VEGETATION COMPOSITION AND STRUCTURE IN OTANAHA FORTRESS GORONTALO CITY

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ABSTRACT

Otanaha Fortress is a tourist attraction in Gorontalo Province. This tourist attraction has a variety of plants that live and become the center of attention for visitors who come. This study aims to determine the composition and structure of plant vegetation in the tourist attraction of Otanaha Fort, Gorontalo City. The method used in this research is the plot strip method (combination of plots and transects), with a plot size of 20m x 20m for the tree level, 10m x 10m for saplings, 5m x 5m for the seedling level. be the basis for determining the type composition. To measure the structure of plant vegetation by calculating the Real Density (KR), Relative Frequency (FR), and Relative Dominance (DR). *Lannea cormendelica*, *Leucaena leucocephala*, *Streblus asper*, *Swietenia mahagoni*, *Ficus benjamina*, *Caesalpinia pulcherrima*, *Jatropha curcas*, *Samanea saman*, *Lepisanthes rubiginosa*, *Garuga floribunda*, *Annona muricata*, and *Mimosa pudica*. The highest IVI at each level, namely the tree level *Swietenia mahagoni* with an IVI of 63.26%, the stake level *Caesalpinia pulcherrima* with an INP of 78.26%, and seedling rate for *Mimosa pudica* with an INP of 61.01%.

Keywords: *Plot Strip Method, Vegetation Composition, Vegetation Structure*

INTRODUCTION

Indonesia is one of the countries rich in natural potentials, either land or marine. Natural diversity, floras, faunas, and human works are potentially commercial to be developed into a tourism business. Indonesia, as a maritime country, has an abundance of water potentials. A fertile soil condition favors Indonesia to be the center of attention of a group of people to domicile and develop businesses, and water potentials, be they seas and beaches, constitute tourism objects in which many domestic and international tourists are interested. The potentials are supported by Indonesia's tropical climate and clear seawater.

Plants are the living creature which possesses leaves, stems, and roots, and hence is able to self-produce food using chlorophylls for photosynthesis. The food they produce is consumed by humans, animals, and themselves. Additionally, they also produced oxygen (O^2) and altered carbon dioxide (CO^2) produced by humans and animals into oxygen (O^2) (Ferdinand, 2009).

Vegetation is a community of plants. Vegetation composition and structure could be analyzed using vegetation analysis (Budiman et al., 2020). Forest stand structure was

commonly characterized by tree density, cover or area of the base of the stand, diameter class distribution, and distribution of types in space (Krisnawati, 2015). Forest stand structure and tree composition demonstrated the influence on the habitats and diversity of vegetation (Putri *et al*., 2019). The types of vegetative composition and structure diversed by climate and soil (Muddin *et al*., 2021). The structure of the community was based on the measurement of several parameters, i.e., density, frequency, type dominance, and importance value index, which was the combination of the first three parameters (Rahim and Baderan, 2019).

One of the areas with vegetation diversity is Gorontalo. As one of the provinces in Sulawesi Island, Gorontalo has high biodiversity, attested to its abundant species spread across the area and indicating different shapes, appearances, numbers, and traits at multiple levels of living things, namely genus, species, and ecosystem.

Baderan and Angio (2019) figured out 739 Families (tribes) scattered in eight points of the Gorontalo Geopark pilot location. In Otanaha Fortress, 50 families with a unique and commercial species, which is *Sterculia foetida*, are found. At Pendaratan Soekarno, Hungayono, Olele Beach, and Perintis Lake, 52, 148, 82, and 57 families were found, respectively. Also, 52 families were found in Limboto Lake, and 49 families, with unique and exceptionally commercial species, were found in Pentadio Resort.

Based on the explanation, the information about vegetation composition and structure is crucial as it can complement the data of biodiversity aspects for Geopark development in Gorontalo Province. This research aims to examine vegetation composition and structure in Otanaha Fortress Gorontalo City.

RESEARCH METHODS

Research Methods

The data collection technique was purposive sampling. Sampling was carried out by creating nesting plots marked with ropes. Plots were 20 × 20 m, 10 × 10 m, and 5 × 5 m in size, respectively for tree strata, saplings, and seedlings. The number of individuals for each species was counted, and the circumference of the stem and the width of the crown were recorded. The types of vegetation found in each of the plots were recorded. Unidentified types were collected for their samples to make an herbarium. Advanced identification was conducted at the laboratory.

Population and Sample

1. Population

The research population was all types of vegetations in Limboto Lake within the Geopark pilot area in Gorontalo District, i.e., Otanaha Fortress Gorontalo City.

2. Sample

The research sample was types of plants found in Otanaha Fortress Gorontalo City. Observations were made using the cruise method.

Data Analysis

Vegetation data collected were investigated to find out the Relative

Density (KR), Relative Frequency (FR), Relative Dominance (DR), and Importance Value Index (INP), Diversity Index, Uniformity Index, and the respective research locations. To observe tree vegetation, INP, which was composed of KR, FR, and DR, was studied by referring to the book *Ekologi Hutan* (Indriyanto, 2006) and Dombois and Ellenberg's formula (1974).

1. Density (K) = $\frac{Number\ of\ individuals}{Sample\ plot\ area}$

   Relative Density (KR) = $\frac{K\ of\ a\ certain\ type}{K\ of\ all\ types} \times 100\%$
2. Frequency (F) = $\frac{Number\ of\ sample\ plot\ area\ where\ a\ species\ was\ found}{Number\ of\ all\ sample\ plot\ areas}$

   Relative Frequency (KR) = $\frac{K\ of\ a\ species}{K\ of\ all\ species} \times 100\%$
3. Dominance (D) = $\frac{The\ base\ area\ of\ a\ species}{Sample\ plot\ area}$

   Relative Dominance (DR) = $\frac{D\ of\ a\ species}{D\ of\ all\ species} \times 100\%$
4. Importance Index Value (INP)

An Importance Index Value (INP) of a species could elucidate the impacts or roles of a type of vegetation within a specific community. The higher the Importance Index Value, the more impactful the species on the ecosystem. To determine INP, we could exert the following formula:

INP = KR + FR + DR

RESULTS AND DISCUSSIONS

Research Results

A. Composition of the types of vegetation

Referring to the data of the composition of the types of vegetation in Otanaha Fortress, 12 species were found, namely *Lannea coromandelica*, *Leucaena leucocephala*, *Streblus asper*, *Swietenia mahagoni*, *Ficus benjamina*, *Caesalpinia pulcherrima*, *Jatropha curcas*, *Samanea saman*, *Lepisanthes rubiginosa*, *Garuga floribunda*, *Annona muricata*, and *Mimosa pudica*. Types of vegetation found belonged to the division of *Magnoliophyta*, six ordos, which were *Fabales*, *Urticales*, *Rasales*, *Sapindales*, *Malpighiales*, and *Magnoliales*, and nine families, which were *Fabaceae*, *Caesalpiniaceae*, *Moraceae*, *Anacardiaceae*, *Meliaceae*, *Sapindaceae*, *Burseraceae*, *Euphorbiaceae*, and *Annonaceae*. Types of vegetation found in the research site are indicated in Table 1.

Table 1. Composition of the Types of Vegetation in Otanaha Fortress

Kingdom	Division	Class	Ordo	Family	Genus	Spesies
Plantae	*Magnoliophyta*	*Magnoliopsida*	*Fabales*	*Fabaceae*	*Leucaena*	*Leucaena leucocephala*
					Samanea	*Samanea saman*
					Mimosa	*Mimosa pudica*
				Caesalpiniaceae	*Caesalpinia*	*Caesalpinia pulcherrima*

			Urticales	*Moraceae*	*Ficus*	*Ficus benjamina*
			Rasales		*Streblus*	*Streblus asper*
			Sapindales	*Anacardiaceae*	*Lannea*	*Lannea coromandelica*
				Meliaceae	*Swietenia*	*Swietenia mahagoni*
				Sapindaceae	*Lepisanhtes*	*Lepisanthes rubiginosa*
				Burseraceae	*Garuga*	*Garuga floribunda*
			Malpighiales	*Euphorbiaceae*	*Jatropha*	*Jatropha curcas*
			Magnoliales	*Annonaceae*	*Annona*	*Annona muricata*

B. Vegetation structure

1. Vegetation structure at the tree level in Otanaha Fortress

Vegetation structure at the tree level in Otanaha Fortress had varying density, frequency, and dominance. The vegetation structure in the research site is manifested in Table 2. Based on the vegetation analysis, *Swietenia mahagoni* had the highest relative density, i.e., 24.00%, and *Streblus asper* and *Caesalpinia pulcherrima* came second at 12.00%. Meanwhile, *Garuga floribunda* had the lowest relative density, i.e., 5.33%. Furthermore, *Swietenia mahagoni* had the highest relative frequency, i.e., 15.00%, whereas *Streblus asper, Ficus benjamina*, and *Lepisanthes rubiginosa* had the lowest one, i.e., 7.50%. *Swietenia mahagoni* had the highest relative dominance, i.e., 24.26%, whereas *Garuga floribunda* came the lowest, i.e., 5.07%.

Table 2. Vegetation Structure at the Tree Level in Otanaha Fortress

Type	KR (%)	FR (%)	DR (%)
Lannea coromandelica	9.33	15.00	13.8
Leucaena leucocephala	9.33	12.50	9.09
Streblus asper	12.00	7.50	10.35
Swietenia mahagoni	24.00	15.00	24.26
Ficus benjamina	10.67	7.50	10.77
Samanea saman	9.33	12.50	7.96
Lepisanthes rubiginosa	8.00	7.50	8.45
Garuga floribunda	5.33	12.50	5.07
Caesalpinia pulcherrima	12	10.00	10.26

Source: Primary Data, 2020

2. Vegetation structure at the stand level in Otanaha Fortress

Vegetation structure at the stand level in Otanaha Fortress had varying density, frequency, and dominance. The vegetation structure in the research site is manifested in Table 3. Based on the vegetation analysis, *Caesalpinia pulcherrima* had the highest relative density, i.e., 31.33%, and *Lannea coromandelica* came second at 13.25%. Meanwhile, *Ficus benjamina, Samanea saman, and Lepisanthes rubiginosa* had the lowest relative density, i.e., 4.82%.

Furthermore, *Caesalpinia pulcherrima* had the highest relative frequency, i.e., 16.67%, whereas *Ficus benjamina* and *Garuga floribunda* had the lowest one, i.e., 5.56%. As regards the relative dominance, *Caesalpinia pulcherrima* had the highest, i.e., 30.26%, whereas *Lepisanthes rubiginosa* came the lowest, i.e., 4.50%.

Table 3. Vegetation Structure at the Stand Level in Otanaha Fortress

Type	KR (%)	FR (%)	DR (%)
Lannea coromandelica	13.25	11.11	14.27
Leucaena leucocephala	7.23	11.11	7.68
Streblus asper	9.64	11.11	9.62
Swietenia mahagoni	9.64	11.11	9.72
Ficus benjamina	4.82	5.56	4.84
Caesalpinia pulcherrima	31.33	16.67	30.26
Jatropha curcas	7.23	8.33	7.25
Samanea saman	4.82	8.33	4.74
Lepisanthes rubiginosa	4.82	11.11	4.5
Garuga floribunda	7.23	5.56	7.11

Source: Primary Data, 2020

3. Vegetation structure at the seedling level in Otanaha Fortress

Vegetation structure at the seedling level in Otanaha Fortress had varying density, frequency, and dominance. The vegetation structure in the research site is manifested in Table 4. Based on the vegetation analysis, *Caesalpinia pulcherrima* had the highest relative density, i.e., 21.05%, and *Swietenia mahagoni* and *Mimosa pudica* came second at 20.18%. Meanwhile, *Streblus asper* had the lowest relative density, i.e., 7.89%. Furthermore, *Mimosa pudica* had the highest relative frequency, i.e., 20.69%, whereas *Sirsak* had the lowest one, i.e., 6.90%. As regards the relative dominance, *Swietenia mahagoni* had the highest, i.e., 30.26%, whereas *Streblus asper* came the lowest, i.e., 8.44%.

Table 4. Vegetation Structure at the Seedling Level in Otanaha Fortress

Type	KR (%)	FR (%)	DR (%)
Jatropha curcas	9.65	17.24	10.24
Leucaena leucocephala	8.77	13.79	9.37
Streblus asper	7.89	10.34	8.44
Swietenia mahagoni	20.18	13.79	21.66
Caesalpinia pulcherrima	21.05	17.24	19.20
Mimosa pudica	20.18	20.69	20.14
Annona muricata	12.28	6.90	10.95

Source: Primary Data, 2020

4. Vegetation INP in Otanaha Fortress
   a. INP at the tree level

Vegetation INP in Otanaha Fortress at the tree level varied greatly at a range of 22-63%. The Importance Value Index of each species of tree in Otanaha Fortress is showcased in Figure 1. As declared

in Figure 1, the highest INP, which was 63.26%, was attained by *Swietenia mahagoni*, and the second, which was 38.13%, was attained by *Lannea coromandelica*. Moreover, *Garuga floribunda* had the lowest, which was 22.90%.

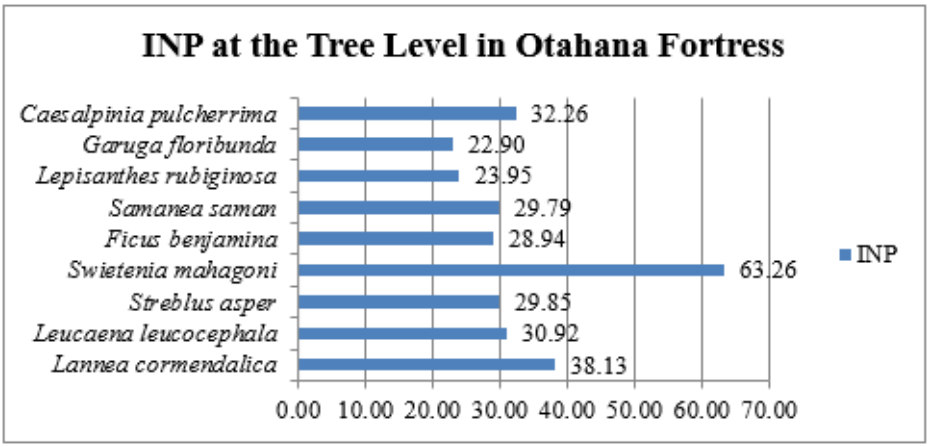

Figure 1. INP at the Tree Level in Otanaha Fortress

Source: Primary Data, 2020

b. INP at the stand level

Vegetation INP in Otanaha Fortress at the stand level varied greatly at a range of 15-78%. The Importance Value Index of each species of stands in Otanaha Fortress is showcased in Figure 2. As declared in Figure 2, the highest INP, which was 63.26%, was attained by *Caesalpinia pulcherrima*, and the second, which was 38.63%, was attained by *Lannea coromandelica*. Moreover, *Ficus benjamina* had the lowest, which was 15.22%.

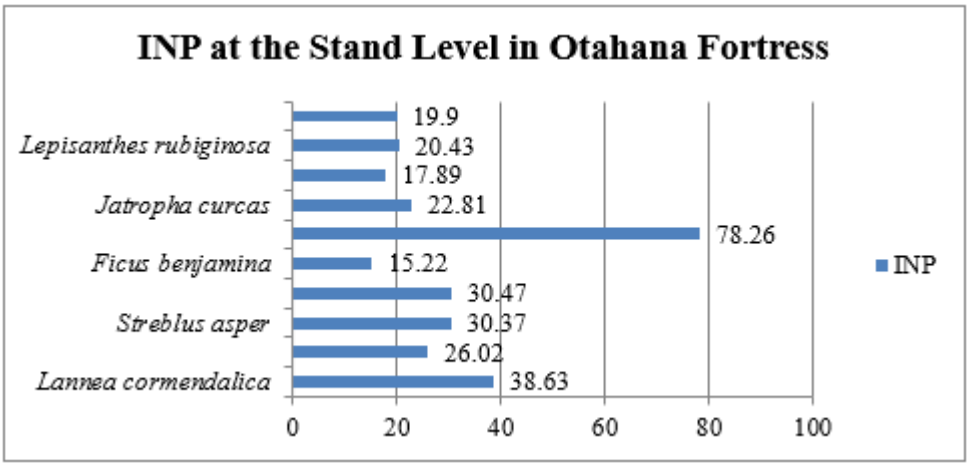

Figure 2. INP at the Stand Level in Otanaha Fortress

Source: Primary Data, 2020

c. INP at the seedling level

Vegetation INP in Otanaha Fortress at the seedling level varied greatly at a range of 26-61%. The Importance Value Index of each species of seedling in Otanaha Fortress is showcased in Figure 3. As declared in Figure 3, the highest INP,

which was 61.01%, was attained by *Mimosa pudica*, and the second, which was 57.49%, was attained by *Caesalpinia pulcherrima*. Moreover, *Streblus asper* had the lowest, which was 26.67%.

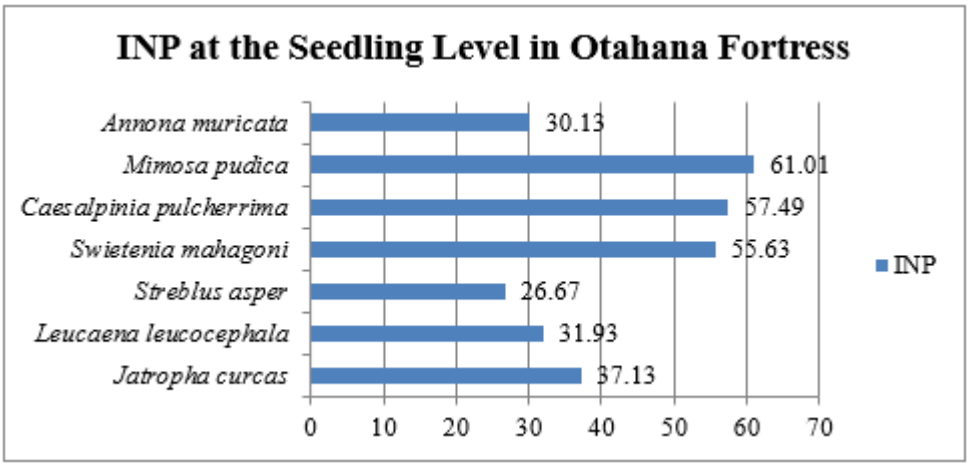

Figure 3. INP at the Seedling Level in Otanaha Fortress
Source: Primary Data, 2020

Discussion

Referring to the research result and data analysis, vegetation in Otanaha Fortress came with different relative density, relative frequency, relative dominance, and INP at each of the levels. The highest INP at the tree, stand, and seedling level was achieved by *Swietenia mahagoni* at 63.26%, *Caesalpinia pulcherrima* at 78.26%, and *Mimosa pudica* at 61.01%, respectively.

Mahogany (*Swietenia mahagoni*) was one of the trees in Otanaha Fortress. It was a shade tree owing to its heat resistance and good adaptability to different soil conditions. The tree was firstly grown in Java as early as the Dutch colonialization. Mahogany wood was sold at a high price, and hence cultivated to fulfill industries needing. It was hard in quality and red in color and suitable for the materials of meuble, furniture, engraved items, and handicrafts. The quality of mahogany wood was similar to that of teak wood and therefore became the second top wood. By types, mahogany consisted of small-leaved (*Swietenia mahagoni*) and big-leaf mahogany (*Swietenia macrophylla*). The quality of the first was better than the second (Ministry of Forestry, 2011).

Mahogany was easily cultivated as it could grow in various types of areas and soil. In general, it could grow on slightly loamy soils with an altitude of 1000 meters above sea level. Multiple research on mahogany was easy to find and defined the high genetic diversity of mahogany (*Swietenia mahagoni*) (Mashudi, 2017). That high genetic diversity engendered high phenotypes, and thereby requiring both morphological and physiological analyses (Martawijaya *et al*., 2005).

Importance Value Index (INP) described the roles of a plant in a community. The higher the INP of a plant, the higher the roles of the plant in a community being measured. In a

dominance concept, if a plant had the highest INP, it showed off competitiveness and higher tolerance than others (Haryanto *et al*., 2015). The higher the INP of a plant, the higher the dominance of the tree. It was commensurate with Tuhono (2010), who spelled out that a specific type of plant might give a significant contribution if having INP > 10% at the seedling and stand levels and over 15% at the stand and tree levels.

Vegetation growth was influenced by environmental factors around the area where the plants grew. Based on the measurement of environmental factors, the temperature of the respective research sites ranged between 27-30^{o}C at an air humidity of 25-30%. This signified that the temperature and condition around research sites were normal and favorable for the vegetation at seedling and tree levels to grow. Additionally, vegetation in research sites was all well preserved.

CONCLUSION

12 species of plants inhibited the area of Otahan Fortress Gorontalo City. They were *Lannea coromandelica*, *Leucaena leucocephala, Streblus asper, Swietenia mahagoni, Ficus benjamina, Caesalpinia pulcherrima, Jatropha curcas, Samanea saman, Lepisanthes rubiginosa, Garuga floribunda, Annona muricata,* and *Mimosa pudica*. The highest INP at the tree level was attained by *Swietenia mahagoni* at 63.26%. At the stand level, the highest INP, i.e., 78.26%, was attained by *Caesalpinia pulcherrima.* Finally, at the seedling level, the highest INP, i.e., 61.01%, was attained by *Mimosa pudica*.

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