Fauna & Flora International's Indonesia Programme

Vegetation and Tree Diversity Report In PT Global Alam Nusantara (PT GAN) Riau Ecosystem Restoration

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VEGETATION AND TREE DIVERSITY REPORT IN PT GLOBAL ALAM NUSANTARA (PT GAN) RESTORASI EKOSISTEM RIAU

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OVERVIEW

Kampar Peninsula Peat Swamp Forest (PSF) is one of the remaining intact PSF of Sumatra located in Riau Province and plays an important role to our life, such as regulating climate and hydrological functions, as well as reserving a huge amount of Carbon. The 36,524 ha PT GAN concession is part of this intact PSF, managed as an Ecosystems Restorations concession. This study aimed to understand the vegetation structure and its species composition, also the tree diversity of GAN PSF in order to develop management recommendations.

Data collection was done using a combination of line transect and permanent plots with a total coverage of 15 Ha. Results showed that the vegetation of GAN PSF is comprised of at least 67 species belonging to 32 families. The average DBH of large trees was 37.86 cm, small tree 19.8 cm, and poles 9.35 cm with densities of each class respectively 43 stems per hectare, 401 stems/Ha, and 1437 stems/Ha. According to the importance value index (IVI), *Shorea teysmanniana* (63.7) were dominant and along with *Campnosperma coriaceum* (23.7), *Pandanus andersonii* (23.5) and *Calophyllum calaba* (22.4) were the most common species. At least 7 threatened tree species occur in GAN concession, and 3 need special attention for conservation because of their IUCN status as Critically Endangered due to small population in a restricted habitat, i.e. *Gonystylus bancanus*, *Shorea platycarpa*, and *Vatica teysmanniana.*

I. INTRODUCTION

1.1 Background

Peat swamp forest is a unique and fragile ecosystem under threat from human-caused disturbance such as conversion of forest to plantations, expansion of agriculture, illegal logging, and fire (Posa et al., 2010). Consequently Sumatra, which historically held the largest area of peat swamp (7 million hectares) has experienced peat swamp forest loss of about 78% (Purba et al., 2014). Riau Province currently has the largest peatland area in Sumatra (4 million hectares) with around 671,125 ha of this in Kampar Peninsula (Tropenbos International Indonesia Program, 2010). The peat swamp forest in Kampar Peninsula is an important site for biodiversity, providing a home for many endangered species as well as ecosystem services, such as carbon stock storage (approx. 2.14 – 2.68 million tons $CO2_e$), clean water, and flood prevention (Tropenbos International Indonesia Program, 2010). However, due to the pressure of land conversion, peat swamp forest in Sumatra has been greatly reduced.

Restorasi Ekosistem Riau (RER) program was formed by APRIL in 2013. With an area of approximately 150,693 ha, RER aims to protect, restore and conserve degraded peat swamp forest ecosystems in the Kampar Peninsula area as a contribution to the Government of Indonesia's program to protect 2,600,000ha of forest through the Ecosystem Restoration (IUPHHK-RE) license. Currently, the RER landscape consists of five concessions, which are valid for 60 years from the Ministry of Environment and Forestry of the Republic of Indonesia. The five concessions are PT Gemilang Cipta Nusantara-KP (20,123 ha), PT Gemilang Cipta Nusantara-PPD (20,598 ha), PT Sinar Mutiara Nusantara (32,781 ha), PT The Best One Unitimber (40,665 ha) and PT Global Alam Nusantara (36,524 ha).

RER collaborates with Fauna & Flora International's Indonesia Program (FFI’s IP) to design frameworks, policies and management plans related to aspects of biodiversity, climate and wider community assessment at the landscape level. The resulting management program is expected to restore important ecological processes and functions in the area. In addition, it can also produce environmental services that provide many benefits for multiple parties, including the community (Riau Ecosystem Restoration, 2015).

Biodiversity is an important component of the ecosystem, helping to ensure the functioning of ecological processes and, in any restoration efforts, biodiversity monitoring becomes an indicator of effective management. Before an effective monitoring activity is carried out, it is important to have baseline biodiversity data from the target location.

RER and FFI’s IP have been conducting studies on biodiversity in Kampar Peninsula

Landscape since 2015, PT GCN, PT SMN, PT TBOT) with a total area of 92,507 ha. In 2021, this biodiversity study was continued in PT Global Alam Nusantara (PT GAN), allowing for a comprehensive biodiversity baseline for RER's peat swamp forest area.

1.2 Objective

This survey was conducted to identify and describe the current condition of Peat Swamp Forest as well as the presence of any potential threats, Specifically, this covered:

1. Vegetation structure and composition,
2. Types of peat forest vegetation,
3. Diversity indices of trees and stands,
4. List of species important for conservation

II. METHOD

2.1 Study Area

The Riau Ecosystem Restoration area (RER), which consists of PT GCN, PT SMN, PT TBOT and PT GAN, is located in in a single continuous block at the center of the Kampar Peninsula with a topography ranging from 2-16 m. The area has a wet-tropical climate with relative humidity ranging from 81-84% (annual average, 82%) and annual rainfall ranging from 1,949-2,951 mm/year. The average monthly air temperature ranges from 26.1-27.5^{o}C, with an annual average of 26.7^{o}C (PT GCN, 2012).

In general, the Kampar Peninsula area has three main ecosystem types; mangrove forest on the coastline, peat swamp forests and riparian forests along river margins. For the RER area, the main ecosystem is peat swamp forest, which can be further classified based on dominant vegetation: 1. Mixed peat swamp forest, 2. Tall pole forest, 3. Low pole forest, and 4. Riparian Forest. Riparian forests in the RER are located along three rivers tht incluce the Turip, Serkap and Sangar rivers. During the rainy season the inundation width of the rivers can reach 1-1.5 km. The depth of peat in the RER area reaches 15m, with the acidity (pH) of water ranging from 3.1 to 3.9 (Tropenbos International Indonesia Program, 2010; PT GCN, 2012).

The peat swamp ecosystem on the Kampar Peninsula, including the RER, is an important habitat for threatened flora and fauna species. Several species of threatened flora that also have high economic value are, ramin (*Gonystilus* sp.), various species of meranti (*Shorea* spp.), durian (*Durio* sp.), kempas (*Kompassia malacensis*) and punak (*Tetramerista glabra*). Some mammals are threatened, such as the Sumatran tiger (*Panthera tigris sumatrae*), Sunda pangolin (*Manis javanica*), and sun bear (*Helarctos malayanus*). Several species of hornbills and predator birds, such as eagles and peregrines, and reptiles like senyulong (*Tomistoma schlegelii*) and biuku (*Batagur borneoensis*) are also present (Tropenbos International Indonesia Program, 2010).

The survey at PT GAN was carried out on 12 transects (Figure 1) and took place during March–August 2021. Three of the 12 transects (GA10, GA11 and GA08) were located along riverbanks. The condition of the forest floor on the GA11 and GA08 (riverside) transects were inundated to depths of 70cm and 60cm, respectively. Two transects, GA01 and GA12, were 4 km from an *Acacia crassicarpa* fiber plantation area.

Figure 1. Vegetation transectx in PT GAN.

2.2 Data Collection

Data collection was along straight-line transects, each measuring 2km in length. Five sample plots were systematically placed at a 500m intervals along each transect (see Figure 2). Each sample plot was divided into three classes of subplots, based on the Diameter at Breast Height (DBH) size group (as in

Table *1*), i.e., subplot A to measure class-A stems (big trees) with DBH 30 cm up, subplot B measures class-B stems (small tree/poles), and subplot C to measure class-C stems (poles).

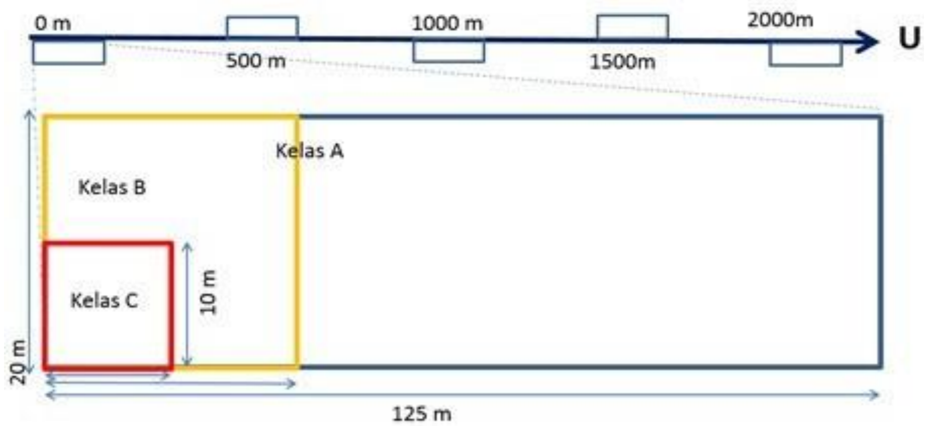


Figure 2. The size and placement of sub-plots on the transect.

Table 1. Size of sub-plots and its class category of tree

Size of sub-plot (m)	DBH (cm)	Category	Class
10 x 10	5 - 15	Pole	C
20 x 20	15 – 30	Small tree/pole	B
20 x 125	>30	Big tree	A

Within each sub-plot, the parameters recorded were tree species, trunk diameter at breast height (dbh), tree height, first branch-free height per individual tree, according to dbh class. The coordinates of each plot were recorded using Garmin GPS, at the starting point (0,0) of the plot. Leaves, twigs, fruit, and flowers samples were collected to make herbarium and was photographed for further identification purposes. Initial identification of plant species was carried out directly in the field. To ensure accuracy, the results from the herbarium specimens and photos collected were matched with FFI IP's plant photo-database, and herbarium specimens in the herbarium. To complete the list of vegetation species outside the plots and obtain a comprehensive description of the habitat in the study area, exploratory observations were also carried out around the sample plots and transects.

2.3 Threat Assessment

The RER threat assessment involved direct recording and documentation of all activities observed (primary data) that could be considered to have an impact on ecological sustainability in the RER area. Evidence of former threats if detected were also recorded, including but not limited to tree stumps, fires, snares, gaps by logging/encroachment, logging trail, etc. Each location of a threat was geo-tagged and the estimated time of when the threat occurred and area affected was recoreded. Secondary data, in the form of interviews regarding community activities around the area and within the RER area, was also collected.

2.4 Data Analysis

Vegetation analysis was based on vegetation structure, floristic composition, floristic diversity, and similarity between communities. Both horizontal and vertical vegetation structure was measured: horizontal structure refers to the stand's density of each dbh class (max., min., average), while vertical structure measures the arrangement and height of the canopy strata layer. In general, the vegetation layer is divided into the forest floor layer (understorey) and the top layer (upper storey). The top layer of peat forest is further divided according to stand height: the upper canopy (25–37.5m), middle canopy (15–25m), and lower/sub canopy (with a span of 5–15m). Sometimes an emergent canopy layer is found, namely trees that have a height exceeding the upper canopy but with a small distribution, so that the trees appear to be sticking out above the vegetation.

Analysis of floristic communities was carried out using the Important Value Index (IVI), while diversity and community analyses used the Shannon-Wiener diversity index (H'), Simpson dominance index (D) and evenness/Evenness index (E). The Bray-Curtis similarity index was used to determine the level of similarity between communities (transects), and to group similar communities. The significance index was calculated using Microsoft® Excel™ 365 software, while the diversity and community indices were calculated using PAST© ver.4.03 (Hammer et al., 2001). The explanation and formulation of each of the above indexes are as follows:

2.4.1 Shannon-Wiener Diversity Index

The Shannon-Wiener Diversity Index (Shannon, 1948) is used to measure the level of diversity of a community by considering species richness and the proportion of species to the total species in the community. This index is calculated by the following formula:

$$H' = -\sum_{i=1}^{n} pi.\ln pi$$

where,
H' : Shannon-Wiener Diversity Index
pi : proportion of species - i
ln pi : natural logarithm of pi

The value of H' is numeric and does not have a specific range, only indicating that the higher the value of H, the higher the diversity of a community. However, in diversity studies, it is very rare to find a value of H' above 5 (Magurran, 2004), so it can be assumed that an H' value of 5 represents the highest diversity value for tropical rain forests. With these assumptions, following the upper range (upper quartile) and lower range (lower quartile), then the value of H' can be categorized as: very low (0-1), low (1-2), moderate (2-3), high (3-4), and very high (4-5).

2.4.2 Evenness Index

This index describes the level of evenness in the distribution of species within a community or ecosystem. The value of E ranges from 0 to 1, whereby, 1 indicates the distribution of species in a community is evenly distributed (or that the proportion/number of individuals, of each species, in a community or ecosystem, is relatively the same). This index is calculated by the formula:

$$E = \frac{H'}{ln\ S}$$

where,
E : Pielou Evenness Index (Pielou, 1966)
H' : Shannon-Wiener Diversity Index
S : Total number of species

2.4.3 Simpson's Domination Index

This index is used to provide information about the dominance by one or several species in a particular community or ecosystem (Simpson, 1949). The value of D has a range from 0 to 1, where a value close to 1 indicates dominance by one or several species in a community or ecosystem (Harper, 2000). This index can be calculated using the formula:

$$D = \sum_{s-1}^{s} (Pi^2)$$

where,
D : Simpson's Dominance Index
S : Number of species in the community
Pi : Proportion of number of individuals/samples in that species

2.4.4 Cluster Analysis

The Bray-Curtis similarity index can provide information about the level of similarity between communities of the constituent types. This index value has a range from 0 to 1, where the closer the value to 1, the higher the similarity between communities. Conversely, a value closer to 0 infers different communities. This index is used to classify vegetation types in peat ecosystems, based on the structure and composition of the vegetation shows into dendrogram. Principal Component Analyses (PCA) are used for further analyses, to cluster plots into groups of vegetation based on vegetational structure and composition. Both cluster analyses are completed using the software Past© ver.4.03.

III. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Structure and Forest Community Composition of PT GAN

Vegetation Structure

Vegetation structure refers to the number and density of tree stems associated with tree diameter (dbh) class per area. (Table 2). In PT GANthe average density of tree stems per hectare for class C, is four; Class B has 40 trees per hectare and class A has 144. The forest of PT GAN has an average dbh of 20.8cm, with a maximum of 83.5cm. The transect with the highest mean dbh and largest diameter was GA11 located in riparian forest next to Serkap River.

Table 2. Numbers and Density of tree by class for each transect in PT GAN.

Parameter	Class	GA 01	GA 02	GA 03	GA 04	GA 05	GA 06	GA 07	GA 08	GA 09	GA 10	GA 11	GA 12
N Species		22	28	24	21	21	29	31	36	24	32	**50**	28
Total Stems		208	**243**	**243**	152	196	182	**237**	190	229	167	198	222
Number Of Stems (Σ) and Density (Σ/Ha) by size class	C	43	18	62	1	40	34	**88**	67	63	72	**84**	74
	ΣA/Ha	34,4	14,4	49,6	0,8	32,0	27,2	**70,4**	53,6	50,4	57,6	**67,2**	59,2
	B	93	82	**115**	42	93	86	98	59	**108**	39	57	88
	ΣB/Ha	465	410	575	210	465	430	490	295	540	195	295	440
	A	72	**143**	66	**109**	63	62	51	64	58	56	57	60
	ΣC/Ha	1440	**2860**	1320	**2180**	1260	1260	1020	1280	1160	1120	1140	1200
Mean DBH (cm)	C	34,1	36,2	36,7	30,2	37,5	37,2	37,2	41,2	36,1	40,9	**43,1**	36,3
	B	21,1	19,0	20,1	17,2	18,8	19,8	19,8	19,3	19,1	21,4	20,3	20,2
	A	10,1	9,1	9,9	7,9	8,5	10,6	8,9	8,6	9,8	8,5	8,0	9,6
Maximum DBH (cm)		43,9	45,7	51,2	30,2	57,5	55,1	62,5	67,4	49,0	61,3	**83,5**	53,4

Note: '**bold**' indicates the number of the highest value group, while red indicates the lowest value group

Based on its vertical structure (see Table 3), forests in PT GAN have a complete canopy layer (top, middle and bottom), as well as an emergent layer. The lower (52.8%) and middle (42.35%) layers dominated the forest canopy cover, with the top canopy layer only covering 4.29%. However, not all locations have complete canopy layers (Table 3). The forest in transects GA01-GA04 (in the peat dome) did not show an upper canopy, but only a lower canopy (5-15 m tall). The forest in transect GA12 (furthest south in PT GAN) also did not have an upper canopy, but the dominant cover layer was balanced between the middle and lower heights.

Table 3. Proportion of Canopy Layer for each transect in PT GAN.

Transect	Proportion of Canopy Layer (%)				
	Understorey	Bottom	Middle	Top	Emergent
RK_GA01	0.48	55.3	44.2		
RK_GA02		65.8	34.2		
RK_GA03		40.3	59.7		
RK_GA04		96.1	3.9		
RK_GA05		62.2	37.2	0.5	
RK_GA06		63.4	32.8	3.8	
RK_GA07	0.42	48.1	48.9	2.5	
RK_GA08		48.4	50.0	1.6	
RK_GA09		49.8	49.8	0.4	
RK_GA10	0.60	40.1	42.5	16.8	
RK_GA11	3.00	35.0	31.0	30.0	0.08
RK_GA12	0.90	41.0	58.1		
PT GAN	**0.45%**	**52.83%**	**42.35%**	**4.29%**	**0.08%**

Tree Community

The tree community in PT GAN is composed of peat forest tree species. based on the importance value of each species which shows the domination of space in the forest. The Importance Value Index (IVI) quantifies the abundance of each species within the community and cumulatively of that species within the forest. The presence of a plant species demonstrates its ability to adapt to the habitat and wide tolerance to environmental conditions (Hidayat, 2017). The greater the IVI of a species, the greater the level of dominance of that species over the community, and its impact on the forest's composition. The dominance of certain species in a community can occur if it can more effectively utilize forest resources than its conspecifics (Hidayat, 2017). The species compositions for each dbh class in the PT GAN transects can be shown as:

A: *Shorea teysmanniana* (138.4), *Calophyllum calaba* (25.1), *S. uliginosa* (18.8), *Ormosia sumatrana* (18.3), *Palaquium leiocarpum* (14,3), *Syzygium incarnatum* (13.8),

B: *S. teysmanniana* (59.7), *Pandanus andersonii* (53,8), *Campnosperma coriaceum* (35.1), *C. calaba* (29.6), *Syzygium incarnatum* (13.2), *Syzygium muelleri* (12.1),

C: *Campnosperma coriaceum* (30.4), *S. teysmanniana* (27.1), *Tristaniopsis merguensis* (25.7), *Syzygium muelleri* (19.2), *Austrobuxus nitidus* (18.1), *C. calaba* (17.8).

Diversity and Important species

The peat forest in PT GAN has at least 67 species of woody plants, from at least 34 families. Of these, the richest families (with the most species member) are: Myrtaceae (5spp), Sapotaceae (5spp), Dipterocarpaceae (4spp), Myristicaceae (4spp), and Rubiaceae (4spp). The range of diversity index values is 2.07-3.45, indicating that the level of diversity is moderate to high (see category H' value in the methodology section) with the distribution of diversity index values in each transect as shown in Table 4.

Table 4. Floristic Diversity Index of tree species within each transect in PT GAN.

Transect	GA 01	GA 02	GA 03	GA 04	GA 05	GA 06	GA 07	GA 08	GA 09	GA 10	GA 11	GA 12
Diversity	2.07	2.62	2.21	2.57	2.21	2.35	2.81	3.04	2.13	2.99	3.45	2.32
Number of Species	22	28	24	21	21	29	31	36	24	32	50	28
Domination (D)	0.24	0.11	0.18	0.10	0.19	0.18	0.08	0.07	0.20	0.07	0.05	0.16
Evenness €	0.36	0.49	0.38	0.62	0.44	0.36	0.54	0.58	0.35	0.62	0.63	0.36

The forest areas in GA08 and GA11 (in riparian forest) have the highest tree diversity, with H'>3 values. In the two transects, the dominance index is low, which means that there is no species that can be considered dominant. This is also indicated by the evenness index value, which tends to be higher than transects with low diversity values.

The lowest tree diversity was found on transects GA01, GA03, GA05 and GA09 (in the peat dome). However, the diversity value in these transects was 'medium' and is most likely linked to the apparent dominance of certain species (the dominance index value in these transects was higher than other transects).

3.1.2 Threats

The forest in PT GAN is generally intact with low threats as no stumps, fires, or snares were found. However, 3 small canals near the Serkap river were estimated to be present prior to designation as an ecosystem restoration concession. Canals were used to drainage peat soils and transport logs from the forest to the rivers. Satellite-imagery identified ex-logging trails and open area's (low forest density cover) near the Serkap River (close to transect RKGA_11). This is evidence that PT GAN historically experienced logging.

Although no immediate direct threats were observed in PT GAN, bird poaching is known to occur within the neighbouring PT TBOT concession. This illegal activity has the potential to spread into PT GAN without continuous forest protection patrols.

3.2 Discussion

3.2.1 Vegetation Structure and Floristic Community of PT GAN

A total of 2,467 trees from 82 species were recorded and placed into one of three dbh classes: A (large tree, >30cm), B (small tree/pole, 15-30cm) and C (saplings, 5-15cm). The average dbh of each class was: A = 37.30cm, B = 19.63cm, and C = 9.08cm. Tree density/ha for each dbh class in PT GAN (Table 5), was similarly comparable with density recorded in other RER concessions as well as other peat swamp forest ecosystems in Sumatra and Kalimantan

Table 5. Comparison of Number of Species and Tree Density between PT GAN, RER and other Peat Swamp Forests.

Location of peat swamp forest	Tree Density (Σ/Ha)	Σ Species	Surveyed area*	References
RER, PT GAN	43,1 (dbh≥30cm) 400,8 (dbh 15-30cm) 1.436,7 (dbh 5-15cm)	87	15 Ha	This Study
RER, Kampar, Riau	50,9 (dbh≥30cm) 317 (dbh 15-30cm) 1.174 (dbh 5-15cm)	112	39,75 Ha	Biodiversity survey FFI-RER 2015
SM Kerumutan	6.932 (dbh ≥1cm)	31-59/plot	0,28Ha	(Kuniyasu & Tetsuya, 2002)
Giam siak kecil,Riau	578 (dbh>10cm)	64	1Ha	Partomihardjo et al. (2011) in (Rosalina dkk., 2013)
Giam Siak kecil-Bukit Batu, Riau	662-2.492 (dbh≥3cm)	135	3Ha	(Gunawan et al., 2012)
Merang Kepayang, Jambi	232-600 (dbh≥10cm)	>100	11,25Ha	(Solichin et al., 2010)
Sebangau, Kalteng	2.689 (dbh≥15cm)	133	2Ha	(Mirmanto, 2010)
Selat Panjang, Riau	550 (dbh≥10cm)	50	1Ha	(Rosalina dkk., 2013)
Sanggau, Kalbar	513 (dbh≥10cm)	60	1Ha	Sambas (1994) in (Rosalinadkk., 2013)

*Measure area = total of plot area (example, there are 20 plots), plot size 20 x 125 m, then the measure area is (20 x 125) x 20 = 50.000 m^2 = 50Ha).

Based on the proportion of canopy layers (Figure 3), the RER peat forest as a whole (all four concessions) still has a complete layer structure; the upper, middle, and lower canopy, as well as an understorey layer that covers the forest floor. The main vegetation cover also tends to be similar and is dominated by the lower and middle canopy layers. However, specifically for the concession in PT GAN, the lower canopy layer dominates, in contrast to the PT GCN and TBOT concessions, which are dominated by the middle canopy. The dominance of the lower canopy is also shown in the PT SMN concession, the only difference is that the proportion of PT GAN's top layer is much lower than that of SMN. The low upper canopy layer indicates that PT GAN's forests is a low forest type.

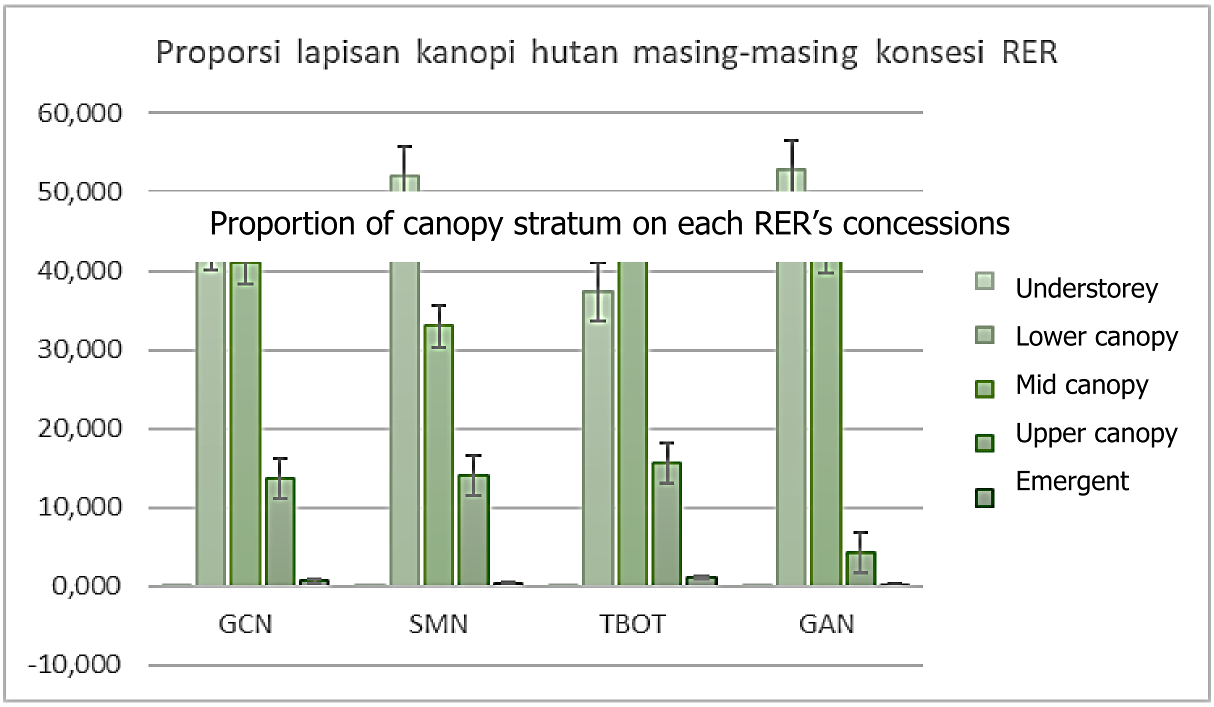


Figure 3. Proportion of vegetation canopy layer for each RER concession on Kampar Peninsula.

Based on comparisons of species numbers, tree density and canopy layer proportions (Table 4 and Figure 3), PT GAN's peat swamp forest tends to have a low number of species, a higher sapling density and a dominant proportion of the lower canopy layer, compared to the other three concessions. Structurally, this shows that PT GAN's forest structure tends to be dominated by low pole forest and is composed by low number species communities. Most of the concession area of PT GAN is a peat dome area, with a deep peat depth (>10m) resembling Phasic Communities (PC) 5 & 6 in the Six Phase Community (Anderson, 1976), and the Low Pole Forest (LPF) community in Page's classification (1999). Conditions in the peat community category have a low species community (species-poor) and are dominated by groups with high density and low canopy (Kobayashi, 1998; Page *et al.* 1999).

Meanwhile, the other three concession areas have many streams and creeks, so that the composition of plant species diversity is higher. In this study, a small part of the area (specifically on the RK_GA08, RK_GA10 and RK_GA11 transects) is traversed by streams and tributaries, while most of the rest is in the form of deep peat areas. In Table 3, the three transects have a high number of species and diversity values compared to other transects, which tend to be less.

The composition of species groups that compound the forest structures tends to vary (see Appendix 1). The families with the highest species richness were Myrtaceae and Sapotaceae, followed by Dipterocarpaceae, Rubiaceae, and Myristicaceae. The species richness of Myrtaceae consists of 11 species, scattered in the forest area (4 Syzygium and one Tristaniopsis), while the Sapotaceae contains five species (two of Palaquium, and one each of Madhuca, Payena and Planchonella). Palaquium is widespread in several locations, causing the Sapotaceae family group to be dominant. Furthermore, the Dipterocarpaceae group has four species (three Shorea and one Vatica), with *Shorea teysmanniana* being the most common species found throughout the PT GAN area, making this family very dominant. The Anacardiaceae group only consists of two species members, from two genera (Campnosperma and Mangifera), but Campnosperma has a very high abundance making this family also dominant. Furthermore, the families Calophyllaceae (Calophyllum) and Pandanaceae (Pandanus) only have one genus member each, but at very high abundances, making this family also dominant.

This is in line with the results of the importance value index for each species, whereby the 15 most abundant species in GAN forests mostly belong to dominant family groups: *Shorea teysmanniana* (63.7), *Campnosperma coriaceum* (23.7), *Pandanus andersonii* (23.5), *Calophyllum calaba* (22.4), *Syzygium incarnatum* (12,6), *Ormosia sumatrana* (10.5), *Syzygium muelleri* (10.2), *Tristaniopsis merguensis* (9.1) and *Shorea uliginosa* (8.5).

3.2.2 Vegetation Type Analysis

Using the Bray-Curtis similarity index towards all plots, with a similarity value around 0.4, it was found that there were two distinct vegetation groups in the survey area, i.e. Mixed Peat Swamp Forest (MPSF) and Pole Forest (PF) (Figure 4). By the low index value (below 0.5, meaning the similarity are low and then differs one to another. Among these two groups, each were divided into two sub-types by the similarity index above 0.5. The cluster were grouped based on structure and composition of 15 species with highest IVI.

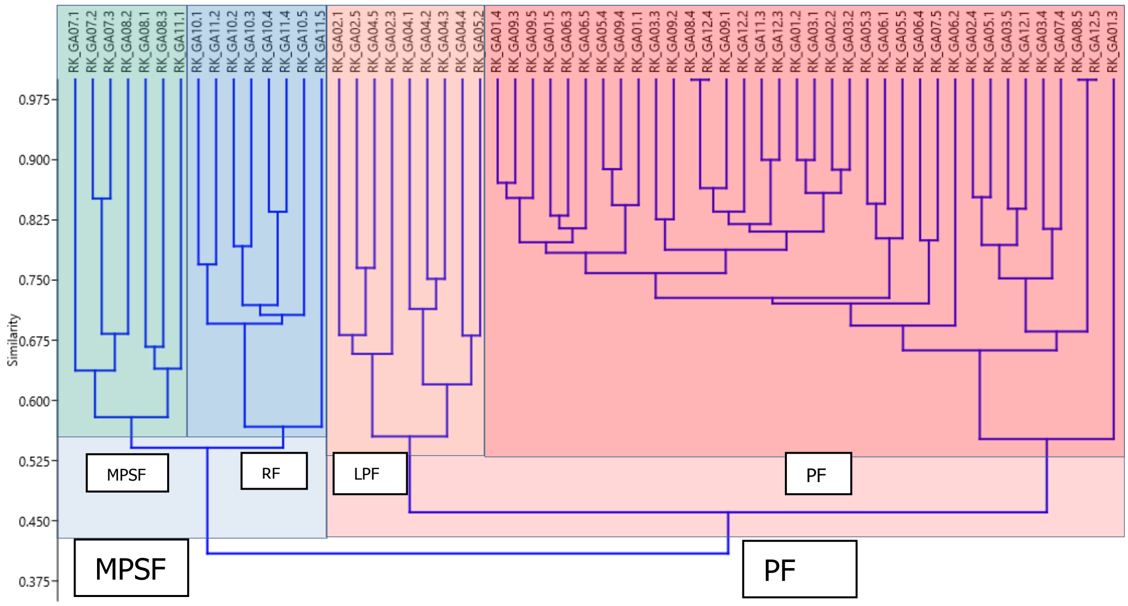
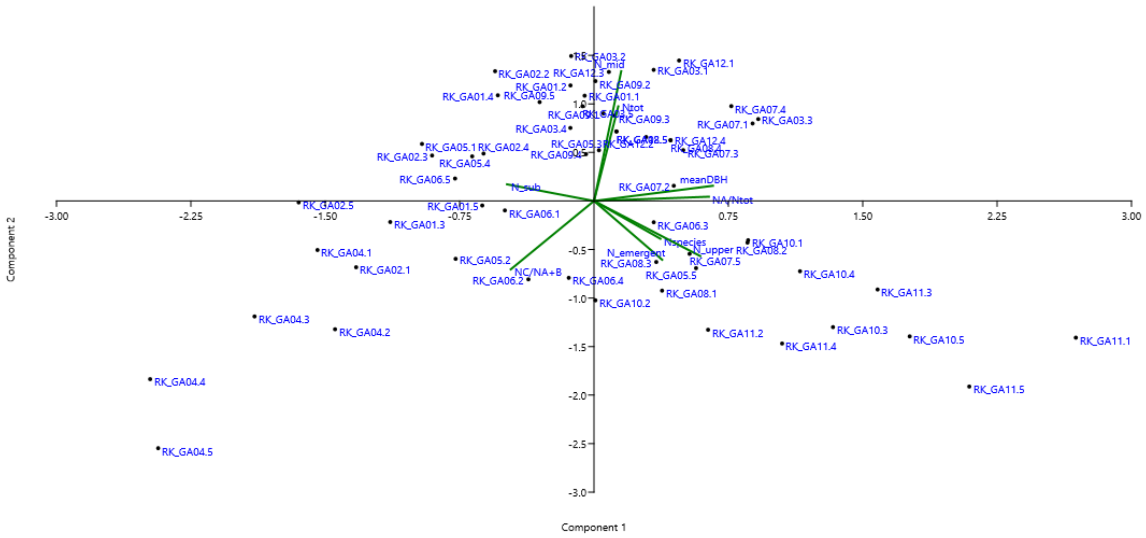


Figure 4. Dendrogram of vegetational group per plot within PT GAN concession

Further analyses show the variables that determine the cluster, using Principal Component Analysis (PCA) to both of structure and composition among plots (Figure 5). Variable of structure i.e. canopy layer, DBH, tree density and proportion of class to total stands. PC 1 and PC 2 combining 79.6% variance of eigenvalue, hence we use PC 1 and PC 2 to demonstrate the cluster. Number of species and mid-canopy stratum with eigenvalue 0.75 and 0.63 respectively in PC1, while lower canopy support a high eigenvalue of -0.76 in PC 2, making these variables determine the cluster.



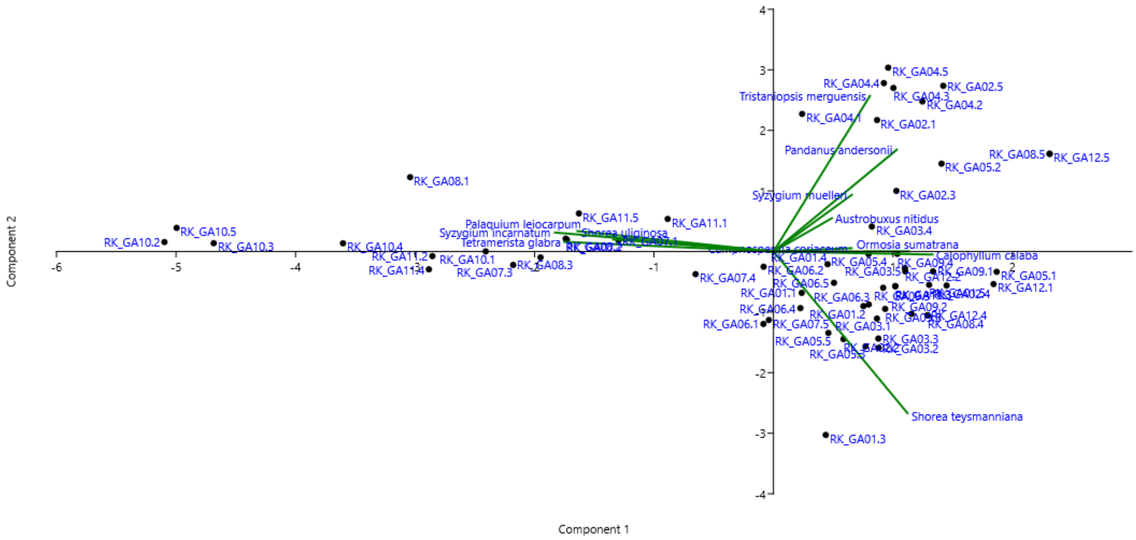


Figure 5. Principal Component Analysis (PCA) of vegetation structure (top) and composition (bottom) for all GAN plots

In PCA of vegetation composition, with variance among PC 1 and PC 2 totalling 66.4% clustering at least 3 groups of communities, i.e, Riparian MPSF in Axis 1 with influenced by *Syzygium incarnatum* and *Tetramerista glabra*, pole fores (PF) in Axis 3 with strongly influenced by *Shorea teysmanniana*, and low pole forest (LPF) in Axis 2 by *Tristaniopsis merguensis* and *Pandanus andersonii*'s influence. Eigenvalue of each species was below 0.5 except *Shorea teysmanniana* by -0.63 and *Tetramerista glabra* by 0.6 both in PC 2. This shows these two species are seems to rather describing the cluster than others in grouping vegetation.

Based on the analyses above, the types of vegetation in the PT GAN concession generally can be identified as follows:

1. Group I, Mixed Peat Swamp Forest (MPSF)

   Large tree density is quite high, with the main canopy present at the middle and lower layers, and an abundant of understorey. Upper canopy remains exist significantly, emergent occasionally appears. The density of large, small and pole trees are tended to even with higher species richness. Hence, the forest inferior appears to be darker, dominated by large trees composed by mixed species. Apparently, the MPSF structure is divided into two sub-groups i.e.:

   - Riparian forest

     The composition of species is dominated by groups commonly found in riparian areas, such as *Syzgygium* spp., *Tetramerista glabra*, *Palaquium leiocarpum* and *Diospyros siamang*. Canopy layer higher with upper canopy tend to dominant.

Forest floor almost always inundated along wet season or at least muddy. Forests with these features are generally referred to as riverine forest and transition riverine to Mixed Peat Forest/MPF (Page et al., 1999). Generally, appears in transect GA_10 and GA_11.

- MPSF at transition

  This forest area is seeming to be a transition between MPSF of riparian to pole forest in the deeper peat depth. The proportions of the middle and lower canopy are more balanced and equally dominant as canopy cover. In addition, the pole density (class C) in this area is also higher than the previous sub-type, but lower than the most PF. Forest floor are dryer and quite solid, but sometimes muddy in rainy season, covered by herbs and shrubs.

  The dominant species are distinctly differed from riparian forest of which is *Shorea teysmanniana*, *Calophyllum calaba*, *Campnosperma coriaceum*. Above similarity of 0.6, transect 07 and 08 are tend to be separated by the difference of dominant vegetation. *Syzygium incarnatum* where mostly found in riparian areas were found in all GA_07 and almost absent in GA_08, similar by the presence of *Shorea uliginosa*. In opposite, *Palaquium leiocarpum* (balam suntai) where usually dominant in deep MPSF were quite abundant in GA_08 while small finding in GA_07. It seems that GA_07 remains influenced more by riparian than MPSF.

2. Group II, complex of Pole Forest (PF)

   Forest with a high density of small trees and/or poles and big trees occasionally occurs, with the main canopy cover in the lower layer almost equal to the middle canopy; the upper canopy almost disappears (sometime occasionally found but few). The complex itself are combination of canopy layer which affect the vegetation structures, distributed quite scatter but tend to be even directing to the dome areas. Forest floor seeming thicker by slower-composed litters and therefore less solid, less muddy.

   The composition of vegetation is strongly dominanted by *Shorea teysmanniana*, co-dominant with *Calophyllum calaba*, and *Campnosperma coriaceum*. Sometimes *Pandanus andersonii* are also dominant forming distinct type of vegetation. If regrouped based on the similarity index at 0.52 then there are two significant sub-groups of this vegetation type, I.e.:

   - Sub-type II-a, Pole Forest

     The main canopy is dominant in the lower canopy layer, but the middle canopy remains quite abundant; the density of large trees is very low and the dominance of poles is very obvious. The transition from MPSF to PF is also appears in the RK_GA3, RK_GA12 and including RK_GA09 transects where the middle canopy keep dominates over the lower canopy or almost equal, large trees keep frequent yet lower than small trees and poles. In this transect, *Shorea teysmanniana* are strongly dominant.

- Sub-type II-b, low pole forest (LPF) at peat dome

  The structure and community of the forest are significantly different from other groups of vegetation type. The dominant trees are dense by poles or saplings and a significant lower canopy layer as the main constituent of the forest. There is very little middle canopy layer and no top canopy. In terms of community composition, this area is dominated by the pandanus (*Pandanus andersonii*), accompanied by other species such as *Tristaniopsis merguensis* and *Cyrtostachys renda*. This type of vegetation resembles the type of Phasix Community "Padang Keruntum" (PC 6) in the Anderson classification (1976).

  This type of vegetation is distinctly described in transect GA_02 and GA_04 where the presence of large trees almost disappears and total domination of pole with lower canopy layer, forming distinctively a low-pole forest. The composition was mostly affected by *Pandanus andersonii* and *Tristaniopsis merguensis*, in particular for GA_04.

Vegetation Map

Following vegetation type above, we analyse spatial distribution among transect and mapping the vegetation types across the concession. Figure 6 demonstrate the vegetation map result where Riparian forest (yellow) are distributed along the riverbank, and MPSF transition (blue) distributed with increasing distance from the rivers towards the peat dome. Most of the transect are distributed along the PF complex (green) as dominant type in GAN concession.

Beside natural vegetation, we also identified some disturbed areas where mostly happened in MPSF (purple) and small area in PF (orange). This disturbed area concentrated next to Serkap stream and apparently was ex-logging since logging period in 1990s.

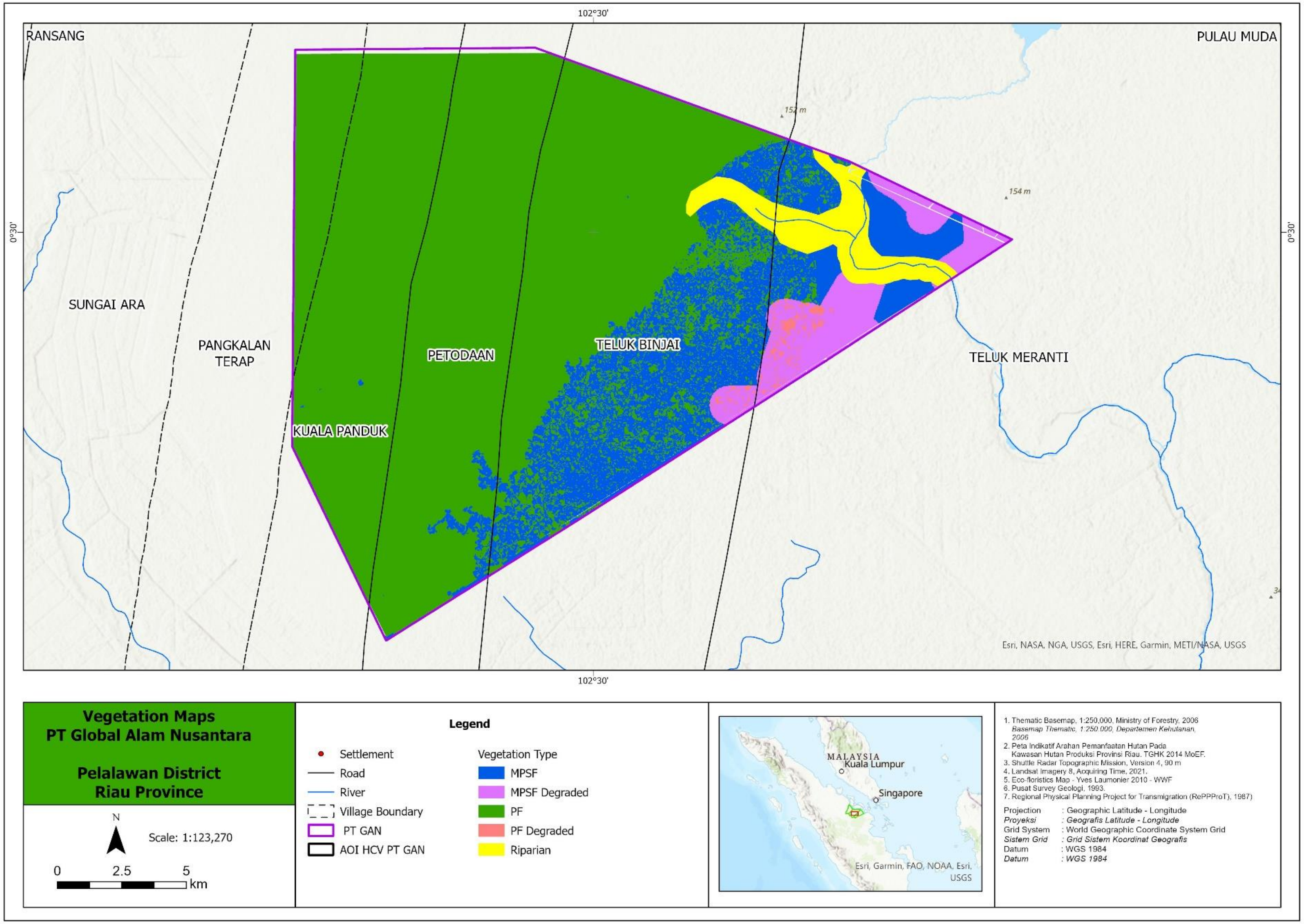


Figure 6 Vegetation Map of GAN Peat Swamp Forest

3.2.3 Diversity and Tree Species Richness

The peat forest in PT GAN has a wide level of vegetative biodiversity in the tree species with a Shannon-Wiener/H' Diversity index value of 3.29 (each transect ranged from 1.89 to 3.45). Table 6 provides a comparison of the H' value of PT GAN's forest with other concession of the RER in Kampar Peninsula and government managed peat forest reserves.

Table 6. Diversity index comparison among peat swamp forest

Location	Σ Species	Range H'	Measure area	Reference
RER PT GCN	122	2.64 – 3.34	39,75 Ha	Biodiversity survey FFI-RER 2015-2016
RER PT SMN		2.42 - 3.07		
RER PT TBOT		2.65 – 3.35		
RER PT GAN	87*	1.89 - 3.45	15 Ha	This study
CA Bukit BatuGiam Siak Kecil		2.7 – 3.6		(Gunawan et al., 2012)
Taman Nasional Sebangau		2.43 – 3.22		(Hamard, 2008)

Note: *) total species found including outside plots

Tree species diversity in PT GAN has a wide range of values as compared to other RER concessions and higher than other peat swamp forests. Species diversity in more distant forest areas (specifically, Bukit Batu Giam Siak Kecil Nature Reserve), is classed as medium-high diversity, with a range of H' (2.7-3.6). PT GAN and the Bukit Batu Giam Siak Kecil Wildlife Reserve are both in Riau province but have significantly different ranges of species diversity. This is because the species diversity in the latter area is dominated by mixed peat forest types with dominant species (*Shorea spp*., *Shorea teysmanniana*, *Durio acutifolius*, *Calophyllum lowii*, *Madhuca motleyana*, *Palaquium leiocarpum* and *Xylopia havillandii*) (Gunawan *et. al.* 2012). Based on the literature, Borneo's peat forests are said to have the highest species richness (>380 species) compared to other Southeast Asian peat areas (Page *et. al.* 2006; Posa *et. al.* 2011). The situation is different when considering the level of diversity in peat forest types on the island of Borneo; in Sebagau National Park (Central Kalimantan) the diversity of peat forest types ranges from 2.43 to 3.22. In his study (Hamard, 2008) identified three types of peat forest (Mixed-Swamp Forest, Tall Interior Forest and Low Pole Forest) from 11 plots.

Looking in more detail at the species diversity in PT GAN's peat forest, the correlation (Pearson correlation) between parameters shows that the diversity index H' has the highest correlation with the dominance index (R=-0.94), compared to species richness, number of stands, and evenness index/E (with correlation values are 0.86, 0.35 and 0.81, respectively). A negative value in the correlation value indicates the opposite. That is, the higher D, the lower H'. This correlation can be seen from the distribution of H' and D, across all transects, in Figure 7.

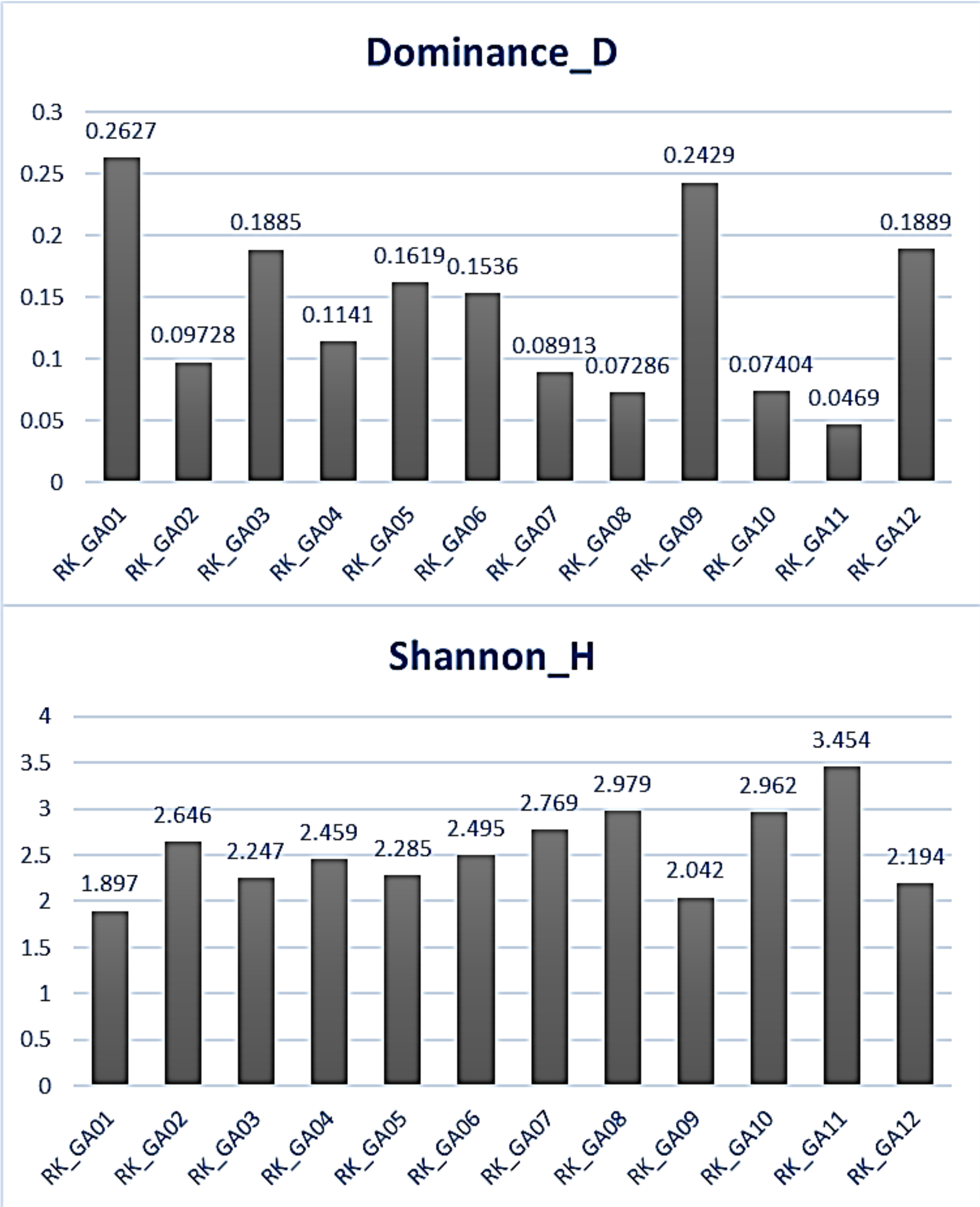


Figure 7. Shannon-Wiener diversity index value (H') and dominance (D)

The correlation between H' and D is clearly seen in RK_GA01 and RK_GA09, which have the lowest diversity and highest dominance values. In both transects, there is one dominant species (meranti bunga/ *Shorea teysmanniana*)), limiting the space for other species and resulting in a low number of species in the area. The same is shown in areas with high H' and low D values; namely on the RK_GA11 transect. The transect does not have a strong dominance by one or more species, as shown by an even distribution of vegetation composition. The high dominance on several transects of PT GAN is not only by *S. teysmanianna*, but also by mengkuang, bintangur, *Syzygium sp*. and terentang. For meranti bunga and terentang, both types are plants specialised in deep peat conditions (Anderson, 1964; Gunawan *et. al.* 2012).

3.2.4 High Conservation Value and Threatened Species

The high diversity of forest tree species in RER is the result of competition between species for control over land and resources (Finnegan, 1984). This phenomenon cannot be separated from the characteristics of each species that allow them to adapt to the high stress of the peat ecosystem. Peat forests have higher stresses than mineral forest ecosystems, as demonstrated by low fertility, high substrate acidity (pH 2-4) and water-logged soils, low nutrients (due to the relatively slow decomposition of litter), and low levels of physical support for trees (Melling et al., 2007). These conditions limit the species that grow there, both in terms of the number of species and their growth rate, giving rise to stunted trees, especially in areas with deep peat that remains wet for much of the year.

The species that survive and dominate these forests are mostly those that have developed stilt-root, tall buttresses and/or pneumatophore roots, for a strong root network system that increases stability, gas exchange under conditions of drought (Melling et al., 2007; Yule, 2010; Posa *et. al.* 2011; Campbell, 2013). The root system becomes more extensive towards deep peat areas, especially peat dome areas (Anderson, 1963; Melling *et. al.* 2007). Several dominant species in the RER peat forest, such as meranti, suntai, terentang and kelat groups, have these characteristics, making them abundant. This also makes these species dependent on peat ecosystems; around 11% of the plants found in peat forest of Southeast Asian are peat specialist species (Posa *et. al.* 2011). In the RER peat forest, several peat specialists include *Shorea teysmanniana*, *S. uliginosa*, *S. platycarpa*, *Vatica teysmanniana*, *Horsfieldia crassifolia*, *Gonystylus bancanus*, *Diospyros siamang* and *Combretocarpus rotundatus*.

There are 87 plant species (include non-trees) found in the GAN peat forest, some of which are listed by both the IUCN Redlist and in the CITES Appendices; several are also protected under Indonesian law (Table 7 and Appendix 1). All Dipterocarps growing in GAN peat forest are threatened species, including the two-dominant species of meranti: *meranti bunga* and *meranti sarang burung*. Most of these species are specialist to peat soils (indicated by asterisks on the list) and globally, the major threat is the loss of natural habitat due to illegal logging and forest conversion (IUCN).

Among these species, *meranti bakau* (also known as *meranti merah paya*), ramin and *resak paya* need more attention, due to their CR status. Apart from being peat specialists, their growth habitat is also very limited; *meranti bakau* only grows in peat areas close to rivers, while *resak paya* is endemic to the peat forests of Sumatra. Meanwhile, ramin grows on dense peat substrate, is critically endangered (IUCN) and is highly restricted for international trade (CITES Appendix II).

Table 7. Threatened species list of PT GAN

Local name	Species	Σ ind. recorded	RI	CITES	IUCN status
Kayu batu	*Ctenolophon parvifolius*	9	-	-	VU
Ramin	*Gonystylus bancanus**	22	Y	App.II	CR
Darah - darah	*Knema glauca*	3	-	-	VU
Meranti bakau	*Shorea platycarpa**	3	-	-	CR
Meranti bunga	*Shorea teysmanniana**	558	-	-	EN
Meranti sarang punai	*Shorea uliginosa**	52	-	-	VU
Punak	*Tetramerista glabra*	44	-	-	VU
Resak paya	*Vatica teysmanniana**[e]	4	-	-	CR

Notes: * = Peat specialist; e = Sumatran endemic; VU = Vulnerable, EN = Endangered/Threatened, CR = Critically Endangered; App.II = Appendix II in CITES list; RI = protected under the law of Republic Indonesia.

Given the large number of threatened species and the potential for additional viable populations of these speceis in PT GAN and the RER, this peat forest is considered as having High Conservation Value globally and in the Malesia Region. Protection of the RER peat ecosystem is an important to preserving the populations of these species.

Considering the presence of evidence of past threats (i.e. logging, drainage canals, and disturbed areas), forest protection should focus on frequent patrols to prevent illegal logging of these species. Species with a small population and low regeneration rate such as *kayu batu*, ramin and *resak paya* require species enrichment to increase the population through planting seedlings and monitoring and protecting natural regeneration. Some small gaps may be restored by enrichment planting using *perepat* (*Combretocarpus rotundatus*), *Syzygium* spp., and *punak* (*Tetramerista glabra*).

IV. CONCLUSIONS AND RECOMENDATION

4.1 Conclusions

1. The current condition of PT GAN's peat forest is an intact forest, composed of large trees (avg dbh 37.30cm), small trees (avg dbh 19.6cm), and poles (avg dbh 9.08cm). Densities of each class were 4.16, 39.64 and 145.64 stems per hectare, respectively. The forest canopy in PT GAN is generally in the lower and middle height layers due to the dominant area of peat dome forest (low pole).
2. In general, the composition of the peat swamp forest vegetation in the PT GAN concession is *Shorea teysmanniana*, *Calophyllum calaba*, and *Campnosperma coriacea*, with eight dominant species being *S. teysmanniana*, *C. calaba*, *Ormosia sumatrana*, *C. coriaceum*, *Tetramerista glabra*, *Syzygium* sp., *Syzygyum* sp.4 and *Pandanus andersonii*.
3. At least two types of peat forest vegetation were identified in PT GAN, namely mixed peat swamp forest (MPSF) and pole forest (PF). MPSF are divided by species composition into riparian forest (RF) and transition MPSF to PF, while PF complex are divided structurally and composition into PF and low pole forest (LPF) in the peat dome.
4. Eighty-seven (87) species of trees belonging to 34 families were recorded during the survey. The diversity of woody species is high, with a diversity index of 3.29. The most important species have root properties adapted to high soil water table such as knee-roots (pneumatophores), stilt-roots, buttresses and leaves that have oil spots, an adaptive response to the extreme environment of the peat ecosystem. These species include meranti (*Shorea spp*), suntai (*Palaquium leiocarpum*), terentang (*Camnosperma coreaceum*), dara-darah (*Myristica lowii*) and family of myrtaceae (*Syzygium spp*), which are abundant in the RER peatlands.
5. At least eight threatened species were found (IUCN Red List, CITES Appendices). Among the eight species including Ramin (*Gonystylus bancanus*), meranti bakau (*Shorea platycarpa*) and resak paya (*Vatica teysmanniana*) require more protection and enrichment because they are critically endangered (CR) with restricted distribution.

4.2 Recommendations

Based on the results of a recent study of the vegetation structure and floristic diversity of the PT GAN concession peat swamp forest, some recommendations for management plans and actions are suggested as follows:

1. In general, the forest is remains intact. The inferior of which has lower canopy and dense by poles instead of large trees are supposed to normal due to the ecology of natural pole forest in deeper peat depth, especially in peat dome. However, the forest areas remain facing potential threats from human activities (hunting, logging), where recently happened in adjacent concessions. Routine forest protection patrols still need to be carried out, especially in easy-to-access areas, such as riversides, canals, and boundary areas next to PT. TBOT.

2. It is recommended to carry out restoration planting in degraded areas, especially in some small gaps and areas next to Serkap River. Possible restoration planting includes: (i) species enrichment with important species (endangered or forage species); (ii) application of Assisted Natural Regeneration (ANR) methods, in the gap areas, to ensure optimal growth of natural regeneration. Both options are possible under the current natural conditions, though option (ii) cannot be carried out if there are too many invasive species (resam, etc.).

3. Undertake periodic biodiversity monitoring, at least once a year, at the same location to monitor patterns of biodiversity and to gather more accurate information, not only regarding threatened plant species but for other taxa, especially important to ecosystem (wildlife food trees, bird's nesting trees, etc.).

4. Conduct population viability studies of threatened species, especially for ramin (*Gonystylus bancanus*), meranti bakau (*Shorea Platycarpa*) and resak paya (*Vatica teysmanniana*). In addition, monitoring of the identified population should also be carried out annually to ensure the population viability and reveals its phenology. With a healthy population size, it is expected that the ecological processes support the improvement of environmental services optimally. Understanding its phenology will help for seeds collection when necessary.

5. Important trees and high conservation value forest species need special attention, and population monitoring can be supported through regular SMART patrols. In addition, especially for those species with small populations and difficult regeneration, it is critical to assist with seeding and planting, especially ramin and resak paya. Undertake research for the propagation of these two species is necessary to determine the best method for seed propagation.

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APPENDICES

Appendix 1. Species list of PT GAN, abundance (INP%) and conservation status.

Local Name	Species Name	Family	INP	Conservation Status		
				IUCN	CITES	PP RI
Parak-parak	*Aglaia rubiginosa*	Meliaceae	1.563	NT	-	-
Mempenai	*Antidesma coriaceum*	Phyllanthaceae	0.728	-	-	-
Kelat putih	*Antidesma montanum*	Phyllanthaceae	0.186	-	-	-
Kelat pisang	*Austrobuxus nitidus*	Picrodendraceae	7.609	LC	-	-
Tempurung bintang	*Blumeodendron kurzii*	Euphorbiaceae	1.339	LC	-	-
Kapas-kapas	*Blumeodendron tokbrai*	Euphorbiaceae	0.295	-	-	-
Bintangur	*Calophyllum calaba*	Calophyllaceae	**22.368**	LC	-	-
Terentang	*Campnosperma coriaceum*	Anacardiaceae	**23.753**	LC	-	-
Garam-garam, Perepat	*Combretocarpus rotundatus*	Anisophylleaceae	6.620	-	-	-
Gerunggang	*Cratoxylum arborescens*	Hypericaceae	3.270	-	-	-
Kayu batu	*Ctenolophon parvifolius*	Ctenolophonaceae	3.730	VU	-	-
Linau	*Cyrtostachys renda*	Arecaceae	6.029		-	-
Simpur	*Dillenia excelsa*	Dilleniaceae	0.180		-	-
Arang-arang	*Diospyros siamang*	Ebenaceae	1.485	-	-	-
	Disepalum rawagambut	Annonaceae	0.205	-	-	-
Perawa	*Elaeocarpus grifftihii*	Elaeocarpaceae	0.237	-	-	-

Local Name	Species Name	Family	INP	Conservation Status		
				IUCN	CITES	PP RI
Ara daun kecil	*Ficus spathulifolia*	Moraceae	3.014	-	-	-
Ara daun lebar	*Ficus sumatrana*	Moraceae	1.198	-	-	-
Manggis-manggis	*Garcinia bancana*	Clusiaceae	1.452	LC	-	-
Balang	*Garcinia cuspidata*	Clusiaceae	7.468	-	-	-
Ramin	*Gonystylus bancanus*	Thymelaeaceae	2.141	CR	App. II	-
Darah-darah	*Horsfieldia crassifolia*	Myristicaceae	3.614	NT	-	-
Mensira	*Ilex cymosa*	Aquifoliaceae	1.545	LC		-
Mensira	*Ilex hypoglauca*	Aquifoliaceae	3.697	LC		-
Darah-darah	*Knema glauca*	Myristicaceae	0.565	-	-	-
Darah-darah	*Knema intermedia*	Myristicaceae	1.747	NT	-	-
	Lauraceae sp.	Lauraceae	0.247	-	-	-
	Lecananthus erubescens	Rubiaceae	0.183	-	-	-
Palas	*Licuala spinosa*	Arecaceae	1.081	-	-	-
Medang	*Litsea gracilipes*	Lauraceae	3.364	LC	-	-
Pisang-pisang/Terpis	*Maasia hypoleuca*	Annonaceae	0.226	-	-	-
Mahang semut	*Macaranga caladiifolia*	Euphorbiaceae	0.459	-	-	-
Nyatoh	*Madhuca motleyana*	Sapotaceae	1.503		-	-
Medang pelam	*Magnolia bintuluensis*	Magnoliaceae	0.710	-	-	-
Salakeo	*Mangifera parvifolia*	Anacardiaceae	3.079	-	-	-

Local Name	Species Name	Family	INP	Conservation Status		
				IUCN	CITES	PP RI
Darah-darah	*Myristica* sp.	Myristicaceae	0.396	-	-	-
Melilin	*Ormosia sumatrana*	Fabaceae	10.486	LC	-	-
Suntai	*Palaquium leiocarpum*	Sapotaceae	6.568	NT	-	-
Seminai air	*Palaquium ridleyi*	Myristicaceae	2.637	LC	-	-
Mengkuang	*Pandanus andersonii*	Pandanaceae	**23.489**	-	-	-
Tenggayun	*Parartocarpus venenosus*	Moraceae	0.558	LC	-	-
Kayu batu	*Parastemon urophyllus*	Chrysobalanaceae	2.773	-	-	-
Balam suntai	*Payena leerii*	Sapotaceae	0.441	-	-	-
Nyatuh air/seminai air	*Planchonella maingayi*	Sapotaceae	0.183	-	-	-
Unal	*Polyscias diversifolia*	Araliaceae	2.412	-	-	-
	Quassia borneensis	Simaroubaceae	1.403	-	-	-
Tepung garam	*Rothmania schoemanii*	Rubiaceae	0.647	-	-	-
Meranti merah paya	*Shorea platycarpa*	Dipterocarpaceae	0.516	CR	-	-
Meranti bunga	*Shorea teysmanniana*	Dipterocarpaceae	**63.751**	EN	-	-
Meranti sarang punai	*Shorea uliginosa*	Dipterocarpaceae	8.505	VU	-	-
	Sp.10	indet.	0.185		-	-
	Sp.11	indet.	0.182		-	-
Pasir-pasir	*Stemonurus scorpioides*	Stemonuraceae	2.480		-	-

Local Name	Species Name	Family	INP	Conservation Status		
				IUCN	CITES	PP RI
Pasir-pasir	*Stemonurus secundiflorus*	Stemonuraceae	2.965	-	-	-
Kelumpang	*Sterculia gilva*	Malvaceae	1.823	-	-	-
Kelat merah	*Syzygium antisepticum*	Myrtaceae	1.764	-	-	-
Ubar, Kemodan putih	*Syzygium incarnatum*	Myrtaceae	12.650	-	-	-
Kelat merah	*Syzygium muelleri*	Myrtaceae	10.205	-	-	-
Ubar, Kelat Jambu	*Syzygium palembanicum*	Myrtaceae	1.250	-	-	-
	Tetractomia majus	Rutaceae	1.368	-	-	-
	Tetractomia obovata	Rutaceae	5.330	-	-	-
Punak	*Tetramerista glabra*	Tetrameristaceae	6.038	VU	-	-
Mensulang	*Timonius flavescens*	Rubiaceae	0.885		-	-
Pelawan	*Tristaniopsis merguensis*	Myrtaceae	9.056	LC	-	-
Resak	*Vatica teysmanniana*	Stemonuraceae	1.068	CR	-	-
	Wendlandia cf. *paniculata*	Stemonuraceae	0.184	-	-	-
Jangkang	*Xylopia fusca*	Malvaceae	0.912	-	-	-

Ket: INP = Important Value Index; IUCN = International Union of Conservation of Nature: LC = Least Concern; NT = Near Threatened; VU=Vulnerable; CR = Critically Endangered; DD = Data Deficient; CITES = Convention on International Trades of Endangered Species: App.II = CITES Appendix II; PP RI = Indonesian Biodiversity Protection Regulations. including PermenLHK 106/2018

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