Preliminary Findings on Impact of Logging on Plant Structure and Potential Indicator on Gap Opening in Peat Swamp Forest

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***Abstract*—**Various parameters may have cause changing of plant structure especially in peat swamp forest (PSF). One major cause of plant structure changes in the PSF might be logging activities to extract valuable timbers out of the area. The logging activities will create gap opening that minimize competition among the plants for nutrients, moisture and sunlight. Some of the plants will eventually dominate and vigorously growth compared to other species. Just after the logging, pioneer plant species grow vigorously due to lower stand density and abundance of sunlight. Therefore the presence of these species can be attributed to the changes on soil properties and water quality of the area. This study is aimed to find possible indicators contributing to this phenomenon. These were done by setting plots in areas with different years after the logging. Preliminary observation showed that Kelubi (Eleiodoxa coferta) is possibly as an indicator species for changes in gap opening in the PSF, at least in early years after the logging completed.

***Keywords*—** Peat Swamp Forest (PSF); gap opening; logging; water quality.

I. Introduction

PEAT Swamp Forest (PSF) is developed from organic soil that is still in the process of decaying, howere it is slow due to its anearobic condition. Most of the materials are from fibric soil materials which contain three-fourths or more (by volumes) fibres after rubbing, excluding coarse fragments. Thickness of the organic soil materials is classified as Ombrogenous which is thicker than 300 cm [1] The organic soil contain large pieces of undecomposed or partly decomposed wood. These pieces of wood are larger than 2 cm in cross-section and consist of logs, stumps and branches. Forest logging creates gap opening, favouring the regeneration of pioneer species. Hence plant structures on the PSF area are changing due to logging activities. Just after logging, pioneer plant species will grow vigorously due to low density stand and abundance of sunlight. Therefore the presence of these species can be attributed to the changes on water quality and soil properties of the area.

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Various parameters may have cause changing of tree vigorosity especially in PSF. Gap opening might minimize the trees competition with each other for nutrients, moisture and sunlight. However, some of the species will eventually dominate and their growth will become the indicators for the soil properties and water quality in the area. Soil of the area was developed from organic materials. The soil classification detail as in Table I.

TABLE I
SOIL SERIES IN STUDY SITE

Soil series	Malaysian Soil Taxonomy	FAO/UNESCO
Gondang	Hemic Ombrogambists	Fibric Histosols

Source: [2].

Prolong period of stagnant water may stimulate damage to the PSF by changing the pH, turbidity and quality of the water. The microclimate changes could lead to the freshwater intrusion (lower acidity) which may influence in the soil water nutrient concentration and all these are shown by the vegetation indicators. Therefore, this study was conducted to investigate impact of logging on plant structures in PSF. It also aimed to find possible indicators contributing to the changes on soil properties and water quality due to the logging activities. Hence, the results of the study would be useful in identification the status of vegetation in primary and logged-over forest of PSF

II. Materials and Methods

The study was carried out at compartment 77 in Pekan Forest Reserve, Pahang, Malaysia. It was situated at about 3o25‘ 46” N and 103o 19‘ 42” E. The rainfall ranges from 1980 mm to 2680 mm based on 4 tears observation. Work by Blackett and Wollesen [3] and UNDP [4] classified the area as Ramin-Bintangor subtype that is rich with Gonystylus bancanus (Ramin melawis). Khali Aziz [5] recorded about 25 trees ha-1 of Ramin in the subtype for tree > 10 cm DBH. Climate of the study area was affected my monsoonal season. There are distinct wet and dry season which are from September to January and March to June respectively.

A. Measurements

The study area was divided into three blocks of 0.48 ha each, namely block 1, 2, and 3 respectively. Block 1, 2 and 3 represent the intact area (virgin jungle), 3-yr after logging and 7-yr after logging respectively. The subsoil water sampling was done by using subsoil water sampler. Soil sampling was done by augering at 4 different soil layers namely 0-50, 50-100, 100-150 and 150-200 cm from the soil surface. These samples were collected at 10 points to make a composite sample. The physico-chemical analysis include N, P, K, Ca and Mg. Soil water sampler will be established in the study plot at 4 different soil layers namely at 50, 100, 150 and 200 cm from the soil surface. Water sampling was done at each soil depth using soil water sampler for all the 3 sites. The chemical analysis include N, P, K, Ca and Mg. Vegetation sampling include measuring of trees in the plot and identification of the trees which has more than 10 cm DBH.

B. Data Analysis

Plant community differences between the sampling sites was analysed using the R Graphical User Interface (RGUI) analysis. The community structure was divided based on the ecological class namely main canopy (C), emergent (E), treelet (T) and understorey (U). Correlation analysis was done to get any significant effect among the parameters measured.

III. Results and Discussion

The average DBH at the temporal division was 25.6, 22.3 and 23.5 cm for Block 1, 2, and 3 respectively. Altogether there were 591 trees measured in all blocks. The distribution of the sampled tress based on ecological class is as in Table II.

TABLE II
ECOLOGICAL CLASS OF THE SAMPLE TREES

Block	Ecological class (stocking)				Total stocking
	Main canopy	Emergent	Treelet	Understorey	
1	17	61	4	90	172
2	26	47	3	116	192
3	32	58	11	126	227
Total	75	166	18	332	591

The dominant tree classes found for main canopy, emergent, treelet and understorey was in Block 3, 1, 3 and 3 respectively. The total number of trees found on each block was in order of 3>2>1. This is characterised as the after logging block has more trees but smaller in size due to regeneration of stages of the forest. Main species found in the study area were *Syzygium inophyllum, Calophyllum ferrugineum, Stemonurus secundiflorus, Santiria rubiginosa, Diospyros lanceifolia, Syzygium inophyllum* and *Gonystylus bancanus*. Distribution of the top five species on each block as in Table III, where in Blocks 2 and 3 there were no presence of *Gonystylus bancanus*, suggesting that all the trees might been cut during the timber logging.

TABLE III
DISTRIBUTION OF FIVE MAIN SPECIES ON THE DIFFERENT LOGGING PHASES

No	Block 1		Block 2		Block 3	
	Species	Stocking	Species	Stocking	Species	Stocking
1	*Calophyllum ferrugineum*	34	*Syzygium inophyllum*	21	*Stemonurus secundiflorus*	25
2	*Syzygium inophyllum*	23	*Diospyros lanceifolia*	19	*Santiria rubiginosa*	17
3	*Diospyros lanceifolia*	14	*Stemonurus secundiflorus*	19	*Syzygium inophyllum*	13
4	*Gonystylus bancanus*	12	*Santiria rubiginosa*	17	*Calophyllum ferrugineum*	10

Table IV showed that stocking of Kelubi (*Eleiodoxa coferta*) increased by many folds on the logged over forest. Whereas the stocking of Mengkuang (*Pandanus* sp.) increased gradually over the years on the logged over forest.

TABLE IV
STOCKING OF KELUBI AND MENGKUANG ON THE DIFFERENT LOGGING PHASES

Block	Stocking	
	Eleiodoxa coferta	*Pandanus* sp.
1	8	15
2	131	35
3	90	81

Table V showed that stocking of more than 10 cm dbh remain about the same, ranging from 180 to 211 for the natural and logged-over forest.

TABLE V
NUMBER OF STOCKING COMPARED TO TOTAL BASAL AREA AND TOTAL VOLUME

Block	Stocking (stem)	Total basal area (m^2)	Total volume (m^3)
1	200	18.36	174.4
2	180	7.75	69.01
3	211	10.61	93.36

The water samples were analysed in terms of its chemical content such as Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca) and Magnesium (Mg). The results for all blocks are showed in Table VI. The subsoil water chemical content showed decreasing value further down the soil layer for P and Mg. Value for N, K and Ca varies for the different soil layer

TABLE VI
RESULT OF WATER CHEMICAL ANALYSIS FOR ALL BLOCKS

Sampling Depth (cm)	Nutrient content (ppm)				
	N	P	K	Ca	Mg
50	1.06	0.70	2.60	5.43	4.43
100	0.41	0.48	3.90	4.84	3.37
150	0.71	0.55	2.92	5.22	3.16
200	0.64	0.45	2.77	4.93	2.83
Average	**0.71**	**0.55**	**3.05**	**5.11**	**3.45**

Table VII Shows The Result Of Statistical Analysis On Water Chemical Content All Logging Phases. There Are Significant Differences In Water Chemical Content Between The Blocks For N, Ca And Mg. N And Ca Water Content Reduced Significantly 3-Yr After Logging And Increase Near To Control Plot's Value 7-Yr After Logging. So Did The K Water Content But No Significant Difference. P And Mg Water Content Increased 3-Yr After Logging Decrease 7-Yr After Logging.

TABLE VII
STATISTICAL ANALYSIS OF WATER CHEMICAL ANALYSIS FOR ALL LOGGING PHASES

Block	Nutrient content (ppm)				
	N	P	K	Ca	Mg
1	1.07 a	0.51 a	2.89 a	6.42 a	4.15 a
2	0.28 bc	0.63 a	2.65 a	3.89 b	4.87 a
3	0.75 ab	0.50 a	3.62 a	5.02 ab	2.25 b
Significan t level	*	N.S.	N.S.	*	*

Note: NS = Not Significant at $p > 0.05$
* = Significantly different $p > 0.05$

IV. CONCLUSION

There are impacts of logging activities on plant structures. It is due to changes on gap opening and water quality of the area. This study is aimed to find indicators species to the different years of logging activities in the PSF. Preliminary observation showed that Kelubi (Eleiodoxa coferta) is possibly as an indicator species for changes in gap opening in the PSF, at least in early years after the logging. Mengkuang also showed its dominance covering the gap opening by woody timber species. The water nutrient content also varied significantly after logging. Further monitoring is required in order to obtain long-term data collection in determining dynamics of the PSF after the logging.

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