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Species Composition and Vegetation Structure in Natural Park PT Badak LNG, Bontang, East Kalimantan

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ABSTRACT
Forest ecological studies in Natural Park PT Badak Bontang, East Kalimantan has been carried out with the transect method. Vegetation observation was done on the transect line made by plot size 20 x 20 meter, and the distance between the plots is 100 meters. This study would be covered on species composition and species importance values. The forest structure could be seen from diameter and height stem classes, where commonly have been still some big tree with diameter > 100 cm and height 50 m tall. Meranti types are the main types of community constituents. These species include *Shorea daspyphylia*, *S.hemsleyana*, *S. gibbosa*, *S. kunstteri*, *S.leprosula*, *S. macroptera*, *S.ovalis*, *S.parvifolia*, *S.pinanga*, *S.johorensis*, *S.ovata*, *S. pauciflora*, *S.pubistyla*, *S.seminis*. Based on the Species Importance Value-s index rankings, respectively, *Anthocephalus* sp. with a value of 27.03, followed by *S. kunsteri* of 16.59, *Memecylon borneensis* of 15.78, *S. alutaceae* of 14.77, *Syzygium* sp. of 14.138 and *Ficus* sp. of 10.55. In the seedling, the level is dominated by pioneer types such as *Syzygium* spp., *Litsea* spp., *Memecylon borneensis*, *Syzygium* spp., *Litsea* spp. The kind of Dipterocarpaceae seedling is scarce. The type of Dipterocarpaceae seedling is short. The regeneration failure of these Dipterocarpaceae species in the future will alter the structure and composition of the plant species and is driven by the dominance of seedlings of pioneer groups.

Keywords: *Species Composition, Vegetation Structure, Species Importance Values*

1. INTRODUCTION

Natural Park area of 7.4 ha located in PT Badak site represents the original ecosystem type of tropical rain forest of lowland of East Kalimantan. This forest is a natural and historical monument before the existence of PT. Badak NGL. This forest's presence plays a vital role as a regulator of the ecological balance in the project footprint that unites the industrial activities and the natural environment to look harmonious, comfortable, natural and beautiful. Based on a topographic map scale of 1: 500, Natural Park area heights ranging from 15-45 m above sea level with geomorphological conditions ranging from flat to sloping or hilly.

The condition of the location overlays are distinguished on Natural Park natural vegetated forest site of 6 ha, and 1.4 ha are shrubs. This Park, located within the PT Badak NGL complex of 7.4 Ha, is an effort to conserve the company's biodiversity of lowland tropical forest. Characteristics of existing plants is a mixture of lowland and coastal communities. This forest results from the fragmentation of Natural forest in Bontang area since 1972, which initially intact became separated and isolated to form a small ecosystem. Based on Gunawan and Prasetyo, 2013, this process can be categorized as a result of habitat fragmentation. Fragmentation impacts the composition, species diversity, dynamics and ecosystem function [1,2].

Based on the estimated age of trees conducted by the IPB Bogor team in 1995 to the plants in Natural Park, several trees are older than 100 years. Some of these plant species are commonly found in primary forests such as *Canarium* spp., *Litsea* spp., *Bischofia* spp., *Eugenia* spp., *Lophopetalum* spp., Ficus spp. etc. The oldest tree (estimated to be 535 years old) is *Canarium caudatum*. In the Natural Park area, there are potential mother trees as a seed source for other planting activities from the inventory that has been done.

There are 18 protected tree species located in the Natural Park area PT. Badak NGL Bontang. The types are *Alstonia scholaris* (Pulai), *Aquilaria malaccensis* (Karas), *Diospyros buxifolia* (Rambai punai), *Diospyros coriacea* (black charcoal), *Diospyros rigidus* (Carbon wood), *Diospyros sumatrana* (Kayu arang), *Diospyros toposioides* (Carbon wood), *Drybalanops* sp. (Marakatan), *Duabanga moluccana* (Benuang laki), *Dyera costulata* (melabuai), *Eurycoma longifolia* (Pasak Bumi), *Eusideroxylon zwageri* (Ulin), *Fagraea fragrans* (Tembesu), *Flacourtia rukam* (Rukam), *Ganua motleyana* (Kemalao), *Lophopetalum beccarianum* (Perupuk), *Shorea leprosula* (Lempung lahung) and *Styrax macrocarpa* (Rice-rice).

The adverse effects of forest fragmentation and isolation are expected to alter forest structure and plant communities, jeopardizing biodiversity, regeneration capacity, and vitality of forests [3]. Loss of forest biodiversity may seriously affect forest ecosystems' functioning (i.e., the activities, processes, or properties of woods, such as decomposition of organic matter, soil nutrient cycling, and water retention). Consequently, the forest's ability to provide ecosystem services [4]. Ecosystem services have been defined as the benefits people obtain from ecosystems and categorized into four broad categories. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate (e.g., though carbon sequestration), pollination, biological pest control, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling [5].

The natural regeneration process in the forest can occur after a light entering the soil surface. The creation of a gap or forest opening that occurs due to the fall or the death of a big tree is the beginning of regeneration or regeneration.

The regeneration of a species encompasses the production and dispersal of seeds, their germination, and subsequently the juveniles' growth until they reach maturity and start producing seeds themselves. At any moment in the regeneration process, an individual may die, for example, following predation or due to adverse environmental conditions. The failure of a species to regenerate will ultimately result in its (local) extinction.

The study provides detailed ecological characteristics of the vegetation structure of Natural Park PT Badak NGL Bontang and aids in understanding the spatial distribution of vegetation descriptors for biodiversity conservation and management.

2. MATERIALS AND METHODS

2.1. Study Area

This study held in natural park of 7.4 Ha in PT Badak NGL Bontang , East Kalimantan (Figure 1).

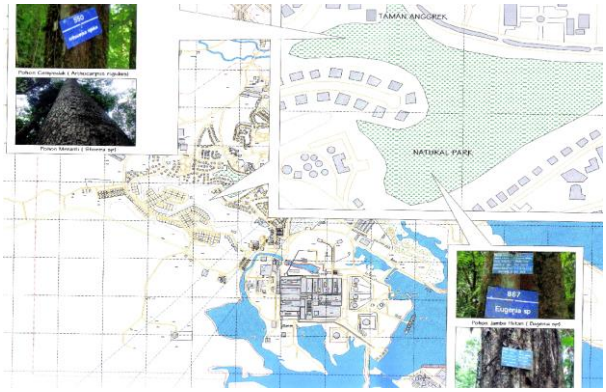

Figure 1 Study plot at Botanical Park PT Badak NGL Bontang East Kalimantan, Indonesia.

2.2. Method

Vegetation observation was done on the transect line made by plot size 20 x 20 meters. The distance between the plots is 100 meters. The data collection taken in this observation is the type of tree with a diameter size above 10 cm. In this sample plot, establish some sub-plots, are 20m x 20m for tree stratum (diameter at breast height/dbh ≥ 20 cm), 10m x 10m for pole stratum (dbh 10–19.9 cm), 5m x 5 m for sapling stratum (dbh 2-9.9 cm), and 2m x2m for seedling stratum (dbh < 2 cm and height < 1.5 m). For unidentifiable types of vegetation, plant parts are taken for later identification. Data were analyzed for calculating tree density (N/ha), Important Value Index (IVI), Diversity Index (H') from Shannon-Wiener, and to identify the stand structure of Natural Park forest.

3. RESULTS AND DISCUSSION

3.1. Species Composition

The wealth of trees in the natural forest is very high, where the results of identification and determination 3643 trees are consisting of 415 species and 56 tribes plants. Among these species are *Aquilaria malaccensis,* which is included in Appendix II status according to CITES and protected trees based on Government Regulation No. 7/1999 dated 27 January 1999, namely *Shorea pinanga* and *Shorea seminis*. The species of meranti group are the main types of natural forest constituents. These types include *S.daspyphylia, S. hemsleyana, S. gibbosa, S. kunstteri, S.leprosula, S.macroptera, S.ovalis, S.parvifolia, S. pinanga, S. johorensis, S.ovata, S .pauciflora, S.pubistyla, S.seminis*. Such species have been rare in the Kalimantan forest due to over-exploitation as an economically valuable timber producer.

Table 1. Phytosociological description of individual tree species of the canopy stratum (perimeter above 10 cm) of the Natural Park PT Badak Bontang.

No.	Species	Density	Relative Density	Frequency	Relative Frequency	Dominance	Relative Dominance	Importance Value Index	Index of Diversity H'
1	*Shorea* sp1.	0.0004	1.404	0.167	1.538	0.860	2.186	5.128	
2	*Shorea* sp2.	0.0004	1.404	0.167	1.538	0.683	1.737	4.679	
3	*Shorea* sp3.	0.0004	1.404	0.167	1.538	0.614	1.560	4.502	
4	*Knema latericia*	0.0008	2.807	0.333	3.077	0.301	0.765	6.649	
5	*Dillenia borneensis*	0.0004	1.404	0.167	1.538	0.828	2.105	5.047	
6	*Syzygium* sp.	0.0017	5.965	0.500	4.615	1.399	3.557	14.138	
7	*Arthocarpus anisophylla*	0.0004	1.404	0.167	1.538	0.069	0.175	3.117	
8	*Memecylon borneensis*	0.0013	4.561	0.500	4.615	2.600	6.609	15.786	
9	*Shorea kunstleri*	0.0013	4.561	0.500	4.615	2.918	7.418	16.594	
10	*Ixonanthes reticulata*	0.0004	1.404	0.167	1.538	0.456	1.158	4.100	
11	*Nothaphobe sp.*	0.0004	1.404	0.167	1.538	0.722	1.835	4.777	
12	*Shorea parvistipulata*	0.0004	1.404	0.167	1.538	0.401	1.021	3.962	
13	*Schimawalichii*	0.0004	1.404	0.167	1.538	0.272	0.691	3.633	
14	*Actinodaphneglabra*	0.0004	1.404	0.167	1.538	0.035	0.189	3.131	
15	*Octomeles sumatrana*	0.0004	1.404	0.167	1.538	0.349	0.888	3.830	
16	*Myristia maxima*	0.0004	1.404	0.167	1.538	1.274	3.240	6.182	
17	*Gonystylus brunnescans*	0.0004	1.404	0.167	1.538	0.083	0.211	3.153	
18	*Shorealaevis*	0.0004	1.404	0.167	1.538	0.707	1.798	4.740	
19	Sp1	0.0004	1.404	0.167	1.538	0.036	0.092	3.034	
20	Sp2	0.0004	1.404	0.167	1.538	0.683	1.737	4.679	
21	*Dipterocarpus* sp.	0.0004	1.404	0.167	1.538	0.902	2.293	5.235	
22	*Xylophia feruginea*	0.0004	1.404	0.167	1.538	0.043	0.109	3.051	
23	*Ficus* sp.	0.0008	2.807	0.333	3.077	1.837	4.669	10.553	
24	Sp3	0.0004	1.404	0.167	1.538	0.057	0.145	3.087	
25	*Nothaphobe* sp.	0.0008	2.807	0.167	1.538	0.374	0.952	5.297	
26	Sp4	0.0004	1.404	0.167	1.538	0.209	0.530	3.472	
27	*Durio griffitii*	0.0004	1.404	0.167	1.538	0.591	1.503	4.445	
28	*Shorea leprosula*	0.0004	1.404	0.167	1.538	0.669	1.701	4.643	
29	*Horsfieldia* sp.	0.0004	1.404	0.167	1.538	0.134	0.340	3.282	
30	Sp5	0.0004	1.404	0.167	1.538	0.067	0.171	3.113	
31	Sp6	0.0004	1.404	0.167	1.538	0.104	0.264	3.206	
32	*Shorea alutacea*	0.0013	4.561	0.333	3.077	2.808	7.139	14.77	
33	Sp7	0.0004	1.404	0.167	1.538	0.362	0.919	3.861	
34	*Alstoni aiwahingensis*	0.0004	1.404	0.167	1.538	0.470	1.194	4.136	
35	*Baccaurea stipulata*	0.0004	1.404	0.167	1.538	0.072	0.182	3.124	
36	*Anthocepalus sp.*	0.0013	4.561	0.167	1.538	8.205	20.93	27.03	
37	Sp8	0.0004	1.404	0.167	1.538	0.409	1.039	3.981	
38	Sp9	0.0004	1.404	0.167	1.538	0.104	0.264	3.206	
39	*Anthocephalus cadamba*	0.0004	1.404	0.167	1.538	0.140	0.356	3.298	
40	*Boueaop psitifolia*	0.0004	1.404	0.167	1.538	0.760	1.933	4.875	
41	*Polyialtia* sp.	0.0004	1.404	0.167	1.538	0.073	0.186	3.127	
42	Sp10	0.0004	1.404	0.167	1.538	0.251	0.638	3.580	
43	*Fabaceae*	0.0004	1.404	0.167	1.538	0.970	2.466	5.408	
44	Sp11	0.0004	1.404	0.167	1.538	0.352	0.895	3.837	
45	Sp12	0.0004	1.404	0.167	1.538	0.269	0.683	3.625	
46	*Cryptocarya crassinema*	0.0004	1.404	0.167	1.538	0.527	1.339	4.281	
47	*Ixonanthes* sp.	0.0004	1.404	0.167	1.538	0.158	0.402	3.344	
48	Sp13	0.0004	1.404	0.167	1.538	1.148	2.918	5.860	
49	*Shorea slovenii*	0.0004	1.404	0.167	1.538	0.234	0.595	3.537	
50	*Campnosperma* sp.	0.0004	1.404	0.167	1.538	0.040	0.102	3.044	
51	Sp14	0.0004	1.404	0.167	1.538	0.249	0.634	3.576	
52	Sp15	0.0004	1.404	0.167	1.538	0.077	0.197	3.139	
53	Sp16	0.0004	1.404	0.167	1.538	0.243	0.617	3.559	
54	*Placordia* sp.	0.0004	1.404	0.167	1.538	0.061	0.156	3.098	
55	*Dracontomelon dao*	0.0004	1.404	0.167	1.538	0.346	0.930	3.872	
56	*Phoebe grandis*	0.0004	1.404	0.167	1.538	0.641	1.630	4.572	
									1.657

3.2. Vegetation Structure

3.2.1. Tree Stratum

The significance index values of various species in the trees (> dbh10 Cm) are presented in Table 1. It can be seen that tree species of this forest community based on the Importance Value Index (IVI) rankings found are Anthocephalus sp with a value of 27.03, followed by *Shorea kunsteri* (16.59), *Memecylon borneensis* (15.78), *Shorea alutaceae* (14.7), *Syzygium* sp. (14.138), and *Ficus* sp. (10.55). Importance Value Index (IVI) is a quantity that indicates the position (dominance) of a type against other types within a community. The larger a type of IIV, its role in the community is increasingly important.

Referring to this concept, it is clear that high and old aged tree species dominate the forest community. The types of meranti are the main types of community constituents. These types include *Shorea daspyphylia, Shorea hemsleyana, Shorea gibbosa, Shorea kunstteri, Shorea leprosula, Shorea macroptera, Shorea ovalis, Shorea parvifolia, Shorea pinanga, Shorea johorensis, Shorea ovata, Shorea pauciflora, Shorea pubistyla, Shorea seminis.*

According to Whittaker (1974), the basic assumption in the analysis of standing structures is to predict forest compositions' tendency where a low-density (or negligible) type of stakes and seedlings will eventually disappear from the community stand. Following these assumptions, several species currently encountered in the natural forest of PT Badak are predicted to disappear from stands in the future.

3.2.2. Sapling Level

The sapling rate results (dbh 2-9.9 cm) in this forest are dominated by pioneer species such as Syzygium spp, Litsea spp, Milletia sericea *Baccaurea stipulata, Nauclea sp*., while the type of Dipterocarpaceae is scarce. This situation indicates the failure of plant regeneration of Dipterocarpaceae. Several factors are causing rebar formation because of the canopy fracture, a drastic change in a microclimate that can cause damage or death of many seedlings. The regeneration failures of these Dipterocarpaceae species in the future will change the structure and composition of plant species and are driven by the dominance of seedlings of a rapidly growing pioneer group, such as *Anthocepalus cadamba* (Jabon), *Litsea sp* (Medang), and *Syzygium sp* (Jambu Hutan).

The type that shows the highest density *is Syzygium racemosum* with a density of 37.33/ha, followed by *Litsea* sp. (19,55/ha), *Memecylon borneensis* (12,89/ha), *Diospyros confertifolia* (7,55/ha), *Bauhinia* sp, (7,55/ha), *Knema* sp. (5,33/ha), *Milletia sericea* (3,55/ha), *Strombosia javanica* (3.11/ha), *Alseodaphne* sp. (2.67/ha), and *Arthocarpus* sp. (1.78/ha). The success of the seedling level of the pioneer types shows these species can utilize light intensity availability. The relative density and relative density values of the ten types of saplings are presented in Table 2.

Table 2. The density of individual tree species of the sapling as regeneration stratum (perimeter 2-9.9 cm) of the Natural Park PT Badak Bontang.

No	Species	Density
1	*Syzygium racemosum*	37.33
2	*Litsea* sp.	19.55
3	*Memecylon borneensis*	12.89
4	*Diospyros confertifolia*	7.55
5	*Bauhinia* sp.	7.55
6	*Knema* sp.	5.33
7	*Milletia sericea*	3.55
8	*Strombosia javanica*	3.11
9	*Alseodaphne* sp.	2.67
10	*Arthocarpus* sp.	1.78

3.2.3. Seedling Level

For the level of seedling (dbh <2 cm) is dominated by the same species as the saplings. The highest density type was *Memecylon borneensis* with a density of 0.5/ha, followed by *Syzygium racemosum* (0.195/ha), *Litsea firma* (0.1667/ha), *Maranthes corymbosa* (0.1383/ha), *Strombosia javanica* (0.1117/ha), *Miletia sericea* (0.055/ha), *Litsea* sp. (0.055/ha), *Litsea teysmanii* (0.055/ha), *Fordia splendidisima* (0.055/ha), and *Syzygium* sp. (0.055/ha). Ten species with the highest relative density and density of the sapling rate are presented in Table 3.

Table 3. Density of individual tree species of the seedling stratum (perimeter < 2 cm) of the Natural Park PT Badak Bontang.

No	Species	Density
1	*Memecylon borneensis*	0.500
2	*Syzygium racemosum*	0.195
3	*Litsea firma*	0.166
4	*Maranthes corymbosa*	0.138
5	*Strombosia javanica*	0.111
6	*Litsea* sp.	0.055
7	*Milletia cerise*	0.055
8	*Syzygium* sp.	0.067
9	*Litsea teysmanii*	0.005
10	*Fordia splendidisima*	0.005

3.3. Diversity

In Table 1, we can be seen that the species diversity after 40 years old in a natural park in the industrial park as remnant is relatively small, i.e., H' = 1.657. From the results of monitoring the biodiversity of plants in Botanical Park of PT Badak Bontang, seen the existence of the dominance of certain species due to the growth of seedling level and sapling of several types of plants to reach climax. The composition of forests will occur dynamically each year, where declines or deaths are more likely to occur due to parent tumbling trees on saplings and stakes, climate change, human activities on the forest, and plant-level competition.

The succession process occurs gradually and depends on the forest environment's state, so it takes a long time to reach the climax. Succession in the early stages begins with the formation of gaps, stimulating the pioneer plants under the fallen breeding canopy to harness the sunlight for growth. In the process of succession to its climax, it will replace the lost brooding individuals. In the process of succession, the dead parent tree will not always be replaced by the same individual species. This is influenced by the type and competition of seedlings and saplings that lie beneath the dead parent. Types of parent trees with a high natural seedling ability will have a high probability of dominating the next climax composition. In contrast, sires with low raw seedling power will gradually be eliminated or lost in this forest's composition.

4. CONCLUSION

(1) The remnant natural forest community in PT Badak LNG Bontang is dominated by tree species of high canopy structure and old age. The types of Dipterocarpaceae (meranti) are the main types of community constituents. These types include *Shorea daspyphylia*, *Shorea hemsleyana*, *Shorea gibbosa*, *Shorea kunstteri*, *Shorea leprosula*, *Shorea macroptera*, *Shorea ovalis*, *Shorea parvifolia*, *Shorea pinanga*, *Shorea johorensis*, *Shorea ovata*, *Shorea pauciflora*, *Shorea pubistyla*, *Shorea seminis*.

(2) Based on IVI rankings, respectively, *Anthocephalus* sp. with a value of 27.03, followed by *Shorea kunsteri* (16.59), *Memecylon borneensis* (15.78), *Shorea alutaceae* (14.77), *Syzygium* sp. (14.138), and *Ficus* sp. (10.55).

(3) The level of seedlings in natural forests is dominated by pioneer species such as *Memecylon borneensis*, *Syzygium* spp., *Litsea* spp. The type of Dipterocarpaceae seedling is scarce. The regeneration failures of Dipterocarpaceae species in a tropical forest *remnant in this place for the future will alter the structure and composition of the plant species and are compelled by the dominance of seedlings of pioneer groups.*

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