetation at Middle Elevations

Madang puspa (*Schima wallichii*), Jamai (*Instia* sp), Alaban (*Vitex pubescens*), and Bati-Bati Menjangan (*Eugenia spicata*). In the above figure, the species with the highest values have reversed compared to the previous elevation. In the previous elevation, Bati-Bati Menjangan had the highest IVI, but at this elevation, Bati-Bati Menjangan has the lowest IVI, while Madang puspa becomes the species with the highest IVI, with a value of 178.11%. The difference in IVI values between Madang puspa and Bati-Bati Menjangan is 151.56%. The above IVI graph also shows that the presence and abundance of Madang puspa are relatively high compared to the others. The IVI values for the upper elevation can be seen in Figure 3.



	Madang puspa	Jamai	Akasia	Bangkal gunung	Bintangur
KR (%)	31,25	31,25	25,00	6,25	6,25
FR (%)	33,33	33,33	11,11	11,11	11,11
DR (%)	34,47	26,52	26,09	7,43	5,50
INP (%)	99,05	91,10	62,20	24,79	22,86

Figure 3. Importance Value Index of Tree Canopy-Level Vegetation at Upper Elevations

The Importance Value Index (IVI)

The diversity index (H) according to Shannon-Weiner states that if the value of $H < 1$, the diversity is considered low. Furthermore, if the value of H is between 1 and 3, the diversity is considered moderate, and if the value of $H > 3$, the diversity is considered high. The diversity index (H) of tree canopy-level vegetation can be seen in Table 4.

Table 4. Values of Species Diversity Index (H) for Tree Canopy-Level Vegetation

Tree Canopy-Level			
No	Elevation (masl)	Value (H’)	Category
1	125-150	2,35	Moderate
2	150-175	1,09	Moderate
3	175-200	1,46	Moderate

Data source: Primary data collected in the field, 2022.

The highest species diversity index (H') for the tree canopy-level vegetation is 2.35 at the lower elevation, while the lowest is 1.09 at the middle elevation. According to Magurran (1988), the value of species diversity index (H') is not only related to the species richness at a particular location but also influenced by the distribution of species abundance. A higher value of the index (H') indicates higher species diversity, ecosystem productivity, pressure on the ecosystem, and ecosystem stability. Low values of (H') can be attributed to the presence of species within physically controlled ecosystems and high biological regulation within the ecosystem (Odum, 1993). Overall, the calculated values of (H') indicate a moderate species diversity, suggesting that the plant community in the location is in a relatively stable condition.

The Index of Species Evenness (E)

The evenness index (E) has values ranging from 0 to 1. As the evenness value approaches 1, it indicates a more even distribution of species, while lower values indicate uneven distribution (Magurran, 1988). The evenness index (E) for the tree canopy-level vegetation can be observed in Table 5.

Table 5. displays the values of the evenness index (E) for the tree canopy-level vegetation.

Tree Canopy-Level			
No	Elevation (masl)	Value (E)	Category
1	125-150	0,95	High
2	150-175	0,79	High
3	175-200	0,90	High

Data source: Primary data collected in the field, 2022.

The above table shows that the highest evenness index (E) is found in the lower canopy-level vegetation with a value of 0.95. On the other hand, the lowest evenness index (E) for the canopy-level vegetation is observed at the mid-elevation with a value of 0.79. According to Magurran (1988), when the evenness index is greater than 0.6, it indicates an even distribution of individuals among species. Conversely, when the evenness index is less than 0.6, it suggests an uneven distribution or dominance of a particular species. Evenness also represents the balance between one community and another. The values in the evenness index also indicate the degree of abundance of individuals for each species. When every species has an equal number of individuals, the community has maximum evenness. The maximum value of evenness (E) occurs when each species has an equal number of individuals. Overall, the calculated values of the evenness index for the canopy-level vegetation indicate a high evenness, suggesting that the forest community in the research location is in a balanced and relatively stable state. This indicates that the plant species within the community have a good distribution or dispersion.

The Index of Community Similarity (IS)

The Community Similarity Index (IS) for tree canopy-level vegetation can be observed in Table 6.

Table 6. Values of the Community Similarity Index (IS) for Tree Canopy-Level Vegetation.

Tree Canopy-Level		
No	Elevation (masl)	IS Value (%)
1	125 - 150 *(B – T)*	50,00
2	125 - 200 (*B – A*)	35,29
3	150 – 200 *(T – A)*	44,44

Data source: Primary data collected in the field, 2022.
Describe: B-T: Lower - Middle elevation; B-A: Lower - Upper elevation; T-A: Middle - Upper elevation

The table above shows the values of the Community Similarity Index (IS) for tree canopy-level vegetation. The highest value of the index is found at the (B-T) height category, with a value of 50.00%, while the lowest value is observed at the (B-A) height category, with a value of 35.29%. The magnitude of the Community Similarity Index reflects the level of similarity in species composition and structure between the two compared communities. Ecologically, observation plots with high similarity indices indicate that the composition of constituent species is relatively similar (Zulkarnaen, 2017).

This finding is consistent with the theory proposed by Barbour et al. (1980), which suggests that similar microclimate conditions will be occupied by individuals of the same species, as these species have naturally developed mechanisms and tolerances specific to their habitat. According to Kusmana and Susi (2015), differences between these communities are influenced by environmental factors such as humidity, soil pH, and temperature, leading to variations in species composition. The presence of shared species in both stands can contribute to soil structure improvement, facilitating subsequent regeneration and growth (Hilwan et al., 2013). Destaranti et al. (2017) suggest that the greater the number of shared plant species between the two compared communities, the higher the community similarity index will be.

The Influence of Elevation on the Number of Tree Canopy-Level Species

Analysis was conducted using a Completely Randomized Design (CRD) with 3 (three) elevation levels (lower, middle, upper) as treatment 1, 2, and 3, respectively. There were 6 (six) measurement plots as replications (U1, U2, U3, U4, U5, and U6). Therefore, there were 3 treatments with 6 replications, and the results are presented in Table 7.

Table 7. ANOVA Test Results of the Influence of Elevation on the Number of Species

ANOVA Test for Tree Canopy-Level						
Source of Variation	Sum of Squares (SS)	Degree of Freedom (df)	Mean Square (MS)	F-Value	F-Table	Conclusion
Treatment	2	23.11	11.56	1.84	3.68	*H0 Accepted*
Galat/ error	15	94.00	6.27			
Total	17	117.11				

Based on Table 7, the analysis on the influence of elevation on the number of species indicates that the null hypothesis (H0) is accepted. This suggests that elevation does not have a significant effect on the number of species found. It is possible that the plant species have adapted and thrived well in their respective growing environments, leading to interactions within the forest community, both among species and with other groups, as part of a larger ecosystem.

Another possible explanation for the lack of influence of elevation on the number of species is the relatively small range of elevation intervals considered in the analysis. The high community similarity values suggest a tendency towards species similarity, which could be attributed to the relatively similar environmental conditions among the compared sites. Since the calculation results do not indicate a significant effect of elevation on the number of individuals found, further tests may not be necessary.

Overall, the analysis suggests that the number of species is not significantly influenced by elevation, likely due to successful adaptation of plant species and relatively similar environmental conditions.

Conclusion

The conclusion drawn from this study is that the species capable of occurring at all three elevations for the tree canopy-level are Madang puspa (*Schima wallichii*) and Jamai (*Instia* sp). Meanwhile, the species that are present at least in two elevations for the tree canopy-level are Alaban (*Vitex pubescens*), Bangkal gunung (*Nauclea subdita*), Bati-Bati Menjangan (*Eugenia spicata*), and Jamai (*Instia* sp). The distribution and abundance of species that can grow at all three elevations for the tree canopy-level are Madang puspa (*Schima wallichii*) with 15 individuals and Jamai (*Instia* sp) with 14 individuals. The diversity and evenness index for the tree canopy-level species are mostly moderate, indicating moderate species diversity, ecosystem productivity, pressure on the ecosystem, and ecosystem stability. Overall, the evenness index is high, suggesting that the forest community in the research location is in a balanced and relatively stable state.

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