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IMPROVING INVENTORY DESIGN TO ESTIMATE GROWING STOCK OF RAMIN (*Gonystylus bancanus*) IN INDONESIA

An Executive Summary

ITTO-CITES Project on Improving Inventory Design to Estimate of Ramin (*Gonystylus bancanus*) in Indonesia

Editors

Hilman Affandi
Soewarno Sutarahardja
Siti Nurjanah
Dian Tita Rosita

ITTO – CITES Project
in Cooperation with
Center for Forest and Nature Conservation
Research and Development
Ministry of Forestry

Bogor, 2010

Gonystylus bancanus
Documented by Mr. Samsuri and team

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An Executive Summary of ITTO CITES Project on Improving Inventory Design to Estimate Growing Stock of Ramin (*Gonystylus bancanus*) in Indonesia

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PREFACE

Forest inventory is an activity to collect data and information of stand and their environment. The activities are might be performed using several techniques depending on the forest types, forest inventory objective and availability of the resources. The outputs derived from forest inventory can be used for many purposes, for instance, to establish yield regulation plan, including land management, species conservation, and opening up forest plan (logging road, rails etc).

The project is expected to produce an acceptable inventory design (method) to estimate standing stock for ramin (*G. bancanus*) growing in PSF in Sumatra and Kalimantan. By reviewing all the existing methods for inventory (pre-harvest inventory), stakeholder consultation and exploration of technology (satellite imagery or remote sensing), the relatively low cost and more accurate method or design will be obtained. The project is also expected to produce relatively more accurate estimation of the current standing stock of ramin in most of the production forest areas in Sumatra and Kalimantan.

The inventory design (method) and its related technology are also expected to be useful for estimating the standing stock of the other species having relatively similar botanical characteristics with ramin. Forest concessionaire, whose working areas are in peat swamp forest, is expected to gain the benefit from this inventory design.

Based on the lesson learned from the previous studies, workshops, seminars and discussions among team members, one recommendation that could be implemented to inventory ramin is by using combination between the use of remote sensing technique and terrestrial approach. For estimating standing stock of ramin, the sampling technique that could be implemented is called as double sampling or two-phase sampling. At the first phase, a set of clusters as sample plots are observed in satellite imageries. Each clusters is consisted of 4 elements or plots (rectangular or circle plots). While at the second phase, a part of cluster that had been measured at the first phase should be re-observed in the field. With this approach, all clusters outlined using satellite imageries. Then, small parts of these clusters are ground checked in the field. During establishment of sampling design, due to the uniqueness of the ramin ecology, the sampling technique that would be implemented should consider the distribution of the ramin.

ACKNOWLEDGEMENT

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PART 1. INTRODUCTION

Efforts to improve management practices of *Gonystylus bancanus* in Indonesia have been taken through various activities. This includes efforts by the Ministry of Forestry to issue various policies on ramin, especially those related to logging activities. Since 2001, the logging moratorium on ramin has been imposed to provide space and time for ramin, especially in logged-over areas to recover. In the same year, ramin was also listed in CITES Appendix III, meaning that the harvest of ramin should received a prior harvest permit from a Management Authority of CITES, which is the Ministry of Forestry. Both the logging moratorium and listing of ramin in the CITES Appendix are aimed to assist the control of both domestic and international trade in ramin.

Obtaining accurate and reliable data is always a difficult problem in forest management. For specific forest ecosystem like the peat swamp forests (PSF), there are some limitations in obtaining the data not only on the availability to utilize current modern technology, but also the readiness of human resource in forestry to capture and utilize the technology for collecting field data. The unavailability of accurate data frequently causes misleading information and mismanagement of the PSF. For example, ITTO PPD87/03 Rev. 2 – *Identification of Gonystylus* spp. *(Ramin), Potency, Distribution, Conservation and Plantation Barrier* has made estimation on the standing stock of ramin in 2005 where the data may be under-estimated or over-estimated due to limited access to use more reliable technology. The estimation was mostly based on the results of pre-inventory cruising carried out by each company. Additional data were the result of interpolation from growth data from other sources. These data, however, bear some fundamental weaknesses primarily due to lack of appropriate inventory methods, extremely low sampling intensity, poor supervision and lack of cross-checks. The estimation by utilizing satellite images (technology) is predicted to be more cost-effective and able to obtain more accurate data for peat swamp forests with specific characteristics of poor accessibility.

The objective of the project is to develop an inventory design for ramin in peat swamp forest areas in Sumatra and Kalimantan for estimating the standing stock of ramin.

Peat swamp forest is a unique ecosystem characterized by vegetation, peat and excess of water for long period of time causing poor accessibility in most parts of the area. This poor accessibility has caused the pre-harvest inventory carried out by forest concession companies to be least optimal and this has led to, perhaps, under- or over-estimates of the standing stock. For CITES-listed species like ramin, this will influence harvest quota and the non-detrimental findings (NDF). Selection of stems to be cut and core trees in this area take more time than that in dry land forests, such as in the lowland forest areas. The project is, therefore, aimed to develop an inventory design by utilizing satellite technology to obtain relatively more accurate data and information on the standing stock of ramin.

Ramin (*G. bancanus*) is found growing in peat swamp forests in Sumatra and Kalimantan. The habitat is characterized by relatively poor accessibility compared to the dry land forests, such as lowland forests and even hill forest habitats. Before logging, under the current silvicultural system, the Selective Cutting with Enrichment Planting (TPTI), it is required to carry out a pre-harvest inventory (cruising) to estimate the standing stock, not only for ramin but also for the other species found growing in the forest. The critical problem in carrying out the inventory in PSF, not only for harvest but also to estimate the overall standing stock, is the accessibility, which is mostly poor as described earlier. This poor accessibility has caused inventory in PSF to be costly and laborious. Large amount of resources spent for field inventory has resulted, in practice, only small portion (very small sampling intensity) of the target area being sampled. Collection of data from very low sampling intensity will produce less accurate and/or unreliable data, either under-estimated or over-estimated standing stock. For ramin, this condition is more critical, since ramin is growing in scattered clumps and not homogenously distributed in the forest area.

The project is expected to produce an acceptable inventory design (method) to estimate standing stock for ramin (*G. bancanus*) growing in PSF in Sumatra and Kalimantan. By reviewing all the existing methods for inventory (pre-harvest inventory), stakeholder consultation and exploration of technology (satellite imagery or remote sensing), the relatively low cost and more accurate method or design will be obtained. The project is also expected to produce relatively more accurate estimation of the current standing stock of ramin in most of the production forest areas in Sumatra and Kalimantan.

The inventory design (method) and its related technology are also expected to be useful for estimating the standing stock of the other species having relatively similar botanical characteristics with ramin. Forest concessionaire, whose working areas are in peat swamp forest, is expected to gain the benefit from this inventory design.

PART 2. THE EXISTING METHODS FOR INVENTORY IN PEAT SWAMP FOREST

Existing methods of forest inventory, including pre-harvest inventory, were reviewed. Results of the review were discussed in a meeting involving all relevant stakeholders, including stakeholders dealing with CITES-listed timber species and wildlife species. The workshop was also directed to identify the most appropriate method to be further developed and used for ramin inventory using satellite technology.

2.1. Objective

The objective of the workshop is to find out the most rational and cost-effective forest inventory technique for estimating standing stock of peat swamp forest.

2.2. Backgrounds

Indonesia has the widest tropical peat forest in the world of approximately 21 million ha, or around 50%, out of 40 million ha of the world peat swamp forest. One of forest types in tropical peat forest is peat swamp forest. Many recent studies reported that most peat land forests in Indonesia are suffering from degradation due to forest conversion, illegal logging, forest fire, forest encroachment etc. If no action is taken then the existence of peat swamp forest is threatened. One particular species existed in peat swamp forest is ramin that registered in Appendix II CITES. This means that there are rules and limitation on ramin utilization for securing its sustainability and conservation. However, now almost no reliable information available that expresses the condition and standing stock of ramin within the peat forest stand.

Estimation of ramin standing stock throughout Indonesia must be conducted to estimate how large standing stock of ramin. Ramin commonly grows at particular habitat of mix-forest in peat swamp forest (PSF). Due to the vastness of the Indonesia forest region and their location that spread out in the area of very limited accessibility, the implementation of terrestrial inventory would be time consuming and costly. To overcome the above problems, the use of quick inventory technique using the hybrid method between terrestrial and remote sensing technique is required.

2.3. Results

2.3.1. Ecological Status of Ramin

Existence of ramin is closely related to the thickness of peat in peat swamp forest. Ramin that belongs to the genus of *Gonystylus* from the family of Thymelaeaceae frequently grows in peat swamp natural forest. Ramin commonly found at the podzolic soil, peat land, alluvial soil and clay that formed from materials of sediment mains.

Besides as a habitat of various vegetation species, peat ecosystem has an important role as a hydro-horologic regulator, suspend intrusion of seawater during the dry season and prevent flood when the rainy season. Peat forest also have significant role as carbon storage as well as habitat of endangered flora and fauna such as tigers, crocodiles, arwana fishes and ramin.

Now, ramin shall only be found in peat swamp forest in Sumatra, archipelagos in strait of Karimata, and Kalimantan of Indonesia. Relatively larger dimensions (larger diameter) of ramin are mostly found in conservation area that is recognized as the last habitat of ramin.

Theoretically, peat swamp forest is divided into several zones, depends on the deepness of peat. Ramin trees are found starting from peat forest having deep of more than 2 meter, mostly in mixed forest. Density of ramin would be gradually increased as the deepness increase then decline again at a certain level.

Processes of peat formation are mostly affected by vegetation existence in the area. Speed of peat formation is approximately 1 mm per year, whereas peat degradation speed is about 100 mm per year. Acceleration of peat land degradation could be occurred in barren peat area. To avoid this condition, rehabilitation of degraded forest in peat forest should be performed.

2.3.2. Inventory of Ramin

The availability of accurate and precise information is deeply needed during forest planning, forest utilization and conservation of ramin. Such kind of data shall only be obtained by using an appropriate rational method. In general, forest inventory can be done using the following three approaches, that are (1) terrestrial forest inventory, where the all measurements of forest stand are performed by direct measurement in the field; (2) remote sensing forest inventory, where all measurement activity are executed indirectly from the imagery data (indirect forest inventory); and (3) combination of the terrestrial and remote sensing approach.

Each inventory method has its limitation and benefit all at once. The terrestrial method is usually suitable for relatively smaller area giving more precise and accurate estimation. However, when the areas to be inventoried becoming wider, the terrestrial approach need more cost and time consuming as well as probably provide non-sampling error. For the second approach, which solely based upon remote sensing approach, the method will provide faster and cost-effective process. However greater sampling error will be occurred, to alleviate the drawback of both approaches, some studies recommended to apply the combination approach between terrestrial and remote sensing technique. For inventorying peat swamp forest standing stock, the use of the last method is recommended. Some studies show that the high-resolution satellite imageries can provide some forest stand variables such as crown closure, crown density, crown diameter with quite good accuracy of more than 85%. For vast area, this technique could be more preferable since it could give cheaper cost for obtaining a similar sampling error.

2.3.3. Technique Development for Inventorying Peat Swamp Forest

Forest stand condition in Indonesia is very heterogeneous especially their stand structure and composition. This condition may provide difficulty to detect tree species. Since ramin (*Gonystylus bancanus*) is one of the *Gonystylus* families and grows naturally in mixed forest, its spatial distribution tends to be clustered. Furthermore, to inventory ramin, we should also consider the associated species in its habitat, particularly the species from the same family. Up to the present, the remote sensing technology has limitation to detect tree species consistently based upon the spectral reflectance and or radiant owing to low spectral resolution. In consequence, the remote sensing technique has not been applied for routine activity in tree species identification. However, the use of remote sensing technology is very promising, since the hyper-spectral sensor is being developed. Even though, the hyper-spectral technology could not completely replace terrestrial survey for tree species identification, it could be useful for identifying and delineating forest type and forest structure that derived from crown closure, crown diameter as well as crown shapes. The use of hyper-spectral CASI images for tree species detection had been reported by Jaya (2005). As far as the remote sensing sensor could differentiate the variation of chlorophyll content and leaf water content, the remote sensing will be useful for forest health monitoring and standing stock estimation.

Up to the present, satellite images are predominantly used for land cover classification and land cover change detection. Since the mid of 1990s, the Ministry of Forestry already used the medium resolution satellite (Landsat TM and SPOT) images to map out forest and land cover throughout Indonesia. At the national level,

the use of low-resolution satellite such as MODIS and SPOT VEGETATION is more recommended for data handling reasons. The higher resolution would provide higher definition of forest/vegetation unit and their standing stock.

In line with the remote sensing technology development, some studies related to multistage sampling are also performed. There is an opportunity to apply remote sensing in estimating standing stock of forest using multistage sampling. Some studies proven that, a multi stage sampling with remote sensing images used for stratification, may reduce sampling error from about 30 percent to only 13%. For better estimation, the use of aerial volume table or satellite volume table can be applied, particularly when applying a double sampling method (two-phase sampling). For estimating standing stock at management unit level, double sampling method would be more efficient (cost-effective and faster). Directorate General of Forestry Planning or the Ministry of Forestry has started to examine the use of high-resolution satellite for estimating standing stock. The use of double sampling method using remote sensing technique and terrestrial survey provided relative efficiency more than 200%. This means that, for providing the same sampling error, the cost required using double sampling technique is approximately a half of cost required for terrestrial survey.

Now, there are some standing stock estimation models developed by the Ministry of Forestry in collaboration with the third parties, particularly for Sumatra, Kalimantan, Sulawesi and Maluku Region. The models are developed for mangrove, swamp forest and dry land forests.

2.3.4. The Status of Ramin Inventory Technique

The standing stock inventory is generally conducted to get information of standing stock of all species having tree diameter (dbh) equal or more than 20 cm.

Terrestrial forest inventory

For terrestrial survey, measurements usually done within the sampling plots having size of 20 m x 50 m (0.1 Ha) in which the line plot is laid out to crosscut peat swamp forest zones. The position of the plot is intended to get more information regarding the variation of vegetation within the plot. Within the main plot, a sub-plots having size (a) 2 m x 2 m; (b) 5 m x 5 m; and (c) 10 m x 10 m are made to measure regeneration stage of trees. The study conducted by Wetlands International-Indonesia Program shows that vegetation type changes when the peat deepness increase.

Now, the Ministry of Forestry has permanent and temporary sample plots that systematically distributed throughout the country. Some of them would be fall into peat swamp forest. The plots were laid out using clustering approach. Each cluster consisted of 72 tracks temporary plots and one ha permanent plot having 16 record unit. For measuring standing stock, nine tracks are made within one cluster. One temporary plot consisted of 8 sub-plots and the measurement is made using point sampling of BAF 4, In permanent plot, 5 tracks are made having 100 m x 100 m size and 16 records.

Forest inventory using remote sensing technique

Even though the use of remote sensing technology for direct detection of ramin is not available yet, some studies regarding land cover changes, vegetation delineation in peat swamp forest had been examined. Some of them are:

(1) Change detection of land cover in peat forest by using satellite image JERS-1.
(2) Change detection of forest and land cover in ex Block A of mega-rice project Block A in Dadahup Area, Central Kalimantan.
(3) Classification of peat forest vegetation in Kalimantan by using satellite ALOS PALSAR. The result indicates that forest of peat bog (peat swamp forest) easily can be differentiated with other forest type (FFPRI-IPB, 2008).
(4) The use of SPOT 5 Supermode satellite images to estimate standing stock of tropical forest. The result indicates that standing stock can be estimated accurately.
(5) Application of remote sensing and GIS to survey and evaluate tropical peat.

Forest Inventory using hybrid between terrestrial and remote sensing approach

The Principle idea of the technique is to measure stand parameter at few parts of sample plots that had been interpreted visually on the imagery. This technique is also called as a sub sampling. The most popular method that used for quick count is by using multi-stage sampling. In this method, the analyst should make observation in the first stage called primary unit. Within the primary unit, some secondary units are developed and then secondary unit is divided into tertiary unit and so on. In other word, the following sub-plots are made within the plot in the previous stage. Commonly, each cluster in the field measurement is consisted of four elements, where distance between center points of plot is 200 m. Some studies in Sumatra and Kalimantan show that there is a good consistency between measurement of crown diameter in the field and SPOT 4 imageries, having 97.6% coefficient of determination.

Reference

Jaya, I.N.S. 2005. Analisis Citra Dijital Perspektif Penginderaan Jauh untuk Pengelolaan Sumber Daya Alam Teori dan Praktek Menggunakan ERDAS Imagine. Fakultas Kehutanan IPB. Bogor.

PART 3. SATELLITE IMAGES AND INTERPRETATION

Methods were selected by utilizing all possible technologies related to satellite technology and their interpretation. A cost-effective method was further discussed and selected for further exploration.

3.1. Objective

The objective of activity “Design an inventory method, procurement of satellite imageries and image interpretation” is to find out several methods for estimating standing stock of ramin in peat swamp forest.

3.2. Outputs

Outputs expected from this activity are:

(1) Map of stand density derived from satellite imageries.

(2) One or several methods that are possible to be implemented for estimating standing stock of ramin.

3.3. Backgrounds

Ramin (*Gonystylus* spp.) belongs to the family of Thymelaeaceae that naturally grows at the peat land. Ramin can easily grow at the site with podzolic soil, peat land, alluvial, and sandy clay formed from sediment mains.

In Indonesia, there are about 10 species of ramin that had been recognized, i.e. *G. affinis* A.Shaw, *G. brunnescens* A. Shaw, *G. confusus* A. Shaw, *G. forbesii* Gilg, *G. keithii* A. Shaw, *G. macrophyllus* A. Shaw, *G. maingayi* Hk.f, *G. velutinus* A. Shaw, *G. xylocarpus* A. Shaw and *G. bancanus* (Miq.) Kurz. Ramin is the commercial name of *G. xylocarpus* A. Shaw, *G. velutinus* A. Shaw and *Gonystylus bancanus* (Miq.) Kurz. Among of them, *Gonystylus bancanus* (Miq.) is the most preferred species for trading.

In Indonesia, ramin is mainly distributed in Sumatra, Java, Kalimantan, Nusa Tenggara Timur, Irian Jaya and Sulawesi. Now, most of the remaining ramin can be found only in peat swamp Forest of Sumatra Island, Karimata strait island and

Kalimantan. High density of ramin stand with larger tree size mainly found at the conservation area.

In Sumatra, particularly for Riau and Jambi, the remaining stand of ramin is found in protected forest of Giam-Siak Kecil, conservation area (Suaka Margasatwa) of Danau Bawah and Danau Pulau Besar, as well as Tasik Belat, Suaka Margasatwa Tasik Sekap, Suaka Margasatwa Bukit Batu and Berbak National Park in Jambi Province. Besides, several ramin habitats are also found at the production forest within concession area. However, the standing stock is commonly low. In Kalimantan, ramin is found in Tanjung Puting National Park, Sebangau and Mentaya catchment areas. Stand of ramin is also found in other regions such as in Cagar Alam Mandor, Cagar Alam Muara Kaman, Taman Buru Gunung Nyiut, Suaka Margasatwa Pleihari Martapura (South Kalimantan), Danau Sentarum National Park and Gunung Palung National Park. Ramin is fancy wood that widely utilized by national and international society. However, no much information is available regarding their standing stock. To obtain more regarding spatial distribution and standing stock of the ramin, it is required to develop an inventory technique. Currently, the terrestrial forest inventory is usually time consuming and costly due to the vastness and low accessibility of forest areas. As their nature, ramin is usually grown in the peat swamp forests which are mostly located in remote areas. Thus, development of inventory technique using remote sensing approach is required, particularly to estimate the standing stock of ramin.

3.4. Satellite Imageries

Forest inventory solely based on terrestrial or remotely sensed data provide many advantages and disadvantages all at once. To some extent, combining these two approaches is more preferable. Now, satellite imageries are frequently used to derive more data regarding forest condition indirectly by measuring several forest stand variables. Besides, satellite imageries are useful to provide stand stratification by stand density and stand size using crown density and crown diameter. The high-resolution satellite can be used to stratify forest cover into low density (10% - 40%), medium density (41% - 70%) and high density (>70%).

In this study, two types of images were examined, i.e., ALOS (Advanced Land Observing Satellite) AVNIR and High resolution SPOT 5 super mode. ALOS is Japanese satellite launched on 24 January 2006, that brought three sensors, i.e., PRISM (Panchromatic Remote-sensing Instrument for Stereo Mapping) that designed for obtaining DTM, AVNIR-2 (Advanced visible and Near Infrared Radiometer type-2) for land cover mapping and PALSAR (Phased-Array type L-band Synthetic Aperture Radar) for detecting land cover in all weather. SPOT 5 is

the newest generation of French satellite. Advanced Visible and Near-Infrared Radiometer type-2 (AVNIR-2) is an instrument of ALOS satellite having multi-spectral channels having 10 meters spatial resolution.

3.5. Image Interpretation Results

According to image interpretation results obtained from ALOS AVNIR-2 imageries, most parts of the Diamond Raya Timber (DRT) sites are covered by dense crown closure (≥70%). Only small part of the DRT study site having crown closure ranging from 10 to 40%. The study shows that ALOS AVNIR could be used for detecting stand density accurately.

3.6. Sampling Site

Ecologically, ramin is well grown the peat swamp forest. Therefore, the sampling design should be designed by considering the peat swamp ecosystem. For these reasons, the study sites selected are Diamond Raya Timber concession area in Riau and Sebangau National Park (SNP), in Kalimantan Tengah. These study sites may represent the sites of peat swap forest in Sumatra and Kalimantan.

3.7. Sampling Technique

The number of sample plots to be measured in the field are 45 clusters per each study site, either in DRT or SNP. These clusters are outlined uniformly so that represents all crown density classes and peat depth classes. The crown density map is overlaid with the peat swamp forest map provided by Wetland International Indonesia Program.

For SNP, the cluster size is 200 m x 200 m and every cluster is consisted of 4 circle-form elements. Each element of the circle have radius of 17.8 m. For DRT, the element of cluster is created with the square shape of 20 m x 20 m. During the sampling design stage, the clusters are systematically distributed where the first cluster is randomly selected. The clusters are also designed to represent all classes of crown density. The selection of the clusters in the field is also considering the accessibility to the plot location.

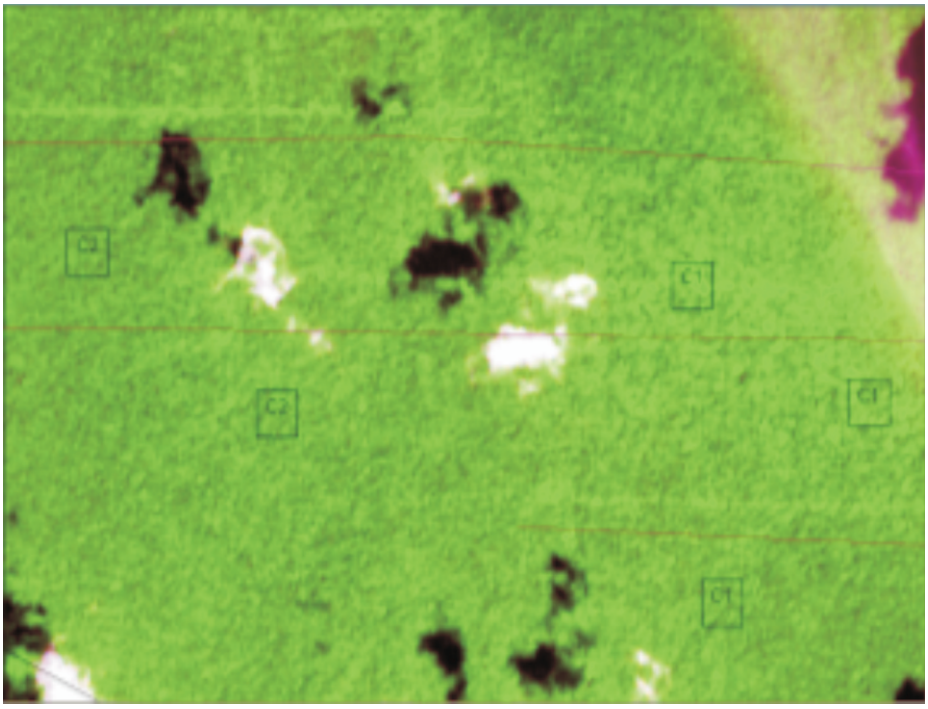

Figure 1. The layout of cluster by peat deepness.

3.8. Standing and Tree Measurement

Tree dimension measured during the field survey are tree diameter, total tree height and clear bole tree height. The tree diameters are measured at about 1.3 m from the base of tree, in which the tree diameter is measured using phi band. On the satellite imageries (ALOS AVNIR and SPOT 5 SUPERMODE) the stand variables measured are crown closure and crown diameter. The measured trees are all life tree within the plot (element of the cluster) having tree diameter at breast height more than or equal to 20 cm.

PART 4. STANDING STOCK OF RAMIN

4.1. Objective

The objective of this activity is to measure standing stock of ramin and non-ramin species, through measuring stand variables such as tree diameter, tree height, tree coordinates (x, y) as well as crown diameter.

4.2. Outputs

The outputs of this activity are (1) tabular and spatial data related to standing stock of ramin and non-ramin in peat swamp forest (2) stand profile (vertical cross section and horizontal cross section) of PSF stand and (3) photos of each stand condition.

4.3. Backgrounds

Forest inventory is an activity to collect data and information of stand and their environment. The activities are might be performed using several techniques depending on the forest types, forest inventory objective and availability of the resources. The outputs derived from forest inventory can be used for many purposes, for instance, to establish yield regulation plan, including land management, species conservation, opening up forest plan (logging road, rails etc).

Now, ramin is one of the conserved species belongs into Appendix II of CITES. As reported by International Union for Conservation of Nature and Natural Resources (IUCN 1994). As listed in red list summary, ramin was identified into critically endangered as well as or has been threatened to be extinct. However, only very few data and information are available regarding ramin. Therefore, more data and information are required to support the existing data and information.

Based on the lesson learned from the previous studies, workshops, seminars and discussions among team members, one recommendation that could be implemented to inventory ramin is by using combination between the use of remote sensing technique and terrestrial approach. For estimating standing stock of ramin, the sampling technique that could be implemented is called as double sampling or two-phase sampling. At the first phase, a set of clusters as sample plots are observed. While at the second phase, a part of cluster that had been measured at

the first phase should be re-observed in the field. With this approach, all clusters outlined using satellite imageries. Then, small parts of these clusters as sample plots are ground checked in the field. During establishment of sampling design, due to the uniqueness of the ramin ecology, the sampling technique that would be implemented should consider the distribution of the ramin.

4.4. Field Result Site

4.4.1. Diamond Raya Timber Concession

Concession area of PT. Diamond Raya Timber is located within Rokan Hilir and Kota Dumai Regencies, in eastern part of Sungai Rokan Catchments area. In this area, there are some rivers that heading West, South, North and East (to Malacca Strait). The study areas could be achieved from Pekanbaru, via Dumai. Distance from Pekanbaru to Senepis Camp is approximately 245 km by car and 48 km by ferry. At daytime, length of time required is approximately 5 hour. PT. DRT concession area is dominated by peat land having depth ranging from 2 up to 8 meters. Based on Landsat image interpretation in 2007, forest cover classes of PT. DRT consisted of primary forest, logged over forest, and non forested areas.

4.4.2. Sebangau National Park

Sebangau National Park (SNP) was determined as national park in 2004 through the Minister of Forestry decree. The extent of Sebangau National Park (SNP) is about 568.700 hectares, located in Katingan, Pulang Pisau and Kota Palangka Raya districts, Province Kalimantan Tengah. SNP is a representative of peat bog ecosystem in Kalimantan Tengah Province having relatively good condition. The peat depth within the SNP is ranging from 3 meters to 12 meters with relatively intact condition. The area also is becoming habitat of the largest population of orangutan (*Pongo pygmeus*) in Kalimantan. Approximately 14% of the orangutan population is found in this area.

Training sample is performed at the upper stream and downstream parts of the Sebangau river. The clusters at downstream of the river are reached by speedboat for approximately 1.5 hour, whereas for clusters located at the upper stream is reached for about 1 hour from Kereng Bangkirai.

4.5. Measurement Technique

During field surveys, number of clusters measured in DRT and SNP are 37 and 35 clusters respectively. These clusters are designed to represent all forest classes

having crown closure and peat depth variation. For DRT areas, each cluster is consisted of 4 element clusters form are rectangular plot, having size of 20 m x 20 m or 0.04 ha, while for SNP, the element clusters form are circle plot, having radius of 17.8 m.

With each cluster element, the measured stand dimensions are tree diameter at breast height (dbh), clear bole tree height, total tree height and tree species for all tree having diameter (dbh) equal to or larger than 20 cm. Dbh was measured using phi band while tree height was measured using clinometers. To map out all tree position in each plot (element of cluster), then the horizontal distance and azimuth of each tree was measured using distance meter and compass.

4.6. Stands Structure

Based on tree height and tree location derived from azimuth and horizontal distance, vertical and horizontal stand profiles are drawn. These stand profiles are drawn using Arc view-based IHMB-extension Version 4.0 developed by Jaya in 2008. As shown in Figure 1, vertical and horizontal cross section of stand is drawn. It is shown that stand density can be examined easily and significantly using this software. For the horizontal cross section, it is clear that ramin is commonly solitary growth.

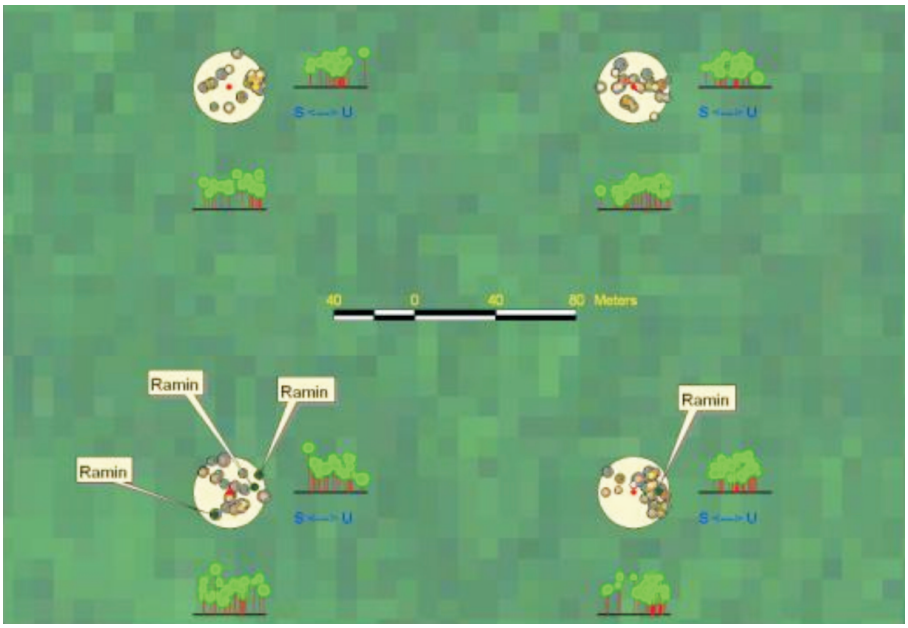

Figure 2. Stand profile at high density of forest cover at peat swamp forest having peat depth of approximately 3-6 m.

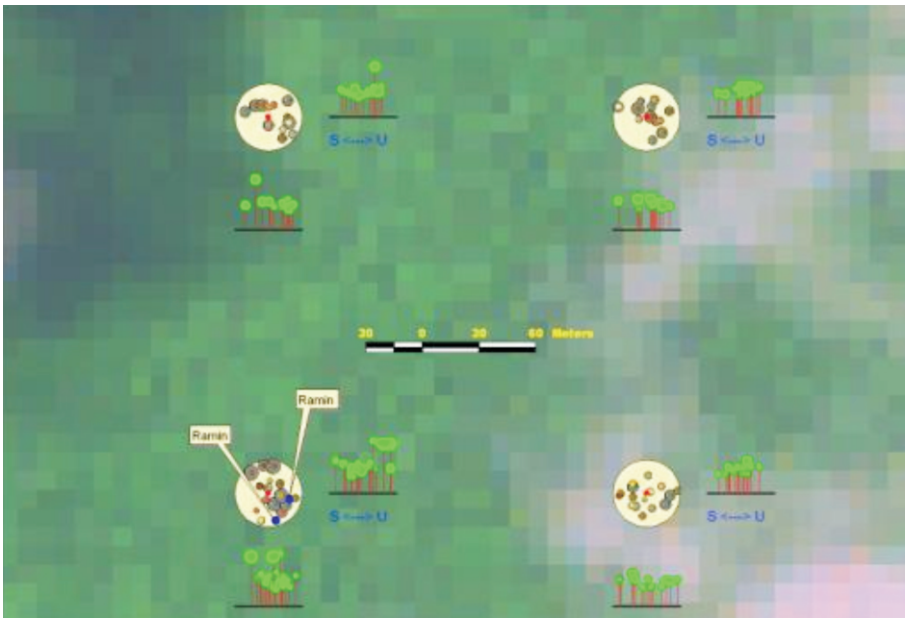

Figure 3. Stand profile with medium density of forest at peat swamp forest having peat depth of approximately 3-6 m.

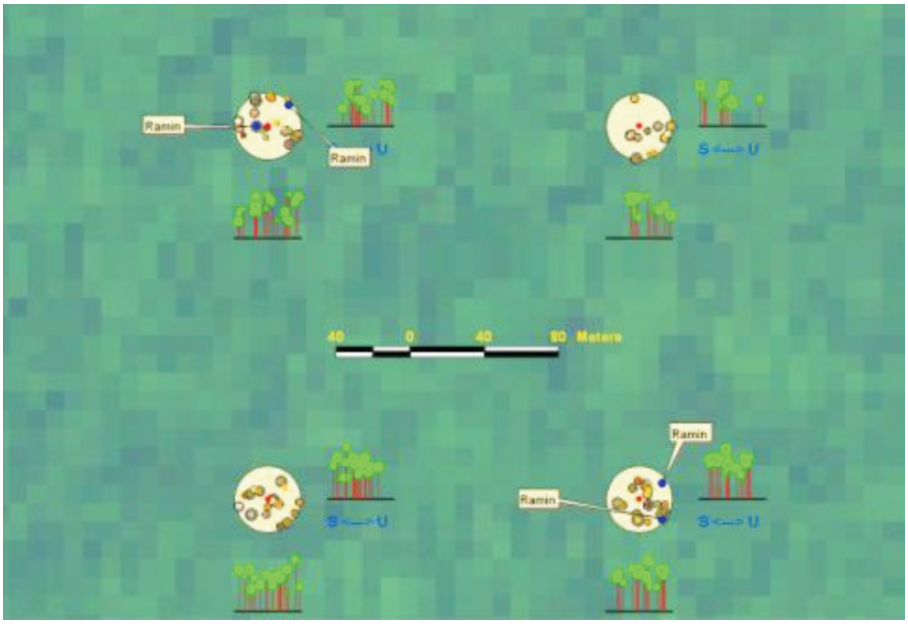

Figure 4. Stand profile with low density of forest at peat swamp forest having peat depth of approximately 3-6 m.

4.7. Standing Stock

- **Peat swamp forest in Kalimantan**

Field survey indicated that all sample plots were belonged into logged over forest. In this study sites, ex rail and skidding roads are existed. According to the land history, before the areas were assigned as national park, the functions of these areas are production forest and convertible areas. The vegetation types of stand floor are dominated by shrub, bush and Pandanus sp. Based on plots measured in SNP, the average of standing stock for all tree species with Ø ≥40 cm is 97.9 m^3 per ha or 151.4 trees per ha, including standing stock of ramin of approximately 2.5 m^3 per Ha or about 4 trees per Ha. Although number of ramin trees is very rare, a lot of ramin seedling and sapling were found.

- **Peat swamp forest in Sumatra**

The DRT areas consisted of old (primary) forest and secondary (logged over) forests. The standing stock for all tree species with Ø ≥40 cm is approximately 185.53 m^3 per ha or 119.4 trees per ha, including standing stock of ramin of approximately 9.24 m^3 per ha or 5 trees per ha.

4.8. Conclusions and Recommendations

Conclusions

(1) Standing stock of ramin could be estimated based upon combination between remote sensing technology and ground survey.

(2) The existence of ramin can be delineated base on ecological characteristic of ramin such as forest type and peat depth maps.

(3) Delineation of peat swamp forest map can be derived from medium-spatial resolution satellite.

(4) Measurement of crown diameter, crown closure, number of trees at upper storey could be detected on the higher resolution satellite.

(5) Crown diameter of each tree is measured in field at the base of the tree by measuring the vertical projection of the crown, i.e., at four direction, from tree base to north, to east, to south and to west. The crown diameter is derived from the average of the crown radius.

(6) The measured tree heights are clear bole tree height and total tree height in the field using clinometers. To compute the field crown closure and spatial distribution, the relative position of the tree from the center of plot is measured.

For this purpose, the tree distance and azimuth from the plot center is measured using distance meter and compass. During field survey, the starting plot is tied with ground control points measured by GPS. From the ground control points (GCP), the distance and azimuth of the clusters as sample plots is measured.

(7) Base on ground survey data, larger standing stock commonly has denser crown closure. This means that there is a close relationship between crown closure and standing stock. The percentage of ramin standing stock in SNP is relatively low, of only about 2.6% of the all species standing stock. For DRT site, the proportion of ramin standing stock is about 5% of the total species. During field survey, although few number of ramin trees found, relatively dense ramin seedlings were recognized.

(8) Most of ramin is found within peat land forest having peat depth between 3 to 6 meters. However, since the ramin trees are randomly distributed and most of the areas are logged over, there is no close relationship between standing stock of ramin and crown closure.

(9) Standing stock of all species and ramin could be estimated using crown closure variable having coefficient of determination ranging from 55 and 70%. Based on the aggregate deviation (SA), all models are statistically acceptable providing SA from -1 and 1.

(10) The exponential models could be used for estimating standing stock of all species and ramin for both Riau and Central Kalimantan sites. For Riau, the use of power model also provides good estimation.

(11) The ramin standing stock could be estimated using ratio value of 5% for Riau and 2.3% for Central Kalimantan of the total standing stock all species.

(12) The approximate standing stock of ramin in Sumatra is 9.24 m^3/ha and in Kalimantan is 2.5 m/ha for diameter of ≥40 cm.

Recommendations

(1) To have precise estimation, it is recommended to use high-resolution optical satellite imageries having spatial resolution less than 10 m. In the finer resolution images, the crown shape of ramin could be very relatively unique with small circle form.

(2) For national and regional level, the use of multistage sampling would be more preferable, while for a management unit level, the use of multiphase sampling is recommended.

(3) Use of the combination between teristrial and remote sensing method is recommended because of its efficiency.

(4) It is recommended to use Manual of Ramin Inventory in Peat Swamp Forest (Panduan Inventarisasi Sediaan ramin di Hutan Rawa Gambut)" and the use of the "Inventory Technique of Ramin in Peat Swamp Forest (Teknik Inventarisasi Sediaan Ramin di Hutan Rawa Gambut)" to undertake future inventory of ramin in PSF.

PART 5. TRAINING WORKSHOP FOR RAMIN INVENTORY

5.1. Objective

The two days training workshop was carried out on 31 May through 1 June 2010 at GIS and Remote Sensing Laboratory, Faculty of Forestry, IPB – Bogor. This training workshop is aimed (1) to improve capacity for relevant institution in conducting forest inventory, especially for peat swamp forest which characterized by poor accessibility and (2) to introduce the newly developed inventory method specific for ramin using a combination of satellite technology and ground survey.

5.2. The Participants and the Instructors

The original target participants are the field staffs, however, since the limited time availability and the participants were two lecturers from Faculty of Forestry, University of Tanjung Pura (West Kalimantan) and University of Winaya Mukti, a senior researcher of FORDA, a senior Trainer from Center for Forestry Training and Education of Kadipaten, West Java and a senior staff of Provincial Forest Service of North Sumatra. These participants are, therefore, treated as for training for the trainer (TOT).

The instructors for this training were professors and senior staff of Remote Sensing Laboratory, Faculty of Forestry, Bogor Agricultural University: Prof I Nengah Surati Jaya, Suwarno Sutarahardja, Samsuri, Tien Lasmini, Edwine Setia Purnama and M. Fatah Noor.

5.3. The Contents of the Training Workshop

The training workshop consisted of introductory part of PSF ecosystem and characteristics, sampling methods, satellite image interpretation, sampling design and how to estimate the standing stock from both satellite image interpretation and ground survey.

5.4. Result of the Training Workshop

Result of the training is six participants are trained to improve their capacitiy in conducting inventory technique, especially for peat swamp forest.

Figure 5. Training Workshop on Ramin Inventory in PSF

PART 6. GUIDELINE FOR ASSESSING NON-DETRIMENTAL FINDINGS FOR RAMIN IN INDONESIA

Ramin (*Gonystylus* Teysmann & Binnendijk) is a member of Thymelaeaceae, which is currently listed in CITES Appendix II. The inclusion of ramin in CITES Appendix is based on the fact that ramin has been heavily traded, especially in the international market and most of its species are rarely found in nature and some of them are under serious threat based on IUCN Redlist criteria. Ramin timber has been used for a wide variety of finish product such as furniture, picture frames, dowels, baby crib, toys, and some other indoor light construction.

CITES regulation for species listed in Appendix II requires that the harvest is regulated based a quota system, which is determined using certain conservative approach or criteria to ensure the sustainable harvest, not to cause a detrimental effect to the population and habitat.

Using developed criteria, a designated party of CITES must conduct an assessment that the harvest (trade) of the species will not cause detrimental effect to the survival of the species.

CITES has published two documents as guidelines to make NDF assessment, namely (1) Guidance for CITES Scientific Authorities: Checklist to Assist in Making Non-Detriment Findings for Appendix II Exports and (2) Principles for Non-Detriment Findings (NDF) for Trees. These two guidelines are to be used as general guidance for conducting an assessment and therefore need to be broken down into more specific for individual species. This guideline is therefore prepared specifically to ramin as genus *Gonystylus*, which consists of more than 30 species. In Indonesia, ten species of *Gonystylus* are currently found.

The objective of preparing this document is to provide technical guideline for assessing a on Non-Detrimental Finding (NDF) for ramin as a genus *Gonystylus*. This document could also be used as an exercise for other Indonesian timber species to assess its NDF.

This guideline consists of three parts:

(1) General guideline,
(2) Guideline for forest management unit, and
(3) National guideline to create a radar plot.

The general guideline gives list of data and information needed to conduct the NDF assessment and contains five basic elements:

(1) Biological characteristics,
(2) National distribution and population,
(3) Harvest management,
(4) Harvest control and monitoring, and
(5) Conservation and protection.

For the biological characteristics, information needed is general characteristics of ramin, regeneration ability, and habitat and edaphic factors. Information needed for the national distribution and protection includes distribution of ramin in various geographical levels (local, national, regional), population structure, and population dynamics. Harvest management includes harvest implementation, silvicultural practices, restoration, and harvest evaluation.

For harvest control and monitoring require information on monitoring and verification system, and optimization of timber products. As for conservation and protection, information needed basically is whether the species has been given enough protection and conservation actions in its natural habitat.

The list is based on the document entitled '*Principles for Non-Detriment Findings (NDF) for Trees*' formulated by Trees Working Group – CITES Plants Committee in Cancun (Mexico, 17-22 November 2008). The content of this document is adopted and later adjusted into the document accordance with the existing natural forest resources in Indonesia.

The guideline for forest management unit is a specific guideline for harvest site (i.e. concession holders). Guideline for the management unit contains more specific steps and general formula to ensure the sustainable harvest. The guideline basically contains necessary steps to ensure sustainable harvest. Some precautionary measures are in place, involving pre-harvest inventory, estimation of harvest volume, annual cutting and harvest quota. A sufficient percentage of non-harvested trees needs to be retained for safe cutting. The volume of timber allowed to be harvested is only 50% of the total existing standing volume (recommended to have minimum diameter of 40 cm), consisted of 30% for the seed tree, 10% for conservation, and additional 10% as safety factor.

For ramin, currently, the Government of Indonesia has set out a regulation that only a concession company which has been granted a certificate of sustainable harvest management is allowed to harvest ramin. In addition, the company required to have annual planning (among other planning documents) before the company is allowed to conduct the harvest. All field assessments are conducted by a team of experts led

by CITES Scientific Authority (CITES-SA). Based on the field assessment, the CITES-SA submits a proposed annual quota which will be decided later by CITES Management Authority.

The national guideline to create a radar plot mainly follows the 'Guidance for CITES Scientific Authorities: Checklist to Assist in Making Non-Detriment Findings for Appendix II Exports' (Rosser & Haywood, 2000). There are 6 components and 26 parameters in this guideline, each parameter having a score of 5 for the best to 1 for worst.

Similar to the general guideline, all 26 parameters have been modified to suit the existing condition for Indonesia. These parameters are:

(A) Biological characteristics
- (1) adaptation
- (2) regeneration ability
- (3) dispersal efficiency
- (4) habitat type

(B) Distribution and population
- (5) national distribution
- (6) national abundance
- (7) population trend
- (8) quality of information regarding distribution and population
- (9) main threat to this species

(C) Harvest management
- (10) illegal harvest and trade
- (11) history of harvest management
- (12) management plan
- (13) objective of the management plan
- (14) harvest quota

(D) Harvest control and monitoring
- (15) harvest in the licensed area
- (16) harvest at conservation area and protected forest
- (17) harvest in non-forest area
- (18) confidence level in the harvest management
- (19) method to monitor harvest
- (20) confidence level in the harvest monitoring

(E) Impact of harvest to environment and ecology
  (21) benefit of harvest (whether it is more beneficial if the species was left un-harvested)
  (22) impact of harvest to the environment
  (23) environment recovery

(F) Conservation and protection
  (24) percentage of un-harvested trees
  (25) effectiveness of protection
  (26) effectiveness of harvest regulation

By scoring all the parameters, a radar plot with 26 polygons is constructed. A larger polygon is an indication that the trade is not detrimental to the survival of the species. A small polygon means that the trade might not be sustainable and might be detrimental to the survival of the species. Parameters with small score (i.e. closer to the center) need to be given a special attention for immediate action.

One species of ramin, *Gonystylus bancanus*, has been used as a study case to test the application of the parameters and a radar plot has been constructed as in Figure 6. The score for each parameter is determined during the experts group meeting in Bogor.

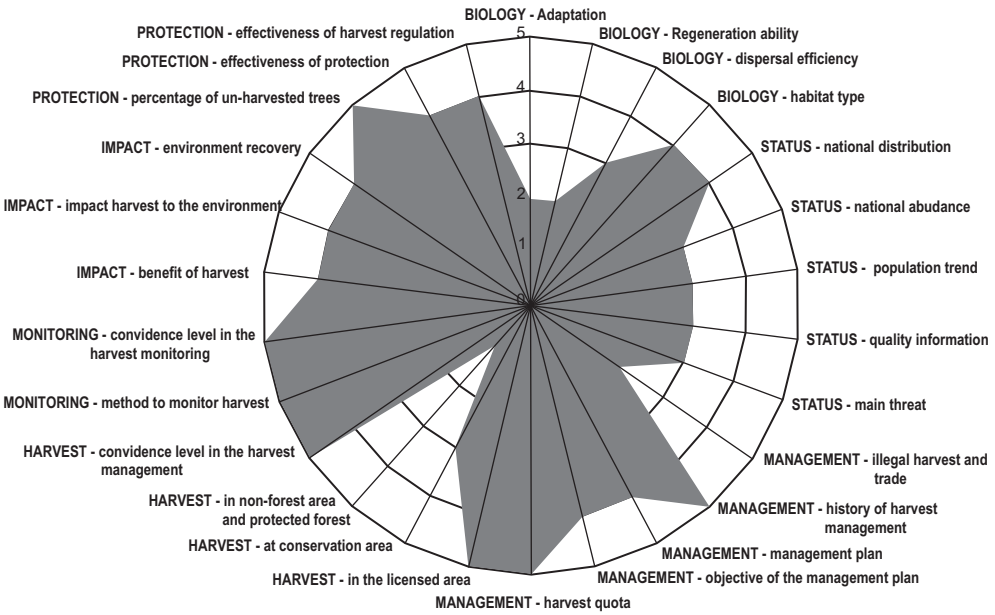

Figure 6. A radar plot for *Gonystylus bancanus* constructed during the Expert Group meeting in Bogor and finalized by Prof. Ani Mardiastuti, Faculty of Forestry, Bogor Agricultural University.

The usage

This radar plot could be used by managers as a quick reference to decide priority for sustainable management and conservation of a species.

For detail please refer to "Guideline for Non-Detrimental Finding Assessment on Ramin(*Gonystylus* spp.) (Panduan Penilaian Non-Detrimental Finding untuk Ramin (*Gonystylus* spp.))."

PART 7. OVERALL CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusions

1. Standing stock of ramin and other timber species growing in Peat Swamp Forest could be estimated more effiently using a combination between remote sensing technology and ground survey, through:
   a). A delineation of peat swamp forest map which could be derived from medium-spatial resolution satellite.
   b). Measurement of crown diameter, crown closure, number of trees at upper storey which could be detected using a higher resolution satellite.
   c). Crown diameter of each tree is measured in the field at the base of the tree by measuring the vertical projection of the crown, i.e., at four direction i.e., from tree base to north, to east, to south and to west. The crown diameter is derived from the average of the crown radius.
   d). The measured tree heights are clear bole tree height and total tree height in the field using clinometers. To compute the field crown closure and spatial distribution, the relative position of the tree from the center of plot is measured. For this purpose, the tree distance and azimuth from the plot center is measured using distance meter and compass. During field survey, the starting plot is tied with ground control points measured by GPS. From the ground control points (GCP), the distance and azimuth of the plots is measured.
   e). Base on ground survey data, larger standing stock commonly has denser crown closure. This means that there is a close relationship between crown closure and standing stock.
   f). The exponential models could be used for estimating standing stock of all species and ramin for both Riau and Central Kalimantan sites. For Riau, the use of power model also provides good estimation.

2. A training workshop to improve capacity and to introduce the inventory method for ramin employing satellite technology has been conducted by involving relevant institutions.

3. Manual of Ramin Inventory in Peat Swamp Forest (Panduan Inventarisasi Sediaan ramin di Hutan Rawa Gambut) has been developed.

4. Inventory Technique of ramin in Peat Swamp Forest (Teknik Inventarisasi Sediaan Ramin di Hutan Rawa Gambut) has been developed.

5. A guideline for NDF assessment for ramin has been developed to ensure the sustainable management and conservation of ramin as required by the listing into CITES Appendix II.

7.2. Recommendations

1. In order to provide resources base data in efficient manner for PSF, it is recommended that the inventory methods for other species growing in PSF be developed.

2. The newly developed Manual of Ramin Inventory in Peat Swamp Forest and Inventory Technique of Ramin in Peat Swamp Forest are recommended to be used for inventorying ramin in Peat Swamp Forest, as well as for further used and practiced for other species.

3. More training workshop to improve capacity and to introduce the technique need to be further carried out.

4. It is also recommended that the Guideline for Non-Detrimental Finding Assessment on Ramin(*Gonystylus* spp.) be used to determine the whether the harvest and trade in ramin will be detrimental to its survival in the wild and its future sustainability, as well as a guide for other species, not necessarily for species listed into the Appendix of CITES.

LIST OF PUBLICATIONS

1. Proceeding Technical Workshop “Review of the Existing Methods and Design for Ramin Inventory in Peat Swamp Forest” - **Pusblished for general distribution.**

2. Selection Methods, Provision of Satellite Images and Interpretation – **Technical Report, published for internal distribution.**

3. Ground Check of Selected Sites – **Technical Report, published for internal distribution.**

4. Re-evaluation of Method – **Technical Report, published for internal distribution.**

5. Relative Efficency of Double Sampling in Peat Swamp Forest – **Technical Report, published for internal distribution.**

6. Manual of Ramin Inventory in Peat Swamp Forest (Panduan Inventarisasi Sediaan ramin di Hutan Rawa Gambut) – **Published for general distribution.**

7. Inventory Technique of Ramin in Peat Swamp Forest (Teknik Inventarisasi Sediaan Ramin di Hutan Rawa Gambut) – **Published for general distribution.**

8. Guideline for Non-Detrimental Finding Assessment on Ramin (*Gonystylus* spp.) (Panduan Penilaian Non-Detrimental Finding untuk Ramin (*Gonystylus* spp.)) – **Published for general distribution.**


TECHNICAL WORKSHOP


STAKEHOLDER CONSULTATION
ON THE ESTIMATED STANDING STOCK
OF RAMIN USING SATELLITE TECHNOLOGY
Bogor, 29 Desember 2009


WORKSHOP NDF ASSESSMENT ON RAMIN
AND EVALUATION OF PERMANENT SAMPLE
PLOTS MANAGEMENT IN PEAT SWAMP FOREST
(RAMIN)
Bogor, 1 Juni 2010


Pelatihan Inventarisasi Sediaan Ramin
di Hutan Rawa Gambut
Design Inventory to Estimate Standing Stock Ramin (Gonystylus bancanus) in Indonesia
Laboratorium Remote Sensing & GIS
Fakultas Kehutanan
Institut Pertanian Bogor

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