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Analysis of importance value index of unlogged and logged peat swamp forest in Nenasi Forest Reserve, Peninsular Malaysia

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Abstract. *Ismail MH, Fuad MFA, Zaki PH, Jemali NJN. 2017. Analysis of importance value index of unlogged and logged peat swamp forest in Nenasi Forest Reserve, Peninsular Malaysia. Bonorowo Wetlands 7: 74-78.* Peat swamp forests are highly significant globally, both for their diverse and threatened species, and represent unique wetland ecosystems. Apart from its critical role in providing habitat for wildlife, the tropical peat swamp forest also acts as a gene bank that harbors potentially useful varieties of plant species. The composition of trees of the peat swamp forest in Nenasi Pahang State, Peninsular Malaysia, were investigated, especially in un-logged and logged-over forests. The objectives of this study are two folds; (i) to identify and compare the dominant tree species in the two types of forests and (ii) to calculate the importance value index (IVI) of the vegetation in the study areas. Two plots of 50m by 20m were established in different forest types. This quadrate was subdivided at each site using 25m by 20m and 5m by 5m, respectively. The results showed that the unlogged peat swamp forest is higher in tree species compared to logged peat swamp forest. There were 10 species distributed among 9 families in the unlogged forest and 7 species in 7 families in the logged forest. The most dominant species identified in unlogged peat swamp forests were *Litsea sp., Syzygium sp.,* and *Santiria laevigata.* The IVI for these species were 71.21, 51.13, and 42.49. In logged peat swamp forests, the dominant species are *Shorea platycarpa, Pometia pinnata,* and *Xylopia fusca*. The IVI of these species were 87.38, 52.66, and 47.55, respectively. The study concludes that about 40 percent of the tree composition in the logged peat swamp forests has declined compared to unlogged peat swamp forests.

Keywords: Peat swamp forest, tree composition, importance value index

INTRODUCTION

Wetlands or peatlands are habitats where the water table is at or near the land surface or where the land is covered by shallow water for a sufficient length of time to cause anaerobic conditions within the root zone of plants (Barnes et al., 2002). In recent years, the problem of ecological degradation and destruction of peat swamp forests and wetlands has attracted scientific communities worldwide. Current research has shown this ecosystem its significance not just as a global carbon store, but its value for biodiversity remains poorly understood (Posa et al., 2011). The forest's biodiversity is poorly understood, and its importance is underappreciated. Vast areas of peat swamp forest have been degraded and disappearing due to logging, fire, and conversion to agriculture and industry.

Presently about 50% of the peat swamp forests in Southeast Asia have been cleared and drained for agriculture (Hooijer et al. 2010). The peat-swamp forests in Malaysia are fragile and sensitive to development. Nowadays, some parts of peat swamp forests in Malaysia are being extensively cleared for agriculture and other development projects (Gasim et al., 2007). Activities such as logging, plantation, and development in the long term will lead to deterioration in the quality of peat swamp biodiversity and forest ecosystems. In Malaysia, 44% of remnant peat swamp forests are moderately or severely disturbed, with the highest proportion in Sarawak (54%). In Peninsular Malaysia, only 18% of peat swamp forest appears to be moderately or severely disturbed (Wetland International-Malaysia 2010). Due to various treats on the peat swamp forest, study on the compositions, conservation status, structural and environmental characteristics of the plant communities in these forests is required.

In general, the importance value index (IVI) measures how dominant a species is in a given forest area. The importance value index (IVI) of tree species was determined as the sum of relative frequency, relative density, and relative dominance (Curtis and McIntosh, 1950). Each of these values is expressed as a percent and ranges from 0 to 100. Due to the massive degraded peat swamp forest, preserving the forest remnants is essential, especially in conservation or reserve areas. Consequently, it is necessary to study the vegetation to elucidate the characteristics and regeneration processes of the remaining peat swamp forest. Therefore, the objectives of this study are two folds (i) to identify the presence/ absence of dominant tree species in unlogged and logged peat swamp forest, and (ii) to calculate the importance value index (IVI) and species diversity in both sites.

MATERIALS AND METHODS

Description of the study area

The peat swamp forests in the southeast Pahang area comprise four forest reserves; Pekan, Nenasi, Kedondong, and Resak cover 87,045 ha (Figure 1). The peat swamp forests harbor a unique flora and fauna, provide benefits and services of national interest, and support the livelihood of the aborigines (*Orang Asli*) communities (Mohd Azmi 2009). All these resources are significant not only for the ecological functioning of the forest but also for future biodiversity conservation and sustainable development of the whole area.

Specifically, the study area is located in two different forest conditions (unlogged and logged forest) but lies in the same locality and similar topographic features. The elevation of the study area is about 25m to 27m above sea level. The site's distance is about 25 km to Kuala Rompin and 55 km to Pekan, Pahang. Nenasi Forest Reserve has an area of 20,546 ha, between Bebar and Merchong Rivers.

Plot establishment and data collection

Two plots were established in unlogged and logged forests. At each site, 50m by 20m quadrate (Q1) was established, and within this quadrate, 25m by 20m (Q2) and 5m by 5m (Q3) plots were established. As each subplot's corner (border) markers, ironwood poles of 5cm x 5cm x 130cm were used as each subplot's corner (border). Every tree in the quadrate was tagged. The quadrate and its subdivision are shown in Figure 2. The peat swamp forest in plot number 1 is un-logged, while plot number 2 is considered the logged forest logged in 2006. A Garmin GPS was used to locate the coordinates of the plots, and other tools such as diameter tape for dbh measurement, Haga altimeter (tree height), densitometer (percentage canopy cover), and magnetic compass (plot establishment) were used during data collection.

Many ways have been used to classify vegetation. Some are based on vegetation physiognomy, vegetation structure, or environmental factors. Some of these approaches are useful at vast scales. For this study classification of trees was based on the tree classification by the Forestry Department of Peninsular Malaysia for Pre-Felling or Post-Felling inventories (Table 1).

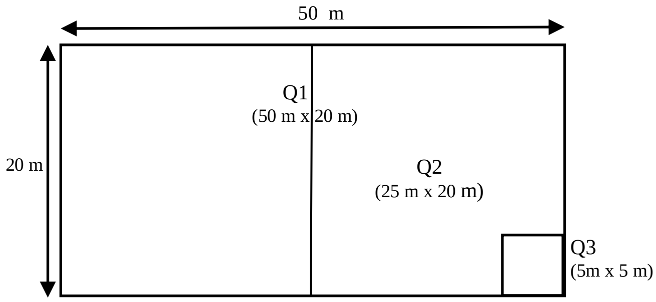

Figure 2. The layout of the quadrate (50 m x 20 m)

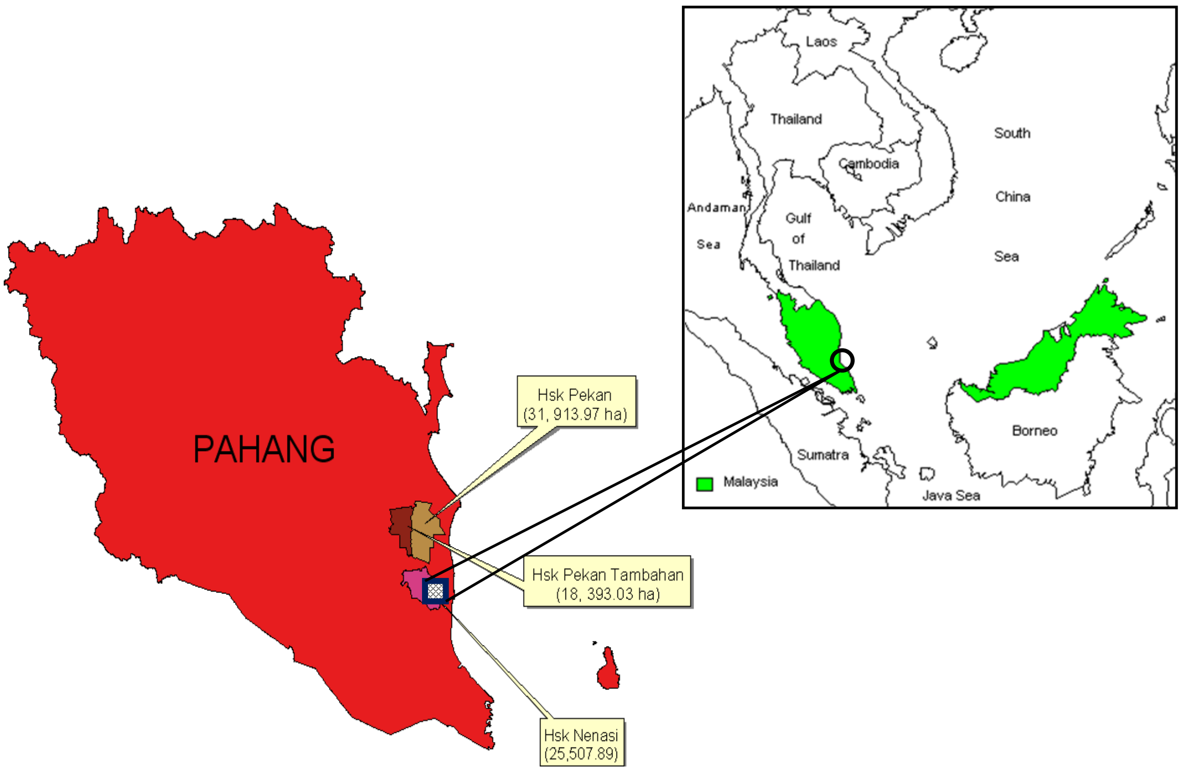

Figure 1. A location of the study area in Pahang state, Peninsular Malaysia

Table 1. Tree classification used in the study

Quadrate	Vegetation layers	dbh (cm)
Q1 (50 m X 20 m)	Big and small tree	> 30.0
Q2 (25 m X 20 m)	Big and small poles	5.0 - 29.9
Q3 (5 m X 5 m)	Sapling	1.5 - 4.9

Data analysis

The Importance Value Index (IVI) of Cottam and Curtis (1956), Cox (1967), and Mueller-Dombois and Ellenberg (1974) was used to describe and compare the species dominant in the plots. The species with the highest IV index were considered the most "important" in a plot. This index is used to determine the overall importance of each species in the community structure. The IVI of the taxon of each plot is defined as the sum of its relative density and relative dominance, which describes the dominance of a species in the whole plot. The IVI is determined for both plots by adding its relative frequency. The relationship, RD+RCC+RF, shows the importance value (IVI) for each species, and hence its value varies from 0 to 300. The species having the highest IVI is considered dominant in the community (Arshad et al., 2002; Noraimy et al., 2014). The following equations are used:

Importance value (IVI) = RD + RCC + RF

$$\text{Relative density (RD)} = \frac{\text{The density of a species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative canopy cover (RCC)} = \frac{\text{Canopy cover of a species}}{\text{Total cover of all species}} \times 100$$

$$\text{Relative frequency (RF)} = \frac{\text{Frequency value of the species}}{\text{Sum of frequency of all species studied}} \times 100$$

RESULTS AND DISCUSSION

Tree analysis

The total numbers of families and species were determined for each. Overall, 39 tree species belonging to 12 families were identified. Total trees, species, families, total number of individuals per unit plot, and canopy height were greater in unlogged peat swamp forest (Table 2 and Table 3). A total of 27 species has been recorded in unlogged peat swamp forest and 12 in logged forest. Species *Syzygium sp.* was dominated most in an unlogged plot with 5 trees. The second dominant species was *Myristica sp.* with only 3 trees. In the logged forest, the dominant species recorded were *Shorea platycarpa* (3), *Pometia pinnata* (2), *and Goniothalamus sp.* (2). Approximately 60% (unlogged) were classified under big and small trees. While only 20% for the logged forest. The largest group of trees (in the unlogged forest) was big and small, but in logged, a group of big and small poles represents 60%. A huge impact occurred on the several tree presence in both sites. The results showed that the massive trees decline was at the logged forest, in which only 12 trees were present compared to unlogged peat swamp forest by 27 trees. The impact of tree harvesting about 6 years ago has caused a significant decline in the presence of the tree (about 40% different between the two plots).

The distribution of dbh classes and several trees for both plots and each quadrate are shown in Figure 5. In unlogged peat swamp forests, the tree stand is intact and shows good composition for each dbh range, and this is typical of all types of forest areas. However, in logged forest, due to the previous harvesting, the distributions are more toward the dbh range between 5.0 cm - 29.9 cm, respectively.

Peat swamp forests contain several valuable timber species and sometimes at high densities. However, this forest has been intensively exploited. There is very little information on the long-term effects of logging on flora and fauna of peat swamp forests (Hadisuparto, 1996). For instance, logging operation with a mechanization system leads to a lack of regeneration of ramin trees (Gonystylus bancanus), the most valuable timber species in peat swamps. The species is now listed as vulnerable on the IUCN Red List. Rashid and Ibrahim (1994) reported that the logging operation has led to more intensive extraction and more significant damage to the residual forest up to 50%.

The most dominant species found in unlogged peat swamp forests were *Litsea sp.*, *Syzygium sp.*, and *Santiria laevigata.* The importance value index (IVI) for these species were 71.21, 51.13, and 42.49, respectively. In logged peat swamp forest, the dominant species are *Shorea platycarpa*, followed by *Pometia pinnata*, *Xylopia fusca*, and *Syzygium sp.* The IVI of these species was 87.38, 52.66, and 47.55. The contribution of the dominant species (relative density) such as *Litsea sp.* and *Xylopia fusca* to the area (unlogged peat swamp forest) were 25.85%, 16.13 %, and 12.9 %. In logged peat swamp forest, the dominant species' relative density was 25% for *Shorea platycarpa* and equal for *Pometia pinnata, Xylopia fusca,* and *Syzygium sp*. (16.67%), and also similar for other species such as *Gluta velutia, Macaranga pruinose*, and *Durio carinatus* (8.33%).

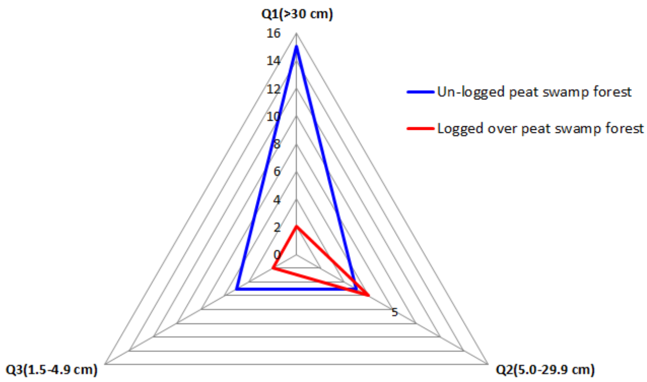

Figure 5. Comparison of the total tree at both site and vegetation layer

Table 2. List of species in unlogged peat swamp forest

Quadrate	Species	Family	dbh (cm)	Height (m)	Crown size (m)	Vegetation Layer
Q1 50m x 20m	*Dacryodes macrocarpa*	Burseraceae	42	6	5	Big and small trees
	Alstonia spatulata	Apocynaceae	31	7	3.6	
	Syzygium zeylenicum	Myrtaceae	36	5.5	3.5	
	Koompasia malaccensis	Leguminoceae	40	15	4.5	
	Syzygium zeylenicum	Myrtaceae	38	5	3.8	
	Instia bijuga	Leguminoceae	48	11	5.0	
	Artocarpus kemando	Moraceae	43	15	8.2	
	Litsea costata	Lauraceae	44	7.6	5.7	
	Santria laervigata	Burseraceae	36	5.6	3.8	
	Xylopia malayana	Annonaceae	39.4	8.3	4.8	
	Alstonia spatulata	Apocynaceae	38	14	5.6	
	Campnosperma coriaceum	Anacardiaceae	45.9	13	6.3	
	Horsfielddia crassifolia	Myristicaceae	36	5.6	4.8	
	Campnosperma coriaceum.	Anacardiaceae	42.8	4.8	5.7	
	Myristica lowiana	Myristicaceae	45.9	7.2	8.5	
Q2 25m x 20m	*Myristica gigantea*	Myristicaceae	12.2	5.2	2.6	Big and small poles
	Syzygium kiahii	Myrtaceae	18.7	6.3	4.8	
	Syzygium napiforme	Myrtaceae	21	5.8	7.0	
	Santiria rubiginosa	Burseraceae	11	2.4	2.4	
	Litsea grandis	Lauraceae	19.2	8.0	5.6	
Q3 5m x 5m	*Goniothalamus sp.*	Annonaceae	2	0.8	-	Saplings
	Myristica gigantea	Myristicaceae	0.3	0.4	-	
	Syzygium lineatum	Myrtaceae	0.2	0.2	-	
	Instia palembanica	Fabaceae	0.2	0.7	-	
	Litsea grandis	Lauraceae	0.2	0.8	-	
	Instia bijuga	Fabaceae	0.4	0.7	-	
	Litsea teysmannii	Lauraceae	0.8	1.0	-	
	Total tree: 27					

Table 3. List of species in logged peat swamp forest

Quadrate	Species	Family	dbh (cm)	Height (m)	Crown size (m)	Vegetation Layer
Q1 50m x 20m	*Pometia pinnata*	Sapindaceae	31.4	4	6	Big and small trees
	Durio carinatus	Moraceae	38.2	6	10.6	
Q2 25m x 20m	*Goniothalamus malayanaus*	Annonaceae	22.5	9	3.5	Big and small poles
	Shorea platycarpa	Dipterocarpaceae	23	10	4	
	Goniothalamus sp.	Annonaceae	9.5	8	2.8	
	Gluta velutina	Anacardiaceae	10.1	9	2.3	
	Shorea platycarpa	Dipterocarpaceae	10.7	7	4.5	
	Pometia pinnata	Sapindaceae	25.6	11	2.7	
	Shorea platycarpa	Dipterocarpaceae	1.7	7.6	8	
Q3 5m x 5m	*Macaranga pruinosa*	Euphorbiaceae	0.9	1	-	Saplings
	Syzygium kiahii	Myrtaceae	0.7	1.5	-	
	Syzygium napiforme	Myrtaceae	2.4	0.8	-	
	Total tree: 12					

Unlogged peat swamp forest is significantly rich in plant species (10 species compared to the logged forest is 7 species). A study by Bruenig and Droste (1995) indicates that selective logging causes changes in forest structure and composition. This may explain that logging activity has opened the forest gap in the logged forest. This is vulnerable to more destruction by the fire where the soil substrate is highly flammable when dry (Langner et al., 2007). Consequently, according to Yeager et al. (2003), the effects of fire on peat swamp forest vegetation are similar to those in other forest types, where the burned forest has lower canopy cover, decreased species richness, and reduced tree and sapling density compared with unburned forest.

Table 4. Quantitative analysis for IVI (Unlogged peat swamp forest)

Species	RD (%)	RCC (%)	RF (%)	IVI
Santiria laevigata	12.9	16.69	12.9	42.49
Syzygium napiforme	16.13	18.87	16.13	51.13
Koompasia malaccensis	3.22	4.44	3.22	10.88
Instia bijuga	9.67	4.94	9.68	24.29
Artocarpus kemando	3.22	8.10	3.22	14.54
Litsea grandis	25.85	19.56	25.8	71.21
Xylopia fusca	9.67	4.74	9.68	24.13
Alstonia pneumatophora	6.45	9.09	6.47	22.01
Campnosperma coriaceum	3.22	6.22	3.22	12.66
Gymnacranthera euginiifolia	9.67	7.31	9.68	26.66
Total	**100**	**100**	**100**	**300**

Note: RD = relative density, RCC= relative canopy cover, RF= relative frequency, IVI = important value index

Table 5. Quantitative analysis for IVI (Logged peat swamp forest)

Species	RD (%)	RCC (%)	RF (%)	IVI
Pometia pinnata	16.67	19.59	16.4	52.66
Durio carinatus	8.33	23.88	8.33	40.54
Xylopia fusca	16.67	14.18	16.7	47.55
Shorea platycarpa	25	37.17	25.21	87.38
Gluta velutina	8.33	5.18	8.33	21.84
Macaranga pruinosa	8.33	0	8.33	16.96
Syzygium gracile	16.67	0	16.4	33.07
Total	**100**	**100**	**100**	**300**

Note: RD = relative density, RCC= relative canopy cover, RF= relative frequency, IVI = importance value index

Conclusion

Previously, the vast majority of the peat swamp areas were covered by forest. Still, logging and large-scale conversion of peat forests to agricultural land have occurred within the last few decades. Because peat swamp forests initially supported high densities of tree species, biodiversity losses have occurred through timber extraction. This study showed that the unlogged peat swamp forest in Nenasi, Pahang, has a more diverse population than the logged peat swamp forest in the same locality. Differences in several individual trees, species, families, canopy cover and dbh can be attributed to harvesting. The number of trees, species, families, individuals per unit plot, and canopy height were more significant in the un-logged peat swamp forest. The impact of tree harvesting has caused a significant decline in the presence of the tree. Research and possible restoration are urgently needed into the biodiversity and ecology of Malaysia's remaining peat swamp forests. The study concludes that about 40 percent of the tree composition in the logged peat swamp forests has declined compared to unlogged peat swamp forests. Conservation and rehabilitation of the peat swamp forest will be crucial in preserving biodiversity.

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