

Vegetation Structure and Composition in the Nusa Gede Panjalu Nature Reserve Area, Ciamis, Indonesia

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Abstract: *The Nusa Gede Panjalu Nature Reserve in Ciamis Regency is a conservation area that holds a variety of biodiversity and within it is a natural tourism area. It is feared that the existence of natural tourism areas will result in damage caused by human activities. This study aims to analyze the structure and composition of vegetation as well as environmental factors that affect vegetation growth in the Nusa Gede Panjalu Nature Reserve area. The method used in this study is the line transect method with sampling using quadrat. The data obtained were analyzed using the Importance Value Index (IVI), the index of Shannon-Wiener, and the index of Evenness. The results showed that the structure and composition of the vegetation in the Nusa Gede Panjalu Nature Reserve consisted of 416 individuals divided into 29 species. The plant species with the highest Importance Value Index (IVI) in the seedling category were *Dysoxylum densiflorum* (28.73%), the pole category *Litsea noronhae* (23.72%) and for the tree category *Dysoxylum densiflorum* (49.12%). The diversity index obtained is included in the moderate level of diversity. Environmental factors affecting the growth of vegetation in the Nusa Gede Nature Reserve are the temperature, humidity, light intensity, and pH with an average temperature of 28.4°C, humidity of 85.1% light intensity of 1070.1 lux, and pH of 6.3.*

Keywords: *Nature Reserve; Nusa Gede; Panjalu; Structure and Composition; Vegetation*

1. INTRODUCTION

Forests are an important part of the environment because they have ecological functions including as a binder of carbon dioxide (CO₂) from the air, regulator of water management, climate control, protecting soil from erosion, and a source of germplasm. Therefore, these natural conditions create an ideal habitat for the survival of flora and fauna ([Bruijnzeel & Hamilton, 2000](#)). Nonetheless, in recent years the rate of habitat development and destruction has increased. Natural disasters that continue to occur are one of the factors causing forest destruction in addition to human activities that overuse natural

resources. Limited management, especially in Nature Reserve areas with sub-optimal supervision can add to forest damage. Continuous forest destruction without proper management can disrupt the balance of forest ecosystems ([da Silva et al., 2017](#)).

Forest conservation has been carried out by the Government of Indonesia through the designation of forests as conservation areas through Law Number 5 of 1990 concerning the Conservation of Biological Natural Resources and Their Ecosystems. Based on this law, a conservation area is a forest area with certain characteristics that has the main function of

preserving the diversity of plants and animals and their ecosystems. One part of the area is the Nature Reserve (Nurjaman et al., 2017).

A Nature reserve is the protection of a forest area whose development takes place naturally and has a unique flora, fauna, and ecosystem. The purpose of establishing a Nature Reserve is to preserve all components in the forest area. All processes in the forest area are allowed to take place naturally without human intervention so the area must be left as it is (Setiarno et al., 2022). One of the Nature Reserve areas in Indonesia is the Nusa Gede Panjalu Nature Reserve.

The uniqueness that is owned by the Nusa Gede Nature Reserve is that it is located in the form of an island surrounded by a lake (Rachman & Hani, 2017). Nusa Gede Panjalu Nature Reserve is a tourist destination that holds a variety of biodiversity. Information on biodiversity species, especially vegetation species in this area, is still scarce. Therefore, a study is needed to find out how much biodiversity and potential, especially the vegetation species in the Nusa Gede Nature Reserve, one of which is by examining the composition, structure, and distribution in the area.

Scientific studies reveal that the preservation of plant diversity on small islands and narrow habitat areas is under much greater pressure than on islands or continents which have wider habitats. The limited distribution area and the threat of environmental degradation make the Nusa Gede Nature Reserve a vulnerable habitat and need to be prioritized in plant conservation efforts (Irawanto et al., 2017). Many plant species that are threatened with extinction will experience a very sharp population decline which can have an impact on the stability of forest ecosystems (Yu et al., 2014).

Vegetation analysis is a method for studying the composition of vegetation according to the shape (structure) of the plant community. Vegetation structure consists of elements of form, growth, stratification, and canopy closure. In conducting vegetation analysis, species, diameter, and height data are needed to determine the importance value index of the forest community constituents. With vegetation analysis, quantitative information can be obtained about the structure and composition of a plant community.

The composition of plant diversity in the forest is influenced by several environmental factors such as light, humidity, soil pH, canopy cover of the surrounding trees, and the level of competition from each species (Kolo et al., 2022).

Based on these matters, it is necessary to carry out research related to the structure and composition of vegetation in the Nusa Gede Panjalu Nature Reserve area. This information on the diversity of vegetation will provide an overview of the richness of the diversity of vegetation and the abundance of their species in the Nusa Gede Panjalu Nature Reserve. This information can be used as a reference for management and conservation in the area so that all the benefits and potential contained therein can be felt by the community without disturbing the existence and sustainability of the forest itself.

2. RESEARCH METHOD

Study Area

The research was conducted from January to February 2023 in the Nusa Gede Panjalu Nature Reserve area, Panjalu District, Ciamis Regency, West Java. The Nusa Gede Panjalu Nature Reserve area is located in the middle of a lake (Situ Lengkong), geographically located between 108°4'00" to 108°21'00" E and 7°9'00" to 7°17'00" S with an altitude 731-760 m above sea level and an average rainfall of 3.195 mm/year. According to the government administration, the Nusa Gede Nature Reserve belongs to the Panjalu Village area, Panjalu District, Ciamis Regency.



Figure 1. The research location is in the Nusa Gede Panjalu Nature Reserve, Ciamis Regency, West Java, Indonesia.

Data collection

The method used in this research is the sampling method or the sample plot used is the line transect and sample plot method, namely the sampling method of a population is on a line/path drawn through the ecosystem area. Plots in the form of transects measuring 300 meters in length and plot squares measuring 20 meters are placed on the right and left of the main transect with a distance of 10 meters between plots. Vegetation composition and structure were observed at the seedling, pole, and tree levels. Vegetation data collected in each plot were the number of species, number of individuals, and tree diameter at breast height (DBH) (Nugroho et al., 2022).

Data analysis

The data obtained were analyzed quantitatively using the Importance Value Index (IVI), Index diversity of Shannon-Wiener and Index of Evenness.

Importance Value Index

Importance Value Index (IVI) of species was calculated to determine the dominant tree and seedling species based on relative density, frequency, and coverage (basal area) (Rahmani et al., 2023).

$$\text{Density} = \frac{\text{Number individual}}{\text{Size of sampling plot}}$$

$$\text{Dominance} = \frac{\text{Total basal area of species}}{\text{Size of sampling plot}}$$

$$\text{Frequency} = \frac{\text{Number of plot where in species existing}}{\text{Total sampling plot}}$$

IVI = relative density + relative dominance + relative frequency

Index diversity of Shannon-Wiener

The diversity index was analyzed based on the formula used by Magurran (1988) with the following formula:

$$H' = -\sum p_i \ln p_i$$

Where:

H' : Shannon-Wiener diversity index

p_i : n_i/N

n_i : Number of individuals of a species

N : Number of individuals of all species

The Shannon-Weiner diversity index value criteria could be categorized as low (H' < 1), moderate (H' 1-3) and high (H' > 3).

Index of Evenness

The evenness index is analyzed based on the formula used by Pielou (1966) as follows:

$$E = H' / \ln S$$

Where:

E : Evenness index

H' : Diversity index

S : Number of species

Index Criteria:

0,00 < E < 0,4 = Low evenness

0,4 – 0,6 = Moderate evenness

> 0,6 = High evenness

3. RESULTS AND DISCUSSION

Vegetation Structure and Composition

Vegetation structure is the appearance of the stand arrangement based on diameter distribution, sapling, pole, and tree rejuvenation levels, crown layers, and spatial distribution. Based on the results of observations in the Nusa Gede Panjalu Nature Reserve area there were 29 species from 19 families where at the seedling level 16 species, 23 species were found at the pole level and 15 species at the tree level (table 1). This indicates that there are differences in the structure and composition of vegetation. The high and low number of individuals at a certain growth level illustrates the condition of the forest that has changed the stand structure. These changes affect the continuity of further regeneration of forest stands (Nurkhotimah et al., 2017).

Table 1. Number of species and individuals at each growth stage

No	Category	Number of species	Number of individuals
1	Seedling	16	204
2	Pole	23	171
3	Tree	15	41

According to [Soerianegara & Indrawan \(2005\)](#) the existence of these differences is caused by changes in vegetation that occur continuously where one population is replaced by another population, even in a stable forest there are always changes. The most common vegetation family found in the observed locations is the Moraceae family. The Moraceae family has the highest number of species, with 5 species at the study site, because this family spreads mainly in the tropics, then in the subtropics, and relatively slightly spreads in temperate climates ([Christenhusz & Byng, 2016](#)).

The Moraceae family is a large family of flowering plants consisting of 40 genera with more than 1000 species, generally distributed in tropical and subtropical regions. The Ficus genus is the largest genus, with most of it growing in the Malesiana area. The majority of species are lowland vegetation, mostly growing in evergreen forests and less common in seasonal forests. Habitus species of Moraceae are trees, shrubs, woody climbers, herbs, hemi-epiphytes, and holo-epiphytes. Habitus Trees in the genus Ficus grow in the coastal, riparian, forest, and secondary land ([Sahromi, 2020](#)).

Table 2. Plant Importance Value Index

No	Category	Family	Species	Highest IVI (%)
1	Seedling	Meliaceae	<i>Dysoxylum densiflorum</i>	28.73
2	Pole	Lauraceae	<i>Litsea noronhae</i>	23.72
3	Tree	Meliaceae	<i>Dysoxylum densiflorum</i>	49.12

Based on the results of the calculation of the Important Value Index (IVI) at the study site in the Nusa Gede Panjalu Nature Reserve (Table 2), it was found that *Dysoxylum densiflorum* was the species with the highest IVI at the growth rate of seedlings (28.73%) and trees (23.72%), while at the pole level the species *Litsea noronhae* had the highest IVI (23.72%). The results obtained were not much different from previous studies at the same location in the Nusa Gede Panjalu Nature Reserve, with the most dominant genera *Dysoxylum* and *Litsea* ([Rachman & Hani, 2017](#)).

The ecologically important values shown (table 2) are the species that dominate the habitat and can be used as habitat indicators at each different growth rate in the Nusa Gede Panjalu Nature Reserve area. [Ayalew \(2020\)](#) explains that the dominant species is a species that can efficiently utilize the environment it occupies compared to other species in the same place. Species that have a higher importance value will be more stable, both from the preservation of the species and from its growth. The results of the calculation of the importance values stated that most of the species have important values that are not much different. Such symptoms are common in vegetation types that lead to the climax and stable conditions.

According to [Tadese et al. \(2021\)](#) the composition of natural forest vegetation that has been formed in the long term will show physiognomy, phenology, and regeneration power which is slow and tends to be steady, so that the floristic dynamics of forest communities are not too obvious and conspicuous. Alternation of generations or species regeneration seems invisible, as a result, it is rare to find a dominant species because all species have adapted over a long period ([Brewer, 1994](#)).

The species *D. densiflorum* is the dominating species in the Nusa Gede Panjalu Nature Reserve area because it has the highest Importance Value Index at the level of seedlings and trees. *D. densiflorum* is part of the Meliaceae family. The genus *Dysoxylum* is distributed mainly in tropical Asia (India, China, Sri Lanka, Laos, Thailand, throughout the Malesiana region: Malaysia, Indonesia, Singapore, Brunei, the Philippines, and New Guinea), and the Pacific islands (Australia and New Zealand). Common in primary and secondary forests that are evergreen or semi-deciduous, on forest edges, along riverbanks, wetlands, and limestone mountains at altitudes up to 2000 m asl. Pollination of flowers is usually assisted with the help of insects. Flowering from January to May and fruiting from April to December ([Ha et al., 2022](#)).

Table 3. Diversity of plant species

No	Category	Index	
		H'	E
1	Seedling	2.66	0.96
2	Pole	2.97	0.98
3	Tree	2.54	0.94

The diversity of a community is highly dependent on the number of species and the number of individuals present in the community (Sutrisna et al., 2018). The species diversity of a community will be high if the community is composed of many species and no species dominates. Conversely, if a community has a low species diversity value, then the community is composed of a few species and there is a dominant species (Indriyanto, 2006).

Based on the diversity index (table 3), plant species at each growth stage at the study site are included in the moderate level of diversity, because the H' values obtained range from 1 to 3. This value is higher than the results of Rachman & Hani (2017) at the same location in the Nusa Gede Nature Reserve with a value of $H' < 1.5$. This may be due to the addition of the number of species at that location. Even though the Nusa Gede Panjalu Nature Reserve forest is located on a narrow island surrounded by waters so that it becomes isolated and the addition of species from outside is difficult, the presence of animals such as birds and bats that move freely through the waters can help as seed dispersers and pollinators.

According to Pavoine & Ricotta (2019) the Evenness Index (E) of species is used to determine whether individuals are more evenly distributed among species that are present at a certain growth level. The high value of (E) indicates that there are no more dominant species in a community, meaning that in general the dominance of the species is relatively the same if only a few species are dominant or almost all species grow evenly.

Based on the evenness index value (table 3), the growth rate of seedlings (0.96), poles (0.98), and trees (0.94) are classified as a high evenness category, because the value of $E > 0.6$. This shows that the distribution of plants in the area is evenly distributed and no particular species dominates significantly. This high distribution is generally

found in Indonesian Natural Forest with a tropical climate (Putri & Indriyanto, 2021).

Environmental parameters

The number of individuals that can live in a certain area (i.e., grow and reproduce) is influenced by environmental factors. Tabel 4 shows the factors affecting the vegetation structure of the forests in Nusa Gede Panjalu Nature Reserve, which includes temperature, humidity, sunlight intensity and pH.

Table 4. Abiotic conditions of the Nusa Gede Panjalu Nature Reserve

Paramater			
Temperature (°C)	Humidity (%)	Light intensity (lux)	pH
28.4	85.1	1070.1	6.3

Temperature is an important factor for plants because temperature determines the speed of reactions and chemical activities in life processes. Temperature is also a climatic factor that supports the existence of vegetation because temperature affects metabolic processes. According to Nursal et al. (2013) for tropical forests, the air temperature is good for plants ranging from 22-33°C. This implies that temperature has an impact on physiological performance (such as survival, growth, and reproduction) and species resource distributions (Villanueva et al., 2022). The calculation results show that the average temperature at the research location is 28.4°C. Based on the results obtained, it means that the air temperature is still within that range. If the temperature exceeds the maximum and minimum limits, plant growth and development will stop (Yuan et al., 2021).

The results of measuring the intensity of sunlight at the study site have an average value of 1070 lux. From the measurement results, the 10 plots have different canopy structures. Xiao et al. (2022) explained that the condition of crown cover can be beneficial for the growth of certain species in the vegetation community (tolerant species) and detrimental to other species (intolerant species). Canopy closure also affects the microclimate changes in plants. Forests with a fairly high density and a growing tree canopy can

block sunlight from entering the forest floor which causes an increase in surface temperature, reduced air humidity, and causes stress on the undergrowth (Poulter et al., 2014).

Most of the plants in the ecosystem grow on the ground so the nature of the soil greatly influences the growth of these plants (Liu et al., 2020). One of the soil climate factors is the degree of acidity (pH) of the soil. According to Arisandy & Triyanti (2018) the optimum degree of soil acidity (pH) for the growth of most plants ranges from the degree of soil acidity (pH) of 6-6.5. While the degree of acidity (pH) of the soil at the study site averaged 6.3, thus the abiotic factors in the Nusa Gede Panjalu Nature Reserve supported the growth of most of the plants in the area. The level of soil acidity greatly determines the availability of plant nutrients. Destaranti et al. (2017) stated that a very acidic soil pH would make it difficult for nutrients to be absorbed by plants and the decomposition process would be slow.

4. CONCLUSION

The Nusa Gede Panjalu Nature Reserve Forest area has a diversity of vegetation species consisting of 416 individuals divided into 29 species. The plant species with the highest Importance Value Index (IVI) in the seedling category were *D. densiflorum* (28.73%), *L. noronhae* pole category (23.72%), and *D. densiflorum* tree category (49.12%). The diversity index obtained is included in the moderate level of diversity because the H' values obtained range from 1 to 3. Environmental factors that affect the growth of vegetation in the Nusa Gede Nature Reserve area include temperature, humidity, sunlight intensity, and soil pH. The average temperature at the study site was 28.4°C, the average humidity was 85.1%, the average sunlight intensity was 1070.1 lux and the average soil pH was 6.3. Thus, the investigation of vegetation species composition, diversity, and interaction of vegetation species in the Nature Reserve provides a frame of reference to other researchers and policy-makers that will ultimately support managing the Nature Reserve and further studies.

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