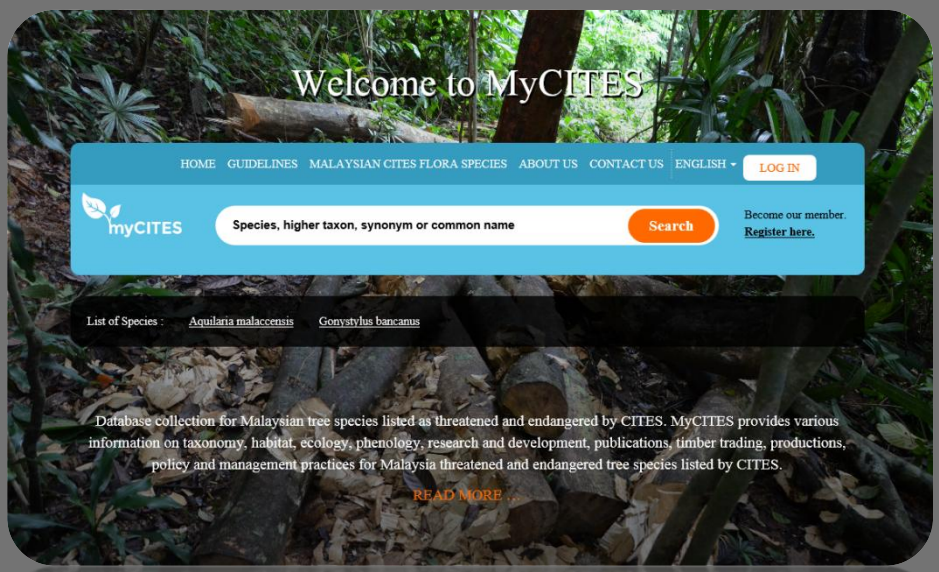
2015

Technical Report

ITTO-CITES Project

ITTO Work Program for 2013 on Support to ITTO-CITES Implementation for Tree Species and Trade/Market Transparency (TMT)

Development of An Information Database for The Conservation and Sustainable Use of *Gonystylus bancanus* (Ramin) and *Aquilaria malaccensis* (Karas) in Malaysia



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This work was made possible by a grant from ITTO under the collaborative program with CITES "Support to ITTO: CITES Implementation for Tree Species and Trade/Market Transparency (TMT)". Donors to this collaborative program include the EU (primary donor), the USA, Germany, the Netherlands and Norway".

IMPLEMENTING AGENCY

Forest Research Institute of Malaysia (FRIM)
Kepong 52109 Selangor
1/5/2015

Technical Report on
Development of An Information System Database for The Conservation and Sustainable Use of *Gonystylus bancanus* (Ramin) and *Aquilaria malaccensis* (Karas) in Malaysia

Prepared by:

F. Mohd Azahari, Y. Siti Yasmin and K. Abd Rahman

Implementing Agency:

Forest Research Institute Malaysia (FRIM)
52109 Kepong, Selangor,
Malaysia

Executing Agency:

Ministry of Natural Resources and Environment Malaysia (MNRE)
Wisma Sumber Asli, No 25, Persiaran Perdana, Presint 4, 62574, Putrajaya,
Malaysia

2015

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We would like to extend our thanks to the Ministry of Natural Resources and Environment (NRE) for their full support throughout the activity. Our special thanks also to the collaborating agency which includes the Forestry Department Peninsular Malaysia (FDPM) and Malaysian Timber Industry Board (MTIB). Without their full support, the collection of information related to Ramin and Karas would not have been possible.

Last but not least, our gratitude also goes to Dato' Dr Abd. Latif Mohmod, the Director General of FRIM for giving us his support and encouragement during the preparation of this technical report.

PROJECT IDENTIFICATION

Activity Title	:	Technical Report on Development of An Information System Database for The Conservation and Sustainable Use of *Gonystylus bancanus* (Ramin) and *Aquilaria malaccensis* (Karas) in Malaysia
Host Government	:	Malaysia
Name of the Executing Agency	:	Ministry of Natural Resources and Environment
Name of the Implementing Agencies	:	Forest Research Institute Malaysia Kepong, 52109 Selangor Darul Ehsan, Malaysia Tel : 603 6279 7000 Fax : 603 6273 1314 Email : feedback@frim.gov.my
Activity Contributor	:	The International Tropical Timber Organization (ITTO) and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
Starting Date of the Activity	:	June 2013
Ending Date of the Activity	:	May 2015
Duration	:	22 months extended for 2 months without additional funding

SUMMARY

With the inclusion of *Gonystylus bancanus* (Ramin) and *Aquilaria malaccensis* (Karas) in Appendix ll of the Convention of International Trade on Endangered Species of Wild Flora and Fauna (CITES) and the concern on the unsustainable exploitation of the species, an assessment to identify the current distribution, production and trading status of these threatened species is compulsory. This Activity is part of a follow-up action to the successful implementation of the previous ITTO-CITES Activities conducted by Malaysia from 2008 to 2010 under Phase 1 of the ITTO-CITES Program. In order to conserve and sustainably manage *G. bancanus* and *A. malaccensis*, a suitable database and information system is required. As such, this Activity is proposed to ensure the continuation of the previous Activities' outputs by developing a comprehensive web-based information database of Malaysia CITES-listed tree species, especially those related to the current status of their population, production, trade, and management practices in Malaysia. The main objective of the Activity is to develop a web-based information system of Ramin and Karas in Malaysia for management and conservation purposes (MyCITES). The expected outputs of the Activity are information on (i) Ramin and Karas distributions in Malaysia; (ii) research and development of Ramin and Karas in Malaysia; (iii) timber trade and production of Ramin and Karas in Malaysia; (iv) Malaysia's policy and management practices of Ramin and Karas; and (v) a comprehensive web-based information system of Ramin and Karas in Malaysia that contains all outputs from (i) to (iv). As a one-stop centre of Ramin and Karas, this web-based information system could be used by various stakeholders as a main source of information which will provide the latest information and details on these species for the purpose of learning, monitoring, conservation planning and other related activities in Malaysia.

CHAPTER 1: ACTIVITY BACKGROUND

1.1 Introduction

In the last two years, Malaysia had successfully conducted and completed eight Activities from 2008 to 2010 under Phase 1 of the ITTO-CITES Program entitled "Ensuring International Trade in CITES-listed Timber Species is Consistent with their Sustainable Management and Conservation". There were four implementing agencies in Malaysia entrusted to carry out these Activities, namely, the Forest Research Institute Malaysia (FRIM); the Forestry Department Peninsular Malaysia (FDPM); the Forest Department of Sarawak (FD Sarawak); the Sarawak Forestry Corporation (SFC); and the Malaysian Timber Industry Board (MTIB).

All the Activities covered various aspects of *Gonystylus bancanus* (Ramin) and to a certain extent also *Aquilaria malaccensis* (Karas). They included resource quantification, sustainable harvest, timber tracking and monitoring, DNA database development, preparation of Non-Detriment Findings (NDF) of Ramin, and population distribution mapping with the main objective to sustainably manage and conserve the Ramin and Karas species (P.S. Tong, et al. 2010). One of the Activities was conducted by FRIM involving the "Generation of Spatial Distribution Maps of Ramin using Hyperspectral Technology and Determination of Sustainable Level of Harvest of Ramin in Production Forests of Peninsular Malaysia".

As a continuation from the Activities, a suitable web-based database and information system is developed as a one-stop centre for easy access to information on these threatened tree species in Malaysia. Until now, there is no available dedicated website and database developed for Ramin and Karas. The information database developed is known as the MyCITES which comprise a full and complete set of information on Ramin and Karas, including the current status of their population, production and trade of their products. The MyCITES is used as a platform to disseminate information on Ramin and Karas, including the outcomes and findings from the Activities implemented under the ITTO-CITES Program. It will also be very useful to all relevant stakeholders with regard to access of information on current sustainable management and conservation efforts taken on these species.

1.2 Objective and Expected Output

The specific objective of this Activity is to develop a web-based database information system of Ramin and Karas (MyCITES) including the information on distributions, habitats, ecology, research and development, publication, import and export, production, management policy and practice of species in Malaysia for management and conservation purposes.

In this regard, the expected outputs of the Activity are as follows:

Output 1: Information on Ramin and Karas distributions in Malaysia.

Output 2: Information on research and development on Ramin and Karas in Malaysia.

Output 3: Information on timber trading and production of Ramin and Karas in Malaysia.

Output 4: Information on Malaysia's policy and management practices of Ramin and Karas in Malaysia.

Output 5: A comprehensive web-based database information system of Ramin and Karas in Malaysia.

1.3 Activity location

Malaysia has been selected as the study area for this Activity. Malaysia is a country in Southeast Asia, located partly on a peninsula of the Asian mainland and partly on the northern third of the island of Borneo. West (Peninsular) Malaysia shares a border with Thailand, is connected by a causeway and a bridge to the island state of Singapore, and has coastlines on the South China Sea and the Straits of Malacca. East Malaysia (Borneo) shares borders with Brunei and Indonesia. Malaysia has a total landmass of 329,847 square kilometres.

The climate of Malaysia is typical of the humid tropics and is characterised by year-round high temperature and seasonal heavy rain. Temperature ranges from 26^0 C to 32^0 C and rainfall ranges from 2000 mm to 4000 mm per annum. The rainfall is very high due to the influence of both north-east monsoon and the south-west monsoon. Malaysia has been endowed with vast amount of natural resources including luxuriant tropical forest which is one of the most diverse and complex ecosystems of the world.

In Malaysia, the National Forestry Policy 1978 laid a firm foundation for the development of the forestry sector. It was revised in 1993 in recognition of the role of forests in providing a multiplicity of goods and services. The revised policy had direct impacts on the management of forests through the establishment of the Permanent Forest Reserve (PFR), large-scale forest plantations, and importation of logs, greater incentives for downstream processing, promoting the utilization of lesser-known species and small-diameter logs, and manufacturing of value-added products. The National Forestry Policy 1978 and the National Forestry Act 1984 provide Malaysia with a strong policy framework and laws to support sustainable forest management. Both the national policy and act provide a sufficient basis for the protection against harmful activities, promote establishment of wildlife parks and reserves, and reduce activities that may cause detrimental impacts on the environment.

Malaysia is one of 180 party that joined CITES since 20th July 1977, however entry into force on 18th January 1978. By joining the CITES Convention, Malaysia agreed to follow and implement all the regulations enacted by CITES regarding to international trade of flora and fauna species covered by the Convention listed in Appendix I, II and III. There are 27 species from *Aquilaria* genus and 40 species from *Gonystylus* genus that are listed in CITES where all these species are listed in Appendix II. From the listed species, five species from *Aquilaria* genus including *Aquilaria malaccensis* and 28 species from *Gonystylus* genus including *Gonystylus bancanus* can be found in Malaysia. Act 686 on International Trade in Endangered Species of 2008 or shortly known as INTESA was implemented in Malaysia with the aim to control the international trade of flora and fauna species listed in CITES and to ensure that Malaysia fulfil their responsibilities as one of the signatory of CITES Convention.

CHAPTER 2: METHODOLOGY

2.1 Implementation Approach

The initial stages of the Activity implementation focused on the collection of secondary data including digital and hard copy of report, journal, working paper, newspaper and book that relevant to any activity on Ramin and Karas in Malaysia. All of the secondary data were collected and kept in standard data format. The project contains five main output and each output have two activities carried out for both species; *Gonystylus bancanus* (Ramin) and *Aquilaria malaccensis* (Karas) (**Table 1**). The first four activities focusing on data collection related to Ramin and Karas for website data information. Meanwhile, the last activity (Activity 5) is the activity related to the development of the web database called MyCITES.

Table 1 Implementation strategy of Activity

Output	Activity	Details of activity
Output 1: Information on Ramin and Karas distributions in Malaysia	**Activity 1.1.** Data collection on non-spatial information of Ramin and Karas in Malaysia.	Collection on non-spatial information of Ramin and Karas in Malaysia such as their ecology, phenology, and habitat. This information is very important and can be used as a primary reference for educational purposes and shared in the website.
	Activity 1.2. Mapping the distribution of Ramin and Karas population in Malaysia.	It involved preparation of maps of potential Ramin and Karas population areas in Malaysia. This information is very important to assist the relevant agencies to plan for better management and conservation of these species

Output 2: Information on research and development of Ramin and Karas in Malaysia	**Activity 2.1.** Gathering information on research and development related to Ramin and Karas species in Malaysia	Collection of information related to research and development carried out on Ramin and Karas including the studies conducted under Phase 1 of the ITTO-CITES Program by the various agencies in Malaysia from 2008 to 2010
	Activity 2.2. Collection of relevant information and publications related to the Ramin and Karas issues in Malaysia	Gathering information on books, journals and publications related to Ramin and Karas that had been published to date. This information is included in the web-based database information system and shared with users who are interested in getting such information
Output 3: Information on timber trading and production of Ramin and Karas in Malaysia	**Activity 3.1.** Gathering information on Ramin and Karas production in Malaysia	Collection of information related to timber and products from Ramin and Karas, and in particular, furniture and gaharu products in Malaysia. This information is important for planning and monitoring the future direction of trade in Ramin and Karas products
	Activity 3.2. Gathering information on import and export of Ramin and Karas products in Malaysia	Gathering all the information on import and export of Ramin and Karas products to ensure that the production of these species from Malaysia's production forests is being carried out in a sustainable manner

Output 4: Information on Malaysia's policy and management practices of Ramin and Karas	**Activity 4.1.** Gathering information on Malaysia's policy in managing threatened tree species	Gathering information on Malaysia's policy in managing threatened tree species is very important to ensure that the policies that have been enacted can give direct impact to better management practices of Ramin and Karas
	Activity 4.2. Gathering information on management practices of Ramin and Karas in Malaysia	Gathering information on effective management practices of Ramin and Karas by all relevant agencies in Malaysia is very important to enhance the level of efficiency in managing threatened tree species in Malaysia
Output 5: A comprehensive web-based database information system of Ramin and Karas in Malaysia	**Activity 5.1.** Development of a comprehensive web-based information system of Ramin and Karas in Malaysia	Development of the MyCITES will be based on an interactive web-based information system to enable the sharing of information and spatial data on Ramin and Karas in Malaysia (**Figure 1**). As a one-stop centre of Ramin and Karas information database, MyCITES can be used by various stakeholders as a main source of gathering the latest information and details on Ramin and Karas trees species for the purpose of learning, monitoring, conservation and preservation activities of these species in Malaysia
	Activity 5.2. Testing and running the developed website and database	Training on the website and database applications that have been developed is a necessity so as to ensure that they were developed based on the needs of the operators

2.2 Website Architecture and Structure

MyCITES have been created to provide information on Malaysia CITES listed species via web browser. User of this database will be able to browse MyCITES portal to login and use the service, view all the information shared in MyCITES (current information on Ramin and Karas) and also can view and download all the information on journals, books and other available publications.

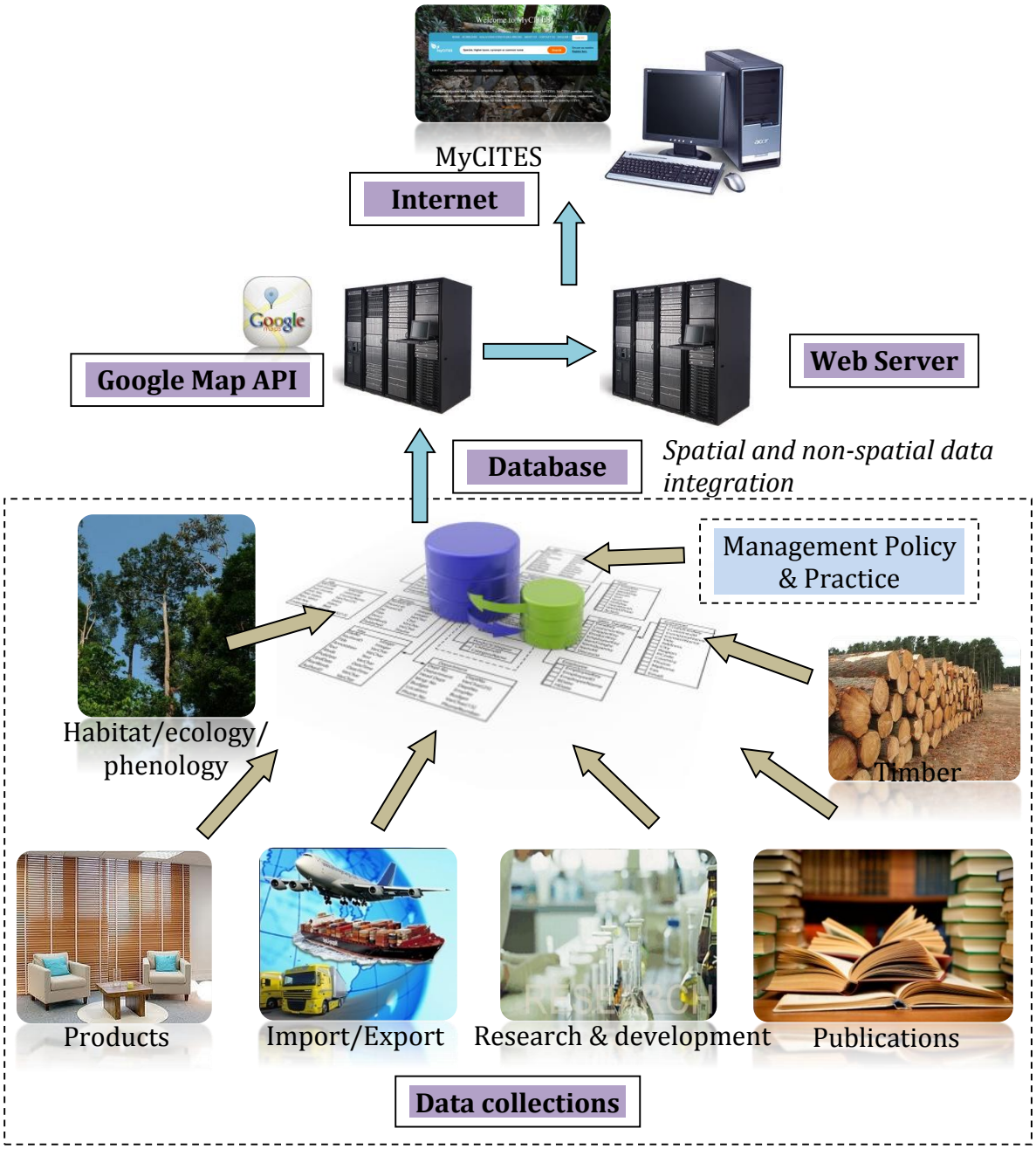


Figure 1 Structure design of MyCITES website and information database

MyCITES web based information system has been developed with client-server architecture. Server part will consist of data storage, file storage which will provide data access and maintenance. The administrator of MyCITES will be able to create and manage articles, publications and updating information via internet. The interfaces are designed to be clean and simple to give comfortable working environment to the administrator. The website part consists of a web portal with key area that include list of species, list of publications (journals, books, research papers), newspaper articles, conference and seminar information and other related information. This website will give access to a wide range of information related to Ramin and Karas. **Table 2** shows the system requirement for development and access to MyCITES website. Back end of MyCITES website has been developed using the latest version of PHP 5 as a programming language and MySQL 5 as the database platform.

Table 2 System requirements for development and access to MyCITES website.

Server Specification	Web Specification
Workstation	Any desktop/laptop
Any OS installed	Any OS installed
Web Server	Internet connection
MySQL DBMS	Any browser installed
Firewall	-

2.3 MyCITES Design and Development

There are five elements in the design of the MyCITES website and database namely layout design & concept, user requirement study, web development, web features, and web system module. **Table 3** shows the characteristics of each element involved in the development of MyCITES.

Table 3 Characteristics of each element involved in the development of MyCITES.

No.	Element	Specification
1	Layout design & concept	✓ Unique Custom & creative web concept ✓ Layout architecture strategy and planning for easy content reading, accessibility, and reading.
2	User requirement study	✓ Understanding objectives ✓ Restructuring the existing web contents to reach the targeted group ✓ Ensure the best visual solutions possible
3	Web development	✓ CMS (Content Management System) Integration with Administrative Control Panel. ✓ A special and customized Content Management System (CMS) to maintain and keep your site updated. ✓ CMS Features: - Admin login access panel, admin notifications and alert - Add new pages with text and image - User Management, text formatting and styling, visual and code view ✓ Page Manager Module - Create unlimited pages - Manage Categories and Page Group - Add/Delete/Rename Categories - Add/Delete/Edit pages - Assign pages to the parent - Create unlimited sub pages ✓ Valid XHTML/CSS Web Conversion for browser compatibility and accessibility - Internet Explorer 10.0 and above, Firefox, Safari and Chrome. ✓ Mobile browser friendly layout design structure and coding. ✓ SEO Friendly Web Structure
4	Web Features	✓ Navigation & Menu - Valid CSS based menu - Customized drop down menu - Cross browser support

		- Navigation Manager - add/edit/delete main menu - Sub Navigation Manager - add/edit/ delete submenu ✓ News Features - Auto latest News at the main page - Add/ edit/ delete news - Archived with pagination ✓ Announcements Features - Auto latest Announcements at the main page, archived with pagination - Add/edit/delete announcements ✓ Media Centre - Image gallery – add/ edit/ delete - Archived with pagination ✓ Online Contact Form - With Forms validation and error checking - Redirect to admin emails or multiple receivers ✓ Multiple Language - Bahasa and English language pack - Language Selector - Management System
5	Web system module	✓ Advanced search filters - Advanced search based on taxonomy fields - Drill down and filtering features - Auto-complete features ✓ Research & Development sections - Management of items - Advanced search filter - Search options based on publication type ✓ Simple User Registration - Online user registration form

CHAPTER 3: RESULT AND DISCUSSIONS

3.1 Information on Ramin and Karas distributions in Malaysia

3.1.1 Data collection on non-spatial information of Ramin and Karas in Malaysia.

In this activity, the information about ecology, phenology, and habitat of Ramin and Karas are compiled. Several series of field verification survey have been carried out to verify the existence of the two species in their natural habitat based on record from FRIM Herbarium and other previous studies.

3.1.1.1 Non-spatial information of Ramin

In Malaysia, *Gonystylus bancanus* are locally known as Ramin melawis. The other name given by local Malaysian peoples are Ramin melawis, Ramin telur (Peninsular) and Garu buaya (Sarawak). Ramin are also the general name used in Brunei Darussalam and Indonesia referring to *Gonystylus bancanus* species. In some Indonesia parts *Gonystylus bancanus* is known as Gaharu buaya (Sumatera and Kalimantan) and Medang keladi. While in Philippines, the peoples called as Anauan and Lanutan-bagyo.

Ramin is one of valuable timber species listed in Convention on International Trade in Endangered Species (CITES) and International Union of Conservation of Nature (IUCN) as endangered and threatened flora species with 27 others species of the same genus listed under Appendix II.

In genus *Gonystylus*, six species of a total of 33 species that are currently known to be commercially valuable. This species are *G. affinis, G. bancanus, G. forbesii, G. macrophyllus, G. maingayi* and *G. velutinus*. However from this valuable six species, *G. bancanus* is the most commonly trade in Malaysia. Compare to other species, *Gonystylus bancanus* are known suitable for various purposes hence very popular in overseas market. Germany (35%), Japan (34%), Italy (11%) and Taiwan (8%) are the main importers of Ramin from Malaysia (MTIB Statistic, 2013). While countries such as Australia, Belgium, Canada, China, England, Hong Kong, Maldives, Netherlands, Norway, Panama, Philippines, Russia, Singapore, Thailand, Turkey, USA and Vietnam also import Ramin based-product from Malaysia, but in a small amount. Ramin is exported in the various form; such as blind fittings, blind slats, dowel, dressed timber, panel flooring, moulding, louvers door, picture frame, round rod and sawn timber.

High demands on Ramin timber has led to over exploitation and under threat of extinction in the future. Many effort have been made to conserve Ramin from over exploitation, for example, imposing harvest quota of Ramin from natural regenerated peat swamp forest (PSF) and also the annual import-export quota set by CITES Scientific Authority and Management Authority. For the year 2015, Malaysia were given 13, 178 m^3 annual quotas to export Ramin and its derivatives. From this amount, 10,000 m^3 were allocated to Peninsular and Sabah, while the remaining 3,178 m^3 for Sarawak.

In addition, the natural habitat of Ramin are also degraded as more PSF are converted into residential, industrial, agriculture (conversion to pineapples, paddy field, palm oil and sago) and aquaculture scheme, poor natural regeneration and lack of silviculture knowledge about Ramin. Currently, natural disaster such as prolonged drought also could contribute to the degradation of PSF. Since Ramin is restricted only to PSF (for Sabah and Sarawak occurs in mixed PSF), geographically *Ramin* distribution in Malaysia is associated with the location of PSF which largely can be found in the state of Sarawak (76% of total swamp forest in Malaysia) and some parts of Peninsular and Sabah. Ramin rarely occurs in lowland freshwater swamp and heath forest of up to 100 meter altitude.

In PSF, the forest can be divided to three layers of tree namely the upper layer, the middle layer and the understory. Ramin is considered as upper layer species. The size of Ramin ranges from medium to fairly large tree. The tree in Peninsular Malaysia have medium size of up to 27 m height and 80 cm dbh (diameter at breast height), while in Sarawak the size ranges are from medium to big sized tress of 45 m tall and up to 120 cm dbh. The medium size of Ramin of 27 m tall and 60 cm dbh are considered as matured tree. Ramin population density is low, between 2 to 21 trees per ha. The mean annual volume increment ranges from 0.01- 1.15 m^3/ha/yr. The wood density is 460-840 kg/m^3 with 15% moisture content. The trunk is straight, cylindrical and branchless up to about 20 m high (**Figure 2)**, sometimes slightly fluted at the base with numerous roots breathing organ. However, many of Ramin trees in Pekan Forest Reserve have straight boles more than 30 m. The surface is often cracked and shallowly fissured and the bark is greyish to red-brown, and the inner bark is reddish brown and fibrous**.** The sapwood is white to pale yellowish cream colour (**Figure 3**).

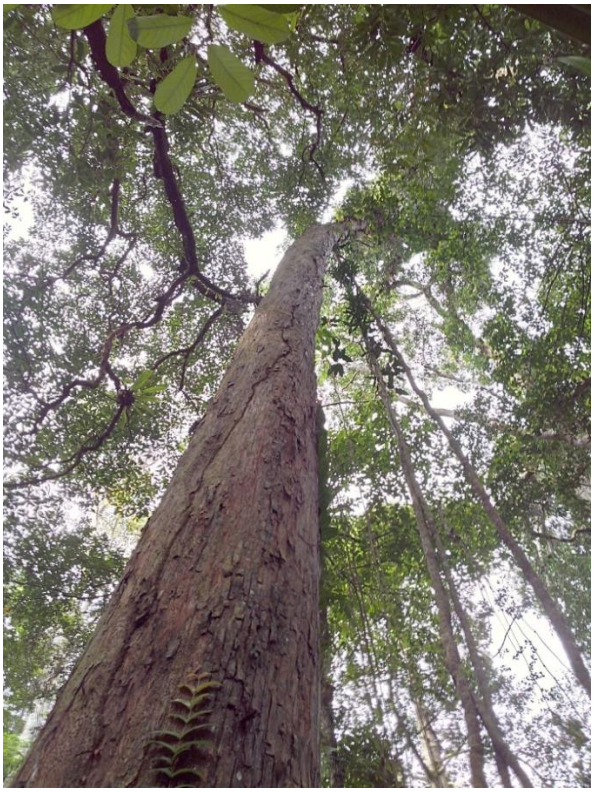


Figure 2 Ramin trunk with straight, cylindrical and branchless up to about 20 m high

Figure 3 Ramin bark is greyish to red-brown, the inner bark is reddish brown, fibrous and the sapwood is white to pale yellowish cream colour.

Ramin flowers have 2 to 5 clusters, 1 to 1.8 cm long with 8-14 mm long pedicles. The fruits are in capsules, woody, rounded and will open naturally when it reach maturity. One to three seeds can be found in each fruit (**Figure 4**). The seed is ovoid, dark in colour and about 28 x 22 x 6 mm in size and contains 250 - 300 seeds in every kilogram seeds collected.

Figure 4 One to three seeds can be seen inside the fruit when three valves are splitting

In Malaysia, research regarding phenology of Ramin are still lacking and restricted to some parts of Ramin habitat. As for now, some studies have been conducted by Nurul Huda (2003), Shamsudin and Ng (1995), Shamsudin (1996) and Ismail et al. (2011) describing the phenology of Ramin in Peninsular Malaysia where all the studies are concentrated in Pekan Forest Reserve, Pahang. While in Sarawak, Dibor (2005) have made observation and evaluation of Ramin phenology in two locations, Lingga (Sri Aman) and Naman FR (Sibu). No study has been conducted in Sabah.

Research by Ismail (2011) proved that the flowering of Ramin was supra-annual (flower randomly without necessarily flower at every year) and required a total of 71–86 days (based on phonological study in Pekan FR on Ramin fruiting season at year 2007) for a full development from budding stage to matured fruit.

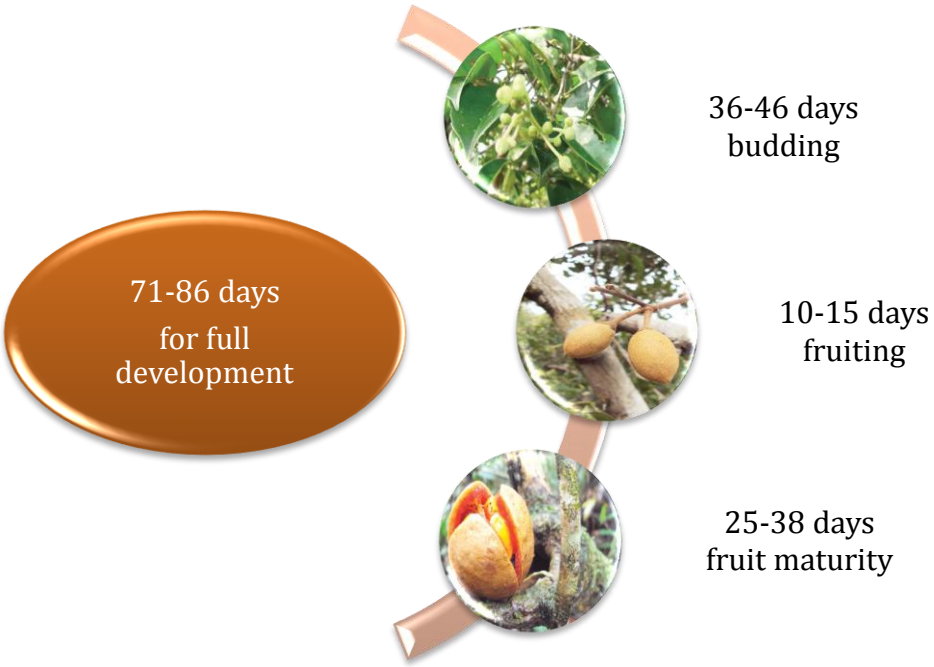


Figure 5 Budding to fruit maturity phase of Ramin

Shamsudin & Ng (1995) and Shamsudin (1996) reported that Ramin trees flower and fruit simultaneously in Pekan Forest Reserve (Pekan FR). Contrary with observations made in 2002-2003 by Dibor (2005) in Lingga (Sri Aman) and Naman FR (Sibu) indicated that Sarawak had an irregular flowering and fruiting habits among the forest. Budding stages required more than a month (36-46 days) and the stages for the flower to become fruit took only about 2 weeks (10-15 days) (**Figure 5**). However only 30% of the buds can survive and turn into flowers and 26% of the flower can turn into fruits. The probabilities of un-matured fruits to fall can reach up to 79%. This is due to the presence of animals such as squirrels and aphid that eating the un-matured Ramin fruits.

3.1.1.1 Non-spatial information of Karas

Aquilaria malaccensis tree are commonly called "Karas" by Malay people. In some places in Malaysia, "Karas" is also known as Chandan, Ching karas, Depu, Gaharu, Gaharu lampong, Gharu, Gohog-galuk (Sakai community), Engkaras (Iban community), Kekaras, Kempas nenasi (Temuan community), Kepang, Tabak, Taboh, and Tengkaras.

While "Gaharu" is the resin that produce by Karas tree are also called Agarwood (English), Aguru (Sanskrit), Agalloch, Aloes, Aloewood, Bois d'aigle de Malacca (Perancis), Chen-xiang (China), Eagle Wood (British), Jin-Ko (Jepun), Kalambak

(Cambodia), Oud (Arab), and Poa d'aguila (Portugis). There are a few titles given to these high value agarwood such as "Wood of God" and "Bridges between Man and God".

Aquilaria is a genus consists of 25 species that are identified to have phyto-geography location in 14 countries comprise Bangladesh, Bhutan, Brunei, China, India, Indonesia, Laos, Malaysia, Papua New Guinea, Filipina, Cambodia, Singapore, Thailand, and Vietnam. *Aquilaria malaccensis* (Karas) species can be found mainly at lowland dipterocarp and mixed dipterocarp forest at altitude up to 270 meter. In Malaysia, this species can be found mainly at lowland dipterocarp and mixed dipterocarp forest at Peninsular Malaysia (Kedah, Penang, Kelantan, Terengganu, Perak, Pahang, Selangor, Negeri Sembilan, Melaka and Johor), Sabah and Sarawak. Even though the species is widespread, but it also occurs at low population density (Chua, 2008). The population density in Peninsular Malaysia is around 2.5 trees/ha. The tree grows at altitudes up to 270 meters from sea level on sandy clay soil of pH 5.5 – 6.6 at temperature of 28-34°C and annual rainfall of 1000-2000 mm. Karas seedlings required 50-80% exposure to the sunlight.

Karas population in Malaysia is under threat and facing extinction in their natural habitat. To assured their survival, this species have been listed under Appendix II in Convention on International Trade in Endangered Species (CITES) since February 1995 and on 1994 by International Union of Conservation of Nature (IUCN) as endangered species that required specific conservation and management. This tree is hunted because of their ability to produce agarwood, a fragrant resin which have high value in global market. However, the agarwood resin only can be produced by Karas tree that are unhealthy, whether caused by natural or man-made or animal, insect such as ants and microbial invasion. The resin produced due to self-defence mechanism of the "sick" tree to fight the fungal attack. Only 10% from total Karas tree in forest facing fungal attack and produce agarwood (Dawned, 2005). The trees that possess diameter of 30 metre and up having high potential to produce the agarwood. Karas can be recognized by several physical characteristics:

i. Leaves

The shape of leave are oblong with tapering tip on every end with size about 6-8 x 3-3.5 cm for matured tree and having 12-16 pairs of alternate leaf vein. The leaves are bigger and thin when the tree still small. The white thread can be seen when the green or dried leaves are torn up (**Figure 6**). All species of *Aquilaria* have this characteristic.

(a)

(b)

Figure 6 Green (a) and dried leaves (b) of *Karas* both produce white-thread when torn up

ii. Trunk

Karas has been categorized as medium sized tree can reach up to 20-40 meter tall with diameter up to 60 cm. The trunk are usually straight, however the old tree can be fluted at the base of the trunk. The bark has finely irregular fissured and uneven colour, from dark to pale grey (**Figure 7**). The bark are tough stringy and hardly to break when pulled. Meanwhile, the colour inside the bark is yellowish white.

Figure 7 The colour of trunk from dark to pale grey.

iii. Flower

Matured tree of 7-9 years begin to flowering and fruiting. The flowers are about 5 mm in size, fragrant, pale greenish yellow colour and bisexual (**Figure 8**).

Figure 8 The flower of Karas

iv. Fruits

The Karas fruit are green, have small egg-shape and contains two seed at each fruits with size about 4 cm X 2.5 cm (**Figure 9**). The dried fruits will turn to brown and cracked into two parts with seeds hanging into the fruits.

Figure 9 The fruits of Karas in natural forest

The main usage of agarwood is in perfume production that has high demand in Arabic countries such as Saudi Arabia and United Arab Emirates (UAE). Other than that, the agarwood also used in medicinal, cosmetics, decorations, jewellery and religious purposes in Islam, Buddhist, Jewish, Hinduism and Christians. For example, joss stick is a tool required during the prayer of Buddhist is produced from lower grade of agarwood powder. In term of medicinal value, leaves for example, is said to contain a type of chemical called *genkwanin glycosides* that capable to remove mercury from body which efficiently help slowing down the aging process. Agarwood herbal tea also used to cure diabetes, high blood and gout. Another benefit of agarwood tea is it strengthen the heart, cure the fever, flu, improve sleep, for beauty, eliminate flatulence, constipation, asthma and for weight loss.

Due to the fact that agarwood from wild source are depleting and the wild agarwood are subjected to annual export quotas set by CITES Scientific Authority and Management Authority, the plantation become an alternative choice to those involve in trading the agarwood-based products. For the year 2015, Malaysia are given 200,000kg annual quotas for exporting agarwood and its derivatives obtained from wild source, meanwhile the crop obtained from plantation are excluded. From

this amount, 200,000 kg were allocated to Peninsular and Sabah, while the remaining 5,000kg for Sarawak.

Planting Karas tree in plantation also do not require intensive care and also have lower risk of loss as long as the tree is given adequate fertilization, disease control such as pest are taken in very early stage and using the correct artificial agarwood inducement technique. Karas tree grow fast and can adapt to various environment, climate and soil types that make this species suitable for plantation crop. At present, over three million Karas tree have been planted in 3,000 hectares of land around Malaysia (Lok, 2014).

3.1.2 Mapping the distribution of Ramin and Karas population in Malaysia.

In the database, mapping of species population was restricted only to forest reserve level due to the security factor. Detailed mapping on individual standing tree population were not exposed to public as this will give an accurate information on tree location especially for Karas species which is hunted due to high market value. Population of Ramin and Karas in Conservation Forest (CF), Forest Reserve (FR), Protected Forest (PF), National Parks (NP), Recreational Forest (RF) and Wildlife Sanctuary (WS) around Malaysia have been identified and verified by three ways;

i. Site validation during the field verification activity
ii. Record from Herbarium in FRIM
iii. Studies conducted by researchers in FRIM and other research agencies

Meanwhile, the species population in plantation area are excluded from the database. Karas species can be found in 86 location, while Ramin in 42 location around Malaysia. The list of location of Ramin and Karas population are shown in **Table 4** and **Table 5**.

Table 4 List of location of Ramin from survey and secondary record

No	Location	State	Survey / Record	Source
1	Lingga FR	Sarawak	2005	Study area in "Phenology of Ramin (*Gonystylus bancanus*) in Logged-over Peat Swamp Forest in Sarawak"
2	Naman FR	Sarawak	2005	Study area in "Phenology of Ramin (*Gonystylus bancanus*) in Logged-over Peat Swamp Forest in Sarawak"
3	Saribas FR	Sarawak	2005	Reported in "Growth and Yield of Logged-over Peat Swamp Forests of Sarawak"
4	Batang Lassa PF	Sarawak	2005	Reported in "Growth and Yield of Logged-over Peat Swamp Forests of Sarawak"
5	Loagan Bunut NP	Sarawak	2007	Reported by Ismail in "Restoring the wetland ecosystem: experience on peat swamp forests restoration trials in Peninsular Malaysia"
6	Triso PF	Sarawak	2010	Study area in "The Development of DNA Database for Ramin in Sarawak", 2010
7	Bukit Lima FR	Sarawak	1993	Geographical Distribution of Ramin (*Thymelaeaceae*) in Peninsular Malaysia map (1991-1993)
8	Setapok FR	Sarawak	1993	Geographical Distribution of Ramin (*Thymelaeaceae*) in Peninsular Malaysia map (1991-1993)
9	Sedilu FR	Sarawak	2009	Study area in "Population Genetic Structure of Ramin Throughout Malaysia: Preliminary Result"
10	Kayangeran FR	Sarawak	2010	Study area in "The Development of DNA Database for Ramin in Sarawak", 2010
11	Pulau Bruit PF	Sarawak	2005	Reported in "Growth and Yield of Logged-over Peat Swamp Forests of Sarawak"
12	Loba Kabang PF	Sarawak	2005	Reported in "Growth and Yield of Logged-over Peat Swamp Forests of Sarawak"

13	Sungai Bawan FR	Sarawak	2005	Reported in "Growth and Yield of Logged-over Peat Swamp Forests of Sarawak"
14	Retus PF	Sarawak	2005	Reported in "Growth and Yield of Logged-over Peat Swamp Forests of Sarawak"
15	Daro FR	Sarawak	2005	Reported in "Growth and Yield of Logged-over Peat Swamp Forests of Sarawak"
16	Batang Jemoreng PF	Sarawak	1986	Reported by Wijdeven et. all, in "Development of A Monitoring System (2005)
17	Niah-Suai FR	Sarawak	1989	Reported by Chai in "Native medicinal plants of Sarawak", 1989
18	Simunjan FR	Sarawak	2005	Reported in "Growth and Yield of Logged-over Peat Swamp Forests of Sarawak"
19	Sebuyau FR	Sarawak	2008	Study area in "Assessment on the Status and Distribution of Ramin telur (*Gonystylus bancanus*) in the Peat Swamp Forest in Sedilu Forest Reserve and Sebuyau Protected Forest, Sarawak"
20	Tatau PF	Sarawak	2005	Reported in "Growth and Yield of Logged-over Peat Swamp Forests of Sarawak"
21	Batang Lupar	Sarawak	1993	Geographical Distribution of Ramin (*Thymelaeaceae*) in Peninsular Malaysia map (1991-1993)
22	Saribas Lupar PF	Sarawak	2010	Study area in "Non-detriment Findings Report on Ramin– A Quantitative Assessment of *G. bancanus* in two selected Permanent Forests of Sarawak" project on 2010
23	Lower Baram FR	Sarawak	1971	Reported by Wood in "Inventory Report No. 21 : Forest Inventory Report for Lower Baram F.R.
24	Balingian FR	Sarawak	1989	Reported by Chai in "Native medicinal plants of Sarawak", 1989
25	Siaungau FR	Sabah	1993	Record from Herbarium, FRIM

26	Mengalong FR	Sabah	1953	Record from Herbarium, FRIM
27	Klias FR	Sabah	2007	Reported by Ismail in "Restoring the wetland ecosystem: experience on peat swamp forests restoration trials in Peninsular Malaysia"
28	Nenasi FR	Pahang	2011	Study area in "Detection Of Genetic Structure Among Ramin (Ramin Populations in Peninsular Malaysia Using a Rapid DNA Fingerprinting Technique"
29	Pekan FR	Pahang	2013	Study area in "Preliminary Findings on Impact of Logging on Plant Structure and Potential Indicator on Gap Opening in Peat Swamp Forest"
30	Resak FR	Pahang	2007	Study area in "Ecosystem and Floristic Diversity of Tropical Peat Swamp Forest, Pahang, Malaysia
31	Kedondong FR	Pahang	2011	Study area in "Phenology of Ramin in Pahang, Peninsular Malaysia"
32	Menchali	Pahang	2002	Reported in "Fire Prevention and Protection in Peat Swamp Forests 'Pahang Experience'"
33	Belara FR	Terengganu	2011	Study area in "Detection Of Genetic Structure Among Ramin Populations in Peninsular Malaysia Using a Rapid DNA Finger printing Technique"
34	Bukit Bauk FR	Terengganu	2006	Record from Herbarium, FRIM
35	Raja Musa FR	Selangor	2011	Study area in "Rehabilitation of degraded peat swamp forest in Raja Musa Forest Reserve, Selangor, Malaysia"
36	Sungai Karang FR	Selangor	2006	Reported in *Gonystylus bancanus*: Jewel of The Peat Swamp Forest
37	Kuala Langat Selatan FR	Selangor	1978	Reported by Putz in A survey of Virgin Jungle Reserves in Peninsular Malaysia
38	Kuala Langat Utara FR	Selangor	1999	Reported in *Kajian Pengurusan Bersepadu Lembangan Sungai Langat*

39	Air Hitam Utara FR	Johor	2011	Study area in "Detection Of Genetic Structure Among Ramin Populations in Peninsular Malaysia Using a Rapid DNA Finger printing Technique"
40	Grik FR	Perak	2009	Record from Herbarium, FRIM

Table 5 List of location of Karas from survey and secondary record

No	Location	State	Survey / Record Date	Source
1	Gunung Jerai FR	Kedah	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
2	Bukit Perangin FR	Kedah	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
3	Gunung Bongsu FR	Kedah	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
4	Gunung Inas FR	Kedah	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
5	Bukit Malut FR	Kedah	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
6	Gunung Mat Chincang FR	Kedah	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"

7	Gunung Raya FR	Kedah	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
8	Sungkap FR	Kedah	1993	Data from Herbarium, FRIM & map of Geographical Distribution of *Aquilaria malaccensis* (*Thymelaeaceae*) in Peninsular Malaysia
9	Ulu Muda FR	Kedah		A Review of The Agarwood (Gaharu) Trade in Malaysia
10	Bukit Lagong FR	Selangor	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
11	Bukit Kiara	Selangor	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
12	Sg. Buloh FR	Selangor	1968	Data from Herbarium, FRIM
13	Forest Research Institute Malaysia (FRIM)	Selangor	2015	Verification survey activity
14	Gunung Panti FR	Johor	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
15	Maokil FR	Johor	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"

16	Lenggor FR	Johor	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
17	Mersing FR	Johor	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
18	Gunung Arong FR	Johor	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
19	Endau FR	Johor	1935	Data from Herbarium, FRIM
20	Renggam FR	Johor	1950	Data from Herbarium, FRIM
21	Gunung Ledang NP	Johor		A Review of The Agarwood (Gaharu) Trade in Malaysia
22	Nenggiri FR	Kelantan	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
23	Batu Papan FR	Kelantan	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
24	Chabang Tongkat FR	Kelantan	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
25	Jeli FR	Kelantan	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"

26	Stong Tengah FR	Kelantan	1993	Data from Herbarium, FRIM & map of Geographical Distribution of *Aquilaria malaccensis* (*Thymelaeaceae*) in Peninsular Malaysia
27	Gunung Rabong FR	Kelantan	1972	Data from Herbarium, FRIM
28	Lebir FR	Kelantan	2004	*Statistik Ladang Gaharu 2011* in Ismail & Mohd Zin, 2011
29	Ulu Sat FR	Kelantan	2005	*Statistik Ladang Gaharu 2011* in Ismail & Mohd Zin, 2011
30	Bukit Nanas FR	Kuala Lumpur	2009	From studies conducted "Airborne Hyperspectral Sensor for Individual Species Counting and Mapping of Karas (*Aquilaria malaccensis*) in Bukit Nanas F.R, Malaysia
31	Bintang Hijau FR	Perak	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
32	Bubu FR	Perak	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
33	Kledang Saiong FR	Perak	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
34	Gunung Semanggol FR	Perak	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
35	Bukit Tapah FR	Perak	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"

36	Belum FR	Perak	1998	Data from Herbarium, FRIM & map of Geographical Distribution of *Aquilaria malaccensis* (*Thymelaeaceae*) in Peninsular Malaysia
37	Piah FR	Perak	2005	*Statistik Ladang Gaharu 2011* in Ismail & Mohd Zin, 2011
38	Chikus FR	Perak	not available	*Statistik Ladang Gaharu 2011* in Ismail & Mohd Zin, 2011
39	Tekak-Tembeling FR	Pahang	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
40	Berkelah FR	Pahang	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
41	Beserah FR	Pahang	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
42	Lentang FR	Pahang	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
43	Som FR	Pahang	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
44	Yong FR	Pahang	1970	Data from Herbarium, FRIM
45	Kemasul FR	Pahang	1962	Data from Herbarium, FRIM
46	Kelau FR	Pahang	1931	Data from Herbarium, FRIM
47	Lepar FR	Pahang	1923	Data from Herbarium, FRIM
48	Krau FR	Pahang	1967	Data from Herbarium, FRIM
49	Tekam FR	Pahang	2002	Lim in A Review of the Agarwood (Gaharu) Trade in Malaysia
50	Tekai FR	Pahang		Review of The Agarwood (Gaharu) Trade in Malaysia

51	Hulu Terengganu Tambahan FR	Terengganu	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
52	Bukit Bauk FR	Terengganu	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
53	Gunung Tebu FR	Terengganu	2014	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
54	Merchang FR	Terengganu	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
55	Taman Botanikal Pulau Pinang	Pulau Pinang	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
56	Bukit Kerajaan FR	Pulau Pinang	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
57	Pelangai FR	Negeri Sembilan	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
58	Pasir Panjang FR	Negeri Sembilan	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"

59	Triang FR	Negeri Sembilan	1936	Data from Herbarium, FRIM
60	Sungai Menyala FR	Negeri Sembilan	1993	Data from Herbarium, FRIM & map of Geographical Distribution of *Aquilaria malaccensis* (*Thymelaeaceae*) in Peninsular Malaysia
61	Tampin FR	Negeri Sembilan	1970	Data from Herbarium, FRIM
62	Lenggeng FR	Negeri Sembilan	n.a.	*Statistik Ladang Gaharu 2011* in Ismail & Mohd Zin, 2011
63	Serting FR	Negeri Sembilan	2005	*Statistik Ladang Gaharu 2011* in Ismail & Mohd Zin, 2011
64	Pasoh FR	Negeri Sembilan	2015	Verification survey activity
65	Sungai Udang FR	Melaka	2012	Population survey on 2014 under project "Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia"
66	Bukit Senggeh FR	Melaka	1918	Data from Herbarium, FRIM
67	Bukit Bruang FR	Melaka	1938	Data from Herbarium, FRIM
68	Bukit Sedanan FR	Melaka	1931	Data from Herbarium, FRIM
69	Batang Melaka FR	Melaka	2004	*Statistik Ladang Gaharu 2011* in Ismail & Mohd Zin, 2011
70	Bukit Bintang FR	Perlis	2005	*Statistik Ladang Gaharu 2011* in Ismail & Mohd Zin, 2011
71	Gomantong FR	Sabah	1989	Data from Herbarium, FRIM
72	Bengkoka FR	Sabah	1951	Data from Herbarium, FRIM
73	Kabili-Sepilok FR	Sabah	2003	Data from Herbarium, FRIM
74	Sook Plain FR	Sabah	2008	Data from Herbarium, FRIM
75	Taman Kinabalu	Sabah	not available	A Review of The Agarwood (Gaharu) Trade in Malaysia
76	Maliau Basin FR	Sabah	not available	A Review of The Agarwood (Gaharu) Trade in Malaysia

77	Kawasan Konservasi Lembah Danum	Sabah	not available	A Review of The Agarwood (Gaharu) Trade in Malaysia
78	Timbun Mata FR	Sabah	not available	A Review of The Agarwood (Gaharu) Trade in Malaysia
79	Crocker Range NP	Sabah	not available	A Review of The Agarwood (Gaharu) Trade in Malaysia
80	Brantian FR	Sabah	1968	Data from Herbarium, FRIM
81	Lambir Hills NP	Sarawak	not available	A Review of The Agarwood (Gaharu) Trade in Malaysia
82	Taman Negara, Kuala Yong	Pahang	1970	Data from Herbarium, FRIM
83	Taman Negara, Batu Bidan	Terengganu	1993	Data from Herbarium, FRIM & map of Geographical Distribution of *Aquilaria malaccensis* (*Thymelaeaceae*) in Peninsular Malaysia
84	Air Keroh RF	Melaka	1993	Data from Herbarium, FRIM & map of Geographical Distribution of *Aquilaria malaccensis* (*Thymelaeaceae*) in Peninsular Malaysia
85	Bukit Pancor FR	Pulau Pinang	2013	FRIM-APFNet Project Report
86	Senaling Inas FR	Negeri Sembilan	2013	FRIM-APFNet Project Report

3.2 Information on research and development of Ramin and Karas in Malaysia

3.2.1 Research and development related to Ramin in Malaysia

The encouragement to conduct research and developments related to Ramin is aimed to ensure the management and conservation is consistent with the international trading. Local agencies such as Forest Research Institute Malaysia (FRIM), Forestry Department of Peninsular Malaysia (JPSM), Sarawak Forestry Department, Sabah Forestry Department, Pahang State Forestry Department, and Malaysian Timber Industry Board (MTIB) are the agencies that involved with the research and development related to this species. International Tropical Timber Organization (ITTO) and Convention on International Trade in Endangered Species (CITES) is some of the international bodies that collaborating with local agencies in Malaysia for conducting the research and development with financial support that comes from European Commission and ITTO donor countries such as USA, Japan, Norway and New Zealand.

Ministry of Science, Technology and Innovation Malaysia also encourage local researchers to conduct research related to Ramin and Karas through establishment of grant schemes such as ScienceFund and Techno Fund that can be apply throughout the year. Since 2001, a number of projects related to Karas have been approved under this fund, but no projects related to Ramin have been awarded. Several institutions of higher learning also identified to contribute to the study related to Ramin (**Table 6**). **Table 7** shows the list of Ramin related research project conducted in Malaysia.

Table 6 Local institutions of higher education contribute to the study related to Ramin in Malaysia

Local Institutions of Higher Education	Faculties
Universiti Putra Malaysia (UPM)	• Faculty of Forestry • Faculty of Agriculture & Food Sciences • Faculty of Science and Environmental Studies
Universiti Teknologi MARA (UiTM)	• Faculty of Applied Sciences
Universiti Kebangsaan Malaysia (UKM)	• Faculty of Science and Technology
Universiti Sains Malaysia (USM)	• School of Industrial Technology
Universiti Teknologi Malaysia (UTM)	• Centre for Artificial Intelligence and Robotics (CAIRO)
Universiti Kebangsaan Malaysia (UKM)	• Faculty of Science and Technology

Table 7 List of Ramin related project conducted in Malaysia

No	Title of Projects	Start Date	Executing Agency
1	Development of An Information Database for The Conservation & Sustainable Use of *Gonystylus bancanus* (Ramin) and *Aquilaria malaccensis* (Karas) in Malaysia	2013	Forest Research Institute Malaysia
2	Use of DNA for Identification of *Gonystylus* Species and Timber Geographical Origin in Sarawak	2012	Sarawak Forestry Corporation
3	National Workshop on Enforcement Compliance for Trade in Ramin (*Gonystylus* species)	2010	Malaysian Timber Industry Board
4	Sawn Timber and Veneer Recovery Study of Ramin (*Gonystylus bancanus*) in Peninsular Malaysia	2010	Forestry Department Peninsular Malaysia
5	Regional Workshop on The Sharing of Findings from The Activities Implemented in Indonesia and Malaysia Under The ITTO-CITES Project on Ensuring International Trade in CITES-listed Timber Species is Consistent With Their Sustainable Management and Conservation	2010	Forest Research Institute Malaysia
6	The Quantification of Dry and Wet Inland *Gonystylus spp.* (Ramin), *Aquilaria spp.* (Agarwood) and *Intsia spp.* (Merbau) in Peninsular Malaysia	2009	Forestry Department Peninsular Malaysia
7	Phenology, Habitat Specialization and Reduced Impact Logging of *Gonystylus (Miq.) Kurz* in Pekan Forest Reserve. Pahang	2009	Universiti Kebangsaan Malaysia
8	The Development of DNA Database for Ramin in Sarawak	2008	Sarawak Forest Department
9	Non-detriment Findings Report on Ramin– A Quantitative Assessment of *G. bancanus* in Two Selected Permanent Forests of Sarawak	2008	Forest Department Sarawak and Sarawak Forestry Corporation.

10	Genetics Study of Ramin Melawis (*Gonystylus bancanus*) in Malaysia for Generating Information on Population Genetic Structure and Establishment The DNA Database to Track Smuggling Activities	2008	Sarawak Forest Department
11	The Development of *Gonystylus spp.* (Ramin) Timber Monitoring System Using Radio Frequency Identification (RFID) in Peninsular Malaysia	2008	Forestry Department Peninsular Malaysia
12	Generation of Spatial Distribution Maps of Ramin (*Gonystylus bancanus*) Using Hyperspectral Technology and Determination of Sustainable Level of Harvest of Ramin in Production Forests of Peninsular Malaysia	2008	Forest Research Institute Malaysia
13	Developing DNA Database for Ramin in Sarawak	2008	Sarawak Forest Department
14	Optimum Harvesting Regimes of Peat Swamp Forest in Peninsular Malaysia	2005	Forest Research Institute Malaysia
15	Study of Regeneration Patterns of Five Emergent Species in Peat Swamp Forest, Pahang	2003	Universiti Kebangsaan Malaysia
16	Status of Peat Swamp Forest in Sarawak	2001	Sarawak Forestry Corporation
17	Threats to Peat Swamp Forests of Sarawak	2001	Natural Resources and Environment Board Sarawak
18	Growth and Yield of The Logged-Over Peat Swamp Forests of Sarawak	2001	Sarawak Forestry Corporation
19	Development of A Monitoring System	2001	Alterra (The Netherlands), Forest Department Sarawak, Sarawak Forestry Corporation
20	Manual for The Establishment and Enumeration of Permanent Sample Plots in A Monitoring System for The Peat Swamp Forest in Sarawak	2001	Sarawak Forestry Corporation

21	Floristic and Structural Diversity of Peat Swamp Forest in Maludam National Park	2001	Sarawak Forestry Corporation
22	Litter-Trap Survey in Maludam National Park	2001	Sarawak Forestry Corporation
23	Phenology of Ramin (*Gonystylus bancanus*) in Logged-Over Peat Swamp Forest in Sarawak	2001	Sarawak Forestry Corporation
24	Effect of Light on Ramin (*Gonystylus bancanus*) Germination	2001	Sarawak Forestry Corporation
25	Regeneration of A Mixed Swamp Forest in Sarawak (Malaysia) - Study Based on 6 Typical Mixed Swamp Forest Species	2001	Alterra (The Netherlands)
26	Seedling Distribution of Ramin and Seed Dispersal in Sarawak, Malaysia	2001	Alterra (The Netherlands)
27	Ramin (*Gonystylus bancanus*) Regeneration and Growth in Sarawak's Peat Swamp Forests	2001	Alterra (The Netherlands), Sarawak Forestry Corporation & Forest Department Sarawak
28	Leaf Properties, Photosynthetic Rates and Growth Strategies of Ramin	2001	Alterra (The Netherlands) & Sarawak Forestry Corporation
29	Improving Biodiversity and Sustainability of Peat Swamp Forests of Sarawak	2001	Sarawak Timber Association
30	A Rapid Diagnostic Appraisal Report of The Socio-Economic Value of Forest Products for The Population in The Vicinity of The Maludam National Park	2001	Alterra (The Netherlands), Daya Rancang, Sarawak Forestry Corporation & Universiti Malaysia Sarawak
31	A Survey of The Constraints and Opportunities of Non-Timber Forest Products (NTFPs) Activities Among The Iban Communities Living Adjacent to The Maludam National Park, Sarawak	2001	Daya Rancang & Alterra (The Netherlands)
32	Restoration of Ramin in PSF of Sarawak	2001	Sarawak Forestry Corporation, Sarawak Forest Department & Tropical Evergreen Enterprise

3.2.2 Research and development related to Karas in Malaysia

The encouragement to conduct research and developments related to the Karas species is aimed to ensure the management and conservation is consistent with the international trading. Local agencies such as Forest Research Institute Malaysia (FRIM), Forestry Department of Peninsular Malaysia (JPSM), Sarawak Forestry Department, Sabah Forestry Department, Malaysian Nuclear Agency (or formerly known as Malaysian Institute for Nuclear Technology Research (MINT)) and Malaysia Genome Institute (MGI) are the agencies involved in research and development related to Karas (**Table 8**) and several institutions of higher learning contribute to the study related to this species are also identified (**Table 9**). **Table 10** shows the list of Karas related research project conducted in Malaysia.

Table 8 Local institutions contribute to the study related to Karas in Malaysia

Agency	Focus / Expertise
Forest Research Institute Malaysia (FRIM)	• R&D on Karas based products, extraction of agarwood oil, inoculation, tissue culture, ecology, conservation, anti-fungal, DNA microsatellite markers, proteome profiling of Karas and etc. • Various consultation services for private company for plantation establishment, silviculture, inoculation, valuation of *Aquilaria* stands, tissue culture propagation protocol, species identification and authentication
Malaysian Nuclear Agency	• Inoculation technique, agarwood oil extraction system, species identification methods and grading (quality) • Mutagenesis of Karas • Development of Karas bioreactor system • Plantation aspects (agronomy) • Large scale production of tissue culture
Malaysia Genome Institute (MGI)	• Genome sequencing service • Elucidating the Gaharu Resin and Other Biosynthetic Pathways by Large Scale Transcriptome and Metabolite Profiling

Forestry Department Peninsular Malaysia (FDPM)	• Terengganu State Forestry Department (JPNT) established Karas research centre with focus of research: i. Inoculation and distillation technique ii. Disease and treatment iii. Soil suitability and type of fertilizer iv. Study on future returns More information regarding Karas research carried out by JPNT. • No specific research on *Aquilaria* were conducted in other branch of Forestry Department, however all branch in general are responsible for monitoring all tree species including *Aquilaria* that growth naturally in forest
Sabah Forestry Department	i. Silviculture treatment ii. Inoculation technique iii. Phonological observation (Seed research) iv. Health assessment

Table 9 Local institutions of higher education contribute to the study related to Karas in Malaysia

Local Institutions of Higher Learning	Faculties
Universiti Putra Malaysia (UPM)	• Faculty of Forestry • Faculty of Science
UniversitiTeknologi MARA (UiTM)	• Faculty of Applied Science • Faculty of Electrical Engineering
Universiti Sultan Zainal Abidin (UniSZA)	• Faculty of Agriculture and Biotechnology
Universiti Malaysia Pahang (UMP)	• Faculty of Chemical Engineering and Natural Resource • Faculty of Industry and Science Technology (FIST) • Faculty of Computer Systems & Software Engineering • Faculty of Electric & Electronic
Universiti Malaysia Perlis (UniMAP)	• School of Mechatronic Engineering • Sensor Technology and Applications Research Cluster
Universiti Teknologi Malaysia (UTM)	• Faculty of Electrical Engineering
Universiti Malaya (UM)	• Faculty of Science
Universiti Malaysia Sarawak (UniMAS)	• Faculty of Resource Science and Technology
Universiti Kebangsaan Malaysia (UKM)	• Department of Chemical and Process Engineering • Department of Botany
Universiti Teknologi PETRONAS (UTP)	• Chemical Engineering Programme
Universiti Sains Malaysia (USM)	• School of Pharmaceutical Sciences
Universiti Islam Antarabangsa Malaysia (UIAM)	• Faculty of Engineering
Universiti Malaysia Terengganu (UMT)	• Faculty of Science & Technology • Institute of Marine Biotechnology

Table 10 List of Karas related project conducted in Malaysia

No	Title of Project	Start Date	Executing/Implementing Agency
1	De Novo Assembly, Annotation and Analysis of Transcriptome Sequences of Callus Culture *From Aquilaria malaccensis Lam.*	2014	Universiti Putra Malaysia
2	Development of An Information Database for The Conservation & Sustainable Use of *Gonystylus bancanus* (Ramin) and *Aquilaria malaccensis* (Karas) in Malaysia	2013	Forest Research Institute Malaysia (FRIM)
3	Miscibility Study of Gaharu Essential Oil in Water and Organic Solvents	2012	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
4	Micropropagation of *Aquilaria malaccensis Lank.* and *Aquilaria microcarpa Baill.*	2012	Department of Plant Science and Environmental Ecology
5	Ploidy Level Changes and The Chemical Contents of *Aquilaria malaccensis* (Karas)	2012	Not available
6	Development of Antioxidant Herbal Based Products From *Aquilaria malaccensis*	2012	Not available
7	The Valuation of Jati and Gaharu Stand	2012	Forest Research Institute Malaysia (FRIM)
8	Forest Plantation Establishment, Silviculture and Inoculation of *Aquilaria* Tree Species	2012	Forest Research Institute Malaysia (FRIM)
9	Authentication of Important *Aquilaria* Species for Plantation in Malaysia Using Molecular Marker Technology	2012	Forest Research Institute Malaysia (FRIM)
10	Effects of Plant Growth Regulators, Carbon Sources and PH Values on Callus Induction in *Aquilaria malaccensis* Leaf Explants and Characteristics of The Resultant Calli	2011	Universiti Putra Malaysia (UPM)

11	Improvement of Socio-Economic Community Through Development of Facility for Extraction of Gaharu Oleoresin Product and Application of Inoculation Technology Karas Tree	2011	Syarikat Asap Koyan Development Community, Belaga Sarawak
12	R&D on The Extraction of Gaharu Oil, Development of Products From Gaharu Oil and Management of Karas Tree Planting	2011	Forest Research Institute Malaysia (FRIM)
13	A Preliminary Study on The Potential of Ants as A Biological Enhancer of Gaharu Production	2011	Forest Research Institute Malaysia (FRIM)
14	Elucidating The Gaharu Resin and Other Biosynthetic Pathways by Large Scale Transcriptome and Metabolite Profiling	2011	Institut Genom Malaysia (MGI)
15	Development of Portable Ultrasonic Tomography for Agarwood Evaluation	2011	Malaysian Nuclear Agency (NUCLEAR)
16	Resolution of Complex Sesquiterpene Mixture in *Aquilaria malaccensis* (Gaharu) Volatile Oils Using Gas Chromatography Methods	2011	Faculty of Industry and Science Technology (FIST), Universiti Malaysia Pahang (UMP)
17	Molecular DNA Studies of Three *Aquilaria* Species in Malaysia	2011	School of Graduate Studies, Universiti Putra Malaysia
18	Optimised Application of The Microwave Extraction Technique of Essential Oils From *Aquilaria malaccensis Lamk* Wood and Cymbopogon Nardus (L.) Rendle Leaves	2011	School of Graduate Studies, University Putra Malaysia
19	Inducement Techniques for Gaharu Production in Malaysian Grown *Aquilaria malaccensis*	2011	Not available
20	The Economics of Karas (*Aquilaria spp.* on Plantation for Gaharu Production	2010	Forest Research Institute Malaysia (FRIM)
21	Planting, Silviculture and Forest Plantation Management of *Aquilaria* (Karas)	2010	Forest Research Institute Malaysia (FRIM)

22	Characterization of Genes Associated with Gaharu Formation and Anatomical Changes in Stress-Induced *Aquilaria Malaccensis Lam*	2010	Universiti Putra Malaysia
23	Wood for The Trees : A Review of The Agarwood (Gaharu) Trade in Malaysia	2010	TRAFFIC Southeast Asia commissioned by the CITES Secretariat
24	Development of Herbal Health Care Products From Gaharu and Selected Plant Extracts of *Aquilaria* Species	2009	Forest Research Institute Malaysia (FRIM)
25	Proteome Profiling of *Aquilaria malaccensis* Upon Cold Stress Conditions	2009	Forest Research Institute Malaysia (FRIM)
26	Joint Research Project on Effective Inoculation Techniques and Treatments on Matured *Aquilaria* Trees	2009	Forest Research Institute Malaysia (FRIM)
27	Extraction of The Essential Oil of *Aquilaria malaccensis* (Gaharu) Using Hydro-Distillation and Solvent Extraction Methods	2009	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
28	Analysis of Agarwood Oil Composition Via Preparative Thin Layer Chromatography	2009	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
29	Analysis Volatile Compound of Gaharu Oil Composition Via Solid Phase Micro Extraction (SPME)	2009	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
30	Analysis of Agarwood Oil Composition Via Preparative Thin Layer Chromatography	2009	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
31	The Investigation of Different Extraction Techniques To Extract Gaharu Oil	2009	Universiti Teknologi PETRONAS, Bandar Sen Iskandar, 31750 Tronoh, Perak Darul Ridzuan
32	The Quantification of Dry and Wet Inland *Gonystylus spp.* (Ramin), *Aquilaria spp.* (Agarwood) and *Intsia spp.* (Merbau) in Peninsular Malaysia	2009	Forestry Department Peninsular Malaysia & Forest Research Institute Malaysia (FRIM)

33	Advisory Services Towards Developing Tissue Culture Propagation Protocol for Menara Murni's Propriety Gaharu – Producing Species	2008	Forest Research Institute Malaysia (FRIM)
34	Advisory/Consultancy Services on The Production of Planting Stocks, Plantation Establishment, Management and Inoculation for Commercial Gaharu Production Project	2008	Forest Research Institute Malaysia (FRIM)
35	Study on Pre-treatment of Gaharu Oil Extraction Process	2008	Faculty of Chemical Engineering and Natural Resource, Universiti Malaysia Pahang
36	Comparison of Agarwood Essential Oil & Water Soluble (Hydrosol)	2008	Faculty of Chemical Engineering and Natural Resource, Universiti Malaysia Pahang
37	Extraction of Gaharu Essential Oil Using Ultrasonic Assisted Hydro distillation	2008	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
38	Extraction of Gaharu Essential Oil Using Ultrasonic Assisted Steam Distillation	2008	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
39	Comparison of Gaharu (*Aquilaria malaccensis*) Essential Oil Composition Between Each Countries	2008	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
40	Application of Solid Phase Micro Extraction in Gaharu Essential Oil Analysis	2008	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
41	Comparison Between Chemical Compounds in Gaharu Smoke (Burning) and Gaharu Oil (Hydro distillation)	2008	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang

42	Characterisation and Sensory Evaluation of Essential Oils From Selected *Aquilaria* and *Curcuma* Species Towards Quality Control Assessment of Herbal Products	2007	Forest Research Institute Malaysia (FRIM)
43	Ecology and Conservation of *Aquilaria* Species in Peninsular Malaysia	2007	Universiti Putra Malaysia (UPM)
44	In Vitro Technology for Mass Propagation and Phytochemical Analysis of *Aquilaria malaccensis* and *Aquilaria hirta*	2007	Forest Research Institute Malaysia (FRIM)
45	Development of *Aquilaria* Plantation and Processing	2007	Malaysian Nuclear Agency
46	Effect of Soil Physical and Hydrological Properties Toward *Aquilaria* Distribution and Resin Production in Natural Tropical Condition	2007	Malaysian Nuclear Agency
47	Study on The Extent of Gaharu Trade in Peninsular Malaysia	2006	Forest Research Institute Malaysia (FRIM)
48	Essential Oil Quality and Standards Based on Novel Marker Compounds Isolated and Identified for *Aquilaria malaccensis* (Gaharu)	2006	Universiti Malaysia Pahang
49	Development of Superior Grade Gaharu Extract Via Enzymatic Intensification Steam Distillation Process	2006	Universiti Malaysia Pahang
50	Extraction of Gaharu Essential Oil Using Spinning Band Distillation	2006	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang
51	Inducement of Gaharu for Commercial Production Through Patented Technology	2006	FRIM (leader) collaboration with Sabah Forestry Department, Sarawak Forestry Department (through the Sarawak Forestry Corporation) and Nuclear Malaysia Agency (ANM)

52	Alternative Extraction Processes for The Production of Essential Oils From Gaharu in Large Scale	2005	Forest Research Institute Malaysia (FRIM)
53	Soil Survey and Site Assessment for Planting of *Aquilaria malaccensis*	2004	Forest Research Institute Malaysia (FRIM)
54	Weaning of Tissue-Cultured Plantlets of Selected Forest Species (Jelutong, Sesenduk and Karas) With Commercial Potential	2003	Forest Research Institute Malaysia (FRIM)
55	Micropropagation of *Shorea leprosula Miq.* and *Aquilaria malaccensis Lamk.*	2000	Universiti Kebangsaan Malaysia
56	Investigation Into The Anti-Fungal Properties of Selected Isolates From The Infected Wood of *Aquilaria malaccensis* (Karas)	2000	Forest Research Institute Malaysia (FRIM)
57	The Investigation of The Formation of Gaharu in *Aquilaria malaccensis* Through Inoculation and Wounding	1997	Forest Research Institute Malaysia (FRIM)
58	The potential of *Aquilaria malaccensis* (Agarwood) Leaves for Lowering LDL-cholesterol	Not available	Forest Research Institute Malaysia (FRIM)

3. 2.3 Publications related to the Ramin and Karas issues in Malaysia

There are various forms of publications produced from research activities on Ramin and Karas in Malaysia. The results of this research was published either as journals, books, reference books, scientific publications, reports, thesis and also proceedings. **Table 11** shows the standardization of term used by different author in their publications as a guide to differentiate the type of publication collected in this study.

Table 11 Standardized of term used by different author in their publications

Types of publications	Term Used by Different Author
Proceeding	Paper presented at Conference, Workshops, Colloquium, Seminar, Invited Paper in Seminar/Workshops/ Congress
Journal	Journal, Articles
Review	Notes, Manuscript, Summary, Reprints
Reports	Technical Report, Working Group Report, Final Report, Meeting of Expert Group, Documentation, Record
Books	Books, Chapter in Books
Bulletin	Newsletter, Leaflet
Poster	Poster
Thesis	Undergraduates, Masters and PhD

The main focus on this study is collecting the publication related to research and development of Ramin and Karas in Malaysia, however the publication from other countries are also listed as references. About 227 publications on Ramin and 387 publications on Karas has been collected (**Table 12** and **Table 13**)

Table 12 Publications related to Ramin

Publications	Malaysia	Others	Total
Proceeding	28	38	66
Journal	35	32	67
Review	7	8	15
Reports	14	22	36
Books	4	6	10
Bulletin	5	14	19
Poster	2	0	2
Thesis (PhD)	1	0	1
Thesis (Masters)	2	0	2
Thesis (Undergraduates)	0	9	9
TOTAL	**98**	**129**	**227**

Table 13 Publications related to Karas

Publications	Malaysia	Others	Total
Proceeding	101	35	136
Journal	51	48	99
Review	8	7	15
Reports	24	12	36
Books	20	5	25
Bulletin	8	12	20
Poster	28	0	28
Thesis (PhD)	3	4	7
Thesis (Masters)	3	4	7
Thesis (Undergraduates)	14	0	14
TOTAL	**260**	**127**	**387**

The complete list of publications related to Ramin and Karas can be found in "Annotated Bibliography of Publication on Ramin and Karas (1927 – 2015)".

3.3 Information on timber trading and production of Ramin and Karas in Malaysia

3.3.1 Ramin production in Malaysia

Ramin wood has significant commercial value and is used to make products such as furniture, toys, broom handles, blinds, dowels and decorative mouldings. Ramin is easy to work to a smooth finish. The heartwood is straw-coloured and the sapwood is similarly coloured and up to 60mm. **Table 14** shows the product that can be produced from Ramin and **Table 15** shows the example of Ramin-based products.

Table 14 Product that can be produced from Ramin

Species	Use
G. affinis	Wood (reddish, floats in water) known to be used for house-construction in Negeri Sembilan, Malaysia
G. bancanus	Timber for general light construction, heartwood used for incense
G. confusus	Decoction of roots given after child-birth (e.g. used in Pahang, Malaysia)
G. forbesii	Comparatively hard and heavy timber, used for construction, but only of minor importance
G. keithii	As fish poison (pounded fruit mixed with ash) and as a medicine (unspecified), in Sabah, Malaysia
G. macrophyllus	Comparatively heavy timber, used for construction; heartwood used for incense
G. maingayi	Timber used for making planks and boards for domestic buildings; a decoction of the roots is administered after childbirth as a protective medicine
G. micranthus	Timber for planks
G. velutinus	Timber for planks and house construction in Sarawak, Malaysia
G. xylocarpus	Timber for cheap furniture (Sarawak, Malaysia)

Source: Van Steenis (1948), Soerianegara and Lemmens (1993) which cited in Framing the picture: An assessment of ramin trade in Indonesia, Malaysia and Singapore (2004)

Table 15 List of Ramin products

No	Products	No	Products	No	Products
1	Logs	36	Toothpicks	71	Straight edges
2	Furniture	37	Fans	72	Barrels
3	Sawn timber	38	Screens	73	Cooperage
4	Dressed Timber	39	Marquetry	74	Staves
5	Dowels	40	Caskets	75	Packs
6	Flooring	41	Statuettes	76	Cases
7	Mouldings	42	Ornaments	77	Boxes
8	Louver Doors	43	Beads	78	Drums
9	Picture Frame	44	Tableware	79	Pallets
10	Blind Fittings	45	Kitchen ware	80	Collars
11	Blind Slats	46	Trays	81	Plywood
12	Round Rod	47	Carpentry	82	Strips
13	Incense	48	Parquet Panels	83	Friezes
14	Carving	49	Ceilings	84	Turnery
15	Antique furniture	50	Panelling	85	Profiles
16	Cue-stick & rests	51	Shingles	86	Door lipping
17	Futon beds	52	Shakes	87	Skirting boards
18	Baby product	53	Window frames	88	Veneer
19	Cabinets	54	Doors	89	Sheets
20	Cases	55	Pins	90	Splices
21	Boards	56	Claddings	91	Finger-jointed planks
22	Desk	57	Thresholds	92	Sawn wood
23	Other bases for electrical	58	Shuttering	93	Decks
24	Umbrella holder	59	Builders carpentry and joinery (BCJ)	94	Cross-arms
25	Walking sticks	60	Stringers	95	Planks
26	Handles	61	Stair treads	96	Scantlings
27	Paper	62	Tools	97	Beams
28	Cardboard / paperboard	63	Lasts	98	Flitches
29	Pulp	64	Shoe trees	99	Poles
30	Hanger	65	Broomstick handles	100	Piles
31	Spools	66	Brush-backs	101	Baulks
32	Bobbins	67	T-squares	102	Saw-logs
33	Reels	68	Set Squares	103	Pulp-logs
34	Splints	69	Rulers	104	Cops
35	Pegs	70	Tripods		

3.3.2 Karas production in Malaysia

Agarwood, a highly valuable and fragrant resin are used in many countries such as Malaysia, West East countries, China, Japan, Vietnam, Thailand since last 20 centuries for wide range of uses. Religions such as Buddhism, Hinduism and Confucius also use agarwood in their religious ceremonies. For example, Buddhists in Thailand include agarwood into the fire during cremation. The joss stick used in prayers by Buddhists also made from grade C of agarwood. Meanwhile, for Muslims especially in Saudi Arabia and United Arab Emirates they used water-based perfumes made from agarwood extract oil popularly known as "attar" oil and use daily to bring freshness especially during prayer. Agarwood also widely used by Muslims in other countries.

In China, the incense is applied as a sedative against abdominal complaints, asthma, colic and diarrhoea, and as an aphrodisiac and carminative. A grated woods enters into various preparations used during and after childbirth, and to treat rheumatism or tuberculosis. However, agarwood extract oil obtained from resin which are synonim in perfume makers also can be used to produce pharmaceutical products, cosmetics, lotion, shampoo and lip balm.

Most people think that resin is the only part of Karas trees that can brings benefit to human, however other parts such as leaves, trunks, roots and blocks also has its own purpose and worth to be commercialized. For example, Karas leaves that are starting to be harvested after three years planted are used in tea powder making and food-based products such as Karas biscuits, seasoning herb soup and ice-cream. In Japan, Karas tea are taken during drink tea ceremony. While in medical, Karas leaves used to produce green tea is said to be able to treat various disease such as diabetes, hypertension, gout and sleep difficulties. *Genkwanin glycoside* in Karas leaves also able to remove mercury from the body to slow down the aging process effectively. In addition, Karas tea also can promote blood circulation and strengthen the heart and the nervous system in the body. While the roots also widely used in pharmaceuticals such in drug production for example diabetes medicine. Compare to other uses of Karas, medicinal industry requires lower grade of *Aquilaria*.

Karas wood blocks are also not exempted from being utilized by producing bracelets as well as art sculptures made on the statues and carvings in Buddhist and Taos temples. In Malaysia, the outer bark of Karas is used by local people as wall for their houses, traditional costumes, ropes and bedding for writings. The properties of outer bark which is strong stringy that are not easily to break when pulled make it suitable to be made as ropes for traditional Malay game called "gasing".

Due to high demand on Karas based products especially agarwood extract oil, most of the products which produce by local manufacturers is exported to international

markets. Most of these products will be exported to Saudi Arabia, United Arab Emirate, Bahrain, Kuwait, Oman, Jeddah, Taiwan, Hong Kong, Vietnam, Japan, Korea, Macau, India, China, Thailand and Singapore.

Table 16 shows the list of Karas-based products that have been commercialized by local manufacturer in Malaysia as well as from other producer countries. This information is useful for references to local entrepreneurs to get new idea to diversify the agarwood based product for overseas market demand.

Table 16 List of Karas-based products

No	Products	Functions
1	Agarwood Block	Some function of valuable agarwood blocks is to produce bracelets, rings, walking stick, sculptures and carvings in Buddhist temples and Taos.
2	Gaharu Chip	Those who suffer from health problems such as cancer, asthma, flatulence, winds, difficulties in urination, stomach ache, vomiting, cough, and cholera are encouraged to sniffed the smoke produced when agarwood chips is burned. In addition, this fragrant smoke also act as aromatherapy fragrance which could be useful for relieving anxiety and insomnia in which these scents can calm the nervous system before bed to allow a person to have longer sleep and soundly. While in Thailand, agarwood chips are thrown into the fire during a Buddhist cremation.
3	Agarwood Powder	Agarwood powder from lower grade such as Grade C is usually used as one of ingredient in the production of joss sticks and mosquito coils. Despite having low resin content, yet the agarwood powder also can still be burned to produce pleasant smell, freshness and create the romantic atmosphere.
4	Agarwood Extract Oil	Used to produce perfumes, medicines, candles and preservatives on accessories. Agarwood extract oil is also included in cosmetic products such as soap, shampoo, and lotion for skin smoothing and fragrant the body.

5	Agarwood Distilled / Boiled Water	Distilled water is a by-product obtained during the cooking process of agarwood powder to produce agarwood oil. Agarwood distilled water resulting from this process is very useful for beauty where it can smooth the skin and treat someone's face. It also can treat fever, malaria, rheumatism, paralysis, stomach ache, difficulties in urination and also used by pregnant women and mothers in confinement as well.
6	Perfumes	Used to produce perfume for human used especially for those in the Middle East countries. It is also used to produce perfume which used in closed area such as house, office space, shops, spa and worship house such as mosques. For Muslims in Arabic countries, they used the agarwood oil to enhance the ambience of wedding ceremonies.
7	Tea	Agarwood leaves will dried and crushed to produce tea. The leaves contain *Genkwanin glycoside* has many dietary benefits and is capable to remove mercury from body which efficiently help slowing down the aging process. Agarwood tea blended with several herbs also said to cure diabetes, high blood and gout. Another benefit of agarwood tea are strengthen the heart, cure the fever, flu, improve sleep, for beauty, eliminate flatulence, constipation, asthma and for weight loss. In Japan, they drink agarwood tea during drink tea ceremony.
8	Food	Karas leaves usually used to produce cookies, snack, chicken soup mix, soup seasoning in instant noodle and etc. This products are good for those who concern about their health and to those who want to cure their illness
9	Cosmetic	Extracts from the leaves Karas and gaharu oil is included in the ingredients to produce soap, shower gel, facial cleanser, masker, anti-aging cream, moisturizer cream, lip balm, hand and body lotion.
10	Joss stick	At the beginning of the process to produce agarwood extract oil, the Karas wood will be cut into small size before being grinded into powder. This powder is then fermented in water for two weeks before being dried and graded. The powder from higher grade will be cook using special kitchen in order to extract the oil. Meanwhile, the lower grade of agarwood powder will be used to produce

		joss stick and incense. The joss stick is used in prayer by Buddhist.
11	Agarwood Rosary / Prayer Beads	Prayer beads or known as rosary are used by Muslim to count the number of Zikr uttered after prayers. By using a rosary made from agarwood is said to increase the focus when someone utter the Zikr and worship to the Creator. Agarwood rosary is also used by monks and Buddhists but the size is greater than the rosary used by Muslims.
12	Agarwood Bracelet	Wearing agarwood bracelet is said can calm someone, eliminate nervous, fear, anxiety and heart palpitations, cure asthma and shortness of breath, treat fainted people and relieve the colds body. According to Muslims, wearing bracelets from fragrant Agarwood is said can avoid the interference of spirit, magic, spellbinding through magic and hysteria that is often experienced by weak person.
13	Agarwood Necklace Beads	Other than as accessories for women, it is also used for functions such as agarwood bracelets.
14	Shampoo	Agarwood extract oil is used as fragrance in shampoos as well as in lotion and soap production. There are also some producers that include Karas leaves for a particular purpose.
15	Lotion	Similar to shampoo and soap, the agarwood extract oil also included in lotion for their fragrant. There are also some producers that include Karas leaves for a particular purpose.
16	Soap	Agarwood extract oil is used as fragrance in soap production, similar to shampoo and lotion. There are also some producers that include Karas leaves for a particular purpose.
17	Medicated Pillow	The Karas leaves will be dried before it is being used in producing medicated pillow. Some producers also produce rectangular-shape of agarwood block to be used as medicated pillow. This pillow will give benefit to people who suffer from insomnia, migraine and lumbago.
18	Candles	Agarwood extract oil is included in the ingredients to produce candles for aromatherapy purposes. The scent of agarwood produced when the candle is burned are sniffed to calm and relief someone's stress. Agarwood

		aromatherapy candles also have the same functions as a burnt Agarwood chips mentioned before, but no smoke is produced when the candle is burned.
19	Agarwood Walking Stick	A walking stick made from agarwood is suitable to be made as exclusive and expensive gifts to the elderly who using walking stick.
20	Cigarette Stick	The agarwood stick of toothpick size is place at the middle of cigarette before the smoker burn the cigarette. The sticks are functioning to release special fragrant, reduce smoking odour, detoxify the body when using alcohol and contribute to improve physiological health of men.
21	Sculptures and carvings	The sculptured usually placed in Buddhist and Taos temples in office and house as decoration. For people in countries such as China, Japan, Hong Kong and Taiwan, which are mostly Buddhists, it is believe that having sculptures made from agarwood block symbolizes their wealth, economic power and social status.
22	Incense	In Japan, the Buddhism will burn the incense or agarwood chips during purification ritual in order to purify the space surrounding the statue of Buddha, when the monk reciting the Buddhist sutras, during funeral and during their visit to graves
23	Medicine	Use in countries such as Malaysia, Myanmar ethnic Chinese population, Taiwan and China for traditional medicine purposes. Some of agarwood functional in medicine are to cure skin disease, anti-inflammatory, diarrheal, cold and digestion problems, anti-asthma antitoxic, antioxidant, mental stress, hypertension, hepatitis, painkiller, cirrhosis, diuretic, angina, fatigue, gastric, avoid vomiting by warming the stomach and etc.

3.3.3 Import and export of Ramin and Karas products in Malaysia

Information on the import and export statistic data from year 2013 to 2014 has been collected from Malaysian Timber Industry Board (MTIB). MTIB is the Management Authority for the issuance of CITES Export Permit for the export of Ramin, Karas and Gaharu wood originating from Malaysia, or the CITES Re-export Certificate for the re-export of Ramin, Karas and Gaharu wood from other countries, or the CITES Import Permit for the import of Ramin, Karas and Gaharu wood. Export of CITES (Ramin wood and Karas product) is subject to export quota. For the export of Ramin CITES export permit application can be made directly, while for Karas products like woodchip or Agarwood oil is subject to the approval of the quota to the company. **Table 17** and **Table 18** shows the annual export of Ramin and Karas from Malaysia from 2012 to 2014.

For 2012, the major importers of Ramin products from Malaysia are Japan (50%), followed by Germany (22%) and Taiwan (8%). For year 2013, the major importers are Germany and Japan, both import 36% from the total export for that year. Meanwhile, the third highest importers are Taiwan (8%). For 2014, the statistics provided only until June 2014. As for June 2014, the major importers of Ramin products are Germany (38%), Japan (35%) and Vietnam (5%).

Table 17 Annual Export of Ramin Products from Malaysia to Different Destination (Volume (m^3))

2012								
Product	**Dowel**	**Dress Timber**	**Flooring**	**Moulding**	**Louvers Door**	**Picture Frame**	**Sawn Timber**	**Total**
Belgium						0.38		0.38
Canada						2.71		2.71
China						2.28		2.28
England	7.33			6.09				13.425
Germany							443.89	443.87
Hong Kong							66.56	66.56
Italy		30.41		8.79	45.69			84.88
Japan		4.40		255.21		0.78	744.88	1,005.26
Norway						1.37		1.37
Panama							60.22	60.22
Russia							93.09	93.09
Singapore			0.69				26.20	26.89
Taiwan							175.27	175.27
Turkey				17.30				17.30
USA						12.24		12.24
Grand Total	7.33	34.80	0.69	287.39	45.69	19.76	1610.11	2005.75

2013

Product	Blind Fittings	Blind Slats	Dowels	Dresss Timber	Moulding	Picture Frame	Sawn Timber	Grand Total
Australia						2.70	2.20	4.90
Canada						0.95		0.95
England			8.36					8.38
Germany				124.43			764.27	888.70
Hong Kong						1.22		1.22
Italy							271.33	271.33
Japan				80.88	376.0989	0.77	421.37	879.12
Netherlands							34.26	34.26
Taiwan							194.88	194.88
Thailand	13.00	28.60						41.60
USA						3.36		3.36
Vietnam							95.55	95.55
Grand Total	13.00	28.60	8.38	205.31	376.0989	9.00	1783.86	2424.25

2014 (Until Jun)

Product	Blind Slats	Moulding	Picture Frame	Round Rod	Dress Timber	Sawn Timber	Grand Total
Australia		4.00					4.00
Belgium			0.21				0.21
Germany						537.35	537.35
Italy						202.35	202.35
Japan		114.71		60.24	3.21	312.03	490.18
Maldives	5.61						5.61
Philippines	1.80						1.80
Taiwan						32.59	32.59
Thailand	50.85						50.85
Vietnam						69.07	69.07
Grand Total	58.26	118.71	0.21	60.24	3.21	1153.39	1394.01

For 2012, the major importers of Karas products from Malaysia are Taiwan (36%), followed by Vietnam (21%) and UAE (18%). For year 2013, the major importers is Taiwan with 35% from the total export, followed by Singapore (31%) and Vietnam (16%). Meanwhile, for 2014, the statistics provided only until June 2014. As for June 2014, the major importers of Karas products still dominated by Taiwan (44%) followed by Singapore (26%) and Vietnam (21%)

Table 18 Annual Export of Karas Products from Malaysia to Different Destination (Volume (m^3))

2012

Product	Block	Chip	Oil	Grand Total
Bahrain			4,000.00	4,000.00
Cambodia	928.00	1,055.00		1,983.00
Hong Kong	117.28	1,272.50		1,389.78
India		7,171.00	800.00	7,971.00
Kuwait		246.80		246.80
Macau	40.00	185.00		225.00
Oman		515.00		515.00
S. Arabia		3,296.06	1,450.00	4,746.06
Singapore	1,342.00	22,374.60	4,800.00	28,516.60
Taiwan	310.00	71,060.50		71,370.50
Thailand	145.00	380.00		525.00
UAE	10.70	21,841.95	14,900.00	36,752.65
Vietnam	14,722.00	27,036.00		41,758.00
Grand Total	17,614.98	156,434.41	25,950.00	199,999.39

2013

Product	Block	Chip	Oil	Piece	Grand Total
Brunei		10.00			10.00
Cambodia	1,275.00	6,295.00			7,570.00
China	24.50	33.00	800.00		857.50
Hong Kong		4.54			4.54
India	36.08	41.00		30.00	107.08
Kuwait		4.00			4.00
Laos			48.00		48.00
S. Arabia		1,276.00			1,276.00
Singapore	13,950.00	32,150.00	16,600.00		62,700.00
Taiwan	530.40	68,472.00			69,002.40
Thailand		114.00			114.00
UAE		21,553.70	3,400.00	30.00	24,983.70
Vietnam	9,950.00	14,216.00		8,740.00	32,906.00
Grand Total	25,765.98	144,169.24	20,848.00	8,800.00	199,583.21

2014 (Until Jun 2014)					
Product	**Block**	**Chip**	**Oil**	**Piece**	**Grand Total**
Cambodia	850.00	435.00			1,285.00
China	1,308.00	5,663.00			6,971.00
France			20.00		20.00
Hong Kong	11.53	579.00			590.53
Jeddah		60.00			60.00
Kuwait		12.00			12.00
S. Arabia		563.00			563.00
Singapore	5,800.00	23,581.50	6,000.00	1.00	35,382.50
Taiwan	311.00	58,928.10			59,239.10
Thailand		50.00			50.00
UAE		1,080.85	1,000.00		2,080.85
U. Kingdom			100.00		100.00
Vietnam	150.30	27,435.50			27,585.80
Grand Total	8,430.83	118,387.95	7,120.00	1.00	133,939.78

3.4 Information on Malaysia's policy and management practices of Ramin and Karas

3.4.1 Malaysia's policy in managing threatened tree species

Malaysia is one of the 180 parties signatory to CITES since 20th July 1977, however entry into force on 18th January 1978. By joining CITES Convention, Malaysia has agreed to follow and implement all the regulations enacted by CITES regarding to international trade of flora and fauna species listed by the Convention in Appendix I, II and III. There are 27 species from *Aquilaria* genus and 40 species from *Gonystylus* genus listed in Appendix II of CITES. From the listed species, five species from *Aquilaria* genus including Karas and 28 species from *Gonystylus* genus including Ramin can be found in Malaysia. The Act 686 on International Trade in Endangered Species of 2008 or shortly known as INTESA was implemented in Malaysia with the aim to control the international trade the species of flora and fauna listed in CITES and to ensure that Malaysia fulfil their responsibilities as signatory to CITES Convention. INTESA contains 6 Divisions and 55 Sections. INTESA have been approved by the Parliament of Malaysia and was gazetted on 14th

February 2008. In Act 686, two regulations have been gazetted on 28 December 2008. These regulations include:

i. Permit, Certificate, Registration and Fees
ii. Conservation Centre

However, INTESA effectively implemented in Malaysia from 1st July 2010. Among the 17 flora species in Third Schedule of Act 686 that must be control for international trade, four groups of Malaysia wood species are subject to control according to CITES including:

i. *Aquilaria spp.* (Karas) – effected since 2001
ii. *Gonystylus spp*. (Ramin) – effected since 1995
iii. *Gyrinops spp.* – effected since 2005
iv. *Podocarpus neriifolius* (Podo) - effective since 80's (not commercially significant)

In Malaysia, Ministry of Natural Resources and Environment (NRE) have been appointed as Scientific Authority responsible for advising the Management Authority on non-detrimental findings and other scientific aspects of implementation and monitoring of national trade of listed CITES species. Meanwhile, Management Authority are responsible to ensure the trade such as import, export and re-export of any specimen or products for flora and fauna species listed in CITES. For timber and timber-product including Karas and Ramin, there are two government bodies appointed as Management Authority Party which is Malaysian Timber Industry Board (MTIB) and Sarawak Forestry Department. MTIB is responsible for managing the timber and timber product located in Peninsular Malaysia and Sabah, while Sarawak is managed by Sarawak Forestry Department. With this appointment, all entrepreneur of timber and timber-based products listed in CITES must apply for a permit or certificate to import, export and re-export from Management Authority.

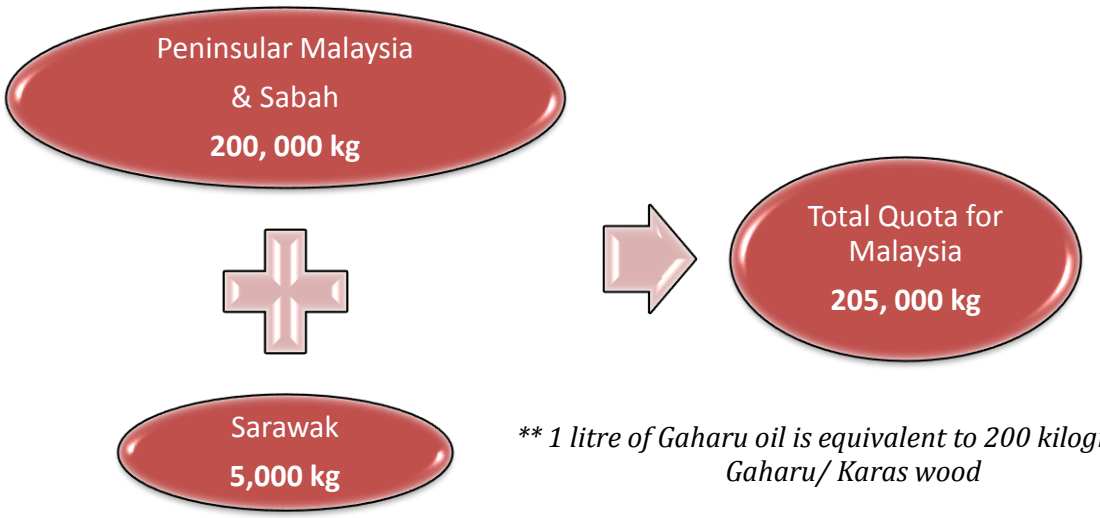
Export of Ramin products and derivatives parts such as dowel, dress timber, flooring, moulding, louvers door, picture frame and sawn timber that obtained from peat swamp forest is subjected to annual export quotas set by CITES Scientific Authority and Management Authority. **Table 19** shows the annual quotas for Peninsular, Sabah and Sarawak set for Malaysia for the year 2014 (*Gonystylus spp.*). The annual quotas may vary for each year as the evaluation and determination of the annual quota is based on report on stocking of Ramin in Malaysia submitted by the Management Authority to the CITES Secretariat.

Table 19 The declination trends of Ramin export quotas in Malaysia due to over exploitation

Year	Peninsular & Sabah (m^3)	Sarawak (m^3)	Total (m^3)
2014	10,000	3,178	13,178
2013	10,000	3,178	13,178
2012	10,000	3,178	13,178
2011	10,000	3,178	13,178
2010	20,000	3,178	23,178
2009	20,000	3,178	23,178
2008	20,000	3,178	23,178
2007	20,000	12,875	32,875
2006	23,000	22,000	45,000

*** 1 m^3 of Ramin volume is equivalent to 540 kilograms of Ramin wood*

In Malaysia, Karas product comes from two sources; naturally grown in natural forest and cultivated plantation. Export of Karas products and derivatives such as essential oils, plant parts and wood chips obtained naturally from forest is subjected to annual export quotas set by CITES Scientific Authority and Management Authority. **Figure 10** shows the annual quotas for Peninsular, Sabah and Sarawak set for Malaysia for the year 2014 (*Aquilaria spp.*). The annual quotas may vary for each years as the evaluation and determination of the annual quota is based on report submitted by the Management Authority to the CITES Secretariat.



*** 1 litre of Gaharu oil is equivalent to 200 kilograms of Gaharu/ Karas wood*

Figure 10 Annual quotas for Peninsular, Sabah and Sarawak that are set for Malaysia for the year 2014 for Gaharu/Karas export activity

To export the wild source of *Aquilaria spp.,* the States must apply export permit before applying CITES permit. Quota application may be made in writing to MTIB and quota approval is subjected to inspection stocks reports belongs to the company. The priority also given to the exporters who has committed investment in producing high value added products. Meanwhile, for *Aquilaria* products that are obtained from sources other than wild source such as plantation and nursery are considered as artificially propagated.

Before any *Aquilaria spp*. products are imported, export or re-export in Malaysia, the traders must apply for permit from the Management Authority (appointed); MTIB for Peninsular and Sabah territory and Sarawak Forestry Department for *Aquilaria spp.* trades made in Sarawak. For all states in Peninsular Malaysia and Sabah, MTIB has ordered that all traders that wish to import, export and re-export any *Aquilaria spp.* products must registered their company with MTIB before applying for a permit or certificate.

3.4.2 Management practice of Ramin in Malaysia

In Malaysia, the National Forestry Policy 1978 laid a firm foundation for the development of the forestry sector. It was revised in 1993 in recognition of the role of forests in providing a multiplicity of goods and services. The revised policy has had direct impacts on the management of forests through the establishment of the Permanent Forest Reserve (PFR), large-scale forest plantations, and importation of logs, greater incentives for downstream processing, promoting the utilization of lesser-known species and small-diameter logs, and manufacturing of value-added products. The National Forestry Policy 1978 and the National Forestry Act 1984 provide Malaysia with a strong policy framework and laws to support sustainable forest management. Both the national policy and act provide a sufficient basis for the protection against harmful activities, promote establishment of wildlife parks and reserves, and reduce activities that may cause detrimental impacts on the environment.

Selective Management System (SMS) is a system established in 1978 designed to control the logging of trees in the forest in Peninsular Malaysia to ensure their long term conservation by allowing only tree species group that having diameter above than specified diameter limits been felled down. This management system originally developed for dry inlands forest. However, peat swamp (PSF) tree species which is Ramin are also make use this system. Using this system, only Ramin tree having diameter more than 45 cm will be felled down. However, in Pahang state, the minimum cutting diameter limit has been increase to 50 cm.

In Peninsular Malaysia, all species in Permanent Reserve Forest areas apply SMS system, meanwhile the logging are prohibited in areas gazetted as Totally Protected Areas (TPAs). Meanwhile, in Sarawak, PSF is managed using Modified Malayan Uniform System (MMUS). The minimum cutting limit allowed by MMUS is 40 cm for Ramin and 50 cm for other species. **Table 20** shows the differences of PSF management system in Malaysia.

Table 20 Differences of PSF management system in Malaysia

Specification	**Peninsular Malaysia**	**Sarawak**
Management System	A modified Selective Management System (SMS)	Modification of Malayan Uniform System (MMUS)
Cutting Cycle	50 years	45 years
Minimum Cutting limit (dbh)	• Ramin : 45 cm dbh (50 cm in the state of Pahang) • 55 cm for other species	• 40 cm Ramin • 50 cm other species
Harvesting Method	Reduced Impact Logging	• Reduced Impact Logging
Timber Transportation Method	• Rimbaka Timber Harvesting – Pahang • Pre-determined Skid Trail - Selangor	• Kuda-kuda

3.4.3 Management practice of Karas in Malaysia

Due to the fact that Karas are depleting in their original habitat due to uncontrolled exploitation, plantations have been introduced to cater the demands for Karas-based products in international markets especially for Arabic countries, Taiwan, Hong Kong, Japan, Korea and China. The Karas plantations are successfully implemented in Malaysia with the support of a number of factors, including the support from government and research institution such as FRIM and MTIB that provide courses and guidance to the planters regarding Karas cultivation, research and development finding to treat the disease that often effected the Karas tree in plantation and the finding of the inoculation techniques that can speed up the formation of the resin. In addition, Karas tree easily can adapt to a variety of plantations environment, that make it suitable for commercial planting.

3.4.3.1 Karas Plantation

The agarwood demands tend to increase the uncontrolled exploitation of this species from natural forest. To cater the high demands for international markets especially for Arabic countries, Taiwan, Hong Kong, Japan, Korea and China, many Malaysian planters had planted several *Aquilaria* species such as *Aquilaria malaccensis, Aquilaria subintegra, Aquilaria crassna, Aquilaria sinensis* and *Aquilaria beccariana*. From this five species, *Aquilaria malaccensis* is the most common species planted in Malaysia. According to a census conducted in 2014, a total 1,571,000 Karas trees have been planted around Malaysia by State Forestry Departments and private plantation companies. **Table 21** shows the statistic of Karas plantation for the year 2014 according to the state in Malaysia.

Table 21 Statistic of Karas plantation for the year 2014 by state in Malaysia.

State	Area (Ha)	No of Trees	Economy Estimation (RM500 / Tree)
Johor	2.0	5,000	2,500,000
Kedah	44.1	109,500	54,750,000
Kelantan	40.5	43,200	21,600,000
Melaka	2.0	5,000	2,500,000
N. Sembilan	20.6	45,000	22,500,000
Pahang	144.1	351,000	175,500,000
Perak	298.2	415,800	207,900,000
Perlis	5.7	14,000	7,000,000
Pulau Pinang	4.0	10,000	5,000,000
Sabah	311.0	342,100	171,050,000
Selangor	16.6	45,500	22,750,000
Terengganu	230.0	185,000	92,500,000
TOTAL	**1,119.0**	**1,571,100**	**785,550,000**

Source: Ismail Muhammad, 2014

The 10% increment compare to trees planted in 2000 – 2005 (1,425,108 trees) gives an indication that Karas plantations is one of profitable business sector. The planters are encouraged to participate in plantation and inoculation courses and workshops which often held by several government agencies such as MTIB and FRIM. Private companies those selling the seedlings and inoculants product also offer consultation services with negotiable price rates from these two agencies.

3.4.3.2 Seedlings Supplies

The supplies of Karas seedlings can be obtained from Karas tree in natural forest during fruiting season or from commercial nursery. Types of seedlings includes:

i. Seedlings

The seedlings collected from mother tree usually perform better than seedlings obtained from matured tree in plantation or produce from tissue culture techniques. To get the best quality of seedlings the suitable mother tree should have perfect crown shape, straight trunk, dense leaves and green colour. When these seedlings are moved to the farm, the twisted roots will not spread widely to find water and nutrients required by the tree. Hence, the insufficient supply of water and nutrients to the tree will affect the plant growth. The other long-term consequences of coiling are the tree easy to collapse and easy to be attack by disease.

Figure 11 Karas seedlings collected in Perak

Some of fruits will be stored in fridge up to six months at 80°C before sell. The percentage for the seedlings to survive is only 10%. Fruit that is not defective, damaged or bruised does not change in colour, and collected before germinating are the suitable criteria for seedlings survival and vigour. **Figure 11** shows the example of Karas seedlings collected in Perak.

ii. Saplings

Seedlings are collect near to parental tree (**Figure 12**). The saplings that possess at least 2-3 leaves or have height of 10-15cm are suitable to be collect. Seedlings should be collect carefully to ensure the spinal root of the

tree is not damage. The best time to collect seedlings is in the morning or rainy season and must be transferred to polybag soon after being collected. The germinated saplings should be left until it having at least 2-3 leaves and height of 10-15 cm before it can be transferred to poly bag.

Figure 12 Karas seedlings in natural forest

iii. Culture tissue

Some of seed suppliers in Malaysia had conducted a research and produce seedlings from tissue culture.

3.4.3.3 Karas saplings arrangement

A compact arrangement of saplings will lead to more intense competition in getting sunlight for saplings to perform photosynthesis (**Figure 13**). As a result, the seedlings will have a little branch, finer trunk but taller than normal seedlings which do not experience the competition.

Figure 13 A compact arrangements of Karas saplings

3.4.3.4 Fertilization

The best fertilization method is by directly putting fertilizer into the polybag, which is putting it onto the soil in each polybag. However, in the nursery, leaf spray method often practiced as fertilization can be done on a number of seedlings at a time which will save time. Furthermore, the seedlings that are arranged closely to each other will cause difficulties to direct fertilization into polybag especially the saplings in the middle of arrangement. Spraying the leaves will cause seedlings to look healthy and fresh; however the roots cannot absorb sufficient nutrients for growth. Rock phosphate such as Egypt Rock Phosphate, Gua Musang RB and Christmas Island Rock Phosphate are the suitable fertilizer for Karas tree.

Figure 14 Egypt Rock Phosphate is one of suitable fertilizer for Karas tree

3.4.3.5 Growing medium

Suitable mixed medium for nurseries is the ratio of 3:2:1 (3 soil parts: 2 sand parts and 1 humus part). The use of pure soil (not mixture with other medium) as a medium for sowing the seedlings are not suitable due to the tree roots will not get good ventilation and good irrigation for growth. This mixture ratio 3:2:1 can ensure that the seedlings grow and get enough nutrients.

3.4.3.6 Shelter

Ensure the seedlings are not located under the shelter for a long period of time or no shelter at all. Seedlings with no shelter will have a small trunk, but taller than normal seedling due to competition for light sources for performing photosynthesis process. The ground surface also will become dry, harden and prevent water to reach the roots. While the seedlings that are placed in the shelter for long period of time will have small size and slow growth rate due to lack of light to perform photosynthesis process. The seedlings should be exposed to the light gradually until it reaches 60% of exposure. Meanwhile, the saplings that are just transferred from nurseries to plantation must be "rest" for at least 1-2 days before it can be planted. This process is called "hardening". The "hardening" process can ensure that the saplings are not shocked with the changes on weather and new environment in plantation, which could differ from its previous nursery.

3.4.3.7 Watering

The seedlings should be watered 2-3 times daily to prevent the seedlings to wilt, stunted growth and died.

3.5 A comprehensive web-based database information system of Ramin and Karas in Malaysia

The successful development of the web-based database information system of Ramin and Karas will contribute towards the best practices in managing and monitoring these endangered species in Malaysia. As a one-stop centre of Malaysian CITES-listed tree species, the information database known as the MyCITES will comprise of a full and complete set of information on Ramin and Karas, including the current status of their population, production, trade and management practices in Malaysia. Team member of this Activity had cooperated with FRIM's ICT officers to decide the requirement that needed in developing MyCITES before the appointment of a web developer to develop MyCITES.

3.5.1 Development of a comprehensive web-based information system of Ramin and Karas in Malaysia

All information gathered will feed into MyCITES web site and can be accessed online by the public. Several discussions and meetings were held with web developer to design and develop MyCITES. The requirements for MyCITES was decided by FRIM's ICT and Activity team member as follows:

i. Operating Server: Window Server
ii. Interface: PHP
iii. Database: Microsoft SQL
iv. Web Server: IIS

MyCITES is located in FRIM server upon completion of web development. The web can be accessed from http://mycites.frim.gov.my as shown in **Figure 15**.

The Homepage is designed for user to find and directed to the desired tree species database. Currently, the project only covered two species database, *Gonystylus bancanus* and *Aquilaria malaccensis*. In future, it is flexible enough to include other Malaysian CITES tree species database into MyCITES. Therefore, MyCITES has been designed to cater the expansion when database for another Malaysia CITES tree species are available and inserted in future. When the number of database increase, the search column would be important to enable the MyCITES user to find their desired species information in a short time.

Besides, the target user of MyCITES are not only for those who knows the species scientific name, therefore, for public who have no ideas what is "Ramin" and "Karas" is all about (what their scientific name) can still find the desired species database by typing their vernacular name, synonyms and etc. The web has two language options; English and Bahasa Malaysia. The species front page is shown in **Figure 16**. Both species have similar interface.

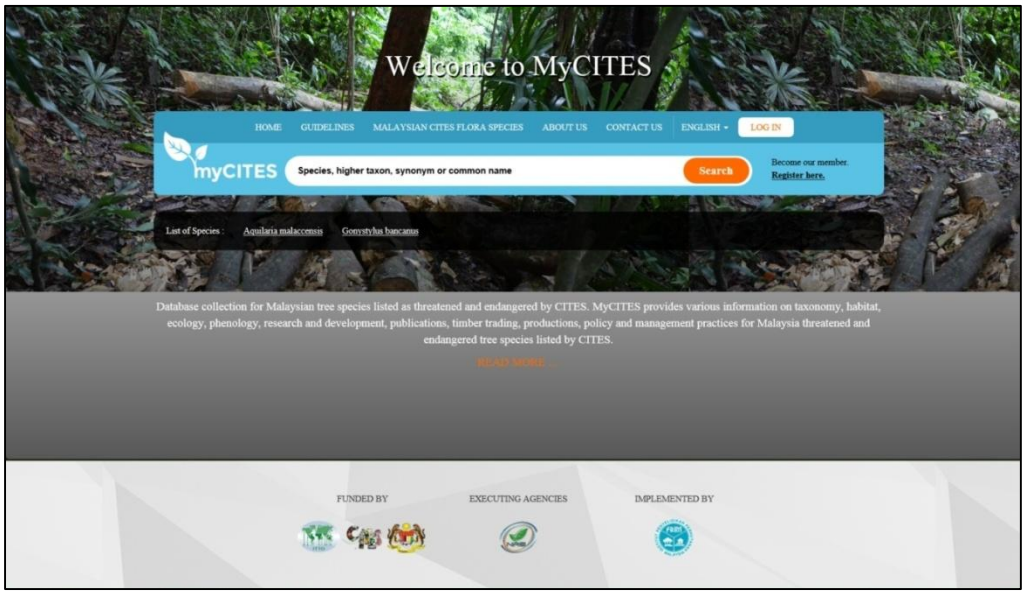


Figure 15 Homepage of MyCITES

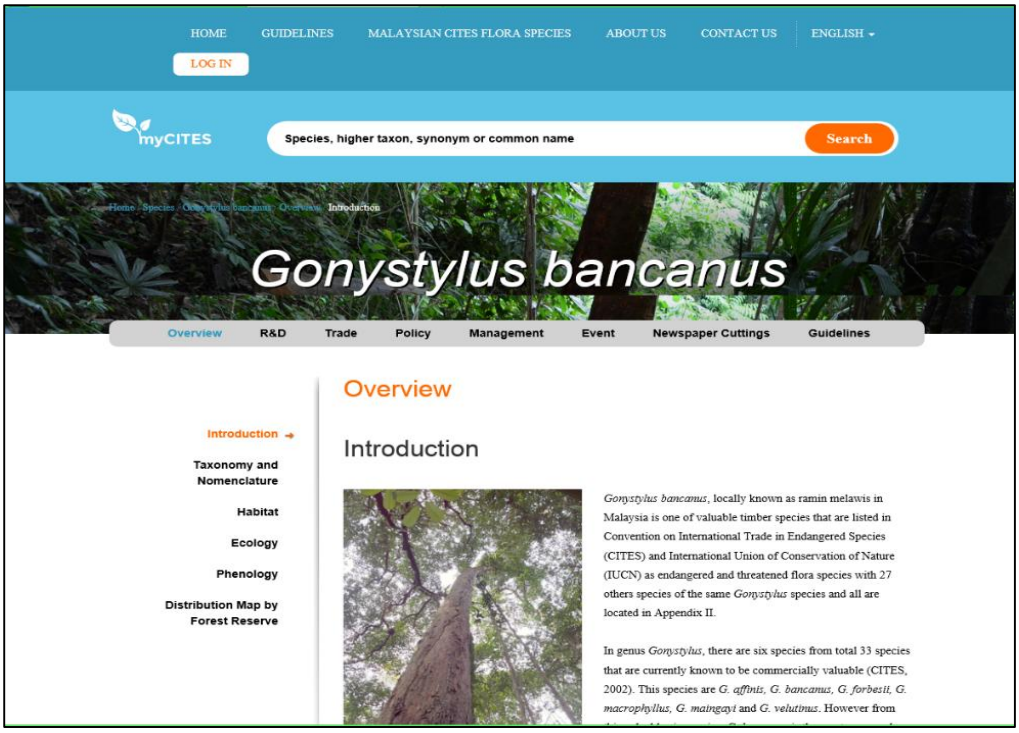


Figure 16 Front pages for Ramin species

The population distribution map (**Figure 17**) for Ramin and Karas in Malaysia are at the forest reserve level. The other species under the same genus (*Gonystylus* and *Aquilaria*) are also included in this map. The user can click at the upper left toolbar to choose to see only Ramin or Karas location. User can also see location of other species under genus *Gonystylus and Aquilaria* simultaneously.

Figure 17 The interface of Distribution Map by Forest Reserve

The list of research project (**Figure 18**) can be sort according to the user selection. A new page that contains further information about the projects will pop-up when the user click on any of their interested project as shown in **Figure 19**.

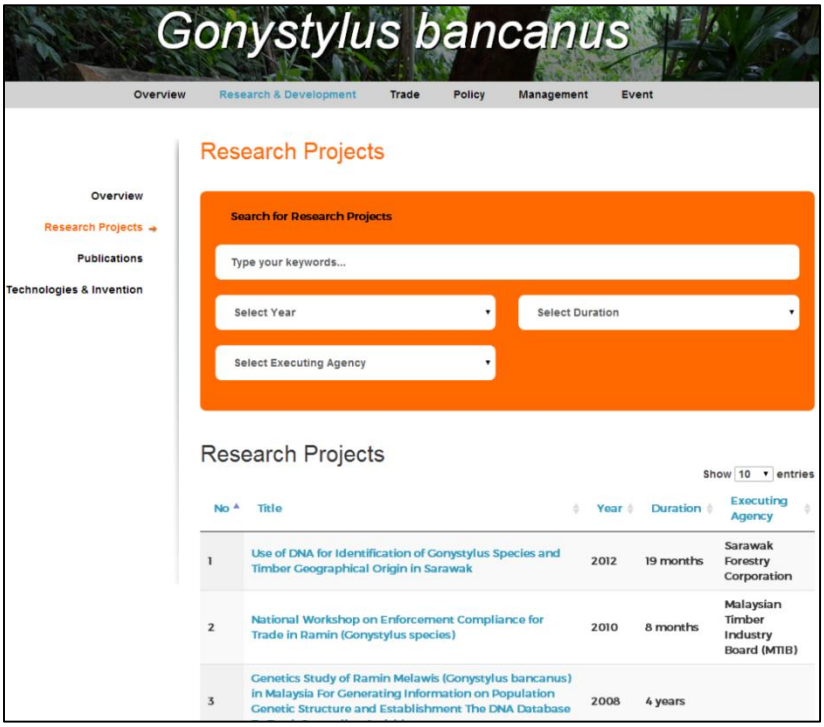


Figure 18 The interface of Research Project page under Research and Development

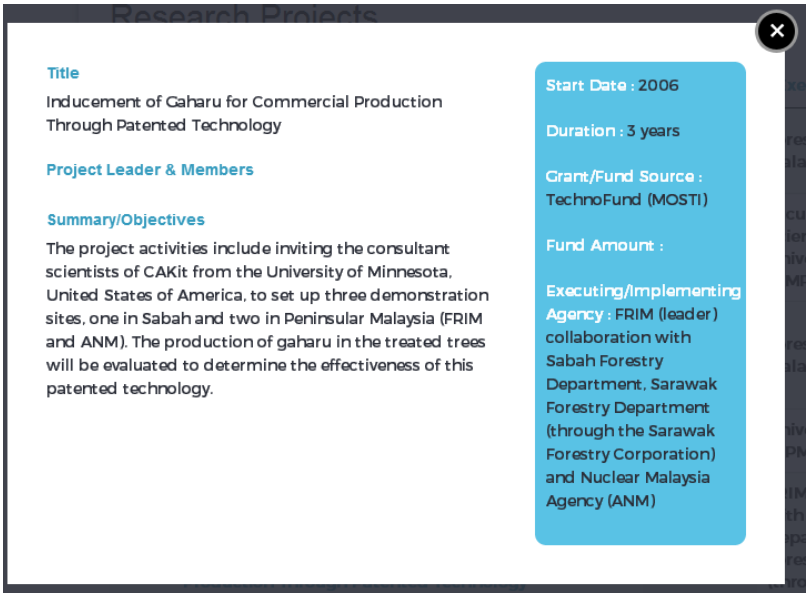


Figure 19 Example: information of selected project

Similar to research projects module, the Publications Module (**Figure 20**) also can be sort according to user's selection. A new page that contains further information about the publication will pop-up when the user click on any of their interested publication as shown in **Figure 21**.

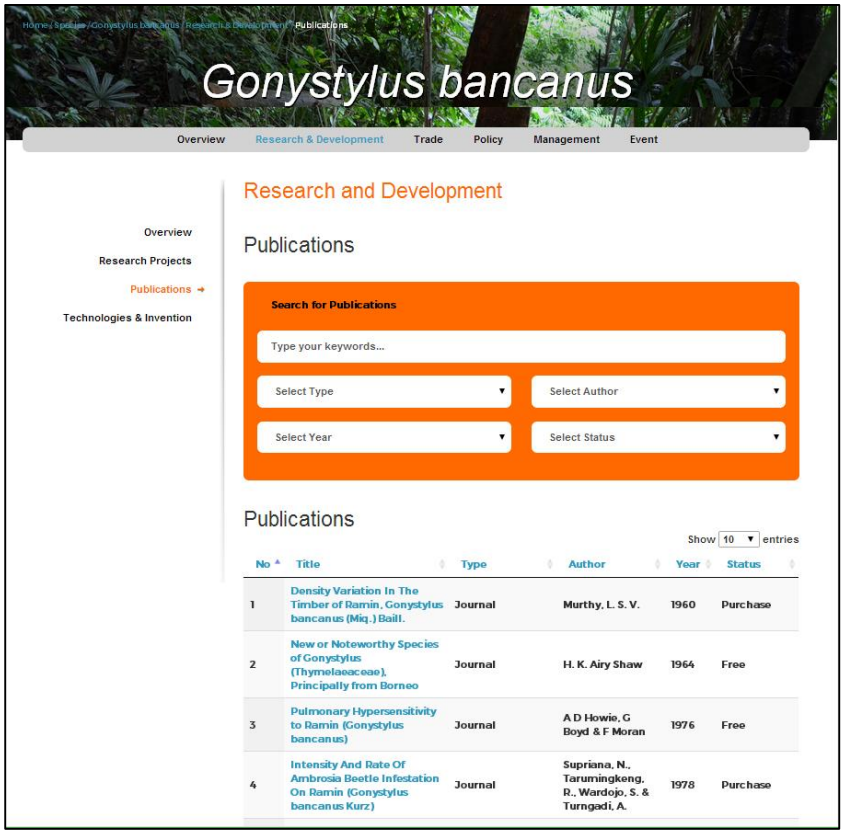


Figure 20 The interface of Publications page under Research and Development

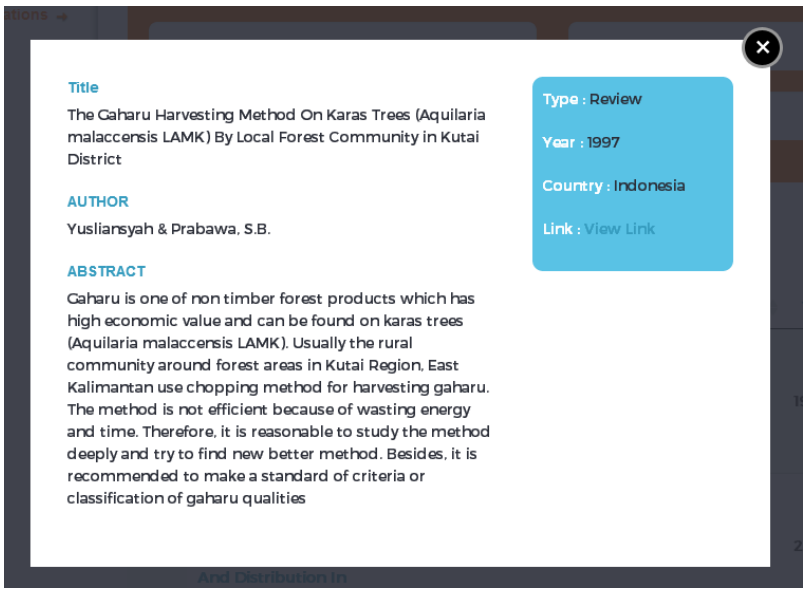
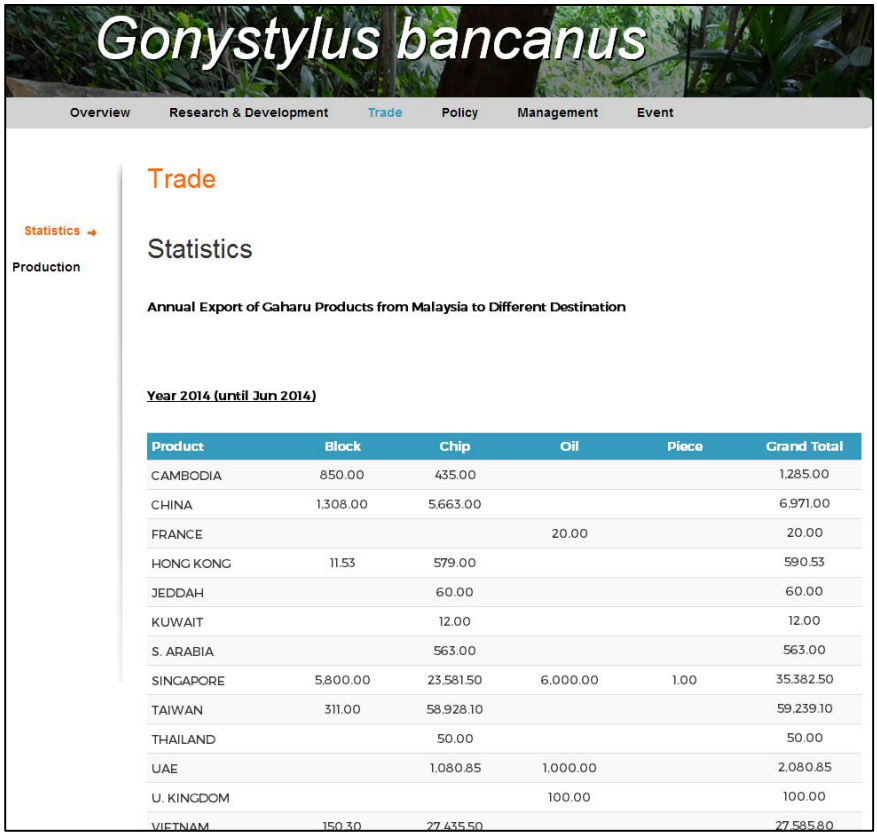


Figure 21 Example: Information of selected publication

For the Trade Module, the Statistic export and import for Ramin and Karas products were specified according to types of product and country (**Figure 22**). Meanwhile, the Production contains list of products and its functions (**Figure23**).



Product	Block	Chip	Oil	Piece	Grand Total
CAMBODIA	850.00	435.00			1,285.00
CHINA	1,308.00	5,663.00			6,971.00
FRANCE			20.00		20.00
HONG KONG	11.53	579.00			590.53
JEDDAH		60.00			60.00
KUWAIT		12.00			12.00
S. ARABIA		563.00			563.00
SINGAPORE	5,800.00	23,581.50	6,000.00	1.00	35,382.50
TAIWAN	311.00	58,928.10			59,239.10
THAILAND		50.00			50.00
UAE		1,080.85	1,000.00		2,080.85
U. KINGDOM			100.00		100.00
VIETNAM	150.30	27,435.50			27,585.80

Figure 22 The interface of Statistics page under Trade

For Policy Module (**Figure 23**), there are seven sub-module as follows:

i. CITES and Malaysia
ii. Appendix
iii. Act 686
iv. CITES Management Authority
v. CITES Malaysia Authorities Directory
vi. Export Quota
vii. Permit Application

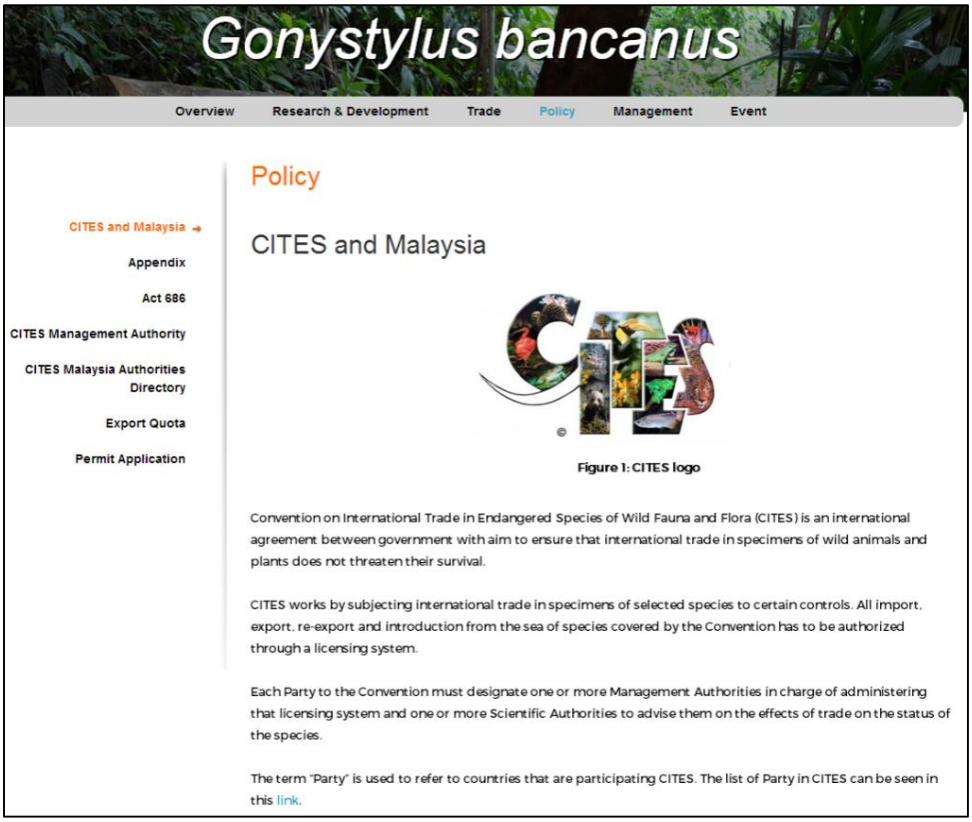


Figure 23 The interface of Policy

For Management Module, each species page contains different sub modules. For *Gonystylus bancanus* page (**Figure 24**); there are three sub-modules:

i. PSF Management System
ii. Harvesting Methods
iii. Ramin Transportation Methods

Meanwhile, the modules contains at *Aquilaria malaccensis* page (**Figure 25**) are:

i. Aquilaria plantations
ii. Pest control and crop disease
iii. Inoculation

Figure 24 The interface of Management for *Gonystylus bancanus*

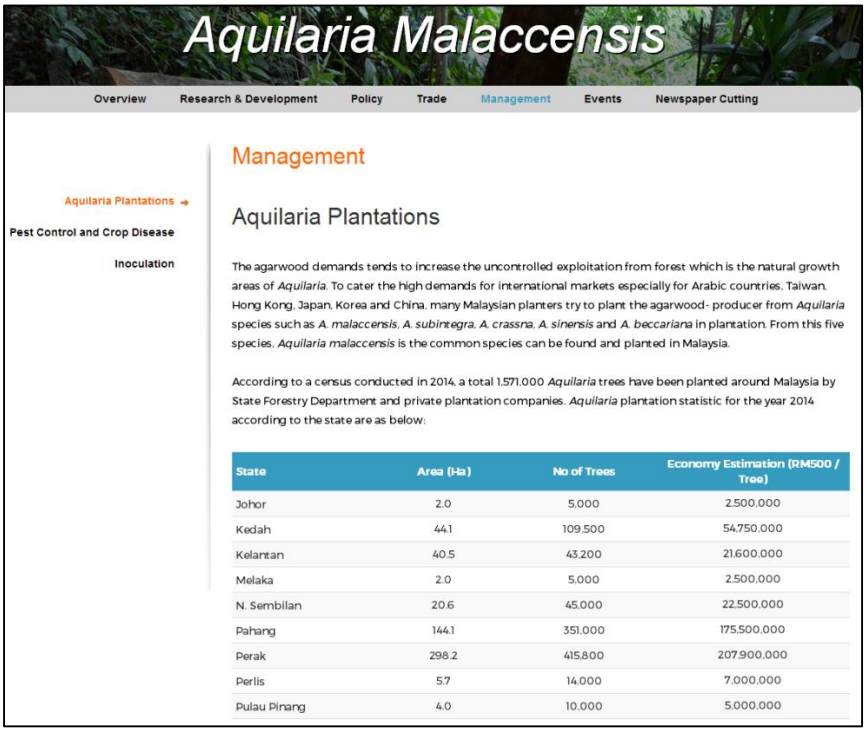


Figure 25 The interface of Management for *Aquilaria malaccensis*

At *Aquilaria malaccensis* page, there are additional module Newspaper Cutting included as shown in **Figure 26**.

There are a lot of newspaper cutting, hence to reduce the searching time for searching the desired news the user can filter using any or combine the filtration methods below:

i. Keywords = filter the search by entering the keywords for the news
ii. Type = filter the search according to type of news such as conservation, crime, industry, medication, plantation or research
iii. Duration = filter the search by the duration of the project implemented
iv. Select Paper = filter the search by select the source of newspaper such as Sinar Harian, Utusan Malaysia, Kosmo or The Star

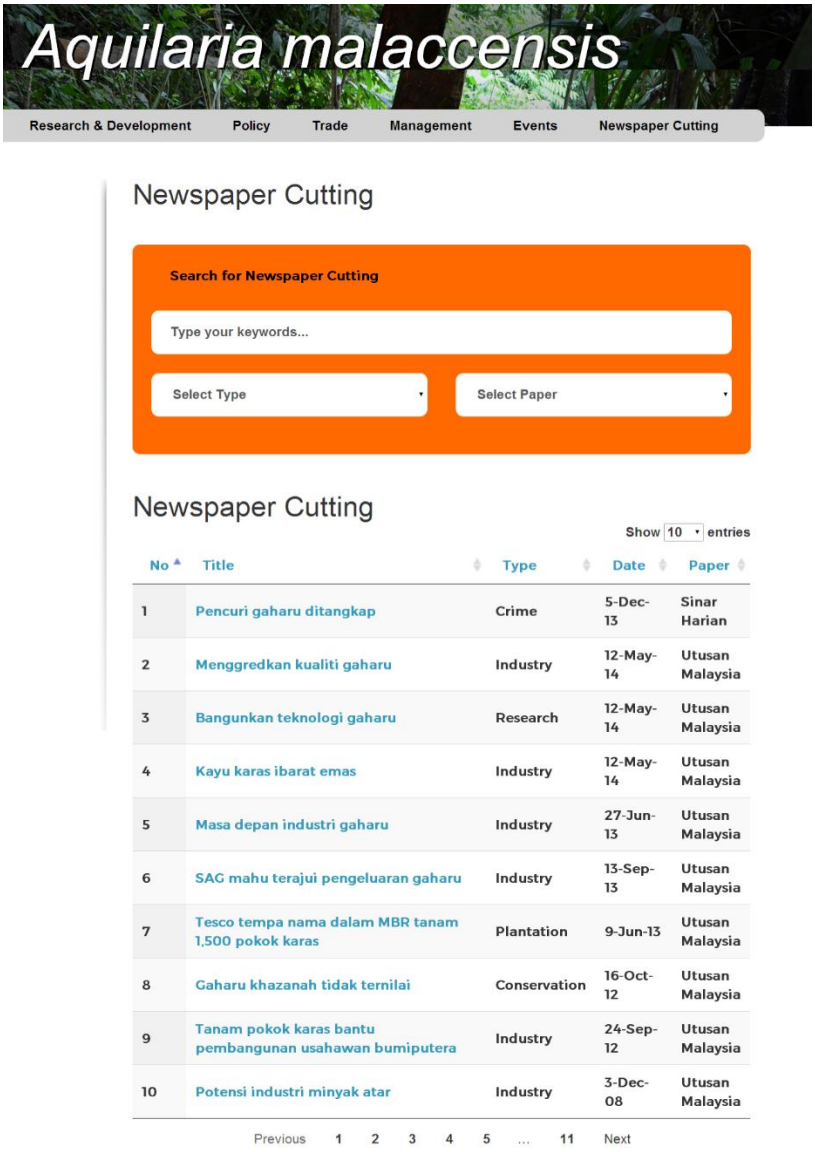


Figure 26 The interface of Newspaper Cutting

3.5.1.1 Content Management

MyCITES website have static page and dynamic page. Static page refer to unchanged or constant page, while dynamic page means changing or lively page. Static Web pages contain the same prebuilt content each time the page is loaded, while the content of dynamic Web pages can be generated on-the-fly. In MyCITES, static page is the page that contains the information that remains as a guide and general information for visitor, including the Home page, Guidelines, About Us and Contact Us. The structure of the dynamic page can vary depending on the content of information stored. Dynamic page will increase if there are additional new information is entered into the database MyCITES. Currently, there are only two dynamic pages in the MyCITES website, which is list of species for *Gonystylus bancanus* and *Aquilaria malaccensis*. List of species section will increase if there is a new species included in the database. In addition, the page information for each of this section can also be added and subtracted as needed. **Figure 27** shows the Administration page for the update and add information in the MyCITES database. All the information on the static and dynamic page can be updated through the Administration panel (**Figure 27** and **Figure 28**).

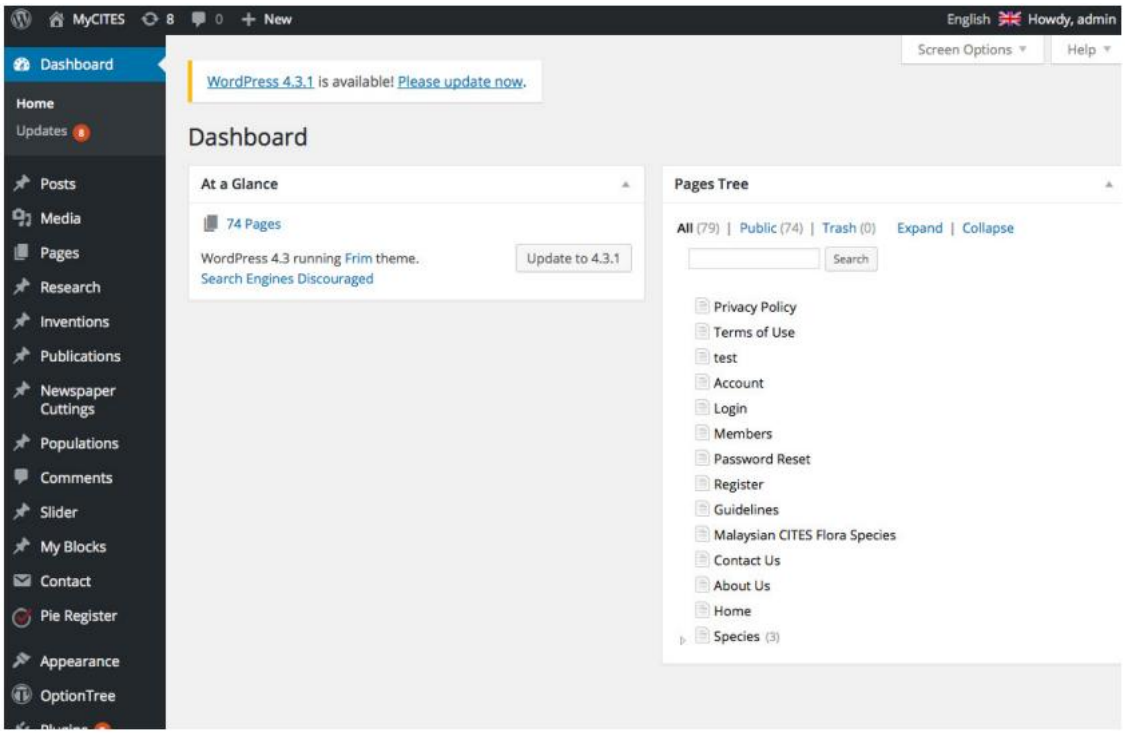


Figure 27 Administration panels of MyCITES database

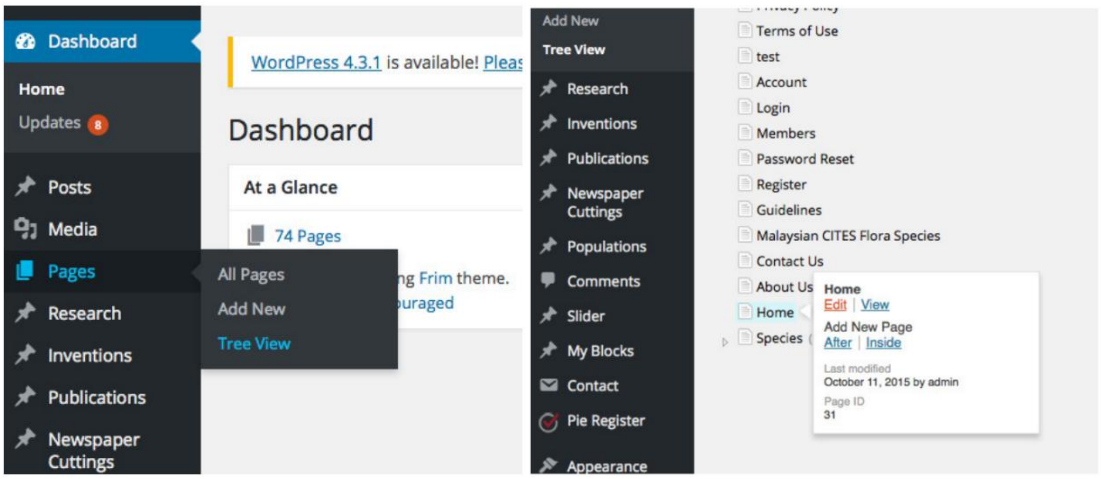


Figure 28 Selection of Tree View for content editing

3.5.1.2 *Updating static page content*

Most pages in this segment are the static website which can be modified directly using the Content Editor. For example, to change and add content in Introduction page below the main menu, click on Pages/Tree View and refer to Species menu before open the Content Editor by click on Edit Button (**Figure 29**).

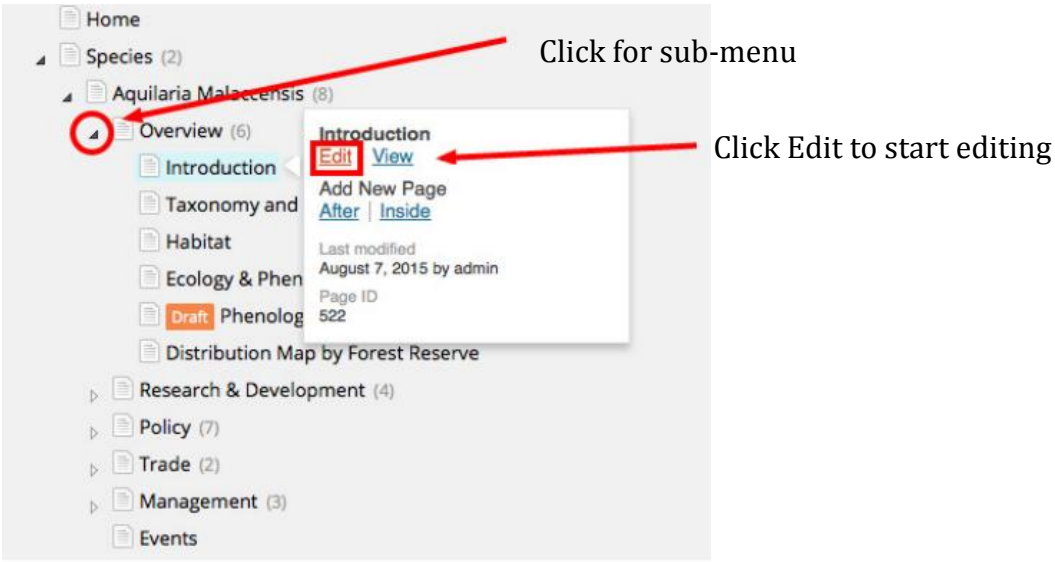


Figure 29 Content Editor Panels for editing content

3.5.1.3 *Updating dynamic page content*

There are few data segment that cannot be modified directly using the Content Editor in MyCITES website. Such sites contain dynamic data, which can only be updated through the data entry process. These segments are Research Projects,

Technologies & Invention, Publications, Newspaper Cutting and Distribution Map. **Figure 30** shows the Administration panel for updating the information in dynamic page. Click Add New to add new data.

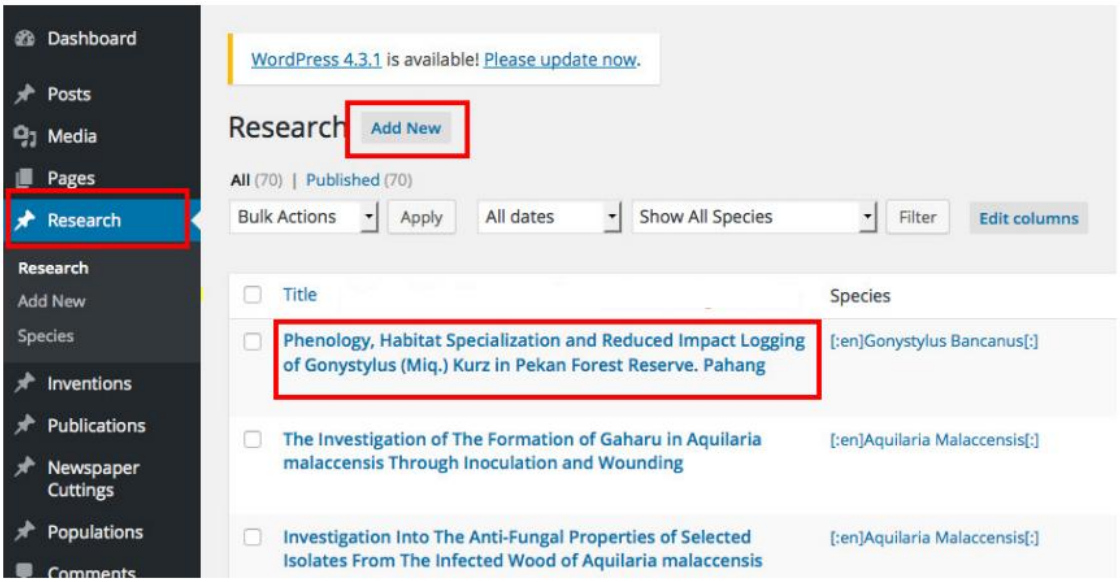


Figure 30 Add content in dynamic page

3.5.2 Testing and running the developed website and database

As the threat landscape for web application changes on a very dynamic basis, attackers need to stay ahead of the curve in order to get in. In this activity, the security test of MyCITES has been carried out by FRIM ICT technical staff by using Acunetix Web Application Security software. Acunetix application provides a comprehensive web application penetration testing service to find security holes in MyCITES web applications before it can be published online. Result from this testing is being used to identify weaknesses and vulnerabilities, while at the same time it can help to improve the structure and design of MyCITES web and database. **Figure 31** shows the example of Acunetix scanning report that has been carried out in this Activity.

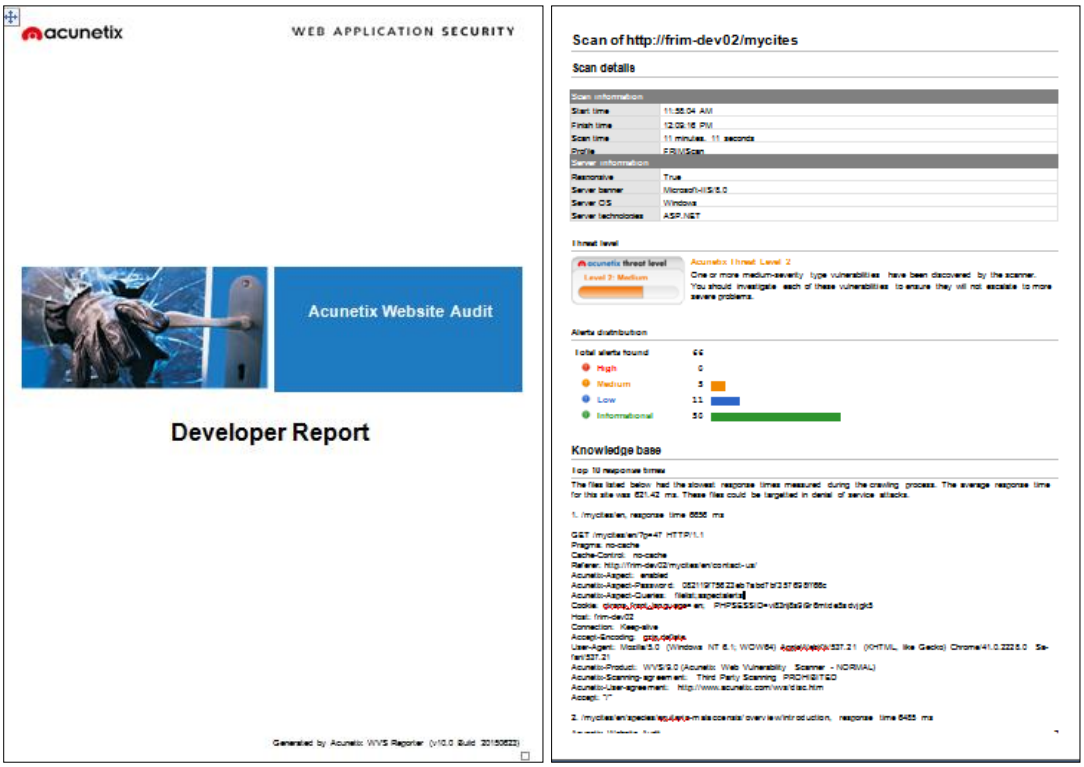


Figure 31 Vulnerability test report using Acunetix software

Chapter 4 Overview and Recommendations

4.1 Problems and limitations

The design of the Activity was sufficient to enable an effective implementation of the Activity. Early consultation with the state authority helped in getting support and approval from them to undertake the Activity. The Activity implementation also took into consideration the active involvement of the state forestry department staff, in particular during the field verification survey. The main challenges that needs to be taken seriously is to expedite the process to appoint a web developer as it involves several levels of approval before appointing a web developer. A good coordination by the team members to avoid the variations between planned and actual implementation of the Activity. The Activity benefited tremendously from the cooperation and participation of various stakeholders in particular forestry departments and Malaysian Timber Industry Board (MTIB). Smooth coordination by the NRE was very important to ensure all agencies involved in the Activity implementation give their full cooperation and participated actively.

FRIM will undertake maintenance and update of MyCITES website and database based on existing human and financial resources in FRIM. The maintenance activity including updating information on new publications, new R&D, next coming annual statistic on production, import and export of Ramin and Karas, and new policy implemented regarding this species. However, the financial contribution either from the Government or ITTO is most welcome when it involves the hardware and software upgrade in the future if necessary. The developed database and website will be regularly updated with current information and FRIM will take the responsibility to monitor the updated information placed on the website. The information that is shared in MyCITES can be used by the relevant government agencies in Malaysia, particularly the forestry authority to have better understanding on these species in the natural forest and enhancing better management of this species in the future.

4.2 Conclusion

The successful development of the web-based database information system of Ramin and Karas will contribute towards the best practices in managing and monitoring these endangered species in Malaysia. As a one-stop centre of Malaysian CITES-listed tree species, the information database known as the MyCITES will comprise of a full and complete set of information on Ramin and Karas, including the current status of their population, production, trade and management practices in Malaysia.

The MyCITES will be used as a platform to disseminate information on Ramin and Karas, including the outcomes and findings of previous ITTO-CITES Activities implemented in Malaysia. The development of the MyCITES could also provide a guide for developing integrated information systems for other endangered tree species not only in Malaysia, but also in other countries. Indirectly, it could assist ITTO and CITES in monitoring the management activities of threatened tree species.

The outcomes of this Activity could also be used as an input to generate relevant information required for the preparation of non-detriment findings (NDF), as required for species listing under CITES in Malaysia.

References:

1. Chua, L.S.L. 2008. Agarwood (*Aquilaria malaccensis*) in Malaysia. NDF Workshop Case Studies.
2. Dawend, J., J. Make, P. Lepun, S. Tan and R.K. Franklin. 2005. System Approach for Sustainable GaharuConservation in Sarawak: An Overview. In: *Proceedings, International Forestry Seminar: Synergistic Approach To Appropriate Forestry Technology For Sustaining Rainforest Ecosystems.* Sarawak Forestry Department, Bintulu, Sarawak, Malaysia
3. Dibor, L. 2005. Phenology of Ramin (*Gonystylus bancanus*) in Logged-over Peat Swamp Forest in Sarawak. Pp. 315-329 in van der Meer, P., Chai, F.Y.C., Hillegers, P.J.M. & Penguang, M. (eds.). Sustainable Management of Peat Swamp Forests of Sarawak with special reference to Ramin (*Gonystylus bancanus*). Alterra, Wageningen UR, Sarawak Forestry Corporation and Forest Department Sarawak.
4. Ismail P., Nizam M.S., Latiff A., Faridah Hanum I., Shamsudin I. 2011. Phenology of *Gonystylus bancanus* in Pahang, Peninsular Malaysia. Journal of Tropical Forest Science 23(2): 143-151. Forest Research Institute Malaysia (FRIM).
5. Lok, E.H., 2014. Agarwood: A highly-prized Forest Produce. FRIM in Focus. p.p 4-5. Forest Research Institute Malaysia.
6. Nurul Huda, H. 2003. Kajian corak regenerasi lima spesies munculan di kawasan hutan paya gambut, Pahang. MSc. Thesis. Universiti Kebangsaan Malaysia (UKM). 252 pp. (unpublished).
7. Shamsudin, I. 1996. *Gonystylus bancanus*: Some observations on its flowering, fruiting, seed predation and germination. Journal of Tropical Forest Science 8(3): 424-426.
8. Shamsudin I. & Ng, T.P. 1995. Population structure and distribution pattern of *Gonystylus bancanus* in primary peat swamp forest at Pekan, Pahang. Pp. 35?44 in Norhara, H., Bacon, P.S. & Khoo K.C. (eds.) Proceedings of Third Conference Forestry & Forest Products Research. FRIM. Vol 1.