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MINISTRY OF FORESTRY
FOREST RESEARCH AND REVELOPMENT AGENCY

IN COOPERATION WITH

INTERNATIONAL TROPICAL TIMBER ORGANIZATION

Bogor - Indonesia
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THE PREVENTION OF FURTHER LOSS AND THE PROMOTION OF REHABILITATION AND PLANTATION OF *GONYSTYLUS SPP* (RAMIN) IN SUMATRA AND KALIMANTAN

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FOREWORD

This is another report on the observation of ramin seed source in Sumatra, especially Riau and Jambi Province. Very limited data and information regarding the seed source of ramin in South Sumatra since collected the population in this province has been significantly decrease.

In this report, only several locations have been observed and field visited to observe potential production of ramin seeds. Therefore in the future, data and information on the seed source of ramin is still needed to be up dated.

We expect the information provided in this technical report will be useful, especially for those who think that ramin is important to be further conserved and rehabilitated. Finally, the project thanks to Dr. Tukirin Partomihardjo, as field team leader who prepares this draft and others who have given contribution to the finalization of this report.

Project Coordinator

ABSTRACT

Ramin (*Gonystylus bancanus* (Miq.) Kurz) is a tropical tree, the only species of 30 species of *Gonystylus* associated with peat swamp habitat. The abundance and distribution of ramin is correlated with the depth and distribution of peat. The population of this tree species is declining due to over-harvesting, in particular for international trade. In order to achieve effective control and to ensure the sustainability of ramin, this species has been listed in Appendix II, CITES since 2004. Despite ramin's listing in Appendix II CITES, the natural population is still declining due to illegal logging and its habitat degradations including habitat conversion and fires. Poor natural regeneration and inappropriate sylvicultural practice applied in peat swamp forest management systems may also contribute to the extinction of natural ramin populations.

Efforts on ramin plantation has been conducted by various stakeholders either enrichment, rehabilitation and restoration of degraded peat swamp forest. However these activities are still insignificant since it was only as small scale such as a demonstration plots and research scale. To support and guarantee ramin plantation effort it was needed to conserve existing stands for seed sources and stop peat swamp forest conversion.

To obtain data and information concerned with ramin seed source, field surveys have been conducted at four locations within two provinces of Sumatra there were PT. Diamond Raya Timber, PT. Bina Daya Bintara and PT. Riaupulp in Riau Province and PT. Putra Duta Indah Wood in Jambi. The field survey of seed source identification was selected from two different forest management systems namely logging concession and timber estate areas. It was revealed that these two forest management systems still have remaining natural peat swamp forests that are potential ramin seed sources.

The objective of the ITTO Project PD 426/06 Rev.1 (F) (Ramin seed source Identification) is to provide vital data on ramin seed sources and to shed light on the difficulties associated with its management. Data and information presented in this Technical Report concentrate on the population of ramin trees in Sumatra which is potential as seed source and supported the continuation of the availability of ramin planting materials.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

LIST OF APPENDICES

I. INTRODUCTION

1.1. Background

Ramin is a timber trade name composed 30 species of tropical timber trees of the genus *Gonystylus* (Thymeleacea). About 10 species of *Gonystylus* are known as tree producing timber with the local name of Ramin. This genus is distributed in tropical forests from Southeast Asia to the Pacific Islands (Ary Shaw, 1934). Among the species of ramin, *Gonystylus bancanus* (Miq.) Kurz is the most popular and valuable timber tree. This species is known as a main component of the peat swamp forests. The distribution of ramin (*G. bancanus)* is associated with the depth of the peat (Istomo, 1988). Its light, slightly lustrous, lack of conspicuous figure, white color and ease to work with, make wood of ramin is very famous for various uses. The wood is suitable for decorative uses such as window frames, skirting, dowels, lind furniture, and toys. Ramin is also used for furniture, doors and even golf clubs. Therefore, ramin is in high demand both in domestic and international markets. Consequently, this species has been heavily exploited and has become the most threatened tropical wood. The population of this species in the natural habitat has been drastically decreasing, since the timber extraction of this species is from the natural habitat only (Daryono, 1996).

After a decade of heavy exploitation for timber, ramin (*Gonystylus bancanus*) is under very threatened condition or near commercial extinction through much of its range. In order to reduce the population loss of ramin in the natural forests since 2001, logging and trade of this species has been banned or under moratorium (temporary stop of logging and trade) based on the decree of Minister of Forestry No. 127/Kpts-IV/2001, except for forest concessionaire which got a sustainable management certificate from the Indonesian Ecolabel Institute (LEI). In CoP 12 CITES, Indonesia included ramin in the CITES Appendix III with annotation # 1 which was in effect since 6 April 2001. Annotation # 1 states that all trade of ramin parts and decorative, with a few exception like seeds, seedlings and tissue culture have to be accompanied by a CITES permit of certificate. However, illegal logging and smuggling from Indonesia to Malaysia and Singapore in international trade of ramin were still increasing (Wyn *et al*, 2004; Curney & Hapsoro, 2004). Since then, some European importer countries, proposed to up-list ramin into Appendix II CITES and it was agreed by the Indonesian government (Samedi 2007). Ramin has been up-listed into Appendix II in the CITES conferences 13 in Bangkok, Thailand 2004. As a result, the ramin wood trade has to be controlled internationally and logging of ramin has been under recommendation of Scientific Authority (LIPI) by quotas setting system. Based on the

current CITES regulation, onlycertified logging concessionaires with sustainable management system certified by independent assesor (LEI and SGS) are allowed to extract ramin with a quota harvest system recommended by Scientific Authority.

Several efforts have been made to reduce the rate of ramin extinction, including (1) conservation of remaining ramin stands and populations (2) law enforcement to combat illegal logging by establishing Quick Respond Unit (*Unit Gerak Cepat Kehutanan*) (3) law enforcement to combat illegal trade by formulating three national task force (Indonesia, Malaysia and Singapore) (4) re inventory of ramin standing stock and its distribution through ITTO Pre Project (5) rehabilitation of ramin habitats through National Movement of forestland rehabilitation (Murniati *et al.* 2005). Despite these efforts, rapid peat lands degradation presently still occurs in Indonesia, including Sumatra, where peat lands are being deforested, drained and burned for development of oil palm and timber plantations, agriculture and logging activities (Hooijer *et al*, 2006). Conversion of peat swamp forest habitat of ramin into other uses is still in operation as indicated by the extensive program of Oil Palm and Timber Estate Plantation on forested peat land habitat in this region. It is worthy to mention that the significant decrease of ramin timber is due to the loss of ramin habitats and degradation of existing populations. Major problems related to ramin depletion have also been identified during ITTO Pre Project i.e. (1) over exploitation of ramin standing stock due to poor implementation of cutting limitation (2) illegal logging, particularly caused significant decrease of ramin growing stock in conservation areas (3) inappropriate silvicultural practices that also contributed to the decrease of ramin population especially in over logged areas (4) no significant plantation and restoration on over logged areas and degraded peat lands (Murniati *et al*, 2005, Komar, 2007). Therefore, a key issue facing Indonesia's concern with the extinction of ramin populations is that the parties responsible for peat swamp destruction and ramin depletion in the past are likely to be involved in replanting and restorations efforts in the future.

To support replanting and restoration movements, inventory and identification of seed sources of ramin in those areas containing populations of ramin is needed, since replanting schemes depend on the availability of materials to be planted. Insufficient supply of planting materials usually becomes the main problem, since this species has an irregular fruiting season i.e. between 2 – 5 years. Furthermore, slow growth and specific site requirements may also inhibit the establishment of ramin plantations. The survival rate of ramin seedlings in plantation trials is poor, especially at the transition stage between shade tolerant and light demanding. Prior to the improvement

of seed supplies, identification of seed sources of ramin from various genetic populations will become important. Earlier data collected by Bismak *et al.* (2005) showed the basic information of current standing stock and distribution of remaining ramin populations.

1.2. Objectives

The objectives of this project are

- To obtain primary data and information of remaining ramin populations which are potential for seed sources from different locations and management systems in Sumatra.
- To collect secondary and relevant data and information of ramin populations and regeneration related to seed sources potential for Sumatra region.
- To identify the potential ramin populations for seed sources from different management systems.
- To select the ramin populations as seed sources which have potential seed production
- To provide complete information and data on ramin seed sources particularly in Sumatra, including a detail map of each site.

II. METHOD

Activities of the ITTO Project PD 426/06 Rev.1 (F) "Identification of ramin seed sources in Sumatra" was carried out from March to April 2007. There were two methods in obtaining information and data concerning the activities of ramin seed source identification in Sumatra i.e. references review and field surveys. Data and information of ramin populations, regeneration and other related potential for seed sources were gathered through field surveys at four different locations in Sumatra.

2.1. References review

References review was conducted in Libraries of Research Center for Biology-LIPI, Research Center for Forestry – Department of Forestry, Seed Technology Center Library, Universities, BIOTROP and District Forestry Services, State and Privates Companies as well as non government organizations such as Wet Land International etc. The review was focused on related information of ramin seed sources, including populations of mature trees (diameter up to 30 cm), habitat condition and number of individual per unit area.

2.2. Selecting area for field survey

In order to get broader data and information, we devoted two different management systems i.e. logged over area of HPH and conservation area of HPH and timber estate. Location of the most ideal site of seed sources was chosen based on the information of local government (Local Forest Agencies), local NGO and other related stake holders (Logging concession, Timber estate) etc. The seed source plots were chosen so that they could represent the appropriate population in the accessed areas.

Bismark *et al.* (2005) reported that there were three provinces in Sumatra indicated to have potential ramin stands i.e. Riau, Jambi and South Sumatra. Forestry Services of Riau Provincial informed that in Riau province there are several locations which might have potential ramin stands including Bagansiapiapi (PT. Diamond Raya Timber), Libo (PT. Bina Daya Bintara) and Pelalawan Peninsula (PT. Riau Pulp and Paper) areas. Jonotoro (2005) reported that there were also several locations of conservation areas in the remaining natural peat swamp forest that might contain natural ramin populations and potential seed sources. For example Senepis Nature Reserve, Kerumutan Nature Reserve, Tesso Nilo National Park, Giam Siak Biosphere reserve (Proposed) and Kampar Peninsula Protected area (proposed) (Figure 1). There are several conservation sites within this area i.e. Tasik Belat, Tasik Serkap and Tasik Metas animal sanctuaries.

There were four selected location which have been visited to get the real data of ramin populations and potential as seed sources in Sumatra (Table 1).

Although ramin was the dominant species in Berbak National Park (Komar *et al*, 2005), this species exists on remote areas. Therefore, in Jambi province the visited area for candidate seed source was only the area of PT. Putra Duta Indah Wood and part of Berbak National Park (Figure 2). Small ramin populations are also found in South Sumatra i.e southern part of Berbak National Park. However, these are less well studied and documented in that area and only a few stands of ramin are remain. Hence, both Berbak National Park and South Sumatra are excluded from the site target of field study.

Table 1. Four sites of peat swamp forest identified as potential seed sources of ramin in Sumatra

No.	Name of the owner	Management system	Total area (ha)
1.	PT. Diamond Raya Timber	Logging concession	100 ha
2.	PT. Putra Duta Indah	Logging concession	200 ha
3.	PT. Bina Daya Bintara	Timber Estate	64 ha
4.	PT. Riau Andalan Pulp and Paper	Timber Estate	50 ha

2. 3. Field Survey

Field surveys were conducted by means of interviews and direct observations. Interview with local stakeholders has been done to find the potential and most accessible locations of ramin stands for seed sources. Collecting baseline data and information on potency and location of ramin stands with the most potential as seed sources in Sumatra was done through reference search or secondary data and ground check. The secondary data is including information of local ramin populations. The ground checks are expected to get the real existing data and information of ramin stands as potential seed sources. The survey was limited on the most accessible sites, since the accessibility in peat swamp forests are mostly extremely poor, especially in logged over areas.

Individual measurement of ramin within each site of seed source was carried out by making temporary plots. Data recorded for individual ramin within each identified seed source plot including stem diameter (DBH), total high, bole high, crown diameter, number of branches, as well as notes on flowering and fruiting. Number of seedling and saplings of ramin were also recorded within each identified seed sources plot.

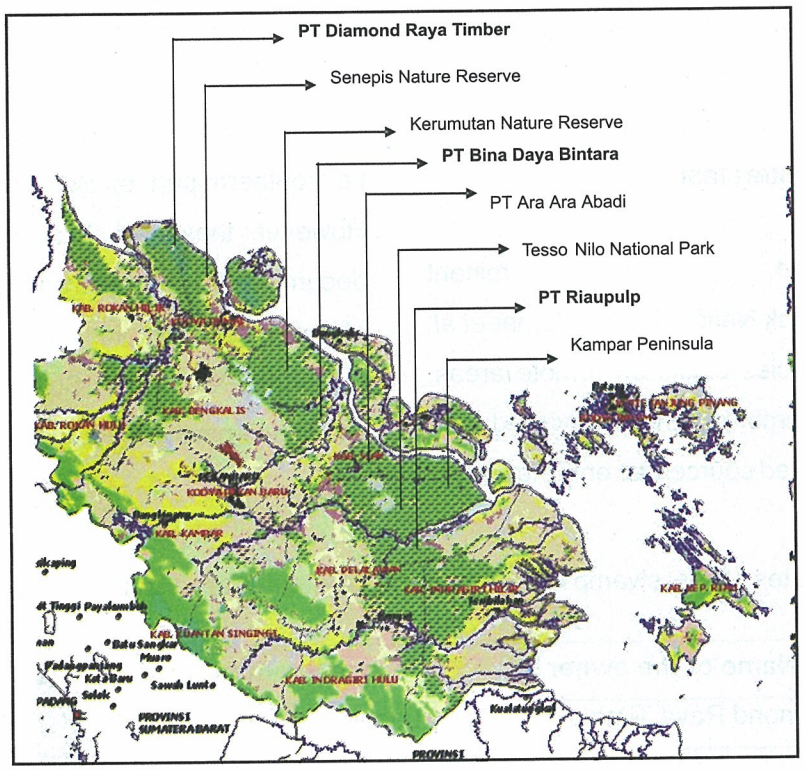

Figure 1. Map of Riau Province showing the location of peat lands habitat that might have ramin stands which potentially as seed sources. The selected area for ramin seed sources are indicated with **bold letters**.

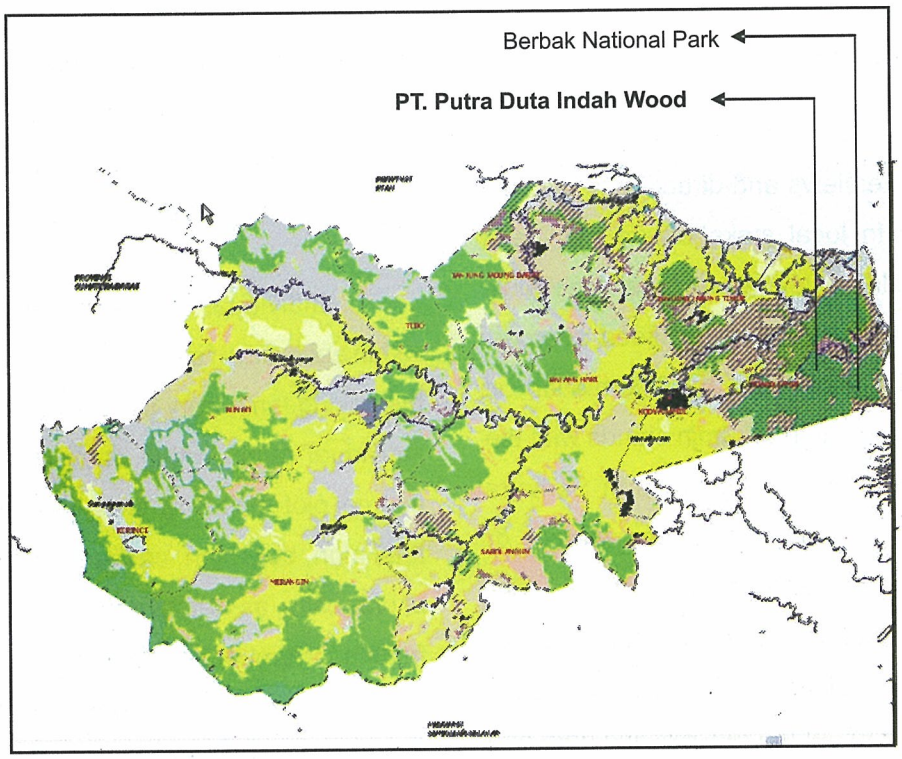

Figure 2. Map of Jambi Province showing the location of peatlands habitat that might have ramin stand for seed sources. Selected areas for ramin seed source indicated with **bold letters**.

The plot size of seed sources identification area was a minimum of 50 ha as a single population of ramin. Structure of the forests of the seed source area was briefly observed including composition of the canopy layer. Information and data recorded of fauna related to ramin were collected from local people and direct observation. This study is a rapid survey to identify seed source of ramin in order to provide detailed information and accurate data of the potential ramin seed source. This study also gives a general figure of the forest condition of potential seed source in the study areas and some recommendations of possible management related to the potential seed source of ramin.

2.4. Description of Selected Sites

2.4.1. PT. Diamond Raya Timber (PT. DRT)

PT. DRT logging concession is located in the northern part of East Coast of Riau Province. Administratively, the area of this logging concession covered 13 villages, belonging to 4 sub districts i.e Bangko, Rimba Melintang, Sinaboi and Sungai Sembilan and belongs to two districts: District of Rokan Hilir and Dumai City. The total area of this concession is about 90.956 ha, consisting of 87.578 ha of peat swamp forest, 1.611 ha of mangrove and 1.767 ha of non forested area. This concession is managed according to the Indonesian Selective Cutting and Replanting System (TPTI). PT. DRT is the only certified logging concession in Indonesia that passed the assessment on sustainable forest management from independent assessor Lembaga Ekolabel Indonesia (Indonesian Ecolabeling Institute) - LEI or Forest Stewardship Council (FSC) and therefore this concession obtained an exception to harvest ramin through a quota setting system. Setting a harvest quota of ramin was carried out annually by "ramin working group" lead by CITES Scientific Authority of Indonesian Institute of Sciences (Partomihardjo, 2006).

To reach the logging concession area of PT. DRT is not too difficult since the public transportation passes near by. However, to enter the forested area of this concession is not easy. Transportation from the public road to the forested area has only been served by the logging company along a private railway used exclusively for logging activities. Therefore it is only possible to enter the forested areas using special transportation operated by the logging company. Traveling time and distance from the capital city province is shown in Table 2.

2.4.2. PT. Putra Duta Indah Wood (PT. PDIW).

PT. PDIW logging concession is located in the eastern part of Jambi Province near Berbak National Park and has a total area of about 61.000 ha. Administratively,

the area of PT. PDIW belongs to the District of Muaro Jambi, Sub District Kompeh Ilir, village of Pematang Raman. The topography of the area is flat with elevation of only about 15 m above sea level. The majority of the area is covered by peat swamp forest ecosystem and small tidal land along the river bank. This concession is also managed according to the Indonesian Selective Cutting and Replanting System (TPTI). However, this logging concession has not passed certification on sustainable forest management from independent assessor (LEI or FSC). Therefore, PT. PDIW is not allowed to harvest ramin trees in its logging activities. Although ramin trees have not been extracted, the population of seedlings within the logged over area was relatively low due to the disturbance by logging activities.

Similar as the logging concession area of PT. DRT, there is also public transportation passing close to the PT. PDIW area. However, to enter the forested area of this concession is also not easy. Trips between the public road and the forested area have only been served by the logging company along a private railway used exclusively for logging activities. Therefore entering the forested areas is only possible using special transportation operated by the logging company or hiring a special boat. Traveling time and distance from the capital city of province is shown in Table 2.

2.4.3. PT. Riau Andalan Pulp and Paper (PT. Riaupulp)

PT. Riaupulp is one of the big members of the multinational holding company of APRIL. The main pulpwood plantation species on the area is *Acacia crassicarpa* which is known to adapted to peatland habitat. The majority of the concession area is peatland habitat located in District Pelalawan, Riau. It has been recognized that developing fiber plantations on peatland habitat, a water management canal system must be implemented. This system serves both as a water control channel and as a transport pathway for many activities of plantation and harvesting. As a responsibility of environmental sustainability, the concession adopted a policy of Mosaic Plantation Concept (MPC) to integrate sustainable fiber production and environmental conservation. Under the MPC, the concession allocated about 20% of the total areas as conservation areas.

To reach the conservation area of PT. Riaupulp is not too difficult, because the public transportation approaches close to this estate area. However, entrance to the estate area is controlled strictly by a security post guard. The trips from the public road to the conservation area have only been operated by the company passing the roads of the company. Therefore entrance into the estate areas is only possible using special transportation operated by the company or by

hiring a private car with permission from the company. The cost for this journey is variable, depending on the kind of vehicle. Traveling time and distance from the capital city of the province is shown in Table 2.

2.4.4. PT. Bina Daya Bintara (PT. BDB)

PT. BDB is one of the partner of big multinational holding company APRIL that producing fiber, pulp and paper. The main pulpwood plantation species on this area is *Acacia crassicarpa* which is known adapted for peat land habitat. The PT. BDB concession area is located in Libo Block - Duri, Riau. The area consists completely of peat land habitat with more or less flat topography and an elevation of about 15 m above sea level. Just as the majority of timber estates operating in peat land habitat, this company adopted canalization and clear-cutting practices before planting. For the purpose of biodiversity and ecosystem conservation of peat land ecosystem, the concession allocated conservation areas of about 10% including riparian, HCVF and wind break areas.

Although the distance from capital city province is not too far, journey to reach the concession area of PT. BDB at Libo Block is not easy. The public transportation approaching close to this estate area directly is relative rare. The trips from the public road to conservation area is only been operated by estate company. Therefore to enter the estate areas only possible using special transportation operated by company or hire private car with permission from the company. The cost for this journey is variable, depending on the kind of the vehicle hired. The normal rate and distant from capital city province was shown in Table 2.

Table 2. The distance and time for traveling from Pekanbaru (capital city of Riau province) to the location of field survey areas

No.	Location	Distance (km) From Pekanbaru	Time (hour)
1.	PT. DRT /Riau	350	5
2.	PT. PDIW/Jambi	90	2
3.	Libo Blok/Riau	200	3 30'
4.	Pangkalan Kerinci / Riau	65	1 30'

III. REFERENCES REVIEW ON RAMIN

3.1. Biology and Distribution of Ramin in Sumatra

As mentioned above, ramin is a trade name of tropical timber from the genus of *Gonystylus*, belonging to the family Thymeleaceae. The number of species within the genus of *Gonystylus* is still in debate. Early comprehension taxonomical work by Shaw (1954) listed 19 species, then Argent *et al* (undated) recorded at least 28 species. The recent studies estimate that the genus of *Gonystylus* comprises of 30 species or more, as exploration of the species has yet to be concluded (Soerianegara *et al.* 1994). Twenty three species of *Gonystylus* are currently listed under CITES. At least 10 species of *Gonystylus* are known as tree producing timber with the local name of ramin. Based on herbarium specimens, 9 species of *Gonystylus* are distributed in Sumatra and three of them have the local name of ramin (Table 3).

Table 3. Species of *Gonystylus* recorded from Sumatra and their habitat distribution (Partomihardjo 2005)

Species	Distribution	Ecology	Remaks
Gonystylus acuminatus Airy Shaw	Malaya Peninsula, Borneo & Sumatra	Primary rain forest at 150 m asl	Small tree 25 m by 50 cm
Gonystylus bancanus (Miq.) Kurz.	Malaya Peninsula, Borneo,SE.Sumatra, Bangka	Peat swamp forest, sometimes pure stand	Morphology & ecology marked
Gonystylus borneensis (Tiegh.) Gilg.	Central Kalimantan Tapanuli	Lowland rain forest	Small tree, up to 60cm diam.
Gonystylus brunescens Airy Shaw	Malaya Peninsula, Borneo, SE.Sumatra	Non-inundated rain forest up to 345 m	Small tree 10 – 20 m
Gonystylus confusus Airy shaw	Malaya Penuinsula, N. Sumatra (Aceh)	Non-inundated rain forest	Small tree 30m by 50 cm
Gonystylus forbesii Gilg.	Sumatra(Mentawai) & South Borneo	Non-inundated rain forest 0 – 1200 m	Medium 40 m by 85 cm
Gonystylus macrophyllus (Miq.) Airy Shaw	Nicobar–Malesiana ex.E.Java&LS.Island	Lowland primary forest, medium altd.	Medium tree 45 by 100 cm
Gonystylus maingayi Hook.f.	Malaya Peninsula, Borneo, Sumatra (Palembang & Sekundur),	Primary rain forest up to 150 m (peat swamp)	Small tree up to 27 m?
Gonystylus velutinus Airy Shaw	Sumatra (Bangka & Belitung), Borneo	Non-inundated rain forest low altitude	Medium 35 m by 70 cm

Among the species of ramin, *Gonystylus bancanus* is known as the most valuable timber tree that grows on peat swamp forests only. Data and information concerned with other species of *Gonystylus* are not well recorded for natural populations and their trade status is unknown. Therefore, the following discussion focuses on *Gonysylus bancanus* (Miq.) Kurz. In Sumatra, this species mainly found in the provinces of Riau, Jambi and South Sumatra where peatland habitat is widely distributed (Bismark *et al.*, 2005).

Ramin (*Gonystylus bancanus*) is known as a slow growing tree species and tree size ranges from small to large depending on the habitat. Hermansyah *et al* (2005) reported that ramin has to be the second slowest growth rate (only 0.4 cm per year in average) after *Cratoxylon* among the 25 species of peat swamp trees in Riau, Sumatra. The diameter at breast height varies from 30 to 120 cm with height sometimes up to 45 m. The natural distribution of ramin is significantly associated with the depth and distribution of peat and peat swamp is the only known habitat of the species. Ramin grows well in places with peat depth of 120 – 600 cm and there is a trend that deeper corresponds to more abundant ramin (Istomo, 1998). In natural habitats, ramin growth is associated with *Alseodaphe umbelliflora, Calophyllum* spp, *Cratoxylum* spp, *Cryptocarya crassinervia, Durio carinatus, Palaquium leiocarpum, P. rostratum, Shorea teysmaniana, Sh. uliginosa, Stemonurus secundiflorus* and *Tetramerista glabra*. Praptiwi (1987) reported that additional associated species are *Dyera lowii, Syzgium* sp., *Tristaniopsis* sp., *Melanorrhoea* sp., *Dyospiros evena, Camnosperma* sp., and *Mussaendopsis* sp. Additionally, Sidiyasa (1993 in Soehartono & Mardiastuti 2003) mentioned that ramin also associated with *Baccaurea bracteata, Cratoxylum arborescens, C. glaucum, Combretocarpus rotundatus, Camnosperma coriaceum, Dyera costulata, Jackiopsis ornate, Xylopia ferruginea* and *Lithocarpus* sp. In Riau, ramin also associated with *Aglaia ignea, Alseodaphne coriacea, Alstonia pneumatophora, A. spatulata, Cratoxylum pulcherimum, Polyalthia glauca* and *Cyrfostachys renda*, a red palm tree associated with peat land habitat (Partomihardjo *et al*, 2005)

Records have never been made persistently on the flowering and fruiting season of ramin. In general, the flowering period of ramin takes place from February to March, but some trees also flower between May and October with a fruiting period extending from February to June until November (Airy Shaw, 1954). A semi-quantitative data record from herbarium specimens was applied to indicate the tendency of the flowering and fruiting periods of this species. It was indicated that the flowering/fruiting period of ramin on Sumatra is between August and October. However, some trees on this island also flowering in May. The fruits generally start ripening within 2-3 months after flowering.

Seed of ramin is categorized as recalcitrant seed type. Seeds loose their viability within a short period of two or three weeks. Even though seed production was relatively abundant, the percentage of germination was low. This was indicated by the low number of seedling under the mother tree.

Young plants require shade (90%) while larger individuals flourish in full sunlight. The regeneration of ramin therefore could be broadly categorized as shade tolerant as shown by the seedling establishment under closed canopy or under the mother trees. However, a recent study reported that the sapling stage of this species requires substantial sunlight of up to 35 - 60 % (Muin & Purwita, 2002). More detailed studies are needed to improve the understanding of biology of ramin for supporting the sustainable management system through rehabilitation and restoration.

3.2. Ramin Plantation

Based on Indonesian Selective Felling and Replanting System (TPTI), any activities of forest exploitation must be followed by replanting activities. The replanting activities must be conducted in accordance with the extent of openness and damage to the forested area. Since seedlings and saplings of ramin require shading, it was recommended that the planting of this species should be in strip of line planting system with a spacing of 5 m X 5 m in logged over area and 3 m X 1 m in secondary forest, respectively (Alrasyid & Soerianegara, 1978; Surianegara & Lemmens, 1994). After 2 – 3 years, shade can gradually be removed to stimulate growth.

In PT. DRT, planting of ramin was carried out as enrichment planting on logged over areas. Planting of ramin as a demo plot was arranged at a surrounding nursery area. The planting materials (shoot cuttings) were obtained from the demo plot and from nursery raised seedlings for the enrichment of the logged over area. It was reported that 20 months after planting, the survival rate was 97.50% and the height and diameter increment were 34.24 cm/year and 0.73 cm/ year respectively (Mujiat & Hermansyah, 2005). No re-measurement efforts have been carried out for enrichment planting as the area is very difficult to access due to the railways are removed following logging.

Enrichment planting activity of ramin in PT. PDIW – Jambi was carried out along the left and right sides of railway track. The planting materials were from wildings. After 3 years planting, it was reported that the survival rate was 31.25% and the height and diameter increment were 44.03 cm/year and 0.13 cm/year in average respectively (Murniati *el al.*, 2005). Planting of ramin as demo plot was carried out at surrounding nursery area from nursery raised seedlings. The planting of ramin also carried out in the secondary forest after fire, using nursery raised seedlings (Agung, 2007 personal communication).

However, this plantation effort was burned again in the early of 2007 fire.

Based on data and information from various stakeholders in the four locations of two provinces of the field survey, ramin has never been planted in large scale. No ramin plantation has been attempted in timber estate areas, except in small numbers as indigenous livelihood species. The ramin plantation efforts made by logging concessions, as either enrichment areas or rehabilitation of open areas, were small in scale and showed window only. There is no evidence of ramin plantations significantly in large scale.

3.3. Distribution of ramin seed sources in Sumatra

The data of ramin populations and seed sources were also compiled from some references. Prior to year 2000, there were some identified seed sources of ramin (Table 4). However, according to current data and direct information from related institutions, some of these seed sources have disappeared because of burning and illegal logging. Therefore, these seed sources locations are no longer recorded in the current "Database of National Forest Tree Seed Sources".

Table 4. The distribution of ramin seed sources in Sumatra

Province	District	Coordinate point		Area (ha)	Status	Management authority	Remarks
Sumatra Utara	Tapanuli Selatan	0.60 N	99.30 E	5.0	ISS	PT. Mujur Timber	Burnt in 1999
Riau	Indragiri Hilir	0.60 S	102.75 E	-	ISS	Dinas Kehutanan	Burnt in 1999
Jambi (associates with Jelutung	Batanghari	1.50 S	103.90 E	100	ISS	PT. PIW	Burnt in 1999
Sumatra Selatan	Ogan Komering Ilir	2.45 – 2.55 S	105.19-105.20 E	100	ISS	PT. Sribumi Traiding Coy	Burnt in 1999
	Sungai Sugihan, Ogan Komering Ilir	2.4 S	106.4 - 107.7 E	100	ISS	PT. Family Jaya	Burnt in 1999
	Sungai Sugihan, Ogan Komering Ilir	2.50 – 2.51 S	105.26-105.27 E	100	ISS	PT. Daya Penca	Burnt in 1999
Jambi (associates with other vegetation	TN Berbak	1.08.41– 1.40.18 S	1.08.41-1.40.18 E			Forestry Department	Burnt in 1994,1999

Sources:
- Peta Sebaran Sumber Benih di Indonesia, 1997. Direktorat Jenderal Reboisasi dan Rehabilitasi Lahan, Direktorat Reboisasi.
- Atlas Sumber Benih Sumatra, 1999, Badan Litbang Kehutanan.
- Database Sumber Benih Tanaman Hutan Nasional, 2006 Direktorat Jenderal Rehabilitasi Lahan dan Perhutanan.

Note:
- ISS = Identified Seed Source

3.4. Criteria for seed sources selection

Seed sources can generally be classified into four types according to the intensity of management and seed productivity: (a) seed orchards, (b) seed production areas, (c) seed stands and (d) seed trees (Mulawarman *et al.*, 2003). Seed orchards are stands established for the specific goal of seed production. They consist of groups of genetically superior individuals growing (planted or naturally) at regular spacing with a specific design. Seed production areas are stands of trees in either natural forests or plantations that have been improved for seed production. Seed stands are groups of trees, either in natural forests or plantations which been identified as having superior characters and are managed for seed production. Seed trees are individual trees from which seeds are collected. These seed sources are vital for any planting activities. In order to get good quality and continuity of seed production, it is important to identify potential seed sources. There are several considerations for identification of seed sources:

- Accessibility, must be easy to reach
- Relatively large area (minimum 200 ha)
- Natural or plantation forests in good condition
- Conservation status (private ownership or conservation area)
- Relatively high population (minimum 25 individuals within a population)
- High genetic diversity
- Minimum distance 100 m between individuals (for Ramin 25 m).

Several general criteria for fruit trees:

- Good growth and have balance performance (diameter, high, branches and crown)
- Straight stem form
- Long, clear, marketable bole
- Uniform crown without heavy branches or double-stem
- Free of pests and diseases.

IV. RESULT

4.1. PT. Diamond Raya Timber, Riau

Figure 4 shows the candidate area of seed source located in the area of PT. Diamond Raya Timber logging concession. There were two different locations we devoted as seed sources sites of ramin at PT. Diamond Raya Timber, permanent plots and conservation areas. The permanent sample plots (PSP) were located on the logged over area with a total area of 2 ha. Both areas were identified as the most accessible sites for seed source in this logging concession. The corridor area has never been logged because it is assigned as a conservation area. In contrast, PSP is a logged over area that must be monitored regularly to obtain a logging impacts data series. This requirement of the certified logging concession in the sustainable forest management system provides supporting data for sustainable management. Conservation areas consist of the corridor located between annual cutting blocks. The total area of this corridor is about 20 ha, while the permanent monitoring plot (PUP) covers only 2 ha. Various tree species typical of climax peat swamp forests are still present in both sample plots. The complete lists of tree species recorded in the sample plots are shown in Appendix 1.

4.1.1. Vegetation and ramin population

The populations of ramin trees in both sites are potential for seed sources. Enumeration of ramin in those areas revealed four different stages i.e. seedling, sapling, poles and mature trees. A total of 13 individuals of poles and trees of ramin were recorded within the 22 ha selected sampling plots ranging from 14 to 61 cm (Figure 3). It can be seen that 9 of 13 individuals of ramin can be categorized as mature trees with diameter at breath height > 30 cm. The population of ramin trees on average in this area was relatively low (< 1 per ha) although these sampling plots are located in deep peat land.

Less than 14 seedlings and saplings were found in this field survey. No ramin seedlings were recorded in the PSP sampling plots. Seedlings and saplings were recorded only from the corridor sampling plots area. The number of seedlings and saplings under mature trees varied from 1 to 5. This number is possibly associated with characteristics of the mother trees and ground damage. The number of seedlings and saplings in open areas was very few or none.

Table 5. Data record of ramin tree for seed source identification in conservation and Permanent Plots areas, PT. Diamond Raya Timber, Riau.

No.	DBH (cm)	Total high (m)	Bole high (cm)	Crown Diam	No. of branch	No. of seedling
1	60	21	18	9.0	8	
2	14	13	11	6.5	7	-
3	39	16	12	8.5	8	-
4	33	16	11	7.0	8	-
5	61	22	19	9.5	9	-
6	53	20	17	8.5	8	-
7	**24.0**	**14**	**8**	**6.0**	**7**	-
8	**22.3**	**21**	**17**	**7.5**	**8**	-
9	**37.2**	**22**	**18**	**6.5**	**7**	-
10	**33.9**	**21**	**15**	**6.0**	**6**	-
11	**35.4**	**18**	**12**	**6.0**	**6**	-
12	**27.0**	**18**	**12**	**6.5**	**7**	-
13	**57.2**	**27**	**21**	**8.5**	**8**	-

Note: Bold letter data record of ramin tree from permanent plot

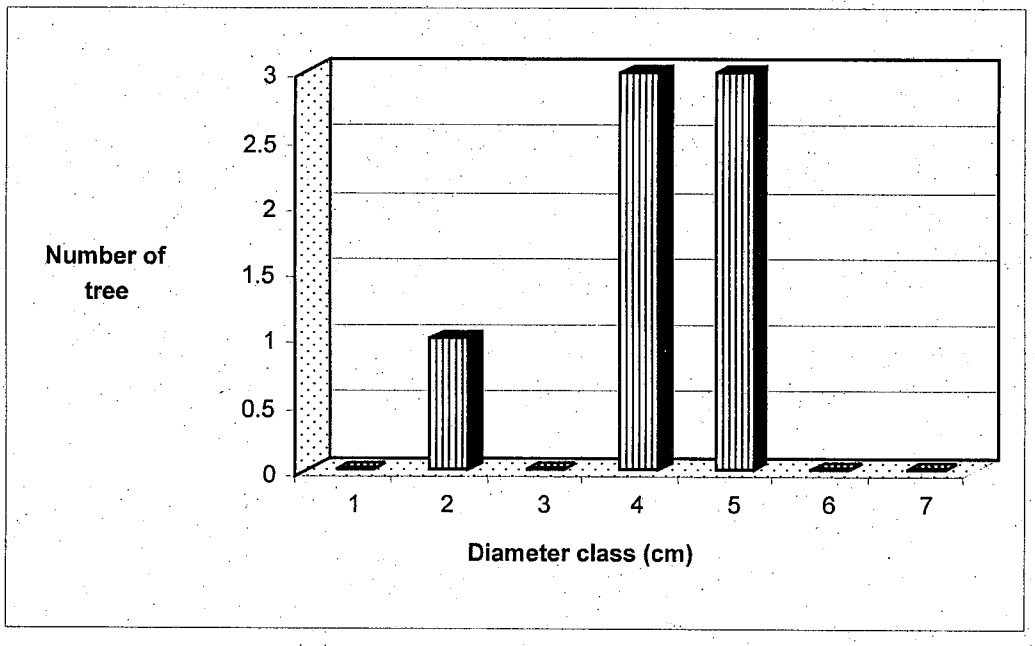

Figure 3. Histogram of the diameter class distribution of ramin trees (DBH ≥ 10cm) recorded in the permanent plots (2 ha) and corridor (20ha) at PT. DRT with total area of 22 ha. 1=10-19.9cm; 2=20-29.9cm; 3=30-39.9cm; 4=40-49.9cm; 5=50-59.9cm; 6=60-69.9cm and 7=70cm up.

4.1.2. Flowering and fruiting

Based on the field survey and information from the local stakeholders, there are several factors associated with flowering and production of fruits of ramin. During the survey, only about 2% of ramin trees within the study plot were fruiting. The number/volume of fruits this year was low, with approximately only 10% of the branches were fruiting. During mass fruiting, the number of fruiting trees of ramin can reach 20% with amount of fruits produced on 50 % of the branches of each tree. The mass fruiting season usually occurs within a 5 to 7 years period, after extreme drought season (Mujijat & Hermanyah, 2005). The fruit production per tree was about 1 kg to 5 kg, with an average of about 3 kg. Each kilo of ramin fruit consists of 200 to 300 seeds (average 250 seeds per kg). Ramin seeds have usually been gathered by collecting fallen fruits on the forest floor. The total amount of fruit production of ramin may be affected by many factors including wildlife eating fruits such as birds, squirrels, wild pigs, etc. In this survey, 4 of 13 observed trees were fruiting.

Photograph 1. Canopy opening of peat swamp forest at logged over area of PT. Diamond Raya Timber – Riau.

Photograph 2. Ramin mature tree at corridor area that potential for seed source.

Photograph 3. Natural seedling of ramin in open site of logged over area.

Photograph 4. Planted seedling of cutting material after 3 years.

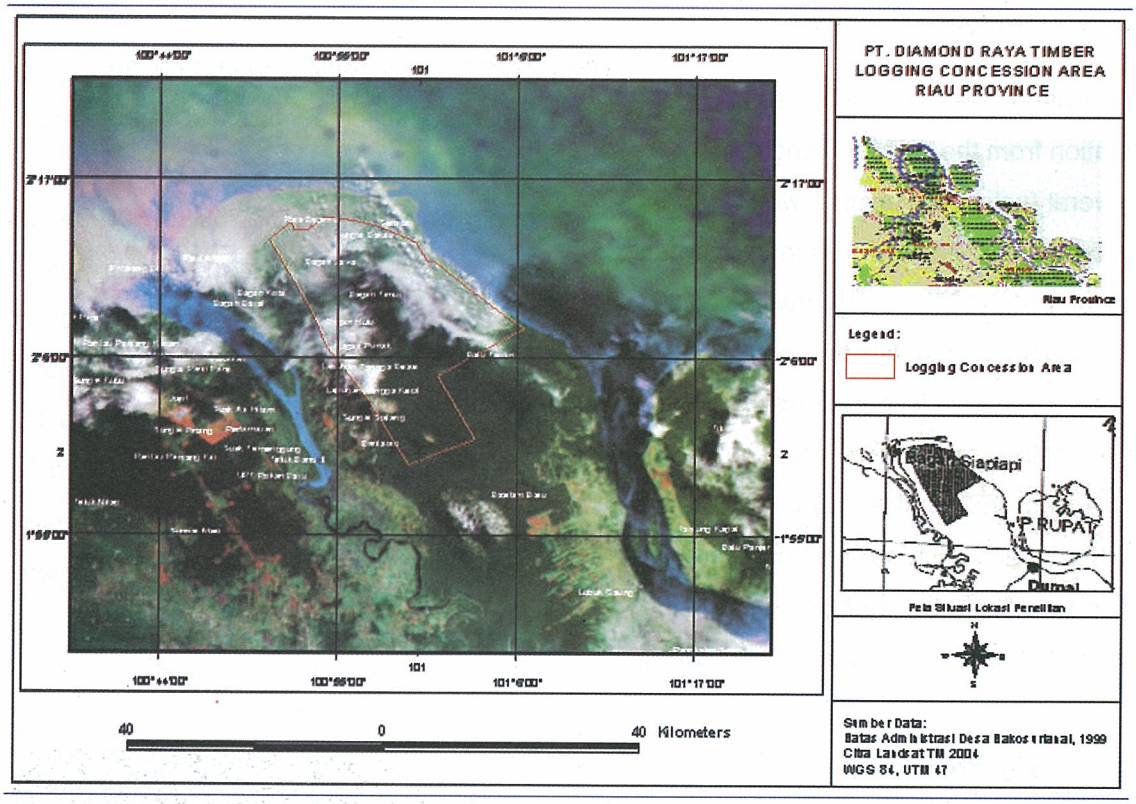

Figure 4. Map of PT. Diamond Raya Timber logging concession area

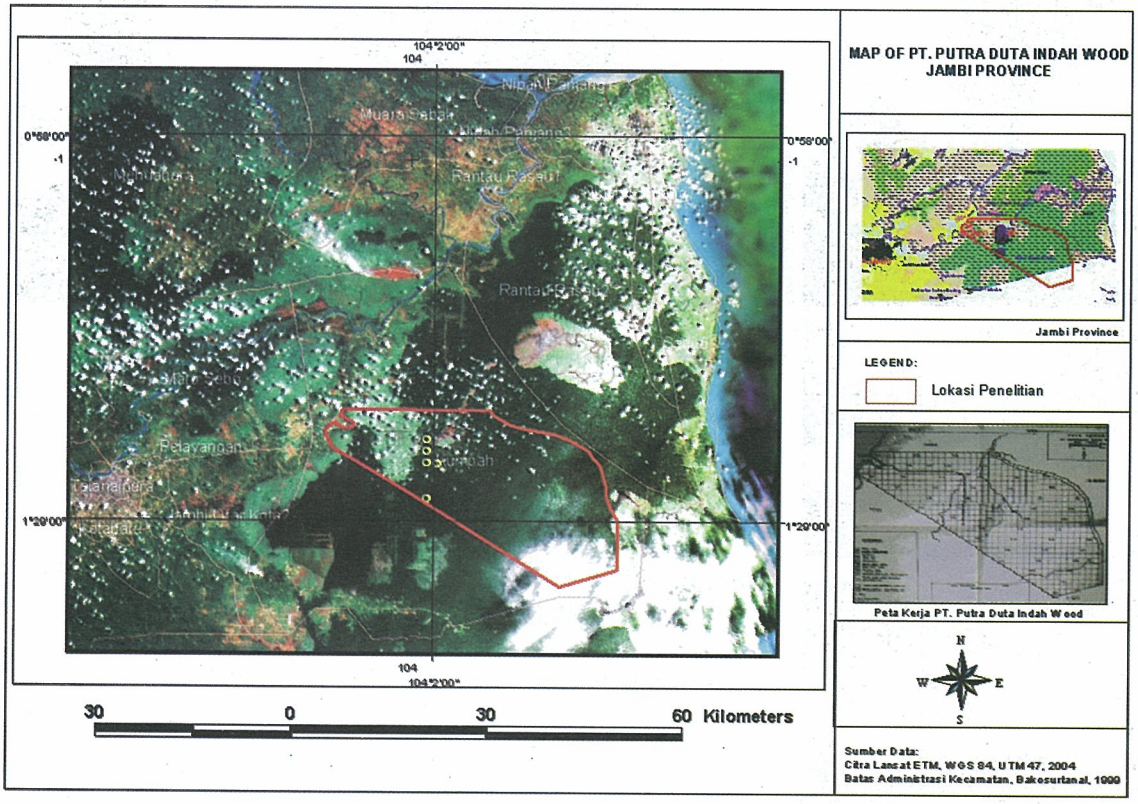

Figure 5. Map of PT. Putra Duta Indah Wood area, Jambi

4.2. PT. Putra Duta Indah Wood, Jambi

The landscape of PT. Putra Duta Indah Wood logging concession is shown in Figure 5. Field surveys on the populations of ramin trees to identify seed sources at PT. Putra Duta Indah Wood were conducted in logged over areas. The populations of ramin trees for seed sources are still potentially identified in this area, since the concession has not harvested ramin. The PT. PDIW has not passed the assessment on sustainable forest management from independent assessor Lembaga Ekolabel Indonesia (Indonesian Ecolabeling Institute)-LEI or Forest Stewardship Council (FSC) and therefore this concession has not been allowed to harvest ramin. Although ramin trees have not been harvested, the logging activities using tractors seem to cause disturbance in the forest floor, especially to the sapling and seedling stages. Consequently, abundance of saplings and seedlings of ramin in this area is very low.

4.2.1. Vegetation and ramin population

Enumeration of ramin revealed that only two different stages i.e. seedling, and mature trees have been recorded. The number of tree stages recorded on surveyed areas varies, ranging from 1 to 4 trees per ha with an average of 1 tree per ha. The distribution of diameter class of all ramin trees recorded on the surveyed area is illustrated in Figure 6. The seed production of each ramin tree can be estimated from the crown size and number of braches as showed in Table 6.

Seedlings have only been found under 3 mature trees with the number varying from 1 to 6 individuals. The variation is possibly associated with the size of the mother tree and ground damage. There are neither seedlings nor saplings recorded in the open area.

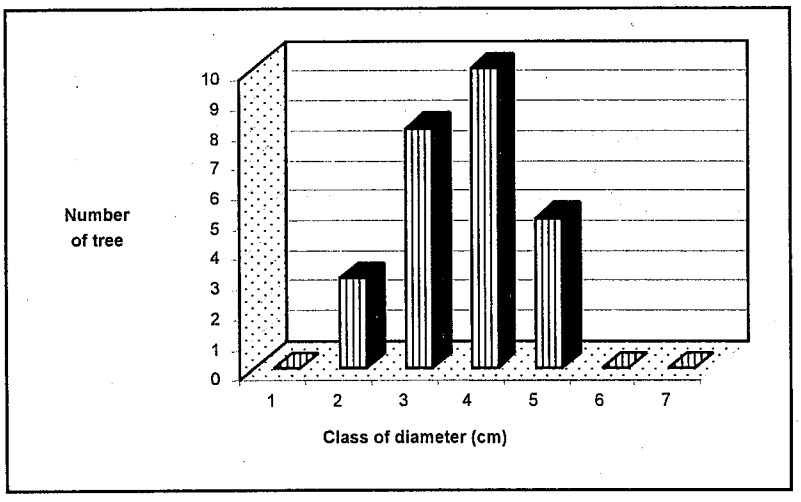

Figure 6. Histogram of diameter class distribution of ramin trees recorded from 24 ha survey areas at PT. PDIW logging concession 1=10-19.9cm; 2=20-29.9cm; 3=30-39.9cm; 4=40-49.9cm; 5=50-59.9cm; 6=60-69.9cm and 7=70cm up

Table 6. Data record of ramin trees potential for seed sources in PT. Putra Duta Indah Wood, Jambi

No.	CBH (cm)	Total High (m)	Bole High(m)	Crown Diameter (m)	No. of branch	No. of seedling	Note
1	132.5	20	15	8	8	2(1-1.5cm)	
2	108	20	15	7.5	6	-	
3	132.5	22	17	8	6	-	Fruiting
4	122	25	18	5.17	8	-	
5	72	19	15	5.72	5	-	
6	100	20	15	5.5	6	-	Fruiting
7	70	18	15	3.5	6	-	Fruiting
8	101	20	16	4.50	11	-	
9	74	15	12	3.0	15	-	
10	147	25	20	8.77	8	-	
11	113	22	15	6.59	10	-	fruiting
12	126	25	18	6.45	6	-	Fruiting
13	177	25	20	6.83	8	6(@30cm)	
14	167	22	17	5.1	10	-	
15	152	30	25	5.87	5	-	
16	129	22	15	7.5	7	-	
17	134	28	23	3.6	4	-	
18	175	25	20	8.11	4	-	
19	139	25	20	3.87	6	-	Fruiting
20	169	25	18	7.3	5	-	
21	133	27	20	3.5	7	-	Flowering/ fruiting
22	181	23	18	8.94	7	-	
23	110	22	19	4.63	6	-	
24	142	25	20	7.05	6	1 (30 cm)	
25	117	20	15	5.54	5	-	
26	111	22	17	6.6	10	-	

Note: CBH – Circle Breast High

4.2.2. Flowering and fruiting

During the survey in the location of PT. PDIW, about 30% (7 of 26) of ramin trees within the survey area were fruiting. According to nursery staff of this logging concession, the volumes of fruits production of ramin this year was low. Approximately 20% of the branches were fruiting. During mass fruiting, the number of fruiting trees of ramin can reach 40%, with fruits produced on 50% of the branches of each tree. The mass fruiting season is different to the previous site; here it occurs within a 2 to 5 year period. The sound fruit production per tree is about 1 kg to 5 kg, with average 3 kg. Each kilo of ramin fruit consists of about 200 seeds. The fruit production was also obtained only by collecting the fallen fruits on the ground. Therefore, the total amount of fruits available of ramin will be affected by wildlife eating fruit such as birds, squirrels, wild pigs etc.

4.3. PT. Bina Daya Bintara, Riau

Figure 8 shows the landscape of the candidate area of seed source located in the PT. Bina Daya Bintara Estate area, Riau.

4.3.1. Vegetation and population of ramin

As a timber estate company, the forest management system on PT. Bina Daya Bintara area is clearing natural vegetation and planting fast growing *Acacia*. The natural vegetation only remains along the river bank and wind break areas. Therefore, the populations of ramin trees as seed sources were identified in these areas only. The PT. BDB is not allowed to utilized ramin. Consequently, there are some ramin trees left as single standing individuals remaining here and there within the plantation. The remaining natural forest was still in relatively good condition. Various tree species typical to primary peat swamp forest are still found, such as *Aglaia ignea, Alstonia pneumtophora, Cratoxylum* sp, *Calophyllum* sp, *Dacryodes* sp, *Durio carinatus, Dyospyros spp, Garcinia spp, Ganua montleyana, Gonystylus bancanus, Knema spp, Litsea spp, Stemonurus sp, Shorea oliginosa, Sh. tejsmaniana, Sh. ovalis* and *Tetramerista glabra.* The list of tree species recorded in this surveyed area is shown in Appendix 1.

Direct field survey on the population of ramin in the wind break area showed that the population of ramin is very low. There were only 3 individuals recorded within 64 ha natural vegetation coverage. Only one individual of sapling stage of ramin has been found during exploration in this area. In order to obtain more data record, survey has also been conducted in clearing and *Acacia* plantation areas. The data record of individual ramin trees on this surveyed area is shown in Table 7 and Figure 7.

Table 7. Data record of ramin trees for seed source identification in Libo Blok of PT. Bina Daya Bintara, Riau

No.	CBH (cm)	Total high (m)	Bole high (cm)	Crown Diameter	No. of branch	No. of seedling	Notes
1	156.5	25	17	9.5	10		
2	88.5	22	17	6.5	5	1 (1.5 m)	
3	177	25	20	7	4		fruiting
4	**185.5**	**22**	**16**	**6**	**5**		
5	**126.3**	**20**	**15**	**8**	**6**		
6	**137.7**	**25**	**19**	**7**	**8**		
7	**182.0**	**24**	**18**	**6**	**7**		

Note: Bold letter is data record of ramin trees from clearing and *Acacia* plantation areas.
CBH = Circle Breast High

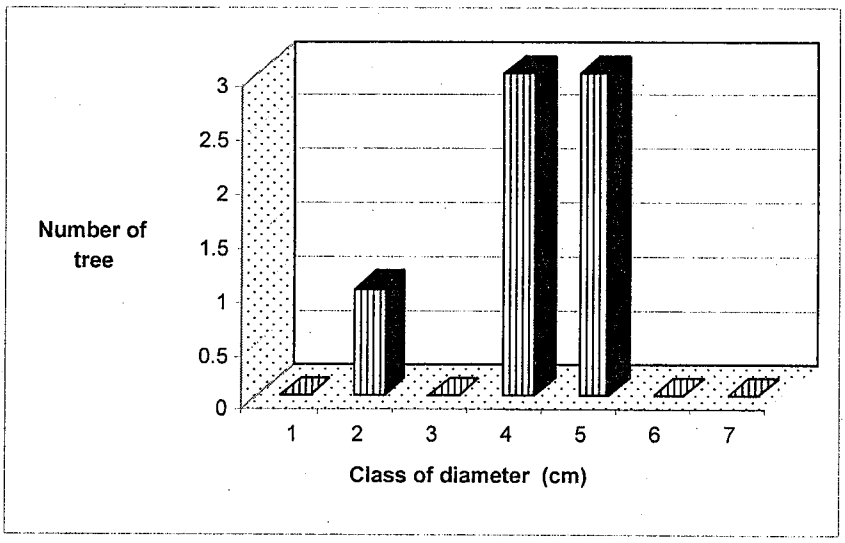

Figure 7. Histogram of diameter class distribution of ramin trees in 64 ha survey area at Libo Blok, PT. Bina Daya Bintara. 1=10-19.9cm; 2=20-29.9cm; 3=30-39.9cm; 4=40-49.9cm; 5=50-59.9cm; 6=60-69.9cm and 7=70cm up

4.3.2. Flowering and fruiting

There is no information about the flowering or fruiting record of the ramin trees in this area. However, this does not mean that ramin tree have never fruiting in this area. Because the activities of the concession involve clearing of land for planting *Acacia*, records on biological information of primary typical trees of peat swamp forest have never been made. Therefore, no data is available for any fruiting trees of the original vegetation. During the field survey, one of three ramin trees in the 64 ha survey area was fruiting. The number of fruits was not high; only about 10% of the branches were fruiting with total production of about 1 kg (approximately 200 seeds).

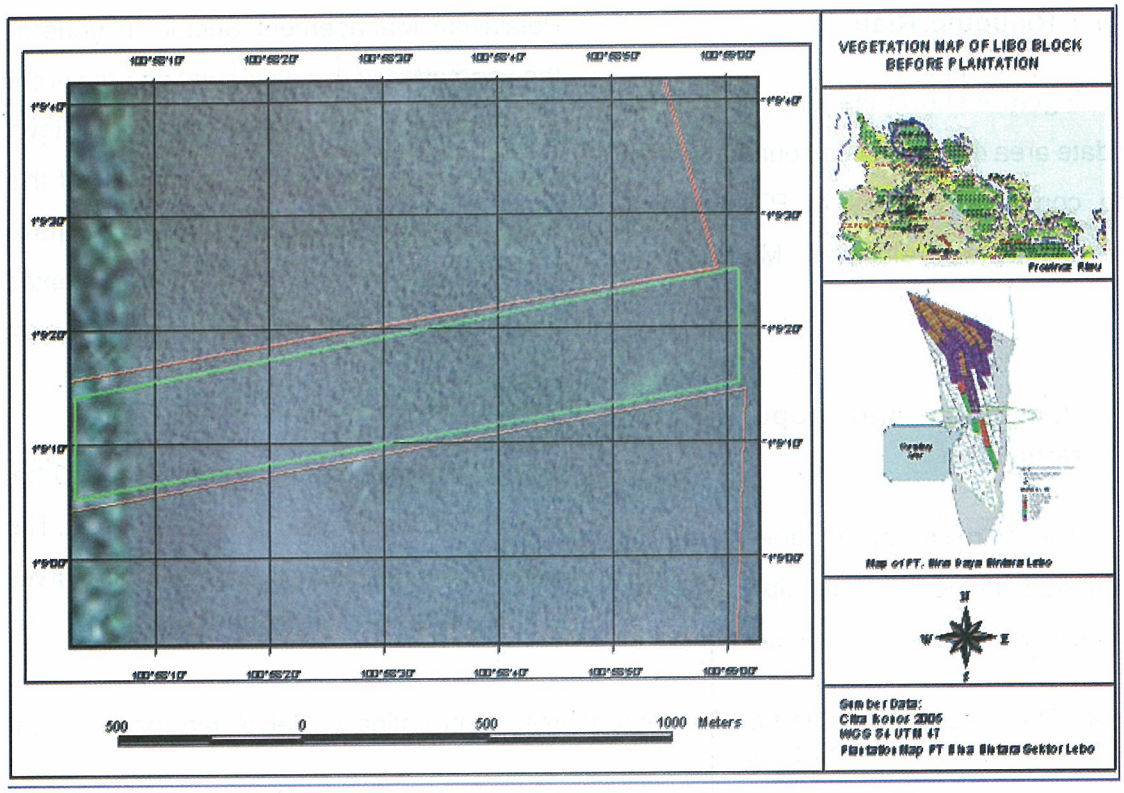

Figure 8. Map of PT. Bina Daya Bintara area Riau, showed forest cover before clearing in the year of 2007

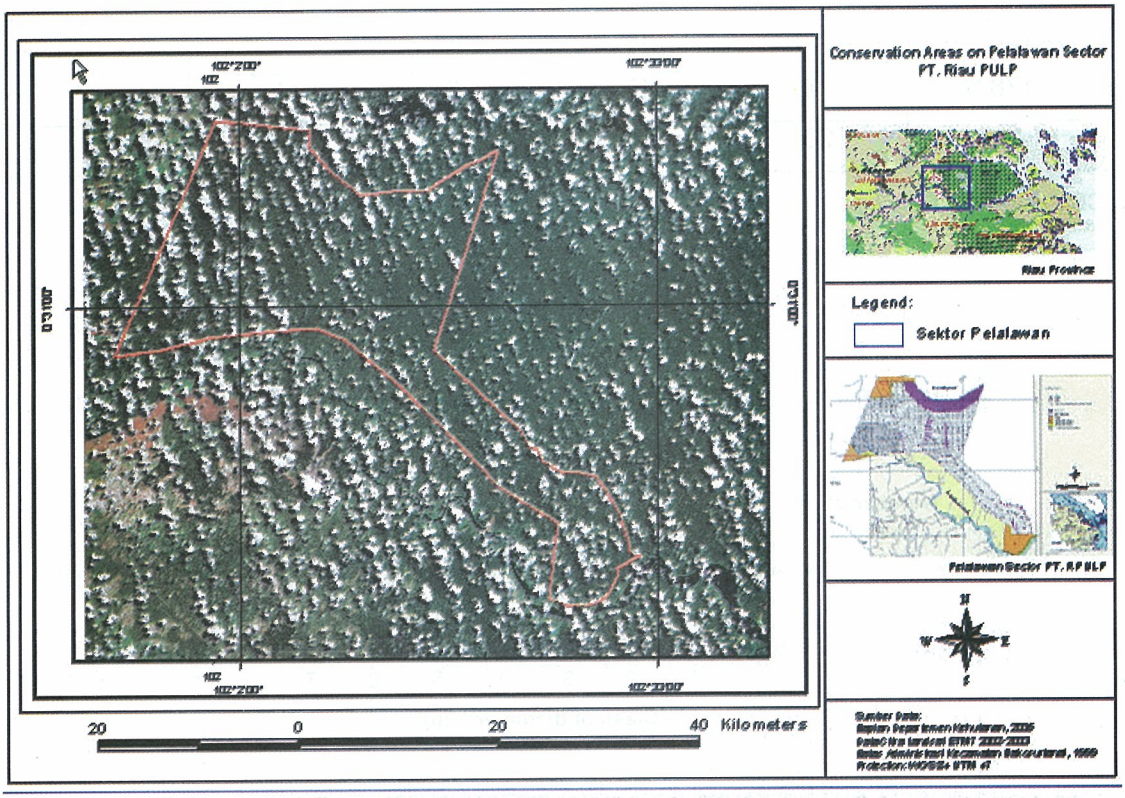

Figure 9. Map of Pelalawan Management Sector of PT. Riaupulp timber estate - Riau, with the distribution of conservation area as a part of mosaic management system.

4.4. PT. Riaupulp, Riau

Figure 9 shows the landscape of the candidate area of ramin seed sources located in the conservation area of PT. Riaupulp timber estate at Pelalawan Management Sector.

4.4.1. Vegetation and population of ramin tree

The field survey of ramin trees for seed sources in the PT. Riaupulp estate was conducted within the conservation area at Pelalawan Management Sector. In general, the vegetation of this conservation area is still relatively good. Due to the water level management system, the forest floor of this natural forest is relatively dry. It seems to have caused some trees to fall and to have created canopy openings in this conservation forest area.

Within the total area of about 50 ha, five individuals of ramin have been found. The data record of ramin trees from this survey area is shown in Table 8 and Figure 10.

Table 8. Data record of ramin tree for seed source identification in Pelalawan management sector of PT. Riaupulp, Riau

No.	CBH (cm)	Total high (m)	Bolehigh (cm)	Crown Diameter	No. of branch	No. of seedling
1	168.5	23	15	8.5	8	-
2	126.7	20	15	7.5	6	-
3	143.4	22	16	8.2	7	-
4	178.5	24	17	9	10	-
5	115	20	15	6	6	-

Note : CBH – Circle Breast High

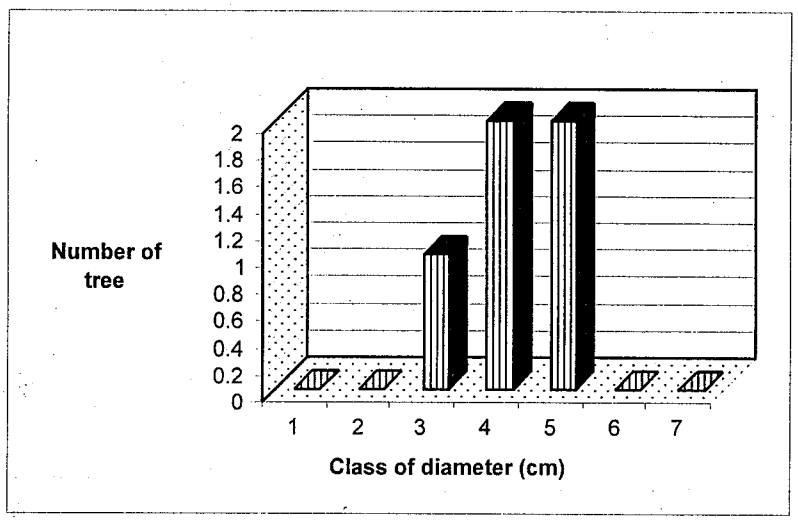

Figure 10. Histogram of diameter class distribution of ramin trees in 50 ha surveyed conservation area of Pelalawan Management Sector – PT. Riaupulp, Riau. 1=10-19.9cm; 2=20-29.9cm; 3=30-39.9cm; 4=40-49.9cm; 5=50-59.9cm; 6=60-69.9cm and 7=70cm up

4.4.2. Flowering and fruiting

Similar to the previous estate concession, there was no information about the flowering or fruiting record of the ramin trees in this area. Because the activities of the concession are concentrated on clearing for planting *Acacia*, records about biological information of primary typical trees of peat swamp have never been made. Therefore, there is no data or information on fruiting trees of the original vegetation of peat land. During the field survey, no ramin tree within the 50 ha survey area was fruiting.

5.2. Plantation efforts and planting materials

Ramin plantations have been attempted by various institutions, either government or non-government organizations including logging concessions, although only in small scale such as research plots and demonstration plots (Murniati *et al*, 2005). Planting material of ramin has usually been obtained from wildings, nursery raised seedlings and by cuttings shoots. In experiments with enrichment planting nursery, raised seedlings showed good survival (67%) and high increment (12.4 m / year) compared with cutting (44% and 5.5 cm/year) and wilding (40% and 12.6 cm/year) (Soerianegara & Lemens, 1994). Since mature ramin trees have no regular fruiting season, and because the populations of mature trees are scarce in most peat swamp areas, conservation of a population of mature trees as a seed source is crucial. The difficulties on propagation of ramin through tissue culture technology also suggest generating planting material of this species by raising nursery seedlings (Syaifulah *et al.* 2003) Thus, seed source identification of ramin from natural populations is vital.

In the concession area of HPH PT. DRT, the average number of existing mature trees (diameter > 40 cm) was 16 trees per cutting block area or 16 trees per 100 ha. This was also revealed from the survey of seed source which only recorded 13 trees (diameter > 10 cm) within 22 ha. Although the population of ramin tree in this area is relatively low, it indicates that seed production of this logging concession should still be considered as a potential seed source. Natural regeneration in some locations (such as permanent sample plots) was relatively rich.

In the PT. PDIW concession area, the number of existing mature ramin trees (diameter > 40 cm) was relatively high, since this concession has not allowed to harvest ramin. It has been mentioned above that the logging concession has not applied appropriate sylvicultural practices. Consequently, the forest has more damage and canopy opening is relatively high. No ramin seedlings have been found surviving in the open areas, potentially due to the largely open canopy. This situation was also possibly caused by the tractor system applied for logging activities that caused great damage of the forest floor.

VI. CONCLUSION AND SUGGESTION

6.1. Conclusion

1. Evaluation and revitalization of remaining seed sources is needed to gain the optimum seed supplies.

2. Designation of ramin seed source is crucial due to the continuous population decline of the species, although several efforts have been applied to prevent extinction.

3. Conservation areas within logging concessions and timber estates are another alternative for seed sources, since these areas will generally be protected and will remain well managed.

4. Logging concessions which have not passed certification of sustainable management are also potential for seed sources. These concessionaries have not been allowed to harvest ramin in their logging activities.

5. Flowering and fruiting season of ramin is very irregular, thus coordination among related stakeholders in the field is needed to share information and data of ramin, particularly related to the flowering and fruiting season.

6.2. Suggestion

1. Construct collection of ramin variety over Sumatra in the guarantee area such as conservation area of the logging and timber estate areas.

2. Construct map of genetic variety over Sumatra which is very important for the next conservation strategy of the species target.

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APPENDICES

Appendix 1. List of trees species recorded from 4 different locations of ramin seed source identification project.

Species	Family	Venancular	IUCN-status	LBB	PLW	DRT	PDI
Acronychia porteri	Rutaceae	Pauh			2		
Adina minutiflora	Rubiaceae	Brumbung			2		
Aglaia ignea	Meliaceae	Pasak linggau			2		
Aglaia rubiginosa	Meliaceae		NT	1		3	4
Aglaonema nitidum	Araceae				2		
Alseodaphne sp.	Lauraceae	Medang	LC/NA	1	2	3	4
Alstonia pneumatophora	Apocynaceae	Pule rawa	LC/NA	1	2	3	4
Baccaurea bracteata	Euphorbiaceae	Rambe rawa			2		
Calophyllum sclerophyllum	Clusiaceae	Bintangur		1	2	3	4
Camnosperma coriaceum	Anacardiaceae	Terentang	LC/NA	1		3	4
Cratoxylon arborescens	Clsiaceae	Gerunggang	LC/NA	1	2	3	4
Cryptocarya crassinervia	Lauraceae	Medang			2		
Cryptocarya nervosa	Lauraceae	Medang	LC/NA	1		3	4
Cyrfostachys lakka/renda	Arecaceae	Pinang merah			2		
Dacryodes rugosa	Burceraceae	Kenari		1		3	4
Dialium indum	Mimosaceae	Keranji	LC/NA	1		3	4
Dillenia excelsa	Dilleniaceae	Simpur			2		
Diospyros maingayi	Ebenaceae	Kayu arang			2		
Diospyros toposia	Ebenaceae	Kayu arang			2		
Durio carinatus	Bombacaceae	Durian burung	LC/NA	1	2	3	4
Dyera costulata	Apocynaceae	Jelutung	LC/NA	1	2	3	4
Diospyros polysanthera	Ebenaceae	Kayu arang		1		3	4
Diospyros sp.	Ebenaceae	Kayu arang		1		3	4
Elaeocarpus stipularis	Elaeocarpaceae	Ganitri			2		
Ganua montleyana	Sapotaceae	Bengku	LC/NA	1	2	3	4
Garcinia celebica	Clusiaceae	Manggis hutan			2		
Garcinia rostrata	Clusiaceae	Manggis hutan			2		
Gluta wallichii	Anacardiaceae	Rengas	LC/NA	1		3	4
Gonystylus bancanus	**Thymeleaceae**	**Ramin**	**VU**	**1**	**2**	**3**	**4**
Horsfieldia grandis	Myristicaceae	Dara-dara	LC/NA	1		3	4
Horsfieldia subglobosa	Myristicaceae	Dara-dara			2		
Hydnocarpus sp.	Flacourtiaceae				2		
Jackia ornata	Rubiaceae	Medang gambut		1	2	3	4
Knema cynerea	Myristicaceae	Dara-dara		1	2	3	4
Knema sp.	Myristicaceae	Dara-dara		1		3	4
Koompassia malaccensis	Mimosaceae	Kempas	CD	1	2	3	4
Litsea accutifolia	Lauraceae	Medang		1		3	4
Litsea angulata	Lauraceae	Medang huru			2		
Litsea firma	Lauraceae	Medang kuning			2		
Lophopetalum pachypyllum	Celastraceae	Prupuk			2		
Macaranga pruinosa	Euphorbiaceae	Mahang putih		1	2		

Macaranga sp.	Euphorbiaceae	Mahang		1		3	4
Madhuca crassipes	Sapotaceae	Nyatoh			2		
Mezzettia parviflora	Annonaceae	Pisang-pisang		1	2	3	4
Myristica sp.	Myristicaceae	Mendarahan			2		
Palaquium leiocarpum	Sapotaceae	Nyatoh		1	2	3	4
Palaquium obovatum	Sapotaceae	Nyatoh		1	2	3	4
Palaquium sumatranum	Sapotaceae		LC/NA	1		3	4
Pandanus immersus	Pandanaceae	Pandan rawa		1	2	3	4
Parastemon urophyllus	Chrysobalanaceae	Milas			2		
Paratocarpus venenosus	Moraceae	Nangkaan	LC/NA	1		3	4
Santiria laevigata	Burceraceae	Kenarian	LC/NA	1	2	3	4
Shorea ovalis	Dipterocarpaceae	Meranti batu	LC/NA	1		3	4
Shorea parvifolia	Dipterocarpaceae	Meranti			2		
Shorea teysmanniana	Dipterocarpaceae	Meranti bunga			2		
Shorea uliginosa	Dipterocarpaceae	Meranti batu		1	2	3	4
Stenochlaena palustrls	Pteridaceae	Paku rawa			2		
Swintonia sp.	Anacardiaceae	Rengas	LC/NA	1		3	4
Syzygium spp	Myrtaceae	Jambu-jambu		1	2	3	4
Tetramerista glabra	Theaceae	Punak	LC/NA	1	2	3	4
Tristaniopsis sp.	Myrtaceae	Palawan			2		
Vatica pauciflora	Dipterocarpaceae	Resak rawa	LC/NA	1		3	4
Xylopia malayana	Annonaceae	Pisang-pisang		1		3	4

Appendix 2. Global Position System (GPS) reading of some locations for ramin seed source identification of Sumatra.

a. GPS readings at PT Putra Duta Indah (PDI) HPT

S : 1. 32. 6,54 E : 104. 03. 7.35	S : 1. 32. 7.90 E : 104. 03. 7.83	S : 1. 33. 2.72 E : 104. 03. 8.49
S : 1. 33. 2.91 E : 104. 03 8.79	S : 1. 33. 2.09 E : 104. 03. 8.60	S : 1. 34. 7.50 E : 104. 04. 0.82
S : 1. 34. 7.03 E : 104. 03. 9.94	S : 1. 34. 3.28 E : 104. 03. 9.90	S : 1. 33. 8.70 E : 104. 03. 9.48
S : 1. 33. 8.27 E : 104. 03. 9.62		

b. GPS Reading PT Bina Daya Bintara

Office areas S : 1. 13. 2.02 E : 100. 56. 3.83	Main canal S : 1. 08. 8.59 E : 100. 58. 6.07
Fire break (400 X 4000) m S : 1. 08. 8.47 E : 100. 58. 2.29	

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