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by Jan Hendriek Nunaki And Insar Damopolii

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Analysis of Vegetation and Similarity in the Nature Tourism Forest of Gunung Meja, West Papua, Indonesia

Jan Hendriek Nunaki and Insar Damopolii

Department of Biology Education, University of Papua, Manokwari-98314, Indonesia
E-mail: j.nunaki.unipa@gmail.com

***Abstract*:** This study aims are to determine the importance value index (IVI) and the similarity of vegetation types in the Manggoapi and Brawijaya area. Data were obtained by continuous strip sampling. A total of 40 plots or 1.74% Ha of the natural forest mountain area was used in this study. The square size of each plot was 100 m X 20 m. Plant inventory activities were conducted in the Manggoapi and Brawijaya areas. There were 126 species from 38 families with 1334 individuals. *Pometia coreacea* was the highest IVI value of 21.98%. The highest and lowest similarity indexes were 47.1% and 0.9%, respectively. A total of 137 species was found in 33 families with 738 individuals from Brawijaya area. *Pometia coreacea* had the highest IVI value of 28.05%, with the highest similarity index of 50%. Moreover, the lowest species similarity was 3.9%. The similarity index values between Manggoapi and Brawijaya areas were low. There was no combination of observations with a similarity index value > 75%.

Keywords: Vegetation, Importance value index, Similarity index, Tree, Nature park

The number of human populations in the world will increase rapidly to 9 billion by 2050 according to the world's population (US Census Bureau 2013). An increase in population causes land use to change ecosystem needs, food, wood, and clean water also increased (European Commission 2009). Biodiversity is particularly dangerous related to socio-economic, climate, and land use (Keenan et al 2015). The plant diversity index is sensitive to change (Faggi and Dadon 2011). The concept of naturalness relates to the extent to which the natural state has been degraded (Winter 2012). Rapid development must be balanced with the maintenance of biodiversity and an emphasis on ecotourism (Brandt et al 2012). Many studies have shown that human activity causes habitat destruction (Kardol and Wardle 2010), changes the plant species distribution (Dawson et al 2011), and triggers the extinction of species (Vetaas et al 2012). Secondary plant communities are increasingly dominant because most primary forests have been depleted (Tang et al 2010), but over time it will lead to natural native vegetation (Fukushima et al 2008, Tang et al 2010). Based on data from the center of World Conservation and Monitoring, more than 10.000 plant species are in danger of extinction in the world. Biodiversity is facing increasing pressures from human activities, including habitat fragmentation, climate change, pollution, habitat conversion, and degradation. Global assessments show that the risk of species extinction. Many ecosystem functions and services rely on biodiversity for the long term (Newbold et al 2015). The diversity of species on earth from simple to complex levels is a common phenomenon. Biodiversity can be measured at various biological levels, from genetic diversity within a species to diverse ecosystems on earth (Guruprasad and Padmaja 2016). In addition, understanding the level of species association and species similarity, there are several treatments mathematically form a similarity index. When two or more assemblies or communities' species compositions are compared, the similarity or inequality index provides a quantitative assessment (Srivastava and Shukla 2016).

The nature park tourism in Gunung Meja is the forest and conservation area located in the middle of Manokwari City, West Papua. It was originally designated as a protected forest with a hydro-orological function (water control). However, the further development of this area was designated as a nature tourism park due to a historical heritage site. This area is designated as nature tourism parks based on the Minister of Agriculture Degree No. 19/Kpts/Um/I/1980 (Lekitoo 2004, Leppe and Tokede 2006). The nature tourism park of Gunung Meja has located at coordinates 134˚03'17" to 134˚04'05" East Longitude and 0˚51'29" to 0˚52'29" South latitude with an area of 460.25 Ha. The north coast of Manokwari is the north border. In the south, it is bordered by Manokwari City. Furthermore, Ayambori Village is the east border, while Papua University Campus is the west border. Calcium (Ca), Sodium/Natrium (Na), Potassium/Kalium (K), and Magnesium (Mg) content impact plant diversities and are low-moderate (Lekitoo 2004, Leppe and Tokede 2006). The development of Manokwari city is accompanied by rapid population growth. The nature park forest of Gunung Meja has been changed in vegetation. It impacts on hydro-orological function in the nature park forest of Gunung Meja (Lekitoo 2004, Leppe and Tokede 2006). There are 23 water sources and two caves in the nature park forest of Gunung Meja . This water source is also used by the community around the nature park forest of Gunung Meja. The surrounding community actively uses the water sources of Manggoapi and Brawijaya. However, the vegetation condition is not yet known, especially the vegetation of woody plant groups. The catchment area is the primary ecosystem that regulates the water system. The study aims are to determine the importance value index (IVI) and similarity of types (IS) of plant vegetation levels in the Brawijaya and Manggoapi areas.

MATERIAL AND METHODS

Study area: This study was undertaken in the natural park forest of Gunung Meja, especially in the Manggoapi and Brawijaya areas. The types of tree vegetation at the plant vegetation level were observed.

Procedures: The descriptive and observation method were used in this study. The descriptive method was intended to describe the condition of woody plant vegetation in catchments and water sources. Data were obtained from the path method and the continuous strip sampling method. The plot was made continuously. Therefore, there was no distance between one plot and the next, with a plot size of 100 m x 20 m. The descriptive and observation method were used in this study. The descriptive method was intended to describe the condition of tree plant vegetation in catchments and water sources. Data were obtained from the path method and the continuous strip sampling method. The plot was made continuously. Therefore, there was no distance between one plot and the next, with a plot size of 100 m x 20 m. A total of 20 sample plots in each Manggoapi and Brawijaya area.

Vegetation analysis: Vegetation analysis was conducted by the calculation of important value index to determine plant density, species distribution, species control, and species role (Mueller - Dombois and Ellenbeg 1974). Importance value index (IVI) was calculated by following formula:

$$\text{Density} = \frac{\text{Number of individuals}}{\text{Plot area}}$$

$$\text{Relative density} = \frac{\text{Type of a density}}{\text{All density}} \times 100$$

$$\text{Frequency} = \frac{\text{The number of discovery plots}}{\text{The number of the entire plot}}$$

$$\text{Relative frequency} = \frac{\text{The frequency of type}}{\text{The frequency of the entire plot}} \times 100$$

$$\text{Domination} = \frac{\text{The area of type base}}{\text{Plot area}} \times 100$$

$$\text{Relative domination} = \frac{\text{Domination type}}{\text{All domination}} \times 100$$

Importance value index (IVI) = Relative domination + Relative density + relative frequency

Similarity index: The level of similarity between the two communities has been calculated based on the frequency of similarity index between two communities by Sorenson (1948).

$$IS = \frac{2C}{A+B} \times 100$$

ID = 100 – IS
C = Sum of common species between two communities
A = Sum of all the species in community A
B = Sum of all the species in community B

RESULTS AND DISCUSSION

Plant vegetation in the Manggoapi area: There were 126 species from 38 families and an average of 66.7 individuals for each observation plot. *Pometia coreacea* was an important species in the composition in the Manggoapi area and was followed by woody plant species such as *Intsia bijuga, Palaquium amboinensis, Pimelodendron amboinicum, Horsfieldia sylvestris, Intsia palembanica Lepiniopsis lanceolatus, Spathiostemon javensis, Pometia pinnata, and Haplolobus lanceolatus* (Table 1).

Pometia coreacea had the highest IVI of 21.98%. This species was a primary plant-level species in the forest area of the Manggoapi area due to it had a large number of individuals. It revealed with the high relative density value of 13.278%. *Palaquium amboinensis* had a second rank with an IVI value of 13.65%. It had a high relative density value of 7.607%. Meanwhile, *Pimelodendron amboinicum* was the third rank with an IVI value of 13.266% and the high relative density value of 6.501%. Different forest types cause different IVI values (Chauhan et al 2020). A total of 38 families was in the Mangoapi area, with the largest percentage of the *Moraceae* family (11.2%) (Fig. 1).

Plant Vegetation in Brawijaya area: There were 137 species from 33 families with an average plot of 36 individuals. *Pometia coreacea* was an essential population and followed by woody plant species such as *Pometia pinnata, Alstonia scholaris, Pterygota horsfieldia,* *Haplolobus lanceolata, Pimeleodendron amboinicum, Flindersia amboinensis, Koordersiodendron pinnatum, Dysoxyllum alliaceum, and Artocarpus incius* in the Brawijaya area (Table 2).

Pometia coreacea had the highest IVI of 28.05% and was a major species in the Brawijaya area. It demonstrated with a large number of individual with a density value of 8.943% and good average diameter growth. *Pometia pinnata* was the second important plant type with an IVI value of 15.501% and density value of 8.672%. Meanwhile, *Alstonia scholaris* had the third rank with an IVI value of 11.439%. It had a high relative density value of 4.336% and a better average diameter growth. A total of 33 families was in the Brawijaya area with the largest percentage of the Moraceae family (12.4%) (Fig. 2).

Vegetation analysis in the two catchments of Manggoapi and Brawijaya shows that the dominant species is *Pometia coreacea*. This type is dominant; one of the factors is the lack of utilization so that it is from a large frequency and high diameter size and results in a density level. The cause of Pometia is dominant because of the lack of utility (Daniel and Hegde 2007). The biotic and abiotic environment greatly influences the composition of the plant structure. External factors significantly affect the disturbance of vegetation

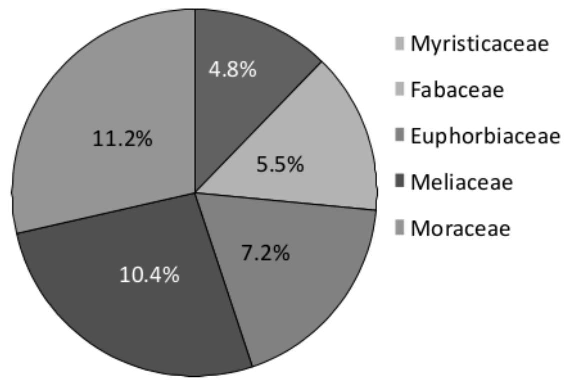

Fig. 1. Percentage of five dominant families in the Manggoapi area

Table 1. Primary plant types in the Manggoapi area

Scientific name	Family	RD[1]	RF	DR[2]	IVI
Pometia coreacea	Sapindaceae	13.278	8.688	0.009	21.98
Palaquium amboinensis	Sapotaceae	7.607	6.028	0.018	13.65
Pimelodendron amboinicum	Euphorbiaceae	6.501	6.738	0.028	13.27
Intsia bijuga	Fabaceae	7.469	5.142	0.021	12.63
Spathiostemon javaensis	Euphorbiaceae	6.086	4.965	0.039	11.09
Pometia pinnata	Sapindaceae	4.564	4.255	0.042	8.86
Haplolobus lanceolatus	Burseraceae	2.766	3.014	0.066	5.85
Lepiniopsis ternatensis	Apocynaceae	2.351	2.660	0,077	5.12
Intsia palembanica	Fabaceae	2.351	2.305	0.060	4.72
Horsfieldia sylvestris	Myristicaceae	2.075	2.482	0.082	4.64

Table 2. Primary plant types in the Brawijaya area

Scientific name	Family	RD[1]	RF	DR[2]	IVI
Pometia coreacea	Sapindaceae	8,943	1,33	17,78	28,05
Pometia pinnata	Sapindaceae	8,672	1,37	5,455	15,50
Alstonia scholaris	Apocynaceae	4,336	1,31	5,789	11,44
Pterygota horsfieldia	Sterculiaceae	1,762	1,02	4,697	7,481
Haplolobus lanceolata	Burseaceae	3,794	1,26	2,329	7,383
Pimeleodendron amboinicum	Euphorbiaceae	3,794	1,1	2,108	7,004
Flindersia amboinensis	Meliaceae	2,168	1,26	1,891	5,318
Artocarpus incises	Moraceae	1,22	1,7	2,088	5,007
Dysoxyllum alliaceum	Meliaceae	1,762	1,12	2,101	4,978
Koordersiodendron pinnatum	Anacardiaceae	1,897	1,1	1,816	4,814

damage from time to time. So that changes in vegetation in a certain location are compared to natural vegetation that is still original or potential, so there is a special method to determine which vegetation is truly native so that species associated with their habitat are studied (Bhatt and Khanal 2010). The plant phenology, dispersal, and birth control influence variation in composition and structure in the plant community. Differences in fecundity and fertility in each plant species often affect the birth of a new individual. The important value index determines the parameter of a plant species role in a community. IVI below 0.5 indicates their fragility (Sunil et al 2016). The existence of a tree species in a location reveals adaptability and resistance towards environmental conditions. Adaptable species will survive and dominate an area.

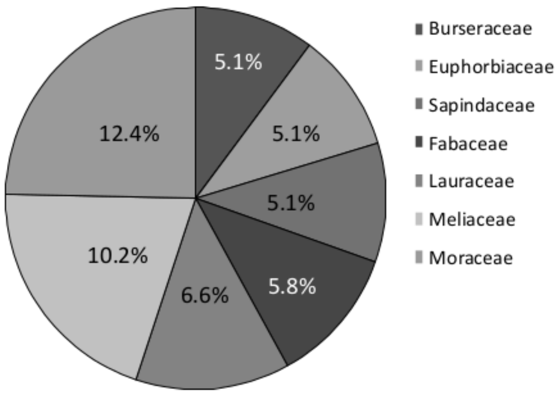

Fig. 2. Percentage of dominant families in the Brawijaya area

Similarity index: The similarity and inequality of each plant vegetation in the Brawijaya and Manggoapi area are presented in Tables 3 and 4. The highest species similarity was in the plot ratio of 9 to 16 (47.1%). In addition, the lowest similarity was in the plot of 1 to 12 (0.9%) - a total of 20 observation plots in the Manggoapi area. The similarity was below 65%. It indicated that there was no similarity among species in the Manggoapi area.

A total of 20 species had a similarity in the Brawijaya area. The highest species similarity was in the plot ratio of 3 to 7 (50%). In addition, the lowest similarity was in the plot of 5 to 17 (3.9%). There were 20 observation plots in the Brawijaya area. The similarity was below 65%. It indicated that there was no similarity among species in the Brawijaya area. This type of inequality is due to the fact that both locations have experienced damage due to the many community activities in the area due to economic factors as motivation resulting in

Table 3. Similarity and inequality index values of plant level in the Manggoapi area

IS/ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1		13.5	14.7	22.1	18.0	15.0	16.1	12.9	4.6	2.5	1.4	0.9	4.7	2.8	6.1	7.9	2.9	1.4	3.7	3.2
2	86.5		25.6	20.0	27.9	26.6	26.9	30.4	20.4	11.5	6.8	3.4	17.6	15.2	15.2	26.1	12.0	10.6	19.8	16.8
3	85.3	74.4		38.0	39.4	20.5	36.5	41.7	21.8	8.5	6.6	3.4	14.9	10.5	21.1	33.7	11.6	6.2	12.8	16.3
4	77.9	80.0	62.0		29.9	18.8	38.4	29.3	19.1	9.0	6.3	7.8	10.9	9.2	16.9	26.2	9.9	4.5	18.6	7.5
5	82.0	72.1	60.6	70.1		38.7	38.3	40.3	19.0	9.6	8.4	3.3	22.4	18.2	28.3	28.3	17.8	7.9	20.4	15.7
6	85.0	73.4	79.5	81.2	61.3		27.1	22.6	10.1	6.3	9.2	2.9	10.7	15.9	23.0	12.4	5.8	7.0	7.1	13.8
7	83.9	73.1	63.5	61.6	61.7	72.9		41.9	21.8	13.2	14.0	7.8	15.5	13.5	28.8	28.8	14.7	11.3	17.5	20.6
8	87.1	69.6	58.3	70.7	59.7	77.4	58.1		27.3	17.1	12.8	5.7	29.6	22.0	31.7	34.1	16.4	16.7	19.8	25.9
9	95.4	79.6	78.2	80.9	81.0	89.9	78.2	72.7		20.9	12.5	8.7	17.9	20.6	23.5	47.1	20.3	22.9	20.9	16.9
10	97.5	88.5	91.5	91.0	90.4	93.8	86.8	82.9	79.1		11.4	15.0	18.5	23.9	16.5	27.5	10.0	16.2	29.6	26.8
11	98.6	93.2	93.4	93.7	91.6	90.8	86.0	87.2	87.5	88.6		12.2	21.1	13.8	10.3	13.8	16.3	20.0	24.6	16.4
12	99.1	96.6	96.6	92.2	91.6	97.1	92.2	94.3	91.3	85.0	87.8		18.8	18.6	18.6	18.6	16.3	15.9	25.9	22.5
13	95.3	82.4	85.1	89.1	77.6	89.3	84.5	70.4	82.1	81.5	78.9	81.2		36.1	16.4	26.2	16.3	15.9	36.7	25.0
14	97.2	84.8	89.5	90.8	81.8	84.1	86.5	78.0	79.4	76.1	86.2	81.4	63.9		25.8	25.8	16.3	25.0	29.5	36.9
15	93.9	84.8	78.9	83.1	71.7	77.0	71.2	68.3	76.5	83.5	89.7	81.4	83.6	74.2		29.0	16.3	25.0	13.1	30.8
16	92.1	73.9	66.3	73.8	71.7	87.6	71.2	65.9	52.9	72.5	86.2	81.4	73.8	74.2	71.0		16.3	18.8	29.5	24.6
17	97.1	88.0	88.4	90.1	82.2	94.2	85.3	83.6	79.7	90.0	83.7	83.7	83.7	83.7	83.7	83.7		18.2	30.8	21.4
18	98.6	89.4	93.8	95.5	92.1	93.0	88.7	83.3	77.1	83.8	80.0	84.1	84.1	75.0	75.0	81.3	81.8		31.7	26.9
19	96.3	80.2	87.2	81.4	79.6	92.9	82.5	80.2	79.1	70.4	75.4	74.1	63.3	70.5	86.9	70.5	69.2	68.3		31.3
20	96.8	83.2	83.7	92.5	84.3	86.2	79.4	74.1	83.1	73.2	83.6	77.5	75.0	63.1	69.2	75.4	78.6	73.1	68.8	

Table 4. Similarity and inequality index values of plant level in the Brawijaya area

IS/ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1		22,7	21,6	26,3	22,6	27,3	26,3	41,6	36,1	39,5	16,2	16,9	14,8	19,8	39,4	35,6	25,4	27,0	19,7	14,9
2	77,3		38,6	36,4	28,9	37,5	33,3	33,0	25,6	37,8	27,3	19,0	34,0	23,4	12,5	13,8	18,2	22,7	32,9	39,5
3	78,4	61,4		44,7	19,4	36,4	50,0	39,0	26,1	34,2	35,1	25,4	34,6	30,0	24,2	19,2	41,3	29,7	22,5	26,9
4	73,7	63,6	55,3		21,9	23,5	23,1	32,9	29,7	23,1	31,6	21,9	31,7	36,6	17,6	21,3	24,6	23,1	32,9	33,3
5	77,4	71,1	80,6	78,1		29,6	15,6	27,7	20,0	34,4	19,4	10,2	17,6	23,5	14,8	9,8	3,9	6,3	13,6	25,5
6	72,7	62,5	63,6	76,5	70,4		32,4	31,9	28,1	32,4	12,1	19,0	25,0	30,6	13,8	18,5	21,8	24,2	28,6	13,6
7	73,7	66,7	50,0	76,9	84,4	67,6		35,4	24,3	33,3	21,1	16,4	34,1	22,0	14,7	21,3	21,3	15,8	19,2	14,5
8	58,4	67,0	61,0	67,1	72,3	68,1	64,6		37,3	40,5	31,2	27,0	33,7	31,3	29,0	34,2	27,3	28,6	21,6	17,1
9	63,9	74,4	73,9	70,3	80,0	71,9	75,7	62,7		35,1	22,2	23,2	25,6	35,9	40,6	36,6	32,8	25,0	26,1	9,2
10	60,5	62,2	65,8	76,9	65,6	67,6	66,7	59,5	64,9		39,5	19,2	39,0	34,1	26,5	26,7	21,3	31,6	30,1	23,2
11	83,8	72,7	64,9	68,4	80,6	87,9	78,9	68,8	77,8	60,5		14,1	32,5	30,0	15,2	19,2	19,0	32,4	31,0	14,9
12	83,1	81,0	74,6	78,1	80,6	81,0	83,6	73,0	76,8	80,8	85,9		26,0	26,0	22,2	17,1	26,7	22,5	29,4	18,8
13	85,2	66,0	65,4	68,3	82,4	75,0	65,9	66,3	74,4	61,0	67,5	74,0		39,5	19,4	22,8	20,3	32,5	26,0	19,2
14	80,2	76,6	70,0	63,4	76,5	69,4	78,0	68,7	64,1	65,9	70,0	74,0	60,5		25,0	17,7	26,1	25,0	13,0	13,7
15	60,6	87,5	75,8	82,4	85,2	86,2	85,3	71,0	59,4	73,5	84,8	77,8	80,6	75,0		49,2	36,4	27,3	22,2	10,2
16	87,5	86,2	80,8	78,7	90,2	81,5	78,7	65,8	63,4	73,3	80,8	82,9	77,2	82,3	50,8		25,8	27,4	22,9	9,1
17	75,8	81,8	58,7	75,4	96,1	78,2	78,7	72,7	67,2	78,7	81,0	73,3	79,7	73,9	63,6	74,2		25,4	16,7	7,1
18	82,4	77,3	70,3	76,9	93,8	75,8	84,2	71,4	75,0	68,4	67,6	77,5	67,5	75,0	72,7	72,6	74,6		33,8	26,9
19	85,2	67,1	77,5	67,1	86,4	71,4	80,8	78,4	73,9	69,9	69,0	70,6	74,0	87,0	77,8	77,1	83,3	66,2		34,4
20	86,2	60,5	73,1	66,7	74,5	86,4	85,5	82,9	90,8	76,8	85,1	81,3	80,8	86,3	89,8	90,9	92,9	73,1	65,6	

the clearing of small-scale agricultural land. Vegetation analysis is a method to determine the composition or composition of vegetation in a plant community based on the vegetation structure. Plant communities have a heterogeneous structure and species composition (Tang et al 2010). Therefore, the analysis of the similarity index is needed as the basic data of each observation plot. The highest similarity was 50% in the Brawijaya area, while the highest similarity in the Manggoapi was 47.1%. It revealed that these two regions have different types in plant-level.

In a present study, the species composition shows low similarity. The smaller similarity index value causes a lower similarity level. It is due to variations in environmental conditions and interactions between species. This phenomenon will be different if the environmental conditions are relatively homogeneous. The condition indicates that the presence of different species at different altitudes indicates different environmental conditions. Altitude is one of the factors influencing species differences (Barman et al 2021, Jazib 2020). In addition, other factors also determine plant species, such as groundwater content, plant properties, climate variables, human disturbances, and humidity (Fousseni et al 2010, Luo et al 2016, Yadav et al 2020, Zegeye et al 2006). Therefore, plant species can be used as an environmental indicator. Further research can examine environmental factors and human disturbances that affect vegetation and the similarity index of plants in these two areas.

CONCLUSION

The research concludes that the number of individuals, species, and families in the Manggoapi and Brawijaya areas were different. The Manggoapi area had 126 plant species. Meanwhile, 137 species were found in the Brawijaya area. *Pometia coreacea* is essential species in both areas. The similarity index values in the Manggoapi and Brawijaya area were low. It indicated by similarity index values below 65%.

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