A CASE STUDY: DISTRIBUTION OF *Gonystylus bancanus* (Miq.) Kurz IN KLIAS FOREST RESERVE

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JUDUL: DISTRIBUTION OF *Gonystylus bancanus* (Miq.) Kurz IN KLIAS FOREST RESERVE

IJAZAH: SARJANA SAINS PENGURUSAN SEKITARAN

SESI PENGAJIAN : 2004-2005

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DECLARATION

I declare that this dissertation is my own work and has been composed by myself. It has not been accepted in any previous application for a degree. All quotation marks and source of information have been specifically acknowledged.

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ACKNOWLEDGEMENT

I am grateful to my supervisor Dr. Kartini Saibeh for her guidance and confidence entrusted to me. Those who have contributed to this research are very much appreciated; they are Zulhazman Hamzah, Sikula Magupin, Jeffrey Augustine (Zul), Jasmi, Stewart Eddy, Godwin Anak, and Zayadi, with their assistance the research come into being. Permission and assistance from from George Agampui, the Beaufort District Forest Officer and his deputy, Idris is really appreciated. I am also thankful to Dr.Jinil Malaji for his support and excellence idea. Finally, very special thanks to my parents and siblings for their encouragement in which I feel indebted and to my loved one, Dorothy F Olin, for her support during the completion of this research.

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ABSTRAK

A CASE STUDY: DISTRIBUTION OF Gonystylus bancanus (Miq.) Kurz IN KLIAS FOREST RESERVE

Penyelidikan ini dilaksanakan di Hutan Simpan Klias (Hutan simpan perlindungan Kelas I), dengan keluasan 3,620 hektar, satu kawasan hutan paya gambut. Objektif penyelidikan adalah untuk menyiasat bilangan pohon kayu Ramin serta komposisi, keujudannya di tahap densiti kanopi hutan serta ketinggian permukaan tanah yang berbeza, dan juga menilai kesihatan spesis. Transek penyelidikan telah dibuat di 3 lokasi berlainan di dalam Hutan Simpan serta kedudukan kordinat transek ditentukan dengan peralatan *Global Positioning System* (GPS) semasa berada di lapangan. Kedudukan kordinat lokasi yang di kaji adalah di N05^{0}16.157, E115^{0}37.075 (transek Utara), N05^{0}17.106, E115^{0}37.380 (transek Tengah), dan N05^{0}19.155, E115^{0}38.555 (transek Selatan). Lokasi-lokasi transek yang dikaji ditentukan berada di dalam kawasan anggaran kawasan Utara, Tengah dan Selatan, sebelum kerjalapangan dijalankan. Bacaan kordinat GPS di setiap transek kemudian ditentukan kedudukannya di peta *Global Information System* (GIS) densiti kanopi hutan serta peta GIS ketinggian permukaan tanah. Kaedah transek yang digunakan adalah transek lurus memanjang dengan jarak 220m dan lebar 20m. Transek ini kemudian dibahagikan kepapa 11 sub-plot berukuran 20m lebar dan 20m panjang. Keputusan penyiasatan menunjukkan bilangan pohon Ramin adalah tinggi di transek Tengah ('Centre') diikuti oleh transek Selatan ('South'), Tiada spesis Ramin ditemui di transek Utara ('North'). Begitu juga dengan pohon Ramin yang bersaiz lebih besar, lebih banyak ditemui di transek Tengah dari transek Selatan. Pohon muda atau anak pokok mendominasi komposisi di kedua-dua transek ini dengan ketiadaan saiz perantara, menggambarkan jurang generasi yang luas. Tren bertentangan diantara kepadatan vegetasi dan bilangan pohon Ramin menggambarkan densiti kanopi hutan yang tinggi tidak semestinya mengandungi bilangan pohon Ramin yang banyak. Ketidakujudan dan keujudan anak pokok Ramin yang tinggi pada tahap densiti kanopi hutan yang sama, dan juga bilangan yang rendah di densiti kanopi yang tinggi menggambarkan perbezaan komposisi species di tempat yang berbeza dalam Hutan Simpan Klias. Kayu Ramin tidak ditemui di transek Utara, kawasan permukaan tertinggi, ditemui banyak di kawasan yang ketinggian (5-6m) tetapi sedikit di kawasan yang lebih rendah (4-5m). Penilaian keadaan kanopi menunjukkan kanopi pokok Ramin yang dikaji adalah berkeadaan baik.

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ABSTRACT

A CASE STUDY: DISTRIBUTION OF Gonystylus bancanus *(Miq.) Kurz IN KLIAS FOREST RESERVE*

The study is carried out in Klias Forest Reserve (Class I protection forest reserve), a peat swamp forest of approximately 3,620 hectare of area, to investigate the tree stand and composition, occurrence in different forest canopy density and surface elevation, and evaluate the species health. Line transects were established in three different location and at each transect site, Global Positioning System (GPS) coordinate were recorded. Transects location coordinates are at N05^{0}16.157, E115^{0}37.075 (transect North), N05^{0}17.106, E115^{0}37.380 (transect Centre), and N05^{0}19.155, E115^{0}38.555 (transect South). GPS coordinate of transects locations in Global Information System (GIS) forest canopy density map and GIS surface elevation map are then determined. Transect design was a straight line transect of 220m in length and 20m wide. Transects are then divided into 11 sub-plots of 20mx20m dimension. Result shows that highest occurrence of Ramin tree stand is in transect Centre followed by in transect South and no Ramin trees found in transect North. Mature bigger and small young trees are also found in higher number in transect North than in transect South. Young trees and saplings dominates composition of tree stands in both transects Centre and South with no intermediate size of trees being found signifying huge generation gap. There is an opposite trend between vegetation cover and number of Ramin tree stand. The trend indicates high density of forest canopy does not necessarily accommodate high number of Ramin trees. Ramin trees are found to exist in one transects but are absence in the other although level of forest canopy density is the same. At higher level of forest canopy density, Ramin tree stands are lesser than at lower level of forest canopy density. These findings signifying the difference in species composition in the different part of forest reserve. Ramin tree is absence in transect North at highest surface elevation of forest reserve. The occurrence of young Ramin trees is higher at elevation of 5-6m than at elevation of 4-5m is observed. Canopy condition evaluation reveals that Ramin trees canopy at investigated areas found to be in good condition.

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ABBREVIATION

ANOVA	Analysis of Variance
AVI	Advanced Vegetation Index
BI	Bare Soil Index
CITES	Convention in International Trade in Endangered Species of Wild Fauna and Flora
DANIDA	Danish International Development Agency
DBH/dbh	diameter at breast height
FCD	Forest Canopy Density
FR	Forest Reserve
GIS	Global Information System
GPS	Global Positioning System
IUCN	International Union for Conservation of Nature
KFR	Klias Forest Reserve
PSF	Peat Swamp Forest
SI or SSI	Shadow Index or scaled Shadow Index
TI	Thermal Index
UNDP-GEF	United Nations Development Programme – Global Environmental Fund

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CHAPTER 1

INTRODUCTION

1.1. Wetlands of international importance

Ramsar Convention accords the importance of wetlands around the world by acting as an intergovernmental agreement which provides the framework for international cooperation for the conservation of wetlands. Malaysia has became a signatory to the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) on March 1995, only 24 years later after the Ramsar Convention was first adopted in 1971 in Iran (Davies & Claridge, 1983).

Ramsar has provided broad definition and is internationally recognized. It define wetland as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static, flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters" (Davies & Claridge, 1993).

Ramsar conservation sites is designated by the national government for inclusion in the list of wetlands of international importance to promote the conservation and sustainable use of wetland areas worldwide and the protection and management of this site is under the responsibility of each sovereign country.

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Designated Ramsar sites in Malaysia namely are Malaysia Tasek Bera listed in 10/11/94, Pulau Kukup in 31/01/03, Sungai Pulai in 31/01/03, and Tanjung Piai in 31/01/03. These areas qualified as Ramsar site as one of eight criterions for listing prerequisite have been complied with.

1.2. The Klias wetlands

The Klias Peninsular is the largest intact wetland area remaining in the western part of Sabah and contains outstanding examples of a form of peat swamp forest (PSF) which is unique to the state, and possibly Borneo (Payne & Vaz, 1998). The area covered is so extensive, approximately of 130,000 hectares (UNDP-GEF, 2004). There is only 40,000 hectares of peat swamp forest (PSF) currently remained in the wetland area, from approximately 60,000 hectares in the 1980s (UNDP-GEF,2004). The Klias peninsula terrestrial ecosystem consists of peatlands, peat swamp forest, closed-canopy blackwater streams, and mangroves and transitional forests.

The Klias peninsula wetland may has not been designated as Ramsar site for the promotion of conservation at international significant but at national level particularly for the State of Sabah, its unique isolated ecosystem merits conservation attention. Even if the general ecosystem perhaps unattractive enough to justify conservation measures, there are threatened and endangered species listed in IUCN Red List and CITES found in this area. There are Proboscis monkey (*Nasalis larvatus*), Klias Fighting Fish (*Betta chini*), Estuarine crocodile (*Crocodylus porosus*), Ramin tree (*Gonystylus bancanus*), Bornean Dungun (*Heritiera globosa*), and Migrant shorebirds and waterbirds as conservation target species recommended by UNDP/GEF (2004).

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Ramin is one of the dominant tree species in this area, an important timber species listed IUCN categorized as vulnerable (VUA1cd). This taxon is vulnerable when it is not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium-term future (World Conservation Monitoring Centre, 1998). In CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) Malaysia categorized it in Appendix III/r in 17/08/2001 (Appendix A). Ramin occurrence almost totally confined to peat swamp forest (Cockburn, 1976). Nevertheless, the habitat loss due to human disturbance, its occurrence is declining and conservation of habitat is approached through protection of forest reserves by State Forestry Department. The listing of Ramin in CITES and IUCN Red List, the rapid population decline throughout its range, and its endemism in peat swamp forest render interest to this study.

1.3. Objective

Objective of this research is to analyze Ramin trees stand and the nature of its distribution within the selected area in Klias Forest Reserve (KFR). This study will enable more understanding on present stand of Ramin species, composition, and distribution. Findings of this investigation will provide additional information for effective and efficient conservation management in forest reserve. More effort can be focused where the investigated species is mostly occurred. Details of objectives are i) To compare the species stand and composition of Ramin tress at three different location of investigated areas namely Transect A, Transect B, and Transect C, ii) To investigate the occurrence of Ramin trees in different level of vegetation cover and surface elevation of forest reserve, iii) To investigate the Ramin trees health, canopy conditions as indicator.

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CHAPTER 2

LITERATURE REVIEW

2.1. Ramin (*Gonystylus bancanus*)

2.1.1. Taxonomy

Several literatures described this species belong to two different families. Hsuan (1978) classified it as belong to the family of Gonystylaceae. However, a monograph of the genus *Gonystylus* and the description of two new small genera from Borneo were prepared by Airy-Shaw in 1953 who considers this family as representing merely a subfamily of the Thymelaeaceae (Hsuan, 1978). As Airy-Shaw wrote "..i see no great function of splitting Gonystylaceae and it is considered as a subfamily of the Thymelaeaceae" (Cockburn,1976). Subsequently, Cockburn has described genera of Gonystylus belong to family of Thymelaeaceae. A report by Chai (2005) on Klias peat swamp forest however refers this family as Gonystylaceae.

Hsuan (1978) further described Gonystylaceae as trees with leaves coriaceous, mostly glandular-dotted, alternate, entire, and exstipulate. The flowers are bisexual, regular, and in cymose panicles. Its calyx-tube is short and the limb is five-lobed with corolla is represented by many (7-40) petaloids appendages which is linear or dissected. Stamens are mostly numerous or filament free and the ovary is three to five loculate (ovule one in each locule) with capitate stigma. Fruit is of woody capsule and dehiscent type with seed is one or two, large, usually arillate, and without endosperm.

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2.1.2. Guide for field identification

As guide for field identification, Wyatt-Smith (1952) has described its identifiable physical appearance as trees without buttresses, bole sometimes fluted at base. Bark is smooth to cracking with shallow fissured or scaly, dull grey to red brown or dark brown (Appendix B, Figure 1). Inner bark usually laminated, yellow brown, pink or orange coloured, with silky irritant fibers. Sapwood is pale yellow or pale white. Leaves are alternate, simple, thinly to thickly leathery, with gland dots.

2.1.3. Ecology, distributions and conservation merits

Ramin habitat confined to lowland, freshwater coastal swamp and peat forest, mostly subject to seasonal flooding. When it is abundant it can forms pure stands more especially in Sarawak and Brunei (Cockburn, 1976).

Cockburn (1976) also reported that this species can be found in Peninsular Malaysia, Sumatra, Banka and Borneo. In Borneo, it is recorded in Sarawak, Brunei, Sabah, East, West and Central Kalimantan. In Sabah, it only can be found in Sipitang and Beaufort district.

Although the range of its occurrence and endemism is widely spread, in Sabah, it only can only be found in Klias peninsula wetland where KFR is located. Other location within Klias peninsula wetland is Binsulok Forest Reserve. Nevertheless, the density of Ramin is believed to be much lesser than in Klias Forest Reserve (Ampong, 2005. *pers. comm*). The level of endemicity of this species in peat swamp forest and the limited and threatened existence peat swamp forest in Sabah, Ramin merits conservation attention.

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2.1.4. Phenology

Cockburn (1976) commented that this species does not seem to flower very often and during the year of 1976 there were no fertile collections at Sandakan available, at least during his time. Observation by Shamsudin (1996) in Pahang peat swamp also found that flowering and fruiting appear to be infrequent. He also reported that poor seedlings regeneration on the forest floor attributed to seeds susceptibility to insect and fungal attack, and predation on immature fruits by bats and squirrels. Good germination occurs around mother trees following a good seed year may explain why Ramin trees including saplings tend to be grouped near mother threes.

Although this plant does not flower very often, some observation stated that it produce flower and fruits at the beginning of the year with mature fruits start to drop in March and April each year (Ng & Shamsuddin, 2001). Seeds are highly shade tolerant and will remain at two-leaf stage on the forest floor for more than a year. Ng and Shamsuddin (2001) further reported that the species shows excellent growth at the early stages when planted in open planting on dry land areas.

2.1.5. Threats of extinction

Besides indiscriminate logging activities for the high market value of its timber, habitat disturbance and obliteration pose the perpetual danger to the existence of this species. Pressures exerted to habitats by people activities such as agricultural development, encroachment to unallocated areas for establishment of kampungs, and illegal logging were reported to be a major threat the natural existence of KFR (UNDP/GEF, 2004). The

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occurrence of fire in some part of KFR was also become the most significant threat to the sustainability of conservation measures. Impact of fires is devastating, through complete eradication of vegetation in the affected area, and fragmentation of habitats. Its occurrence is high which attributed to drought session and peat swamp characteristic.

The conversion of alienated land surrounding KFR by construction of drainage channels is to lower the water table and enable faster runoff during wet period. Study on the current drainage scheme in the alienated land revealed a significant impact on both the groundwater levels but probably more important on the groundwater dynamics (Jessen *et al.*, 2004). This report notwithstanding found that, in general it can be said that the drainage impact from the current drainage scheme is not a threat towards the sustainability of the KFR, as the impact is localized to the edges of the forest reserve boundaries. The impact however is highly speculative as long term negative effect can not be anticipated accurately.

For the KFR the land use impact is a real threat as increased subsidence on the alienated areas could increase the gradient from the forest and thereby potentially have an increased drainage effect on the forest reserve. The impact from increased subsidence would be comparable with the drainage effect from the current logging canal, and the impact would probably be limited inside the forest reserve while noticeable along the edges of the reserve (Jessen *et al.*,2004). The remaining question is what the long term effect of an increased edge impact has on the KFR. The other issue related to the land use impact is the irreversible decay and subsidence impact that eventually will turn the barren peat soil areas into wetland areas and thereby making the areas unusable for agricultural usage.

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Ramin trees are characterized by peat swamp forest habitat. With the collapse of peat swamp habitat, it will definitely bring Ramin trees into extinction, particularly in the KFR thereby allowing the disappearance of distinctive characteristic of KFR.

2.1.6. Research history

An in depth research of ecological study of endemic flora species in peat swamp particularly for Ramin in KFR was has not been readily available. A lot of investments for the conservation of this Forest Reserve have been in place such as fund allocation by United Nations Development Programme (UNDP). Besides the corrective intervention by UNDP, other independent organization for example DANIDA of Denmark generously sponsored a study on hydrology of KFR completed in 1984. With abundance supply of base line data, further ecological research may become more interesting, in a way that limited fund and time can produce more value added research.

2.2. Canopy condition and crown dieback in broadleaves

Crown condition is a major variable in the U.S. Forest Monitoring Programme (Reed & Mroz, 1997). Although there is no single system to measure crown condition certain variable can provide an indication of tree vigour.

Crown dieback is defined as branch mortality that begins at the terminal end of the branch and extends towards the main bole. Dieback occurs on both conifers and hardwoods and is different from self pruning, which occurs naturally when branches in the lower portion of the tree bole are shed. Dieback occurs in the upper crown above the

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region of self pruning. Some extent of crown dieback is normal, but excessive crown dieback is possible indicator of serious health problems (Reed & Mroz, 1997).

Measurement of crown dieback can examines the process of stem and branch mortality. Therefore, extent of crown dieback in broadleaves provides a good measure of the health of individual trees. The system developed by Westman in 1989 is applicable for measurement of crown dieback (Innes, 1993) which involves assessing the degree, location and extent of dieback. Degree of dieback as follows; 0: no dieback, 1: leaf loss only, 2: breaks to thin branches, 3: breaks to thick braches, 4: stem broken, 5: other (lightning, wind). Location of dieback within individual trees and extent of dieback (percentage of dieback within the individual trees) are not used to gauge individual trees health due to time constraint and lack of skill. There are other measurement of crown condition to assess tree vigour and health such as crown transparency, crown discolouration and needle retention (Innes, 1993).

2.3. Forest density classification map

Forest density classification (FCD) map is produced from ASTER 2002 image with combination of four indices namely, Advanced Vegetation Index (AVI), Bare Soil Index (BI), shadow Index or scaled Shadow Index (SI, SSI) and Thermal Index (TI). This approach can be used to estimate the ground status of study area on continuum ranging (in percentage) from rich conditions to exposed soil conditions (Zulhazman, 2005). A summary of statistical result for the different classes of forest canopy density classifications of the peat swamp forest based on ASTER image analysis is shown in Table 2.1

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Table 2.1: Statistical result of five Classes from FCD classification (Source: Zulhazman, 2005)

Class name	FCD (%)	Category	Area Extent (ha)
1	100 – 81	Very good forest	1607
2	80 – 61	Good forest	3060.8
3	60 – 41	Moderate forest	800.8
4	40 – 21	Poor Forest	54.4
5	20 – 0	Very poor forest	1730.8

Figure 2.1 shows the Forest Canopy Class Map of Aster 2002 image resulting from forest canopy density classification. It shows clear relationship between canopy density and the dynamics of forest ecology, in which dense canopies are features of healthy forest where as sparse or less canopies indicate the opposite. Ground verification work done in FCD of 100% to 81% indicated the western side is occupied by solitary relics of emergent strata with low disturbance, while the northern side was dominated with the strata of dense and homogenous main canopy. FCD of 80% to 61% is associated by forest strata of sparse main canopy or emergent with low disturbances. FCD of 60% to 41% is related with areas of secondary forest characterized by shrubs and herbaceous layer of recently re-growth after burning and disturbances where most of this area lack of emergent and main canopy stratum. FCD of 40% to 21% shows areas of recently disturbed and re-colonized for approximately not more than ten years and considered to be very heavily disturbed. FDC of 20% to 0% is allied with the area of barren and water logged where most of the place are covered with species of grasses, ferns, hyacinths and reeds.

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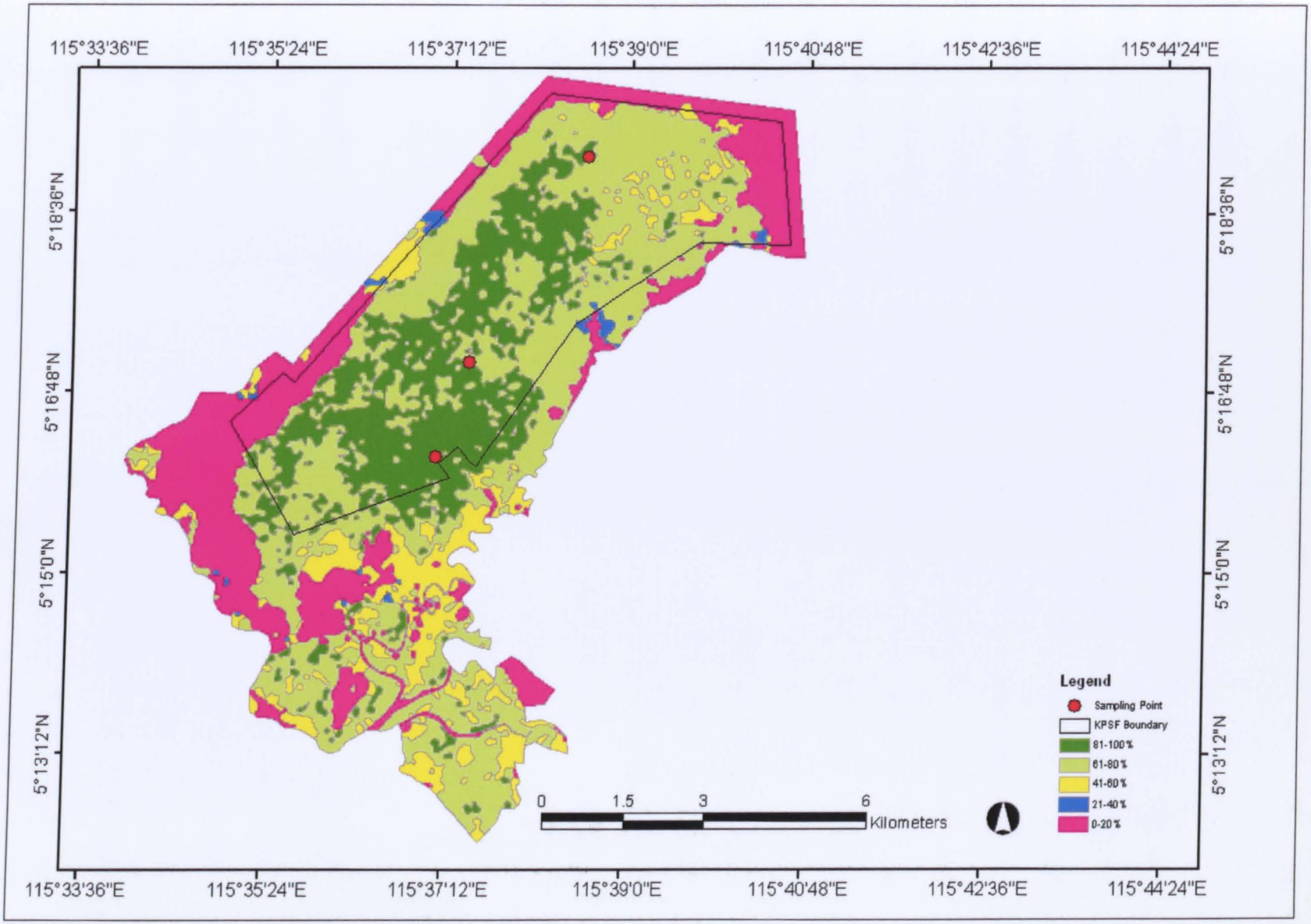

Figure 2.1: Forest Canopy Density Map of ASTER 2002 image and sampling location (Source: Zulhazman, 2005)

2.4. Vegetations

Despite having been logged in the past for the valuable species (e.g. *Dactylocladus stenostachys*, *Gonystylus bancanus*, and *Dryobalonops rappa)*, the forest within the FR is generally capable of regenerating naturally. The mixed PSF is characterized by the dominant association of several species, namely *Dryobalanops rappa* (kapur paya), *Shorea platycarpa* (seraya paya), *Dactylocladus stenostachys* (jongkong), and *Gonystylus bancanus* (ramin). Together, these species usually make up about 60-70 % of the standing basal area. Other common species include *Calophyllum havilandii* (bintangor), *Madhuca motleyana* (nyatoh ketiau), and *Stemonurus scorpioides* (katok). *Dryobalonops rappa* (Kapur paya) appears to be one of the most dominant constituents of the upper canopy. However, it cannot be certain whether its current social status reflects the original structure of the forest. This is because past logging operations may have removed only commercial species, like ramin and jongkong, during a time when kapur paya was either not highly marketable or difficult to transport (i.e. the kapur logs sink in water). In the drier areas, the presence of *Shorea smithiana* (seraya timbau) was noted.

Forest structure and floristic composition are not uniform within the mixed PSF. They may vary depending on peat depth and distance from dryland. Canopy height decreases and becomes more open in response to the increase in peat depth. Pandans (Pandanaceae) and sedges (Cyperaceae) are common ground cover and form impenetrable thickets where conditions are more open, thus allowing more light to reach the ground.

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