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CONFERENCE

ADVANCING SUSTAINABLE FORESTRY THROUGH
DIGITALIZATION & TECHNOLOGY

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“Advancing Sustainable Forestry Through Digitalization and Technology”



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FOREWORD

The theme for the 18th Malaysian Forestry Conference, —*Advancing Sustainable Forestry through Digitalization and Technology* was timely. This is because with the changing of time, managing our forests in the future needs us to innovate and adapt in order to ensure that forestry is significant and relevant. The use of advanced technologies towards managing our forests is one of the ways forward for us to consider.

Technology will help to address the challenges for sustainable forestry in the 21st century. Malaysia having a huge forest area needs to adopt the use of advanced techniques like geospatial technology which is becoming essential for accurate and timely spatial database for effective monitoring and safeguarding its forest resources. It is high time to deliberate and share knowledge on the use of digitalization and technology towards advancing sustainable forestry in this conference.

A total of 106 papers are included in the Proceedings, comprising 3 keynotes, 24 working papers, 24 information papers and 55 posters abstracts. The working papers were presented at the conference based on six sessions, namely: Sub-Theme 1, Forest Governance: Policy, Legislation and Enforcement, Sub-Theme 2, Sustainable Forest Management: Technology, Innovation and Practices, Sub-Theme 3, Forest Biodiversity: Conservation, Restoration, Rehabilitation and Protection, Sub-Theme 4, Plantation Forestry/Industrial Forest: Sustainable Wood Production and Wood Based Industry, Sub-Theme 5, Forest Ecosystem Services: Food, Water, Energy, Climate and Recreation, Payment for Ecosystem Services (PES) & REDD+, Sub-Theme 6, Forest Beyond Timber: Social Forestry, Ecotourism, Education Programmes, Non Timber Forest Products (NTFP).

Eight (8) resolutions were deliberated and successfully adopted at the end of the conference. These resolutions provide road map for the forestry departments of Peninsular Malaysia, Sabah and Sarawak to act on in the next three years.

I would like to record my appreciation to the authors for their contribution. I would like also to take this opportunity to thank the Conference Paper and the Proceedings Committee for their diligence and perseverance towards the publication of this 18th Malaysian Forestry Conference Proceedings.

Thank you.



DATU HAMDEN BIN HAJI MOHAMMAD

Director of Forests

Forest Department Sarawak

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1.0 INTRODUCTION

The Malaysian Forestry Conference (MFC) is held every three years on a rotational basis amongst the Forestry Departments of Sabah, Sarawak and Peninsular Malaysia. This conference provides a forum for Malaysian foresters to exchange and share information, views and experiences in the administration, management and development of the nation's forest resources. Since the first MFC in 1966, a total of 18 conferences have been held. The 18th MFC was hosted by the Forest Department Sarawak and Sarawak Forestry Corporation Sdn. Bhd., which is also the 6th of such conference to be held in Sarawak.

The conference objectives are as follows:

- to provide a platform for discussing and resolving problems collectively, pertaining to the aspects of forest development;
- to coordinate the planned management of the forest resources and their utilization, seeking means and methods leading to the development and diversification of the forest industries with the aim of maximizing their contribution to the socio-economic development of the nation;
- to coordinate lines of research and the use of improved techniques in all aspects of forestry operations and utilization;
- to establish a closer working relationship and understanding among foresters from all over Malaysia; and
- to generate public awareness in the importance of forestry as an integral element in nation building

18th Malaysian Forestry Conference

2.0: CONFERENCE PROGRAMME

Theme: Advancing Sustainable Forestry Through Digitalization and Technology
31st July 2018 - 2nd August 2018
Imperial Hotel, Kuching, Sarawak

Day 1: 31st July 2018 (Tuesday)

- 8.30 am **Closed Session** (For members only)
- Appointment of Conference Chairman
- Appointment of Conference Officials
- Reporting: Action taken on 17th Malaysian Forestry Conference Resolutions
- Discussion
- Amendment to ‘Standing Orders’ (*Peraturan Tetap*) Malaysian Forestry Conference
- Opening Ceremony**
- 10.30 am Arrival of Invited Guests
- 10.45 am Arrival of The Honourable Ministers and Distinguished Guests
- 10.50 am Arrival of The Honourable Datuk Amar Haji Awang Tengah bin Ali Hasan, Deputy Chief Minister, Second Minister of Urban Development & Natural Resources and Minister of Industrial & Entrepreneur Development of Sarawak
- 11.00 am Arrival of The Right Honourable Datuk Patinggi (Dr) Abang Haji Abdul Rahman Zohari bin Tun Datuk Abang Haji Openg, Chief Minister of Sarawak
- Negaraku and Ibu Pertiwiku
- Recital of Doa
- Keynote Speech by ITTO Representative, Ms. Sheamala Satkuru
- Welcoming Speech by Mr. Hamden bin Haji Mohammad, Director of Forests, Forest Department Sarawak
- Speech by The Right Honourable Datuk Patinggi (Dr) Abang Haji Abdul Rahman Zohari bin Tun Datuk Abang Haji Openg, Chief Minister of Sarawak
- Launching Ceremony

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Presentation of Souvenir

Launching of REVLOG Mobile Application

Recognition of Achievement for Forest Management Certification

Plenary Session

2.00 - 2.20 pm	Forest Department Sarawak
2.20 - 2.40 pm	Sabah Forestry Department
2.40 – 3.00 pm	Forestry Department of Peninsular Malaysia
3.00 – 3.30 pm	Break

Sub-Theme 1

Forest Governance: Policy, Legislation and Enforcement

Session Chair : Jack Liam

3.30 – 3.50 pm	Paper 1: Pencegahan dan Penguatkuasaan Hutan di Sarawak. By Abdul Wahab Ahmad, Mohammad Hidayatullah, Syafiani Osman, Santey Berikom, Asminie Wati Belaja and Carole Lenan
3.50 – 4.10 pm	Paper 2: Precision of Enforcement to Combat Forest Crimes. By Nor Akhirrudin bin Mahmud, Borhanuddin bin Arshad, Mohd Ridzuwan bin Endot, Mohd Khairul Abdullah and Muhamat Azman Yahaya
4.10 – 4.30 pm	Paper 3: Prevention vs Enforcement: One-Stop Compliance Centres (OSCCs) Experience. By Mohamad Jirin bin Anis and Willy Chin Siaw Min
4.30 - 4.50 pm	Paper 4: Forest Enforcement in Sabah and The Way Forward. By Zulkifli Suara, Hj. Mohd. Nasir Ag. Suman, Miskon Simin, Pius Primus, Peter Maurice Lidadun, Peter Jack, Donatus Loisang, Mahali Yusin and Ismailey Ismail
4.50 – 5.10 pm	Q & A
5.10 pm	End

Welcoming Dinner at Imperial Hotel, Kuching

7.00 pm	Arrival of Invited Guests
7.20 pm	Arrival of The Honourable Ministers and Distinguished Guests
7.30 pm	Welcoming Speech by Mr. Hamden bin Haji Mohammad, Director of Forest Department Sarawak

Speech by The Honourable Datuk Amar Haji Awang Tengah bin Ali Hasan, Deputy Chief Minister, Second Minister of Urban Development & Natural Resources and Minister of Industrial & Entrepreneur Development, Sarawak

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Presentation of Souvenir

Cultural Performances

10.30 pm End

Day 2: 1st August 2018 (Wednesday)

Sub-Theme 2

Sustainable Forest Management: Technology, Innovation and Practices

Session Chair: Mashor Mohd Jaini

- 9.00 – 9.20 am **Paper 5:** Mangroves Mapping and Monitoring Using Free Access Satellite Imagery as Inputs Data for Mangroves Information System in Sabah.
By Valeria Linggok and Hamdan Omar
- 9.20 – 9.40 am **Paper 6:** Development of Geospatial Solution for Assessing Residual Forest Stand Characteristic and Timber Stockings Towards Sustainable Forestry.
By Voon Mufeng and Malcom Demies
- 9.40 – 10.00 am **Paper 7:** Sustainable Management and Conservation of Peat Swamp Forest In Peninsular Malaysia.
By Regina Mariah Jong and Mohd Radhi Chu Abdullah
- 10.00 – 10.20 am **Paper 8:** Strengthening Sustainable Forest Management Through Forest Management Certification.
By Madeline G.P., Wilhelmina C. and Abg Ahmad, A.M.
- 10.20 – 10.40 am Q & A
- 10.40 – 11.00 am Break

Sub-Theme 3

Forest Biodiversity: Conservation, Restoration, Rehabilitation and Protection

Session Chair: Dato' Mohd. Ridza bin Awang

- 11.00 - 11.20 am **Paper 9:** Conserving of Rafflesia In Kelantan, Peninsular Malaysia: Issues, Challenges and Way Forward.
By Fauzan Mison, Rosilan Said, Hamidi Abd Halim, Zahari Ibrahim and Zulhazman Hamzah
- 11.20 - 11.40 am **Paper 10:** Diversity of Aphyllphoraceous Fungal Community Structure at Kubah National Park.
By Habibah Salleh, Satoshi Yamashita, Abdul Ghani Yusuf, Seling Anyi, Me'eng Sihoi, Abu Serah Aboi and Siti Haryanie Mohamad

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- 11.40 - 12.00 pm **Paper 11:** Approaching A Decade of IUCN Red List Assessment in Sabah: The Way Forward.
By Joan T. Pereira, Sandy Tsen, Lee Yew Leung, Suzika Juiling, Colin R. Maycock, John Sugau, Reuben Nilus, Andi Maryani A. Mustapeng, Richard Majapun, Alexander Hastie Yuk Loong and Eyen Khoo
- 12.00 - 12.20 pm **Paper 12:** Research for Intensified Management of Bio-Rich Areas (RIMBA) of Sarawak.
By Nickson Joseph Robi and Roslina Ragai
- 12.20 – 12.40 pm Q & A
- 12.40 – 2.00 pm Break

Sub-Theme 4

Plantation Forestry/Industrial Forest: Sustainable Wood Production and Wood Based Industry
Session Chair: Dr. Alik Duju

- 2.00 - 2.20 pm **Paper 13:** Planted Forest Research Programme Towards Viable Industrial Forest Establishment in Sarawak.
By Julaihi Abdullah, Millicent Abdullah and Phui Seng Loi
- 2.20 - 2.40 pm **Paper 14:** Forest Plantations and The Need for Demonstration Plots for Local Timber Species in Sabah.
By Eyen Khoo, Alexander Hastie, Kevin Pang, Jaffrin Lapongan, Anuar Mohammad and Robert Ong
- 2.40 - 3.00 pm **Paper 15:** Preliminary Study on Trial Planting of Ramin (*Gonystylus bancanus*) at Bukit Lima Nature Reserve, Sibul, Sarawak.
By Aurelia D.C., Nur Safinas, J., Halipah, B., Yahud, W., Mohd Iskandar, S. and Stephen, G.
- 3.00 - 3.20 pm **Paper 16:** Pembangunan Ladang Hutan di Semenanjung Malaysia – Isu dan Cabaran.
By Helmy Tariq Othman, Lim Kee Leng, Marlina Omar, Sharifah Amira Salim and Khairul Anwar Mustapha
- 3.20 – 3.40 pm Q & A
- 3.40 – 4.00 pm Break
- 4.00 pm End

Day 3 : 2nd August 2018 (Thursday)

Sub-Theme 5

Forest Ecosystem Services: Food, Water, Energy, Climate and Recreation, PES & REDD+
Session Chair: Frederick Kugan

- 9.00 – 9.20 am **Paper 17:** From Degraded to Functional Forest: A Success Story.
By Indra P.H. Sunjoto, Robert M. Mijol and Siti Zubaidah S. Abdullah

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- 9.20 – 9.40 am **Paper 18:** Spatial Variation of Disturbed Soil in a Mangrove Ecosystem Based on Their Physical and Chemical Properties.
By Salfa Katira Abdul Kadir, Affendi Suhaili, Mohd Effendi Wasli and Jayneeca Lawen
- 9.40 – 10.00 am **Paper 19:** Skim Pembayaran Perkhidmatan Ekosistem (Payment For Ecosystem Services, PES) Menerusi Projek Mini Hidro Di Hutan Simpan Kekal Negeri Perak.
By Mohamed Zin Yusop, Muhammad Abdullah and Muhammad Ezhar Yusuf
- 10.00 – 10.20 am **Paper 20:** Creating Green Lung for Miri through the “Bring Back The Rainforest” Project.
By Connie Geri, Tinna Wound and Oswald Braken Tisen
- 10.20 – 10.40 am Q & A
- 10.40 – 11.00 am Break

Sub-Theme 6

Forest Beyond Timber: Social Forestry, Ecotourism, Education Programmes,
Non Timber Forest Products (NTFP)
Session Chair : Dato’ Lim Kee Leng

- 11.00 - 11.20 am **Paper 21:** Sport Fishing For Sustainable Non-Timber Forest Products (NTFPs) at Puah Reservoir, Terengganu: A Case Study and Preliminary Assessment.
By Ahmad Fadzil Abdul Majid, Lokman Fakru, Mohd Shahril Nizam Mat Ali, Alif Iqbal Omar, Mohd Shafiq Zakeyuddin, Shahril Mohd Husin and Ayuni Samsul Bahri
- 11.20 - 11.40 am **Paper 22:** Beginning of a Journey... Implementation of Gaharu Agronomy at Ulu Sungai Menyang Conservation Area.
By Suliman Jamahari and Lim Chan Koon
- 11.40 - 12.00 pm **Paper 23:** Building Partnership Through Community-based Monitoring in REDD+: Case Study of the EU Programme Entitled ‘Tackling Climate Change Through Sustainable Forest Management and Community Development’ in Sabah.
By Rosila Anthony, Rashidah Maqbool Rehman, Joseph Pirin, Jambery Siong and Bellinda D. Raymond
- 12.00 - 12.20 pm **Paper 24:** Local Communities Engagement Towards Forest Management Certification in Sarawak: Issues and Perceptions.
By Evelyn Jugi and Jacqueline Henry Ripan
- 12.20–12.40 pm Q & A
- 12.40–2.00 pm Break

Closed Session (For members only)

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2.00 - 4.00 pm Conference Resolution Presentation & Adoption

4.00 - 4.30 pm Break

Closing Ceremony

4.30 pm Arrival of The State Secretary of Sarawak

Negaraku and Ibu Pertiwiku

Recital of Doa

Closing Remark by The Honourable Tan Sri Datuk Amar Haji Mohamad
Morshidi bin Abdul Ghani, State Secretary of Sarawak
Presentation of Souvenir

Photo Session

5.00 pm End

Closing Dinner

7.30 pm Speech by Tuan Haji Zolkipli bin Mohamad Aton,
Chief Executive Officer, Sarawak Forestry Corporation Sdn. Bhd.

Regional Performance

Prize Presentation

Souvenir Presentation

10.30 pm End

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WELCOMING ADDRESS BY MR. HAMDEN BIN HAJI MOHAMMAD DIRECTOR OF FORESTS FOREST DEPARTMENT SARAWAK

YAB Datuk Patinggi Abang Haji Abdul Rahman Zohari bin Tun Datuk Abang Haji Openg,
Chief Minister of Sarawak,

YB Datuk Amar Awang Tengah Ali Hasan, Deputy Chief Minister, Second Minister of
Urban Development & Natural Resources and Minister of Industrial & Entrepreneur
Development of Sarawak,

YB Datu Len Talif Salleh, Assistant Minister of Urban Planning, Land Administration and
Environment,

YBhg. Dato' Hj. Nor Akhirrudin bin Mahmud, Director General of Forestry Department
Peninsular Malaysia,

YBhg. Datuk Sam Mannan, Chief Conservator of Sabah Forestry Department,

YBhg. Datuk-Datuk, Ladies and Gentlemen,

Assalamualaikum and good morning to all.

Terlebih dahulu saya ingin merakamkan ucapan terima kasih dan penghargaan kepada Yang
Amat Berhormat Ketua Menteri kerana sudi menerima undangan kami bagi merasmikan
Persidangan Perhutanan Malaysia kali yang ke-18.

Saya juga bagi pihak Jawatankuasa Pengelola mengalu-alukan kedatangan semua delegasi
dan pemerhati terutamanya yang datang dari Semenanjung, Sabah dan juga dari Sarawak ke
Persidangan Perhutanan Malaysia atau lebih dikenali sebagai MFC yang ke-18, di Kuching
Sarawak.

YAB Ketua Menteri, tuan-tuan dan puan-puan yang dihormati sekalian,

MFC was first organized in 1966 in Forest Research Institute, Kepong and had been held on a
rotational basis amongst the forestry departments of Peninsular Malaysia, Sabah and
Sarawak. The first time Sarawak hosted the MFC was in 1970 and the last time was in 2008.
This year it is our turn again to become the host for this prestigious event of the forestry
agencies in Malaysia. MFC is a forum for Malaysian Foresters to exchange views, share
information and experiences in the administration, management and development of the
nation's forest resources.

The theme chosen for this conference is "Advancing Sustainable Forestry Through
Digitization and Technology". This theme is chosen in view of the current development of
global forestry that is using technology to assist in the sustainable management of the forests.
Technology could help in addressing issues and challenges by providing timely forestry
related information for decision making process. Of course there is no silver bullet to ensure
sustainability but with the advancement of technologies, progress can be facilitated with a
systematic approach to forest management.

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In Sarawak for example, we have been using geospatial technologies such as GIS way back in 1995 when we have collaboration with GTZ, the German Technical Agency. Since then, other technologies such as drone and hyperspectral are also used especially in monitoring and enforcement works. Taking advantage of information technology as a replacement to the conventional method of collecting timber revenue data & monitoring the movement of logs, the Log Tracking System known as LoTS was also enhanced with the development and introduction of the REVLOG System in 2016. Mobile apps were also introduced whereby data from REVLOG is integrated into a device to facilitate field checking.

The use of hyperspectral technology in forest management is one of the advanced ways to manage and conserve in a faster and time saving. The forest mapping and surveillance are the capabilities of hyperspectral technology can provide in forest management. For example, forest mapping, distribution of forest type with different species of trees with high resolution image can be produced by using this technology in order to improve regulation and policy for better forest management. Besides that, the application of hyperspectral in surveillance can be helpful to monitor encroachment activity within Totally Protected Areas (TPAs) and Permanent Forest Estates (PFEs). This will lead to efficiency in preventive and enforcement especially in detecting illegal logging activity.

YAB Ketua Menteri, tuan-tuan dan puan-puan yang dihormati sekalian,

The MFC will be organised in 6 plenary sessions covering wide ranging topics such as (i) Forest Governance, (ii) Sustainable Forest Management, (iii) Forest Biodiversity, (iv) Plantation Forestry, (v) Forest Ecosystem Services and (vi) Forest Beyond Timber. During this 3 days conference, you will have the opportunity to listen to 24 presentations. Besides that, posters and exhibition will also be displayed at the foyer outside this hall. As a tradition, we also organise friendly sport tournament and games to foster friendship spirit among the three regions forestry agencies.

I am pleased to inform that there are 439 participants and observers attending this conference. The participants beside those from the three regional forestry agencies also come from various research and academic institution related to forestry, relevant government agencies and ministries, timber industries as well as NGOs. I hope that with the participations from various agencies and institutions, this conference will become a platform to gain knowledge and experiences as well as to exchange ideas and collaboration through networking.

The hosting of the 18th Malaysian Forestry Conference this year is almost coincides with the commemoration of the 100 years of the establishment of Forest Department Sarawak which is next year. After almost a century, the management of our forests become more and more challenging. Some of the challenges include competition for land development, depleting forest resources, issues on climate change, deforestation etc. which require better information technologies to support decision making, and need more options for managing and conserving biodiversity.

Throughout the years we have seen many collaborations and cooperation with other agencies and institutions either locally, regionally or internationally. I would like to take this opportunity to update on our recent collaborations and initiatives such as MoUs with Natural Resources Institute Finland (LUKE) on development of integrated forest management

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system, Japanese Research Consortium on Tropical Forests in Sarawak (JRCTS), Copenhagen Zoo, Denmark on wildlife management and Sarawak Energy Berhad (SEB) on non-timber forest products to name a few. Besides that, the State Government through Sarawak Forestry Corporation also launched the initiative called RIMBA in 2015 with the objective to provide platform for scientific research collaboration in Totally Protected Areas in Sarawak. RIMBA promotes international and regional collaborations with renowned universities and institutions of higher learning and institutions recognized in the field of R&D.

Let us work together in the next three days to discuss, deliberate and come up with the practical resolutions to better manage our forests in addressing the challenges faced by forestry sectors especially in managing our forest sustainably.

YAB Ketua Menteri, tuan-tuan dan puan-puan yang dihormati sekalian,

Once again I would like to extend my appreciation to the right honourable Chief Minister of Sarawak for his presence today. My sincere appreciation and gratitude also to the organizing committee in particular Forest Department Sarawak and Sarawak Forestry Corporation for their hard work and dedication and other agencies i.e. Sarawak Timber Industry Development Corporation, Sarawak Timber Association, Harwood Timber Sdn. Bhd. and Sarawak Planted Forests for the financial support in organising this conference. Not forgetting to our counterparts from Sabah Forestry Department and Forestry Department of Peninsular Malaysia for your cooperation.

Finally, I wish all participants the very best in their deliberations and discussion in the 18th Malaysian Forestry Conference. For those who come from outside Sarawak, welcome to Sarawak, the Land of Hornbills and enjoy your stay in Kuching.

Thank you

Sekian,

Wabillahi taufiq wal hidayah,
Wassalamualaikum warahmatullahi wabarakatuh

18th Malaysian Forestry Conference

OPENING ADDRESS BY YAB DATUK PATINGGI (DR) ABANG HAJI ABDUL RAHMAN ZOHARI BIN TUN ABANG HAJI OPENG CHIEF MINISTER OF SARAWAK

Yang Berusaha, Encik Hamden bin Mohamad, Director of Forest Department Sarawak,

YB Datuk Amar Awang Tengah Ali Hasan, Deputy Chief Minister, Second Minister of Urban Development & Natural Resources and Minister of Industrial & Entrepreneur Development of Sarawak,

YB Datu Len Talif Salleh, Assistant Minister of Urban Planning, Land Administration and Environment,

YBhg. Dato' Hj. Nor Akhirrudin Bin Mahmud, Director General of Forestry Department Peninsular Malaysia,

YBhg. Datuk Sam Mannan, Chief Conservator of Sabah Forestry Department,

YBhg. Datuk-Datuk, Ladies and Gentlemen,

Assalamualaikum and a very good morning to all

Preamble

1. It is a great pleasure for me to be here this morning, to officiate the 18th Malaysian Forestry Conference 2018 with the theme “Advancing Sustainable Forestry through Digitization and Technology”.

2. Firstly, let me extend my very warm welcome to all of you especially those from Peninsular Malaysia and Sabah to the Land of Hornbills.

3. It is great to note that this conference is participated by officers, administrators and researchers from forestry agencies in Malaysia and other observers from institutions related to forestry, timber industries and NGOs who come to gather in Kuching with the common objectives to discuss and share on what's new and how best to manage our nation's forest resources sustainably.

Ladies and Gentlemen,

Forest Resources

4. Malaysia is blessed with its mega-rich biodiversity of tropical forests. We always regard our forest resources as important and valuable resources. As of 2016, forest constitutes about 55 % or 18,119,338 ha of Malaysia's land mass. In Sarawak, forest constitutes 64% of its total land mass.

5. For the past 100 years, forestry has been the backbone of State's economy and has contributed significantly towards socio-economic development of the State as well as the well-being of its people. About 50% of Sarawak's population is rural communities whom

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mostly still depending on forest and forest resources for livelihood and employment. Forest industry development had provided access and communication to the rural communities especially those in the most interior part of Sarawak.

6. The State acknowledges that with any developments, there is always the other side of impacts. Therefore, we are committed to strike a balance between the need for development and safeguarding forest resources, environment and well-being of the people. The sustainable development is always a priority agenda of the State.

Ladies and Gentlemen,

Sustainable Forest Management

7. The State Government is committed in ensuring its forest and forest resources are managed in a sustainably manner. In fact, we have a good forest policy statement as early as 1954 which warrant sustainability.

8. However, with rapid socio-economic developments which require more areas for developments and competition for land use as well as encroachment into our Permanent Forest Estate the management of our forests become more and more challenging.

9. Realizing this, the State Government has to re-look at its policies and ordinances to strengthen our forest management and wood-based industries. Policy reform is needed to catch-up with current issues facing forestry either locally or globally. Among the policies that being reviewed and newly introduced are:

- I. Sarawak Forest Policy
- II. Forest Management Certification (FMC)
- III. Development of Planted Forest
- IV. Wood Industries Development Plan
- V. Raw Material for timber industries
- VI. Forest Revenue especially cess from downstream products

These draft policies are in the final stage of deliberation before they are endorsed.

10. In line with our policy reform, the State Government has made it mandatory for all long-term forest timber licensee to obtain certification by 2022. In the past, FMC was merely on voluntary basis.

11. With growing local and global concern on environmental issues, forest management certification has become the main requirement for buyers to ensure that timber and timber products come from sustainably managed forests. It is also has become the key interest for environment and social based non-governmental organizations (NGOs).

12. We acknowledge that in the beginning of this journey, shortcomings and challenges are inevitable, especially on the capacity of both implementing agencies and timber industry. Nevertheless, we believe that with strong cooperation and collaboration from all relevant ministries and agencies, timber industries, NGOs and local communities a balance between environment, economy and socio-economic development can be achieved.

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13. I would like to take this opportunity to congratulate four of our Forest Management Units (FMUs) namely Anap Muput FMU for being able to maintain its certification and Ravenscourt FMU, Kapit FMU and Linau FMU for being certified recently. Not forgetting to our Forest Plantation Management Unit namely Segan, Lana, Masama, Penyuan and Kejin Long Lama for being certified Forest Management (Plantation) Certification. I hope that other FMUs would follow suit very soon.

14. I am made to understand that Peninsular Malaysia and Sabah are well ahead than Sarawak in implementing Forest Management Certification. This is perhaps, where the area of collaboration among the forestry agencies in these three regions could be enhanced. Please use this platform to discuss and find common areas for cooperation and collaboration.

Ladies and Gentlemen,

Advancement of Technologies

15. Today, with the advancement of technologies and digital world, we are no longer oblivious and isolated as our forests can be seen and monitored from all over the world. At the same time, the advance technology can be used to our advantage in managing our forests more efficiently.

16. In developed countries like Finland for example, forest owners can take care of their forest-related business from the comfort of their homes. They have the service portal that provides latest information of forest areas in terms of forest stands, stocking, soil types etc. This service portal could also suggest possible logging method or other forest management activities for the area as well as providing related income and cost estimates.

17. As in other industries, information system is one of technology that has a big impact in their operation; likewise, it also applies in forest management. Sustainable forest management requires timely and accurate information, and with the advancement of technologies this information is readily and easily available with the snap of your finger. This would enable the decision maker to make an informed decision. Technologies also offer options for a more pragmatic approach in conservation of biodiversity e.g. wildlife tracking and monitoring. This is also in line with the State's aspiration to become a digital government.

18. For Sarawak, we strive to stay abreast with the latest technologies in the area of forest planning, monitoring and enforcement. Drone for example is widely use in monitoring works especially in area where access is limited. Geospatial technology is capable of capturing, storing, analyzing and displaying geographically referenced information in real time. Since our country is a signatory to many international conventions and multi-lateral environmental agreements, data on forest and other land uses need to be reported periodically. All of these are made possible with the help of technology. At a larger scale, Sarawak has embarked on information sharing through "big data" to enable better coordination within State agencies.

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Ladies and Gentlemen,

Forest Beyond Timber

19. Beyond timber, others such as non-timber forest resources are very much under-utilized. Non timber forest resources play a key role in rural communities' livelihood for subsistence and local economy. This however, takes place just as an informal sector of economy.

20. Non-timber forest resources such as eco-tourism, carbon credit and community-based forestry could be explored as alternative source of income for the State and the community.

Ladies and Gentlemen,

Way Forward

21. Having said that, and with all the advancement of technology that is being use now is secondary if the integrity and sanctity of our forests is not sufficiently guarded. Therefore, this is where the focus and emphasize on research and development is vital. The existing platform such as the Heart of Borneo initiative could also be used to enhance collaboration, networking and knowledge sharing. Our colleagues from Peninsular Malaysia could also share with us their experiences in implementing the Central Forest Spine Project.

22. Therefore, it is my fervent hope that the conference resolutions would capture various issues on research and development, technologies and develop ideas on how we move forward as one to address challenges in forest management at the national, regional and global levels as well as for future collaboration in forestry.

23. Last but not least, for all those who come from afar, I wish you a pleasant stay in Sarawak and enjoy what Kuching has to offer.

23. With that note, it gives me a great pleasure to **officially declare** open the 18th Malaysian Forestry Conference 2018, Kuching, Sarawak.

Wishing you all the best. Thank you

Sekian,

Assalamualaikum

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KEYNOTE SPEECH BY ITTO REPRESENTATIVE, SHEAMALA SATKURU





MALAYSIAN FORESTRY CONFERENCE 2018
31 July – 2 August
Kuching, SARAWAK

** Advancing Sustainable
Forestry through
Digitalisation & Technology*

S. Satkuru
ITTO





ITTO's mandate: Article 1 ITTA 2006:

Include.....a consultative forum for producing and consuming members.....the expansion, diversification, and structural improvement of the international tropical timber trade..... reforestation and other forest management activities.....processing of tropical timber in the producing countries.....research and development.....technology transfer.....support for development of national policies in sustainable utilization and conservation of tropical forests..... with special regard for ecological balance.....
ITTO'S PRIORITIES ARE.....

ITTO'S PRIORITIES ARE.....



FORESTS (WOOD PRODUCTS + NTFPS)
DIRECTLY AND INDIRECTLY

↓↓↓



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SOME STARK FACTS:

UNSPF TARGET – Reverse forest loss and INCREASE forest area by 3% by 2030

Deforestation reduced to 3.3 million ha in 2015 from 7.3 million ha in 2000 BUT

Agriculture still responsible for 80% of forest loss (conversion) More than 50% of 193 UN member states have less than 20% forest cover

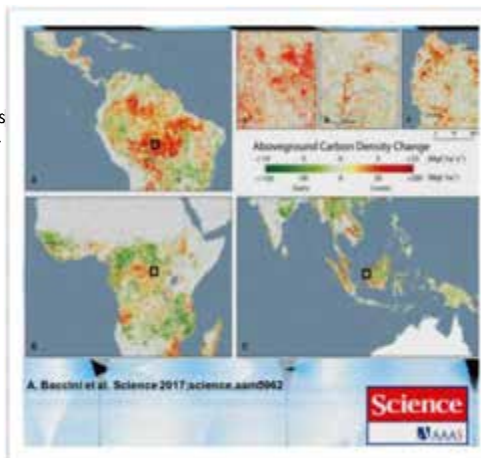
Global population = 9 BLN 2050, = ↑ food, wood products, woodfuel, income

Forest DEGRADATION larger problem, URGENT NEED FOR
REFORESTATION & RESTORATION/SUPPLEMENT RAW MATERIALS

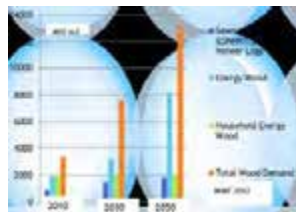


Tropical forest degradation: geography of carbon density change

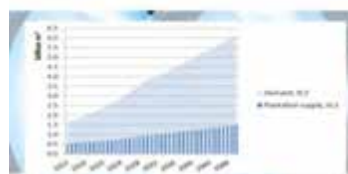
- Tropical forests are a net release of carbon of $425.2 \pm 92.0 \text{ Tg C yr}^{-1}$ (losses of $861.7 \pm 80.2 \text{ Tg C yr}^{-1}$ and gains of $436.5 \pm 31.0 \text{ Tg C yr}^{-1}$ from forest growth)
- Losses result from (i) deforestation and (ii) reductions in carbon density within standing forests (degradation) accounting for 68.9% of overall losses



Increasing Global Wood Demand

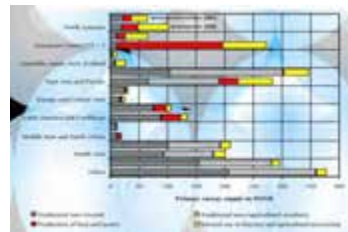


Increasing Gap for Industrial Roundwood

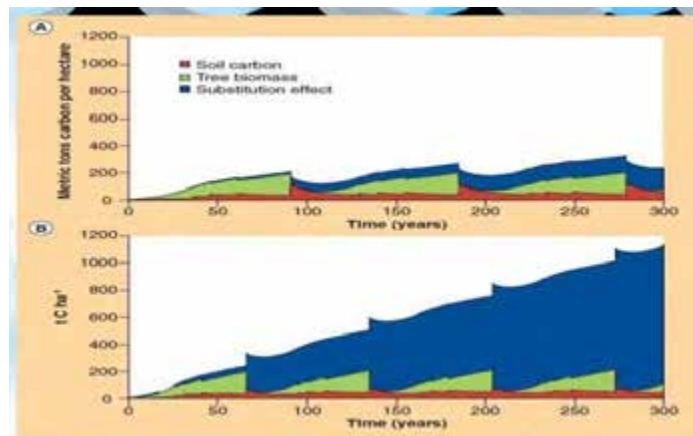


Demand in woodfuel and charcoal continues to increase

- 2.8 billion people will depend on TRADITIONAL FUELS in 2030
- Massive increase in demand for wood energy in industrialized countries



* Mitigation Benefits of Sustainable Forestry Value Chain



Canadian Journal of Forest Research 37 (3)2007

* Need for capacity building throughout Green supply chains



International and National Legality and Sustainability Frameworks

SDGs, UNSPF, National Policies, Intl. Agreements, Proofs of Legality (Certification Schemes, Timber Tracking Systems, DNA Fingerprinting, ...)



RECENT KEY ACTIVITIES:



- SUSTAINABLE SUPPLY CHAINS INITIATIVE CONFERENCE WITH CHINA PRIVATE SECTOR - ITTO web page: http://www.itto.int/news_releases/id=5622

12 leading companies signed a formal declaration to adopt the principle of green supply chains for their businesses – Total Production value 2017 US\$ 12.8 billion, 15.6% of China's imports and exports of timber products in 2017 - 4% of China's total timber industry.

CPF Members ACTIVITIES:

- HALTING DEFORESTATION: From aspiration to action
- Sustainable Wood 4 a Sustainable World (SW4SW)
- Review of ITTO Forest Landscape Restoration Guidelines with GEF/IUCN
- Forest Landscape Restoration activities with CPF members

18th Malaysian Forestry Conference



*** Urgent Need for Action, inter alia:**

- *Creating awareness across international forest regime; policy processes, broad public
- *Promoting the paradigm of bio-economy
- *Urgent need for fiscal and taxation incentives as stimulant
- *Capacity building at all levels: producers, traders, processors and consumers
- *Developing universal procurement criteria and GSC guidelines to reduce complexity
- *Piloting supply chains/markets: from legality to sustainability
- *Support emerging sustainable supply chain initiatives, etc etc etc



Actively promote sustainable production & consumption of wood products, NTFPs & NTFS in international and domestic markets



ITTO's Activities on Technology & Digitalisation

ITTA 2006.....research and development.....technology transfer.....

SOME EXAMPLES OF ITTO'S WORK.....



***Timber tracking**

*Reliable information on the flow of forest products through the supply chain to:

- *Improve forest management
- *Assure legality and sustainability
- *Ensure fair capture of forest revenues

*Rapid evolution of timber tracking systems

- *Technology
- *Scope of products and scale





ITTO's work on timber tracking

*Guatemala's electronic information system for forest enterprises

<https://www.youtube.com/watch?v=MyhZNKVYMqU>



* ITTO projects on legality and traceability of timber



- * Species identification and timber tracking using DNA finger printing and stable isotopes (Africa & Indonesia)
- * Guatemala's timber traceability system
- * Data management system for the forest sector in Ecuador
- * Online platform to facilitate the flow of information on timber legality to SMEs in China
- * Chain of custody verification in PNG
- * Capacity building in monitoring and control mechanism in Panama

Further details of ITTO's projects available from ITTO's project search
http://www.itto.int/project_search/
A magazine with a comprehensive review of above projects is available at
<http://www.itto.int/tfu/id=4367> or from "TFU app" (Apple & Google Play)



* DNA finger printing & stable isotopes

- *DNA fingerprinting and stable isotope techniques use characters inherent to the timber and are impossible to falsify
- *Testing = extracting DNA from wood samples- comparing the genotypes with the genetic reference material. Similar case for stable isotopes (carbon, hydrogen, nitrogen, oxygen, strontium and sulphur)
- *DNA fingerprinting and wood anatomical testing used to determine species
- *DNA fingerprinting and stable isotope testing is used for geographic origin
- DNA DATABASES:
 - *iroko (*Milicia excelsa*)
 - *sapelli (*Entandrophragma cylindricum*)
 - *ayous (*Triplochiton scleroxylon*)
 - * from seven African countries: Cameroon, Congo, DRC, Côte d'Ivoire, Gabon, Ghana and Kenya



•DNA finger printing & stable isotopes



- DNA-based traceability systems are assisting to control trade in two CITES-listed tree species: *Pericopsis elata* (timber) and *Prunus africana* (bark)
- Detect attempts to substitute timber and bark from non-authorized harvest zones with two approaches:
 - * Matching of *Prunus africana* bark with individual trees in controlled harvest zones
 - * Traceability of bark back to distinct *Prunus africana* populations for which sustainable harvest plans have been drawn up and approved. (known as "Prunus allocation units")
- * These capabilities enable the independent scientific verification of CITES document claims
- * The identification of sufficient genetic markers enables reliable discrimination between individual trees of the same species, and between trees of different geographic origin.



* DNA finger printing & stable Isotopes



- *Border applications:
 - *Effective mechanism for detecting illegally harvested bark in the supply chain, closing off channels to market for illegally harvested forest products
- *DNA traceability works on top of existing document controls
- *Export markets gain access to a wider range of controlled timber sources, and responsible exporters gain better access to overseas markets



Videos from ITTO projects on timber tracking and timber identification:



Guatemala timber tracking

<https://www.youtube.com/watch?v=MyhZNKVYMqU>

Mapping selective logging in Brazil

<https://www.youtube.com/watch?v=75CNqHVG680>

Identification of CITES tree species

https://www.youtube.com/watch?v=W_ONG7r54mU

TFU issue 24/1 also features several articles of digitalization and use of technology for SFM, including DNA timber identification in Africa, Ecuador's forest information system, Guatemala's timber traceability system, Online platform in China to share information about timber legality.

18th Malaysian Forestry Conference

• ITTO PROJECTS IN MALAYSIA

www.itto.int/projects

38 IN TOTAL – 24 DIRECTLY RELATED TO SARAWAK

Ongoing Projects :

Title	Executing Agency	ITTO budget (US\$) / donor
SEANGAI BUJANG BUTTERFLY ZONE MANAGEMENT FOR PAUONG TAU NATIONAL PARK WITH INVOLVEMENT OF LOCAL COMMUNITIES IN SARAWAK, MALAYSIA	Sarawak Forest Department (Leader: Dr Paul Chai)	517,450 Japan, JICA, Switzerland
POKONG RAN 3 (P) COMMUNITY BASED FOREST MANAGEMENT OF SUNGAI MOKHT WATERSHED, SARAWAK, MALAYSIA	Sarawak Forest Department (Leader: Mohamed Shahbudin H) Sabik)	460,000 APFNet (China)

QUOTE FROM DR. GERHARD DIETERLE

Executive Director ITTO:

- ITTO wishes to express its sincere gratitude to the Government of Malaysia for its outstanding commitment and support to ITTO from its inception.
- ITTO welcomes the commitment shown by the Sarawak Government and the Forest Department Sarawak over the years for proactively implementing ITTO projects and for its efforts to secure additional funding from the Sarawak Government to enable effective activities to be implemented. Gratitude also goes to our donors for their confidence in supporting Sarawak in its aims, proven by the quality outcome of projects executed.
- ITTO further congratulates the Sarawak Government's commitment aiming for the certification of its FMUs in the near future. ITTO stands ready to support our members in carrying forward our mandate under the ITTA 2006. WE WELCOME CONTINUOUS COLLABORATION!!

FORESTS & SDGS 2030





TERIMA KASIH

Connect:



YouTube: Ittosfm



Twitter: @itto_sfm



Instagram: itto_sfm



Facebook:
International Tropical
Timber Organization

TFU app



Get the app

Social media and apps

Videos are attached in CDs provided

18th Malaysian Forestry Conference

4.0 PROCEEDINGS OF CONFERENCE

4.1 CONFERENCE OFFICIALS

Conference Chairman:	Hamden bin Haji Mohammad Director of Forests, Forest Department Sarawak
Vice Chairmen:	YBhg. Datuk Sam Mannan Chief Conservator of Forest, Sabah Forestry Department YBhg. Dato' Haji Nor Akhrrudin bin Mahmud Director General Forestry Department Peninsular Malaysia
Conference Secretary	Jack Liam Deputy Director, Forest Department Sarawak
Sub-theme Chairperson:	
Sub-theme (i)	Jack Liam Forest Department Sarawak
Sub-theme (ii)	Mashor Mohd. Jaini Sabah Forestry Department
Sub-theme (iii)	Dato' Mohd Ridza bin Awang, Forestry Department Peninsular Malaysia
Sub-theme (iv)	Dr. Alik Duju Sarawak Forestry Corporation Sdn. Bhd.
Sub-theme (v)	Frederick Kugan Sabah Forestry Department
Sub-theme (vi)	Dato' Lim Kee Leng Forestry Department Peninsular Malaysia

Resolution Committee	
Chairman	Abg Ahmad Abg Morni Forest Department Sarawak
Vice Chairman	Oswald Braken Tisen Sarawak Forestry Corporation Sdn. Bhd.
Members	Dato' Lim Kee Leng Forestry Department Peninsular Malaysia Dato' Mohd Ridza bin Awang Forestry Department Peninsular Malaysia Jack Liam Forest Department Sarawak Dr. Alik Duju Sarawak Forestry Corporation Sdn. Bhd. Frederick Kugan Sabah Forestry Department Mashor Mohd. Jaini Sabah Forestry Department

18th Malaysian Forestry Conference

Rapporteurs	
Chief Rapporteur	Oscar Johin Ngayop
Forest Department Sarawak	Madeline George Pau Hajah Mohizah binti Mohamad
Sarawak Forestry Corporation	Evelyn Jugi Julia Sang Audrey Cassandra
Forestry Department Peninsular Malaysia	Izaidah binti Taib Mohd Aizat bin Aripin Mohamad Umar bin Abdullah
Sabah Forestry Department	Dr. Arthur Chung Mohd. Aminur Faiz bin Suis Viviannye Paul

4.2 STANDING ORDERS OF THE MALAYSIAN FORESTRY CONFERENCE (no amendment in the 18th Malaysian Forestry Conference)

Preamble

The Forest Department of Sabah, Sarawak and Peninsular Malaysia, and Sarawak Forestry Corporation having a common interest in the planned development of Forestry and proper utilisation of the forest resources of Malaysia and desiring to further the attainment of these ends through common cooperation have agreed to hold regular conference as a platform for the exchange of information, ideas and experiences.

Definitions

1. The Conference shall be known as the MALAYSIAN FORESTRY CONFERENCE (PERSIDANGAN PERHUTANAN MALAYSIA) and shall hereinafter be referred as the conference.
2. For purpose of these standing orders, Sabah, Sarawak and Peninsular Malaysia, and the Sarawak Forestry Corporation shall hereinafter be individually referred to as the State and Corporation respectively.
3. A conference Session is one when the Conference sits for purpose other than a Plenary Session, under the chairmanship of the Conference Chairman.
4. Plenary Session is one when working papers are being presented and discussed, under the chairmanship of the Plenary Sessions Chairman.
5. A Workshop Session is one when a group participants elected by the Conference, sits for a specific purpose as decided by a Plenary or Conference Session.

Rule 1: Participation

The participants to the Conference shall be:

- (a) all officers of the Forest Services of Sabah, Sarawak, and Peninsular Malaysia, and the Corporation.
- (b) all volunteers, associate experts and consultants being employed by, seconded to or posted to the respective Forest Services of the State and the corporation.

18th Malaysian Forestry Conference

Observers

Anyone with interests in forestry may be invited to attend the conference as observers, and shall be required to pay a registration fee, the amount of which shall be determined at the discretion of the host state.

Rule 2: Objectives

- 2.1 To discuss and resolve common problems pertaining to all aspects of forestry development.
- 2.2 To coordinate the planned management of the forest resource and its utilization, and to seek means and methods leading to the development and diversification of forest industries with the aim of maximising its contribution to the socio-economic benefits of the nation.
- 2.3 To coordinate lines research and use improved techniques in all aspects of forestry operations and timber utilisation.
- 2.4 To establish closer working relationship and understanding between the officers from the three States.
- 2.5 To generate public consciousness through publicity and education on the importance of forestry as an integral element in the national economy.

Rule 3: Frequency

- 3.1 The venue and dates of the Conference shall be determined by the State to host the Conference.

Rule 4: Venue, Date and Duration 18th Malaysian Forestry Conference

- 4.1 The venue and dates of the Conference shall be determined by the State to host the Conference.
- 4.2 The duration of the Conference shall not exceed 14 days inclusive of tours.

Rule 5: Theme

- 5.1 The theme of the Conference shall be decided upon by the host State, after due consultation with the other States. The Conference may also propose the theme for the next Conference.

Rule 6: Emblem

- 6.1 The Conference shall have as its official emblem the design of a cross-section of a log of wood, the centre of which will be fourteen pointed star adopted from the national flag. On the left of the star, within the log cross section will be a microscope depicting forest resources. In place of bark on the lower half of the log cross-section, will be part of a toothed wheel representing industry. Below of the log cross-section will be a map, arranged on the left and right side of the log cross-section, showing the component regions of Malaysia. Around the top half circumstance of the log cross-section will be written the following words, —PERSIDANGAN PERHUTANAN MALAYSIA". Below the lower circumstance of the log cross-section and between the two halves of the map will be the Conference Session number and the year.

Rule 7: Papers and Posters

- 7.1 Papers presented at the Conference shall be classified into two categories, viz, working and information papers. Only working papers shall be tabled at the Conference.
- 7.2 The guidelines to authors as in **Appendix I** should be adhered to in the preparation of papers.

18th Malaysian Forestry Conference

- 7.3 The guidelines to authors as in **Appendix II** should be adhered to in the preparation of posters.
- 7.4 Working papers must be distributed to participants at least one week before the Conference Session.
- 7.5 The host State may for specific interest invite papers from outside the Forest Department of Sabah, Sarawak and Peninsular Malaysia to be presented as Working Papers.

Rule 8: Registration

- 8.1 All participants and observers to each Conference Session shall register themselves for the conference.

Rule 9: Opening Ceremony

- 9.1 The conference shall be opened by a distinguished personage, from the Ministry responsible for forestry or by any other personage of similar or higher status from the Government.
- 9.2 There shall be a welcoming speech by the Head of the Forest Services of the host State.

Rule 10: Conference Officials

- 10.1 The Conference shall, during each Conference Session, elect a Chairman, two Vice-Chairmen and a Secretary whose terms of office shall continue until the next session of the Conference.
- 10.2 Nominees shall be duly proposed and seconded from the floor and election shall be by open majority vote.
- 10.3 There shall be one or more Plenary Session Chairman, and one or more Rapporteurs for each Plenary Session Chairman and Rapporteurs shall terminate at the end of the Conference.

Rule 11: Duties of Conference Officials

11.1 Conference Chairman 18th MALAYSIAN FORESTRY CONFERENCE

The Conference Chairman shall:

- (a) Call the Conference to order.
- (b) Ensure due observance of these Standing Orders.
- (c) Maintain order and proper conduct of the Conference.
- (d) Have the right to give the floor to any speaker and determine the time limit for a speaker to speak.
- (e) Call for votes should there be occasion requiring such action.
- (f) Have a casting vote.
- (g) Declare the closing of the Conference session.
- (h) Cause the proceedings to be prepared, published, and subsequently distributed.
- (i) Effect follow-up actions on resolutions for implementation by all concerned.
- (j) Cause to notify the host State to organise the subsequent Conference.

11.2 Conference Vice-Chairman

The Conference Vice-Chairman shall exercise all the functions of the Chairman in the absence or at the request of the Chairman.

11.3 Conference Secretary

The conference Secretary shall:

- (a) Form a Conference Secretariat whose function will be to organise and coordinate the smooth running of the conference.
- (b) Maintain order and conduct of the particular Plenary Session.

18th Malaysian Forestry Conference

- (c) Receive, collate and circulate documents, reports and resolutions of the Conference as and when necessary.

11.4 Plenary Session Chairman

The Plenary Session Chairman shall:

- (a) Chair the Plenary Sessions for which he is elected.
- (b) Maintain order and conduct of the particular Plenary Session.
- (c) During the Plenary Session, reserve the right to give the floor to any speaker, determine the time limit for a speaker to speak, call for votes should there be a necessity and have a casting vote.

11.5 Rapporteurs

Rapporteurs shall:

- (a) Record all proceeding during the Plenary Session for which he is elected.
- (b) Collate, summarise and submit the record of Plenary Sessions proceedings to the Conference Secretariat.

Rule 12: Conference Procedure

- 12.1 As soon as appropriate after the official opening ceremony, the last Conference Chairman shall call the Conference Session to order.
- 12.2 The first function shall be the election of the Conference Chairman, who shall then take over the Chair, and thenceforth continue the election of other Conference officials.
- 12.3 The respective heads of the three State Forest Services shall give a resume on actions taken to implement the resolutions of the last Conference.
- 12.4 The Plenary Session shall be chaired by the appointed Plenary Sessions Chairman or in his absence the Conference Chairman.
- 12.5 Presentation of Working Papers should be limited to a maximum of 20 minutes. About 30 minutes shall be allotted for discussions but the period shall be left to the discretion of the Chairman.
- 12.6 Resolutions may be initiated at a Plenary Session, and a Workshop Session shall be elected to draft the resolutions. **18th MALAYSIAN FORESTRY CONFERENCE**
- 12.7 The Conference shall have a Closing Conference Session in which the resolution proposals or/and findings of the Workshop Session shall be discussed.

Rule 13: Workshop Sessions

- 13.1 Workshop Sessions or Working Groups may be formed by the Plenary Sessions to look into any specific topic or draft resolution.
- 13.2 Workshop Sessions shall meet at times other than when the Plenary or Conference Session, unless by special sanction of the Conference Chairman.

Rule 14: Resolutions

- 14.1 Resolutions can be initiated at a Plenary Session, but shall be drafted by a Workshop Session elected for this purpose.
- 14.2 All Resolutions must be precise, brief, and as concise as possible.
- 14.3 All Resolutions put forward shall be decided by a show of hands.

Rule 15: Tours

- 15.1 The Conference shall also include tours to place related to the theme and/or deemed necessary by the host State.
- 15.2 Post-conference tours may also be arranged at the discretion of the host State.

18th Malaysian Forestry Conference

- 15.3 Conference tours shall be held within the period of the Conference, with sessions before and after the tours.

Rule 16: Amendments

- 16.1 The power to cause any amendment to any part, these Standing Orders shall vest upon the Conference Session and any decision for such amendment shall be decided by an open majority vote.
- 16.2 Any proposals for amendments shall be submitted to the State to host Conference, not less than one month before the due date of the Conference.
- 16.3 The State to host the Conference, on receipt of such proposals, shall cause copies of the proposals to be distributed to all participants not less than one week before the date of the Conference.
- 16.4 Any proposals for amendments shall be presented to the Conference Session before the Plenary Sessions commence.

4.3 RESOLUTIONS OF THE 17TH MALAYSIAN FORESTRY CONFERENCE

The 17th Malaysian Forestry Conference was Held on 11-12 November 2014 in Kota Kinabalu, Sabah with the theme — A Century of Forest Management: Lessons Learnt and The Way Forward.

The Conference was conducted in six sub-themes (6), namely:

Sub-theme 1	: Forest Management, Technology, Innovation and Practices
Sub-theme 2	: Forest Governance: Policy, Legislation and Enforcement
Sub-theme 3	: Forests Biodiversity: Restoration, Conservation and Protection
Sub-theme 4	: Plantation Forestry: Sustainable Wood Production and Wood Based Industry
Sub-theme 5	: Forest Ecosystems Services: Food, Water, Energy, Climate and Recreation
Sub-theme 6	: Social Forestry: Stakeholders, Participatory and Awareness

Conference Objectives:

- to provide a platform for discussing and resolving problems collectively, pertaining to the aspects of forest development;
- to co-ordinate the planned management of the forest resources and its utilization, seeking means and methods leading to the development and diversification of the forest industries with the aim of maximizing its contribution to the socio-economic development of the nation;
- to co-ordinate lines of research and the use of improved techniques in all aspects of forestry operations and utilization;
- establishing a closer working relationship and understanding among foresters from all over Malaysia; and
- generating public consciousness on the importance of forestry as an integral element in nation building.

18th Malaysian Forestry Conference

4.4 Reports of Actions Taken on the 17th Malaysian Forestry Resolutions

Resolutions of the report of action recorded during the 17th Malaysian Forestry conference:

4.4.1 Sabah Forestry Department

By Datuk Sam Mannan (Chief Conservator of Sabah Forestry Department)*

4.4.2 Forestry Department of Peninsular Malaysia

By Dato' Hj. Nor Akhrrudin bin Mahmud (Director General of Forestry, Peninsular Malaysia)*

4.4.3 Forest Department Sarawak

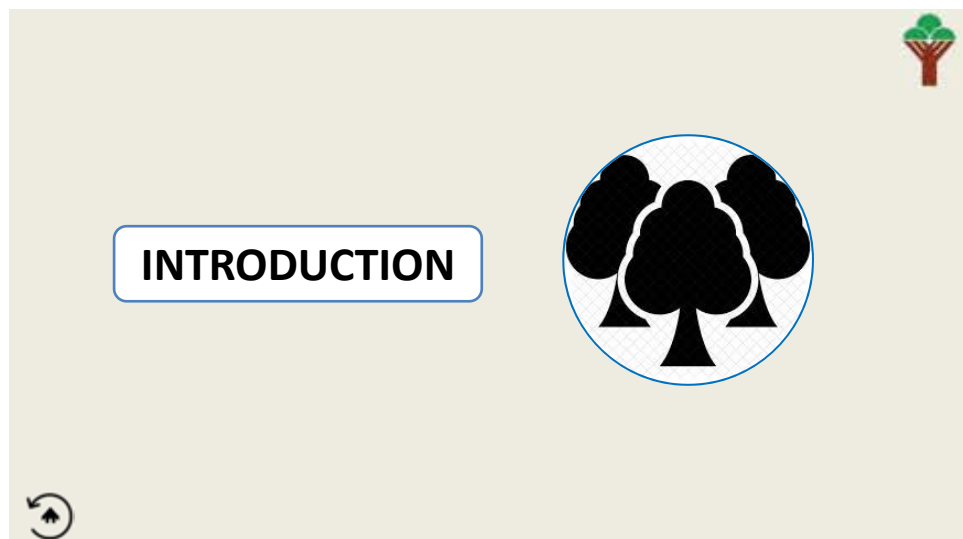
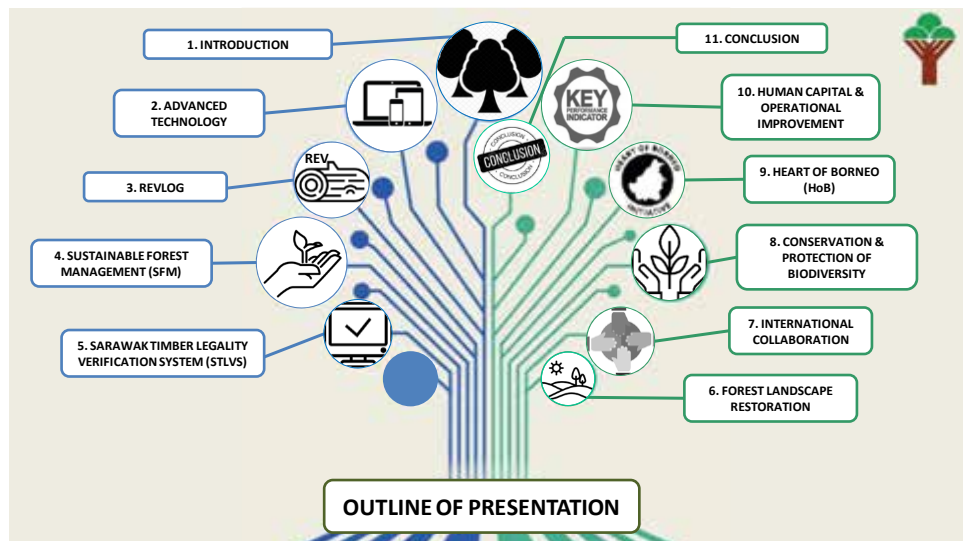
By Hamden bin Haji Mohammad (Director of Forests, Sarawak)*

***Videos are attached in CDs provided**

5.0 PLENARY SESSION

18th Malaysian Forestry Conference

5.1: Keynote Address by Hamden bin Haji Mohammad, Director of Forest Department Sarawak



MERAWA CAMP



SERAPI SUMMIT VIEW



HEAD-HUNTERS TRAIL,
MULU NATIONAL PARK





***'ADVANCING SUSTAINABLE FORESTRY
THROUGH DIGITALIZATION AND
TECHNOLOGY'***

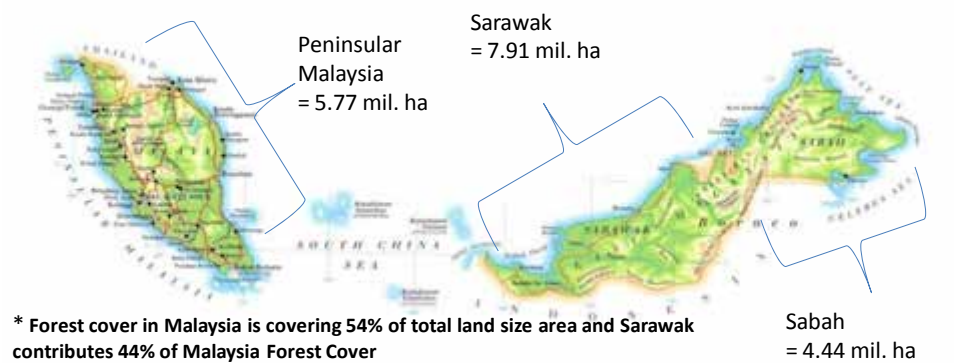


**ADVANCED
TECHNOLOGY**

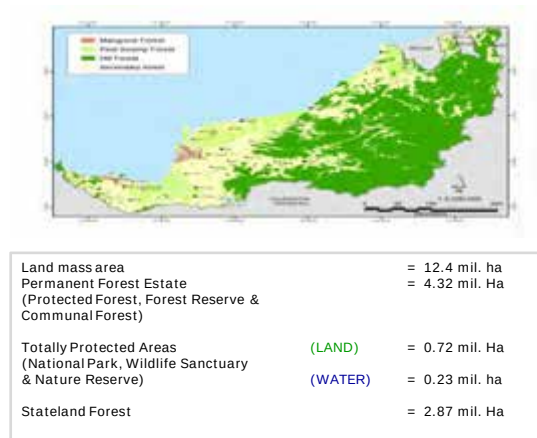


18th Malaysian Forestry Conference

MALAYSIA FOREST COVER



SARAWAK FOREST COVER



64 %

SYSTEMS APPLICATION AND DEVELOPMENT UNIT (SADU)



- Formed 2008
- Undertake **application development** in **Advance Technology & providing of Geospatial Services** to Department and other State agencies

- Sarawak experience in hyperspectral sensing operations:

- **Tasks**
 - ✓ Resource monitoring & inventory
 - ✓ Aerial surveillance & enforcement
- **Airborne system**
 - ✓ Fixed wing (large area mapping)
 - ✓ Helicopter (enforcement)



18th Malaysian Forestry Conference

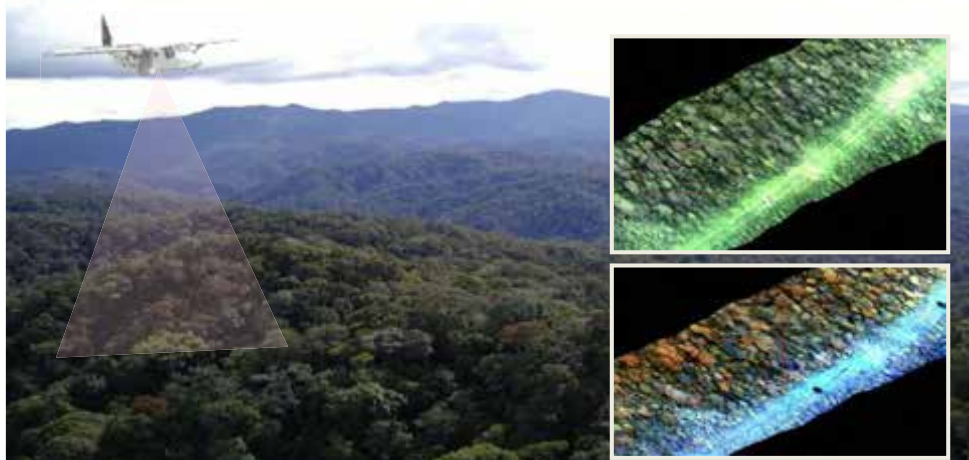
ASSETS USED IN AIR OPERATIONS (PLATFORM)



MANPOWER

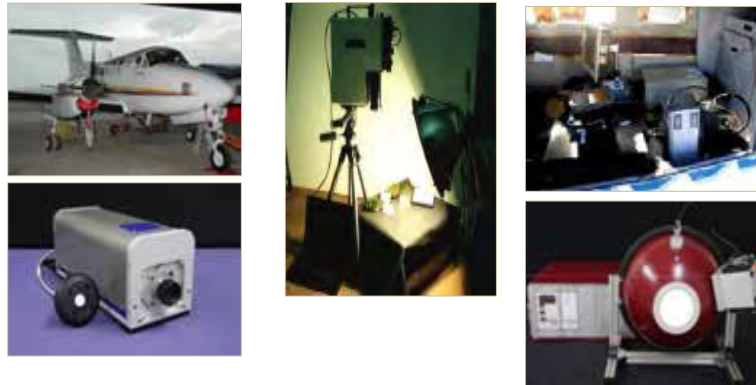


USING HYPERSPECTRAL TECHNOLOGY FOR FOREST MANAGEMENT AND PROTECTION

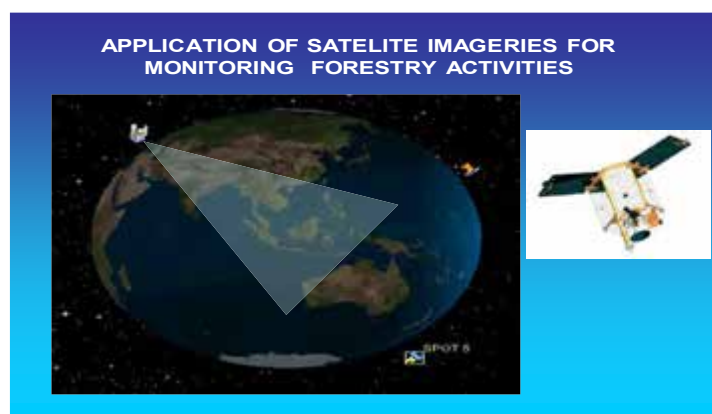
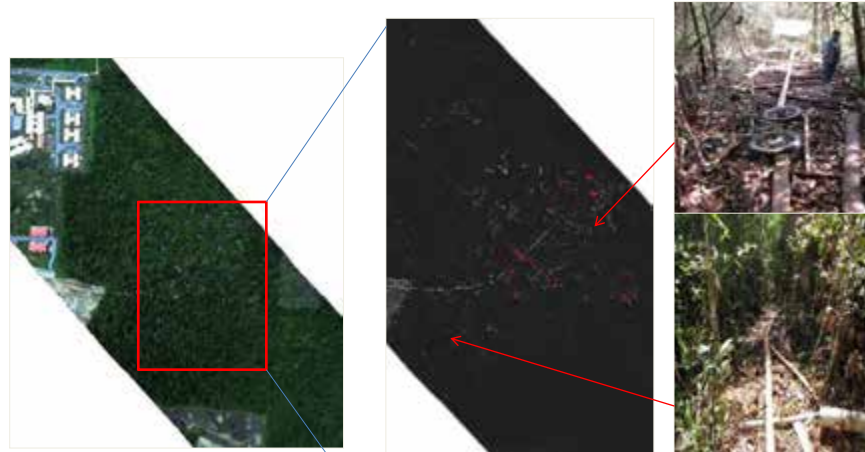




TECHNOLOGY APPLICATION FOR TRANS-BOUNDARY
CONSERVATION AND MANAGEMENT
(HYPER SPECTRAL SENSING SYSTEM)



SYSTEM APPLICATION IN ENFORCEMENT



18th Malaysian Forestry Conference

COMPACT AIRBORNE TACTICAL SYSTEM (CATS) FOR FOREST MONITORING AND ENFORCEMENT



Operator Display & Controls



Mobile Navigation & Pilot Display



Hyperspectral Imaging Sensor & Gimbal Component fitted onboard Bell 206L4 helicopter



FIELDWORK FOR DATA COLLECTION

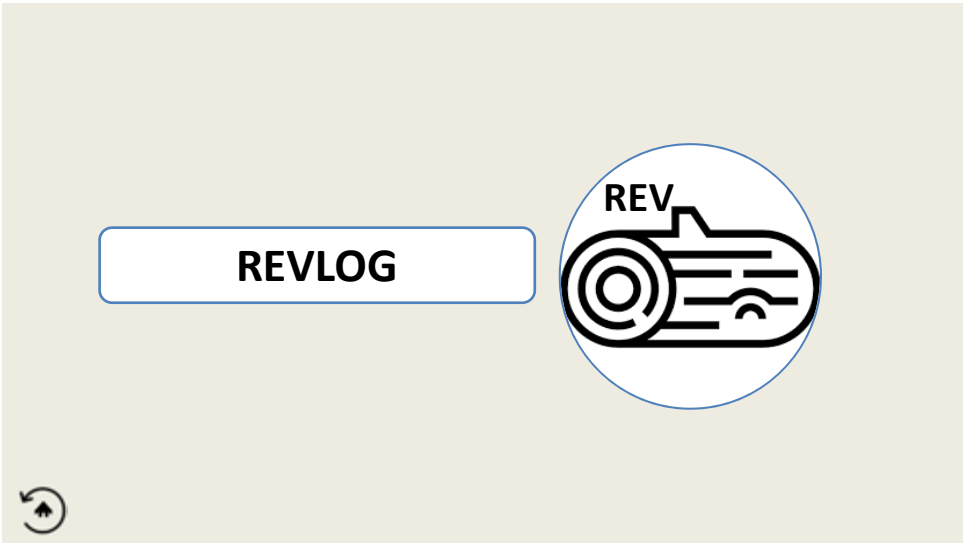


FIELDWORK FOR DATA COLLECTION





FOREST OPERATION
THROUGH AIR
SURVEILLANCE

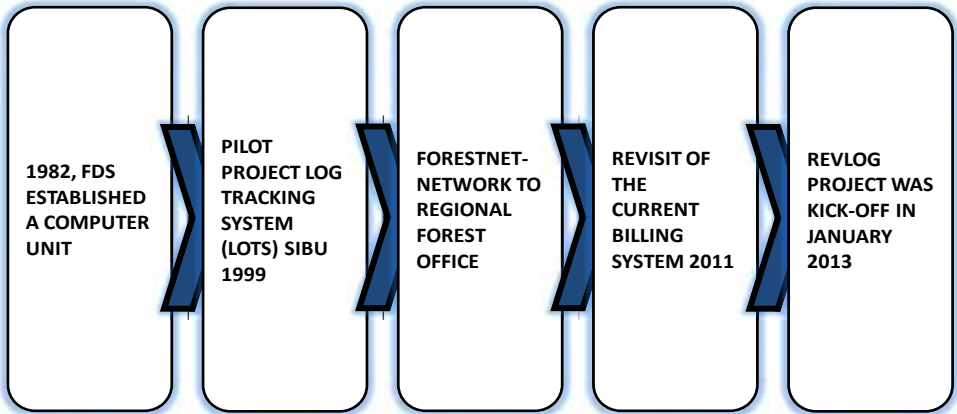


WHAT IS REVLOG?

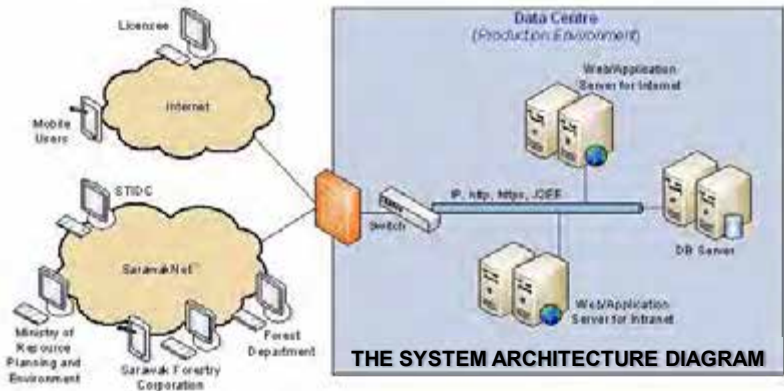




HISTORY OF REVLOG



**SARAWAK FORESTRY REVENUE
MANAGEMENT SYSTEM VERSION 1.0**



NOW ...



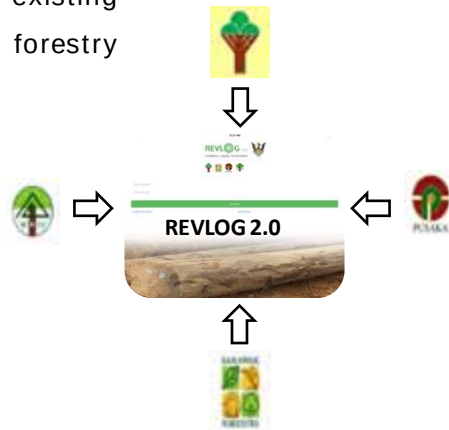
REVLOG 2.0

18th Malaysian Forestry Conference

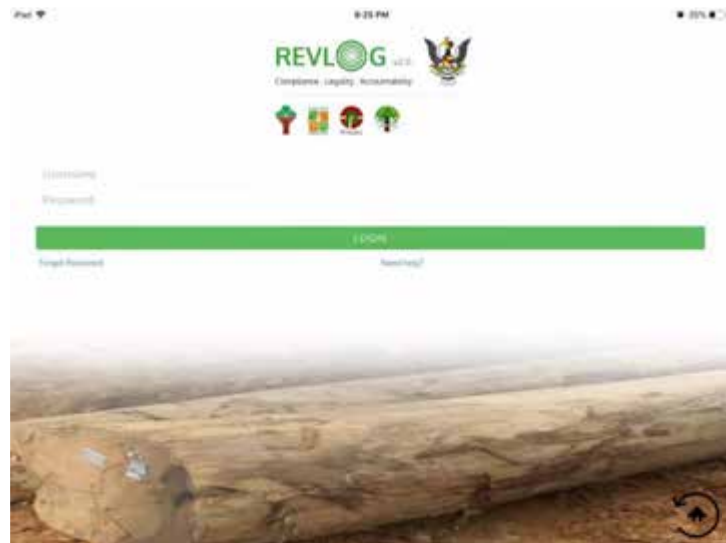


REVLOG 2.0:

An integration of all existing systems used by all forestry agencies in Sarawak.



MOBILE APPS
INTERFACE...



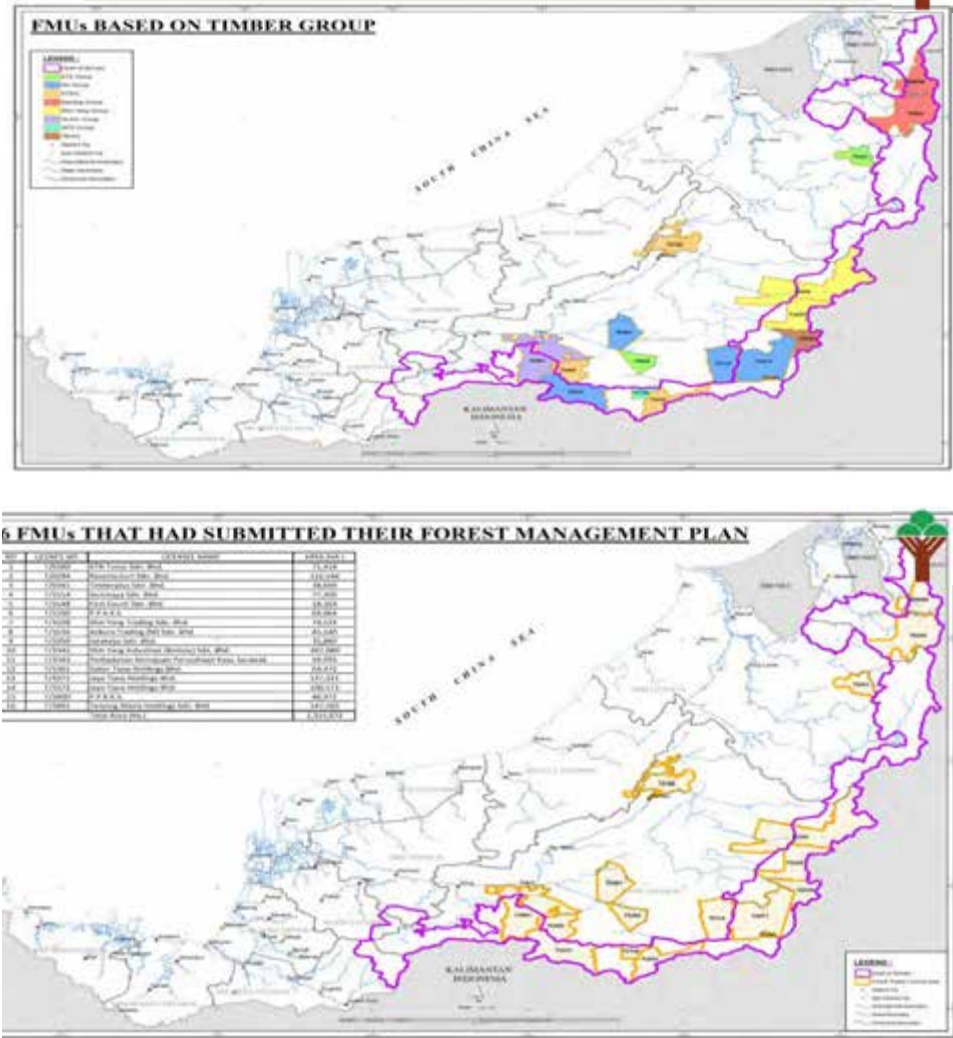
**SUSTAINABLE
FOREST
MANAGEMENT
(SFM)**



SUSTAINABLE FOREST MANAGEMENT



MAP SHOWING FMUs IN SARAWAK (BIG 6 PLUS STDC)



18th Malaysian Forestry Conference



Stage 1 Audit: T/3491 Tanjong Manis Holdings Sdn Bhd



Stage 1 Audit: T/3228 Shin Yang Trading Sdn Bhd



Stage 1 Audit: T/3236 Bahau Kahei FMU



18th Malaysian Forestry Conference

Stage 2 Audit: T/0294 Ravenscourt FMU



Stage 2 Audit : T/3228 Linau FMU



Verification Audit : T/0294 Ravenscourt FMU



18th Malaysian Forestry Conference

Meetings/Discussions with Licensees



Shin Yang Group @24 Feb 2017



Ta Ann Group @13 Feb 2017



KTS Group @ 23 Feb 2017



STIDC Group@23 Feb 2017

Meetings/Discussions with Stakeholders



Workshop to Review FMC Guidelines on 4-6/10/17



18th Malaysian Forestry Conference



ANAP MUPUT FMU

1st FMU CERTIFIED







RAVENSCOURT FMU

2nd FMU CERTIFIED





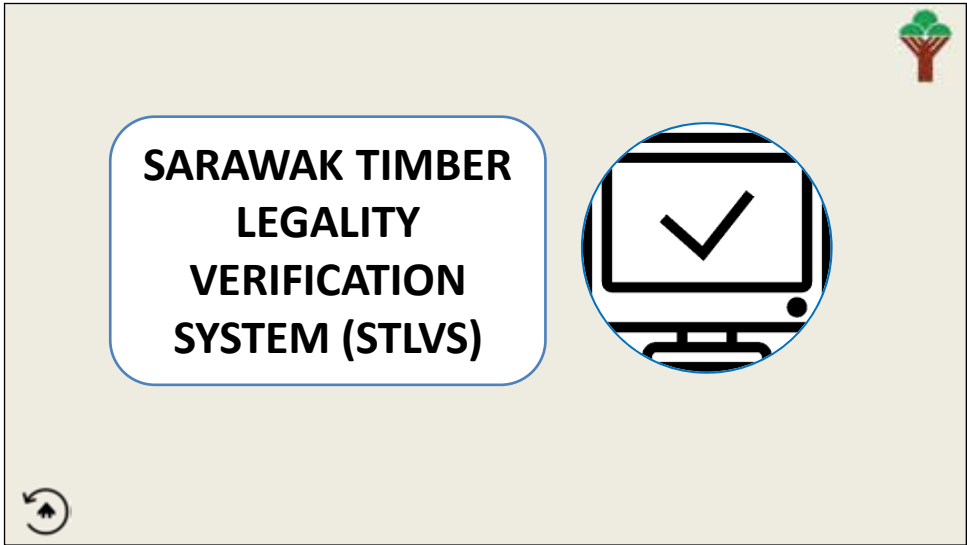


KAPIT FMU

3rd FMU CERTIFIED



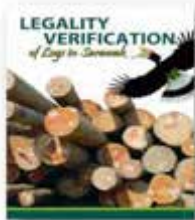


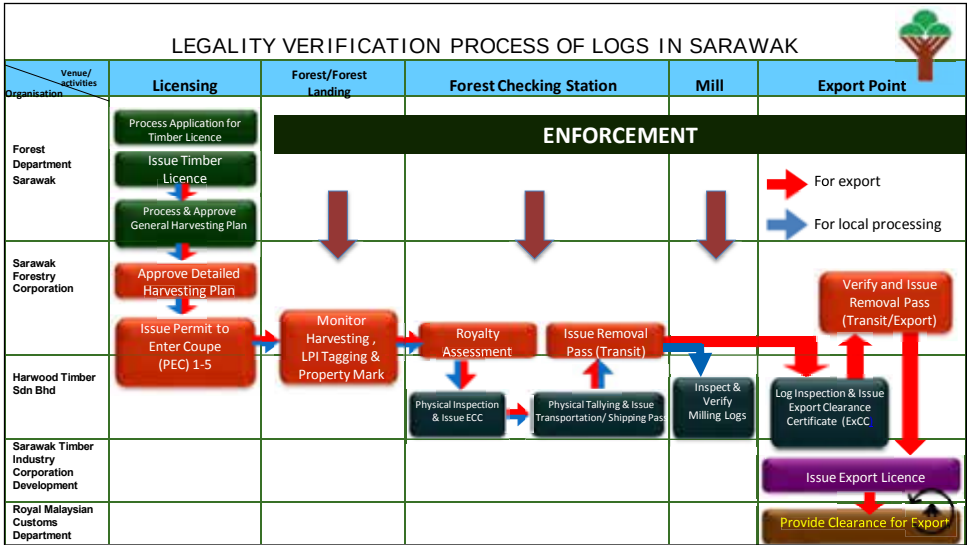


SARAWAK LEGALITY VERIFICATION SYSTEM



“Logs harvested by licensed persons from approved areas and verified by the relevant authorities in accordance with the laws, regulations and procedures pertaining to forestry and trade in Sarawak”





FOREST LANDSCAPE RESTORATION





SEEDS COLLECTION / WILD SEEDLINGS (*EUSIDEROXYLON Z WAGERI*, *EUSIDEROXYLON MALANGAGAI*, *SHOREA SP. DAN SEBAGAINYA*), NON-TIMBER FOREST PRODUCTS- NTFP (*CALAMUS SP.*, *DONAX SP.*, *AQUILARIA SP.*)



AGARWOOD SEEDLINGS COLLECTION WORKS AND SETTING UP A TEMPORARY NURSERY PLOT AT BUDUK BUI, **BA'KELALAN**



AGARWOOD SEEDLINGS GROWTH PROCESS



Newly sown agarwood seedlings



After 7 days



After 14 days



After 30 days



STIC NURSERY, OYA FOREST RESERVE



UPGRADING WORKS AT STIC NURSERY,
OYA FOREST RESERVE



COMPOUND CLEANING WORKS AT STIC NURSERY, OYA



SOWING OF SEEDLINGS AT STIC NURSERY, OYA FOREST RESERVE



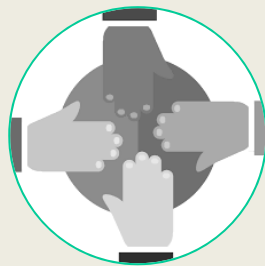
**ONE-STOP COMPLIANCE CENTRE (OSCC)
SABAL FOREST RESERVE NURSERY**



MAINTENANCE WORKS AT OSCC SABAL FOREST RESERVE NURSERY



NIAH NURSERY, MIRI.



**INTERNATIONAL
COLLABORATION**



INTERNATIONAL / NATIONAL COLLABORATIONS



International Organization/ Developed countries had rendered technical and financial assistance towards forestry development in the state. It started in 1967 with FAO for inventory of Mixed Dipterocarp Forest in Sarawak.



Japan, Netherlands, German, Denmark, USA, Australia, NZ, India, China, ASEAN, Middle East, EU, etc.



ITTO, APNet, FAO, UNDP, GEF, JICA, FOMISS, ALTERA, DANCED9/DANIDA, GTZ, Copenhagen Zoo, Natural Resources Institute (LUKE) Finland etc.



Salford University, Lincond University, UNIMAS, UPM, ASM, FRIM, etc.

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...MoU between Sarawak State Government & Copenhagen Zoo of Denmark for collaboration in the conservation and management of wildlife and protected areas...

25th June 2018



...MoU between Sarawak State Government and Natural Resources Institute Finland (LUKE) in carrying out joint research and development activities or consultancy work on sustainable forestry in Sarawak...



25th January 2018



...MoU between Forest Department Sarawak and Sarawak Energy Berhad (SEB) on community development projects in Murum & Batang Ai...

11th July 2018



**CONSERVATION &
PROTECTION OF
BIODIVERSITY**



CONSERVATION AND PROTECTION



Total existing number of TPAs:

NAME	TOTAL	AREA (ha)
National Parks	41(50)	792,510.00
Nature Reserves	14	2,539.00
Wild Life Sanctuaries	5(7)	225,791.40
TOTAL	60(71)	1,020,840.40

*inclusive waterbodies



NIAH NATIONAL PARK





BAKO NATIONAL PARK



GADING NATIONAL PARK



LOAGAN BUNUT
NATIONAL PARK





LAMBIR NATIONAL PARK



SIMILAJAU
NATIONAL PARK



BATANG AI NATIONAL PARK





MALUDAM NATIONAL PARK



KUBAH NATIONAL PARK



MULU NATIONAL PARK





SEMENGGOH NATURE
RESERVE



MATANG WILDLIFE CENTRE



LANJAK ENTIMAU
WILDLIFE SANCTUARY







INTERNATIONAL RECOGNITIONS

Bako Buntal Bay (BBB)
1st East Asia Australasia Flyway Network Site in Malaysia in 2013



BBB is an important wintering site for waterbirds. 32 species of shorebirds comprising an estimated 20,000-25,000 individuals winter in the Bay and its immediate surroundings.





CENTRE OF EXCELLENCE:
*Center for Orangutan Research in Nanga Delok (BANP) &
Centre for Plant Research in Nanga Bloh (LEWS).*

- Sarawak State Government approved the establishment of a Center of Excellence for Orangutan Research in Ng. Delok (BANP) & a Center of Excellence for Plant Research in Ng. Bloh (LEWS).







**HEART OF BORNEO
(HOB)**

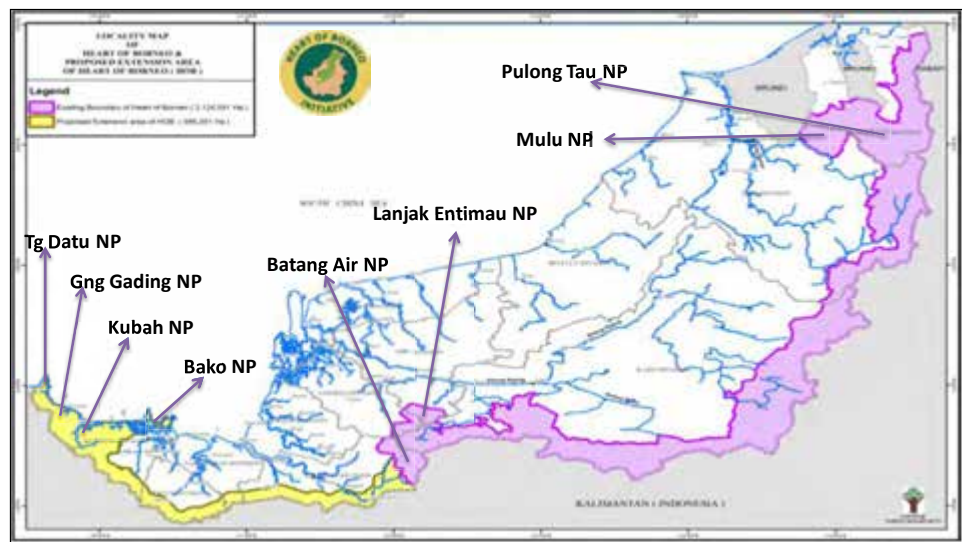
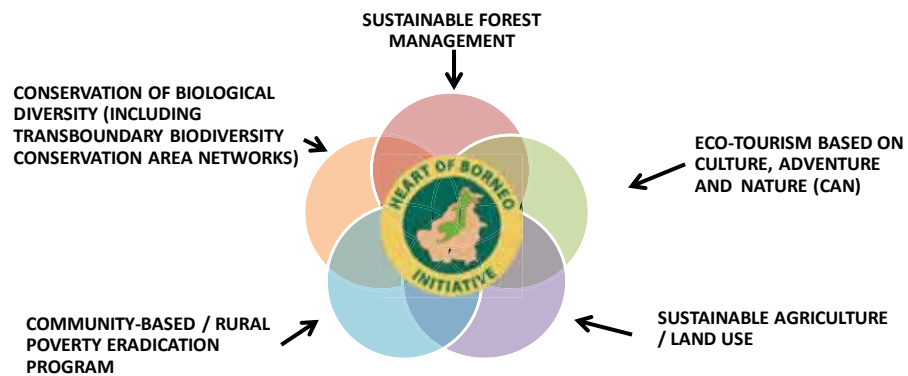


WHAT IS HEART OF BORNEO?

Heart of Borneo (HoB) Initiatives - a voluntary transboundary cooperation between **Malaysia, Indonesia and Brunei Darussalam** to conserve and manage the tropical forests, across the borders of the three countries on the island of Borneo in the Malaysia states of Sarawak and Sabah.



5 – PILLARS OF HOB SARAWAK



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HEART OF BORNEO (HOB) SARAWAK

- i. Initial Area of HoB = 2,124,551 ha
- ii. Extension area of HoB* = 565,251 ha

Area of HoB after extension = 2,689,802 ha

1. Initial Area of HoB consists of:-

- ❑ Northern Region (Miri and Limbang District), Central Region (Kapit District), Southern Region (Sri Aman, Sarikei, Sibu and part of Song and Kapit)
- ❑ Mulu National Park, Pulong Tau National Park, Batang Ai National Park, Lanjak Entimau Wildlife Sanctuary

2. Extension Area of HoB consists of:-

Batang Ai to the west of Sarawak, along the boundary of connecting Batang Ai, Kelingang Banjaran, Gunung Apeng National Park, Bungo Banjaran National Park, Mount Pueh National Park, Gunung Gading National Park, Kubah National Park, Wetland Kuching National Park, Santubong National Park, Bako National Park, Samunsam Wildlife Park and Tanjung Datu National Park

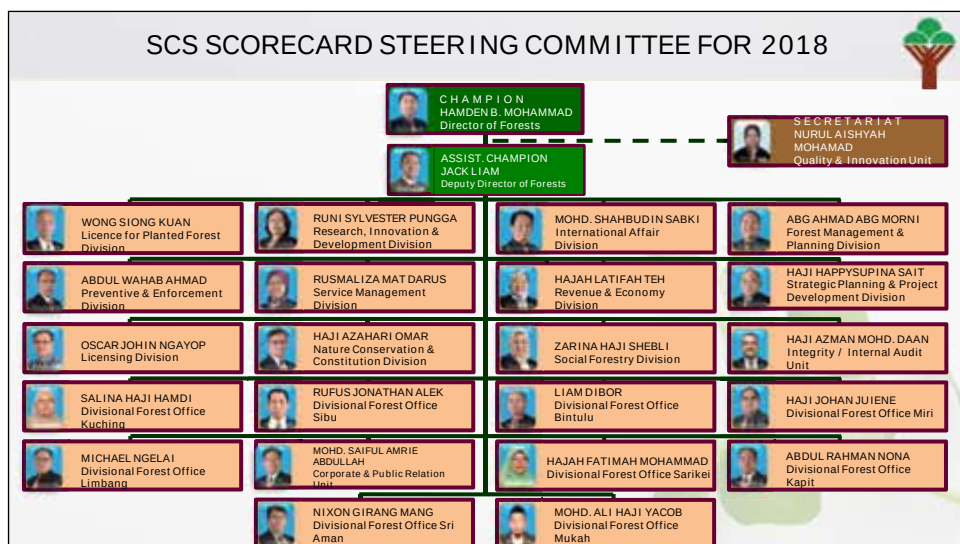


HUMAN CAPITAL & OPERATIONAL IMPROVEMENT

FOREST DEPARTMENT SARAWAK SCORECARD 2018 	
Vision	Excellence in the management and conservation of tropical forests
Mission	To manage and develop the forest resources for socio-economic and environmental sustainability
Strategic Themes	• Stakeholder excellence • Forest resource sustainability excellence • Regulatory excellence
Strategic Results	• Stakeholder satisfaction • Sustainability of forest resources • Effective preventive measures and enforcement
Tagline	Forests beyond timber
Core Values	SCS Shared Values; • Integrity • Professionalism • Result Oriented • Sense of Urgency and Ownership • Kind and caring • Team Spirit



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FOREST DEPARTMENT SARAWAK SCORECARD 2018			
Vision	Excellence in the management and conservation of tropical forests		
Mission	To manage and develop the forest resources for socio-economic and environmental sustainability		
Strategic Themes	Stakeholder Excellence	Forest Resource Sustainability Excellence	Regulatory Excellence
Strategic Results	Stakeholder Satisfaction	Sustainability of Forest Resource	Effective Preventive Measures and Enforcement
Customer (30.00)	CS1(30.00): Enhance Customer Satisfaction		
Financial (25.00)	F1 (7.50): Prudent Budget Management		F2 (7.50): Ensure Financial Regulatory Compliance
Internal Process (40.00)	IP1(6.00): Enhance Sustainable Forest Management (SFM).	IP2 (6.00): Effective Enforcement and Regulation.	IP3 (6.00): Effective Management of Permanent Forest Estate (PFE) & Totally Protected Area (TPA).
	IP5 (5.00): Enhance R&D in Conservation and Management of Forest Resources.	IP6 (5.50): Enhance Inter-agency Collaboration.	IP 7 (6.00): Enhance the usage of technology and digital system in forestry.
Organizational Capacity (15.00)	OC1 (7.50): Enhance Training & Development.		OC2 (7.50): Inculcate Shared Values.

30 FOREST GUARD TRAINEES
ATTENDING FOREST GUARDS
CERTIFICATE COURSE AT
KEPONG FORESTRY SCHOOL





30 FOREST GUARD TRAINEES
ATTENDING FOREST GUARDS
CERTIFICATE COURSE AT
KEPONG FORESTRY SCHOOL



***...THE ACTIONS WE
TAKE TODAY
DETERMINE THE
FUTURE OF OUR
FOREST...***



18th Malaysian Forestry Conference

**5.2: Keynote Address by Datuk Sam Mannan
Chief Conservator of Forests
Sabah Forestry Department**

Video is attached in CDs provided

**5.3: Keynote Address by Dato' Hj. Akhirrudin bin Mahmud
Director-General of Forestry
Forestry Department Peninsular Malaysia**

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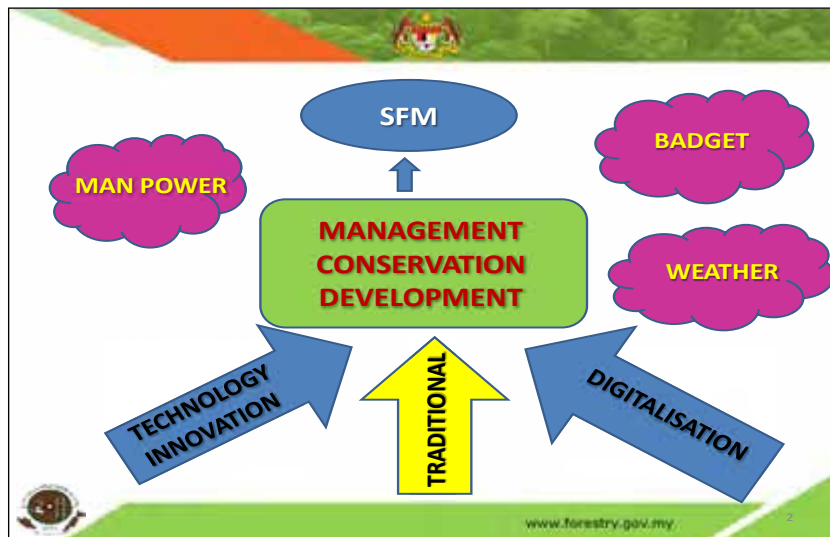
THE 18TH MALAYSIAN FORESTRY CONFERENCE 2018
PERSIDANGAN PERHUTANAN MALAYSIA KE-18

KEYNOTE ADDRESS

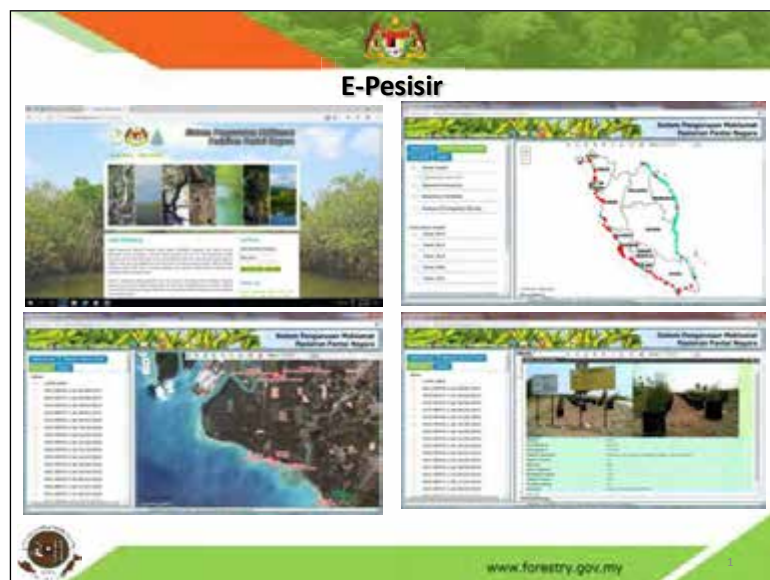
BY:

DATO' HJ. NOR AKHIRRUDIN BIN MAHMUD
DIRECTOR-GENERAL OF FORESTRY,
PENINSULAR MALAYSIA

www.forestry.gov.my



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**E-Geospatial
Perhutanan (e-GP)**



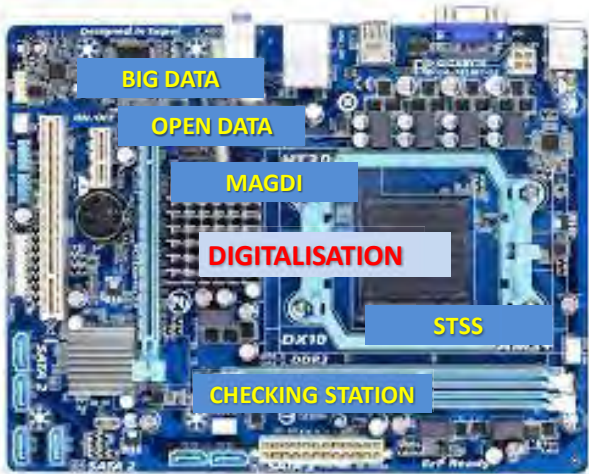
www.forestry.gov.my



FDPM WAR ROOM



www.forestry.gov.my



BIG DATA

OPEN DATA

MAGDI

DIGITALISATION

STSS

CHECKING STATION

www.forestry.gov.my

CHECKING STATION

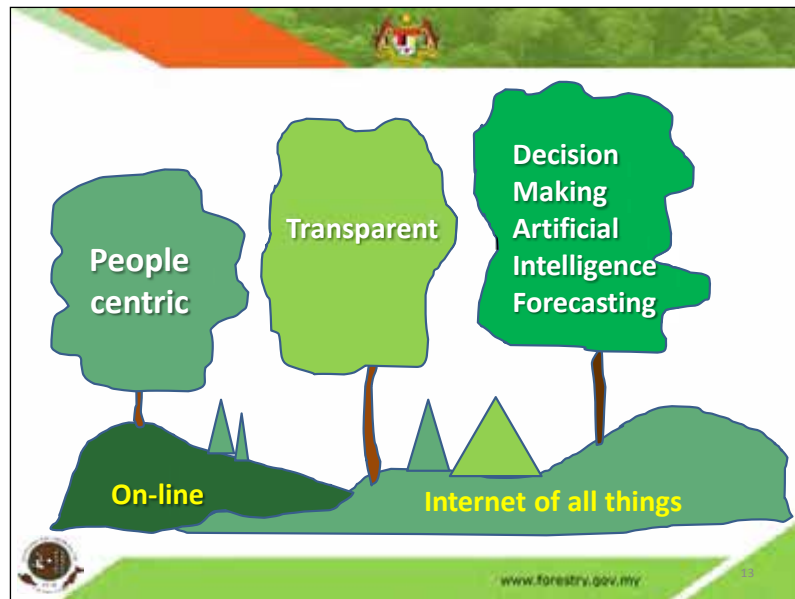
www.forestry.gov.my

STSS

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WAY FORWARD

www.forestry.gov.my



THANK YOU

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ORAL SESSION

Sub Theme 1:

Forest Governance:

Policy, Legislation and Enforcement

PAPER 1: PENCEGAHAN DAN PENGUATKUASAAN HUTAN DI SARAWAK

**Abdul Wahab Ahmad, Mohammad Hidayatullah, Syafiani Osman, Santey Berikom,
Asminie Wati Belaja and Carole Lenan**

Forest Department Sarawak

Abstrak

Penguatkuasaan merupakan salah satu fungsi Jabatan Hutan Sarawak yang penting. Sejak dahulu lagi fungsi ini telah banyak memberi kesan yang positif terhadap perkembangan industri perikanan di Sarawak. Buktinya sehingga ke hari ini Sarawak masih mampu mengeluarkan kayu balak bukan sahaja untuk kegunaan industri tempatan malah 30 pertatus daripada pengeluaran adalah untuk eksport. Sepanjang lima tahun yang lepas banyak kaedah penguatkuasaan terkini telah diadaptasi oleh Jabatan Hutan Sarawak bagi memastikan hutannya senantiasa terpelihara. Penggunaan imej satelit, dron dan hiperspektral diantara yang telah digunakan sehingga kini untuk mengesan dan membentasi kegiatan pembalakan haram. Penggunaan teknologi terbaru ini telah dapat memberi pengesanan di peringkat awal aktiviti disesuatu kawasan sehingga pihak jabatan dapat mencegah dan seterusnya mengambil tindakan pemantauan yang agresif bagi mengekang kegiatan lanun-lanun balak. Statistik sepanjang empat tahun lepas (2014-2017) menunjukkan kadar penurunan kes dan jumlah rampasan kayu balak di Sarawak dapat membuktikan ketegasan Jabatan dalam memerangi kegiatan haram ini sepanjang masa. Jabatan Hutan Sarawak tetap komited memastikan kelestarian hutan Sarawak untuk generasi yang mendatang.

1.0 PENGENALAN

Jabatan Hutan Sarawak (JHS) telah ditubuhkan pada tahun 1919 bagi menerajui pengurusan hutan berkekalan di negeri Sarawak. Penguatkuasaan ordinan dan peraturan hutan merupakan salah satu fungsi utama Jabatan Hutan Sarawak seperti yang telah digariskan di dalam Dasar Perhutanan Negeri 1954. Negeri Sarawak mempunyai keluasan 12.4 juta hektar dimana 8.04 juta daripada keseluruhan kawasan dilitupi oleh hutan. Penguatkuasaan hutan yang dipertanggungjawabkan kepada Jabatan Hutan Sarawak adalah merangkumi kawasan Hutan Simpan Kekal (PFE) iaitu seluas 4.3 juta hektar, manakala kawasan Hutan Tanah Negeri (*Stateland*) seluas 3.05 juta hektar dan Kawasan Hutan Terlindung seluas 0.67 juta hektar.

Bersesuaian dengan visi jabatan iaitu Cemerlang Dalam Pengurusan Hutan Tropika dan misi Mengurus dan Membangunkan Sumber Sumber Hutan ke Arah Pembangunan Sosio-Ekonomi dan Kelestarian Alam Sekitar, JHS telah dipertanggungjawabkan untuk menguatkuasakan tiga (3) ordinan utama dibawah peruntukan:

- i. *Forests Ordinance, 2015 (Cap.71);*
- ii. *Wild Life Protection Ordinance, 1998; and*
- iii. *National Parks and Nature Reserves Ordinance, 1998.*

2.0 INISIATIF

Penguatkuasaan merupakan salah satu fungsi Jabatan Hutan Sarawak yang penting. Sejak dahulu lagi fungsi ini telah banyak memberi kesan yang positif terhadap perkembangan industri perikanan di Sarawak. Buktinya sehingga ke hari ini Sarawak masih mampu

mengeluarkan kayu balak bukan sahaja untuk kegunaan industri tempatan malah 30 peratus daripada pengeluaran adalah untuk eksport. Sepanjang lima tahun yang lepas banyak kaedah penguatkuasaan terkini telah diadaptasi oleh Jabatan Hutan Sarawak bagi memastikan hutannya sentiasa terpelihara. Di samping itu, penggubalan ordinan kepada Forests Ordinance 2015 (Cap.71) dengan hukuman yang lebih berat untuk kesalahan hutan telah digunapakai sejak 1 Jun 2015.

Statistik sepanjang empat tahun lepas (2014-2017) menunjukkan kadar penurunan kes dan jumlah rampasan kayu balak di Sarawak dapat membuktikan ketegasan jabatan dalam memerangi kegiatan haram ini sepanjang masa. Jabatan Hutan Sarawak tetap komited memastikan kelestarian hutan Sarawak untuk generasi yang mendatang sentiasa terjamin.

Antara inisiatif yang telah dibuat bagi memerangi kegiatan pembalakan haram adalah seperti;

2.1 Penubuhan State Illegal Logging Task Force

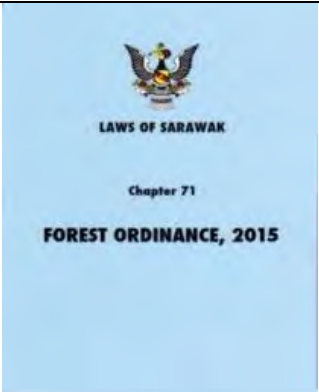
Selaras dengan arahan Ketua Menteri Sarawak pada 2014 untuk membanteras pembalakan haram di negeri ini, satu jawatankuasa khas iaitu ***State Illegal Logging Task Force*** yang dipengerusikan oleh YB Datuk Amar Haji Awang Tengah Bin Ali Hasan, Menteri Pembangunan Bandar dan Sumber Asli II telah ditubuhkan dan turut dianggotai oleh pelbagai agensi kerajaan, badan berkanun dan wakil daripada industri perkayuan. Jawatankuasa khas ini bermesyuarat dan menetapkan halatuju dalam membanteras pembalakan haram. Mesyuarat terkini, jawatankuasa ini telah diadakan pada 21 April 2017 di Wisma Sumber Alam. Ketetapan dari mesyuarat diperturunkan kepada Jabatan Hutan Sarawak melalui Pengarah Hutan Sarawak.



2.2 Penggubalan Forest Ordinance 2015 (Cap.71)

Penggubalan Forest Ordinance 2015 (Cap.71) telah dilaksanakan bagi menggantikan Forest Ordinance 1958 (Cap.126). Ia telah digunapakai berkuatkuasa pada 1 Jun 2015 dimana hukuman untuk kesalahan hutan dikenakan hukuman yang lebih berat.

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FOREST ORDINANCE 1958 (CAP.126)	FOREST ORDINANCE 2015 (CAP.71)
	
80. Whoever, in contravention of section 47, 50, 58 or 59, unlawfully cuts, collects or removes any forest produce from any State land, Government reserve, communal forest or alienated land shall be guilty of an offence: Penalty, imprisonment for one year and a fine of ten times the value (as estimated by the Director or a person authorized by him in that behalf) of the forest produce in respect of which the offence has been committed or two thousand ringgit, whichever is the greater. Penalty for illegal collection of forest produce in other cases. (Am. Ord. No. 10/61; Am. Ord. No. 2/79; Am. Cap. 49.)	Penalty for illegal collection of forest produce 90.—(1) Whoever collects forest produce in permanent forests, State land or alienated land without a licence issued to him under sections 40, 54 or 55, shall be guilty of an offence and shall, upon conviction, be punished with a fine of not less than twenty-five thousand ringgit and not exceeding one hundred and fifty thousand ringgit, and imprisonment for a term not exceeding five years. (2) When a person is convicted of an offence under this section, the court shall, in addition to any penalty which it may impose, order such person to pay to the Government a sum of not less than ten times the value (as assessed by the Director or any forest officer authorized by him) of such forest produce in respect of which such offence has been committed, and any sum ordered to be so paid shall be recoverable by the Government as a civil debt.
81. Whoever commits any act in contravention of this Ordinance relating to licences, royalties and fees, as set forth in sections 51, 52, 54, 56, 61, 62, 64 and 66, shall be guilty of an offence: Penalty, imprisonment for one year and a fine of two thousand ringgit. Penalties for revenue offences. (Am. Ord. No. 16/57.)	Penalty for revenue offence 91.—(1) Any person who contravenes this Ordinance relating to licences, royalties, premium, cess and fees, as set forth in sections 40, 45, 46, 47, 48, 49, 52, 57 and 59, shall be guilty of an offence and shall, upon conviction, be punished with a fine of not less than twenty-five thousand ringgit and not exceeding one hundred and fifty thousand ringgit and imprisonment for a term not exceeding one year. (2) When a person is convicted of an offence under this section, the court shall, in addition to any penalty which it may impose, order such person to pay to the Government a sum not less than ten times the royalty, premium, cess and fee, as the case may be, and any sum ordered to be so paid shall be recoverable by the Government as a civil debt.

2.3 Ikrar Integriti Korporat

Pada 18 November 2014, sebanyak 21 agensi kerajaan, perbadanan, pelesen balak dan kontraktor telah memberi komitmen dengan menandatangani Ikrar Integriti Korporat yang disaksikan oleh YAB Mantan Ketua Menteri Sarawak.



2.4 Penguatkuasaan Pensijilan Hutan Untuk *Sustainable Forest Management*

Dalam memastikan hutan diurus secara berkekalan dan mematuhi piawaian antarabangsa, Kerajaan Negeri telah mewajibkan semua lesen pembalakan jangka panjang untuk mencapai pensijilan pengurusan hutan menjelang tahun 2022 iaitu daripada badan diiktiraf dunia samada dari Malaysia Timber Certification Scheme (MTCS) (affiliate to Programme for the Endorsement of Forest Certification - *PEFC*) atau daripada Forest Stewardship Council - FSC. Pendekatan *self-regulatory* ini akan melalui proses audit oleh pihak ketiga bagi memastikan pematuhan pihak pelesen terhadap kriteria dan indikator yang telah ditetapkan.



2.5 Operasi Pencegahan & Penguatkuasaan Oleh Jabatan Hutan Sarawak

Seterusnya, dari segi operasi dilapangan, beberapa inisiatif terus diambil seperti pemeriksaan di logpond, pemeriksaan di kilang dan pemantauan dari udara. Sekatan jalan turut diadakan secara berterusan dan merangkumi static mobile blockade. Rondaan dalam skala besar turut dilaksanakan bersama Pejabat-Pejabat Hutan Wilayah. Sehingga kini, Jabatan Hutan Sarawak masih giat melaksanakan pelbagai strategi penguatkuasaan. Antara yang telah dilaksanakan adalah:

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2.5.1 *Pemeriksaan di Kawasan Lesen*



2.5.2 *Pemeriksaan di Kilang*



2.5.3 *Pemeriksaan di Eksport Point*



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2.5.4 Pemantauan Udara



2.5.5 Sekatan Jalan



2.5.6 Rondaan Seluruh Sarawak



2.5.7 Penggunaan Teknologi Hiperspektral dan Dron

Penggunaan imej satelit, dron dan hiperspektral di antara yang telah digunakan sehingga kini untuk mengesan dan membanteras kegiatan pembalakan haram. Penggunaan teknologi terbaru ini telah dapat memberi pengesanan di peringkat awal aktiviti disesuatu kawasan sehingga pihak jabatan dapat mencegah dan seterusnya mengambil tindakan pemantauan yang agresif bagi mengekang kegiatan lanun-lanun balak.

APLIKASI HIPERSPEKTRAL DALAM OPERASI PERHUTANAN:

1. Pembangunan pangkalan data maklumat geospasial untuk spesis pokok hutan Dipterokarp campuran (MDF) yang komprehensif
2. Membangun *MRV Tool* berasaskan karbon dan REDD+
3. Peningkatan keupayaan serta pengetahuan agensi pelaksana dalam operasi teknologi maju (cerapan hiperspektral)
4. Peningkatan keupayaan serta pengetahuan agensi pelaksana dalam operasi teknologi maju (pemantauan taktikal udara)



2.6 Kerjasama Agensi Penguatkuasaan Lain

Operasi bersama agensi penguatkuasaan yang lain juga menjadi salah satu inisiatif dalam memerangi pembalakan haram dan penyeludupan kayu balak.



2.7 Penggunaan Sistem Revlog & UbiQTrac

Dalam memastikan integriti pegawai sentiasa terjamin, Jabatan Hutan Sarawak dengan kerjasama *Sarawak Information Systems* (SAINS) telah mengaplikasikan teknologi pengesanan kenderaan, **UbiQTrac** di setiap kenderaan rasmi penguatkuasa. Pergerakan kenderaan akan dikesan dan dipantau oleh pegawai yang telah dilantik. Penggunaan sistem ini adalah penting dalam memastikan integriti pegawai sentiasa terjamin dan mengelakkan tomanhan.

Forest Department's Vehicles which have been installed with UbiQTrac VTS									
No.	Brand	Model	Type	Registration	Installation Location	Installation Date	UbiQTrac VTS S/N	Simcard No.	Remark
1	KUCHING	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4359	KUCHING	30.01.2015			
2	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5 MT	PICK-UP	QSG 4360*	KUCHING	30.01.2015			* Installed with Vehicle A, Personal Surveillance Camera (Model: 4735/2015)
3	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4361	KUCHING	30.01.2015			
4	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4362	KUCHING	30.01.2015			
5	ISUZU	ISUZU PICK-UP	PICK-UP	QSG 1836	KUCHING	30.01.2015			
6	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4363	KUCHING	29.01.2015			
7	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4366	KUCHING	29.01.2015			
8	NISSAN	X-TRAIL 4WD 2.0L A/T	JEEP	QSG 4007	KUCHING	*Not			
9	FORD	RANGER DBL XLT MT	PICK-UP	QSG 3418	KUCHING	29.01.2015			
10	ISUZU	TROOPER UBS 17	JEEP	QSG 1732	KUCHING	29.01.2015			
11	TOYOTA	CORONA BT191	MOTOR CAR	QSG 1415	KUCHING	29.01.2015			
12	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4364	KUCHING	29.01.2015			Sri Aman
13	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4365	KUCHING	29.01.2015			Simunjan
14	FORD	EVEREST 3.0L TDCI 4X4 AT LTD	LAND	QSG 3267	SIBU	04.02.2015	867622010404443	019-4904717	
15	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 3347	SIBU	04.02.2015	867622010369927	019-4904042	
16	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4365	SIBU	04.02.2015	867622010393083	019-4904722	
17	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4367	SIBU	04.02.2015	359772039988004	019-4904027	
18	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4368	SIBU	04.02.2015	867622010398892	019-4904689	
19	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4373	SIBU	04.02.2015	867622010398179	019-4904710	
20	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4384	SIBU	04.02.2015	867622010397562	019-4904723	KANOWIT
21	TOYOTA	TOYOTA LAND CRUISER	LAND CRUISER	QSG 1548	SIBU	04.02.2015	*Not installed		MUKAH
22	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4370	SIBU	04.02.2015	867622010309535	019-4904029	MUKAH
23	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4369	SIBU	04.02.2015	867622010404583	019-4904673	SARIKES
24	NISSAN	NISSAN X-TRAIL 3.0L	LAND	QSG 3670	SIBU	04.02.2015	867622010362054	019-4904025	SARIKES
25	TOYOTA	TOYOTA HILUX DOUBLE CAB 2.5	PICK-UP	QSG 4374	SIBU	04.02.2015	867622010333593	019-4904103	KAPT

2.8 Penubuhan Talian Hotline Untuk Aduan Awam

Maklumat dan aduan yang diterima adalah daripada pelbagai sumber termasuk risikan, sistem pesanan ringkas, talikhidmat, rondaan, surat aduan, media sosial dan surat khabar. Pada 2016, *Hotline* telah dilancarkan secara rasminya di SibU yang bernombor **1-800-88-7777** pada Oktober, 2016. Talian ini beroperasi 24 jam, namun dua (2) orang pegawai ditugaskan untuk menerima panggilan pada waktu pejabat, manakala selepas waktu pejabat semua aduan akan dirakam secara automatik.



2.9 Inter-Agency Standard Operating Procedure

Prosedur ini adalah untuk memperkemarkan fungsi agensi-agensi yang terlibat dalam rantaian pengeluaran kayu balak yang mana telah menjurus kepada skim persijilan kayu yang unik utk negeri Sarawak iaitu Sarawak Timber Legality Verification System (STLVS).



2.10 Penubuhan OSCC

Penubuhan OSCC di 48 lokasi adalah bagi memastikan kayu balak yang dikeluarkan mengikut prosedur yang telah ditetapkan.



2.11 Capacity Building

Disamping itu, *Capacity Building* masih terus menjadi inisiatif dalam memperkasakan penguatkuasaan jabatan hutan. Antaranya adalah latihan menembak, kursus ORBAT dan kursus pegawai penyiasat.



2.12 Kempen Kesedaran Awam

Sebuah kempen kesedaran awam Usaha Membanteras Pembalakan Haram, Pencerobohan Kawasan Terlindung Sepenuhnya dan Eksploitasi Hidupan Liar telah mula dirancang untuk seluruh Sarawak. Setakat ini 3 buah kempen telah diadakan bagi daerah Betong, Lundu/Sematan dan Kanowit yang melibatkan Ketua-Ketua Masyarakat dengan kerjasama Pejabat Daerah berkenaan. Antara objektif kempen adalah seperti yang berikut:

- i. Memberi pendedahan kepada orang awam mengenai usaha pencegahan & penguatkuasaan oleh Jabatan Hutan Sarawak;
- ii. Mendidik orang awam mengenai *Forests Ordinance, 2015 (Cap.71)*, *Wild Life Protection Ordinance, 1998* dan *National Parks and Nature Reserves Ordinance, 1998*; and
- iii. Membangunkan medium untuk berkomunikasi dan bekerjasama dengan orang awam di dalam menangani aktiviti pembalakan haram, pencerobohan Kawasan Terlindung Sepenuhnya dan pemburuan haram hidupan liar.

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Fig.1: Kempen Kesedaran di Daerah Betong



Fig.2: Kempen Kesedaran di Daerah Kanowit



Fig.3: Kempen Kesedaran di Daerah Lundu dan Sematan

2.13 Ikrar Integriti

Jabatan Hutan Sarawak berpegang kepada konsep integriti dimana ia diterapkan bagi mengelakkan gejala rasuah, penyelewengan dan salahguna kuasa, sekaligus bagi meningkatkan kecekapan pegawai dalam melaksanakan amanah dan kuasa yang telah dipertanggungjawabkan. Antara perkara yang telah dilaksanakan oleh Jabatan Hutan Sarawak adalah:

- i. **Majlis angkat sumpah integriti dan seminar integriti** akan diadakan pada setiap Majlis Bersama Pengarah Hutan di setiap Pejabat Hutan Bahagian termasuk di Ibu Pejabat yang terdiri daripada semua pegawai dan kakitangan di seluruh Sarawak. Majlis ini diadakan pada setiap tahun.

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- ii. **Unit Integriti** telah ditubuhkan di peringkat Jabatan, yang berhubung terus dengan Pengarah Hutan Sarawak. Unit Integriti ini diketuai oleh Pegawai yang telah dilatih dan ditauliah oleh Suruhanjaya Pencegahan Rasuah Malaysia.



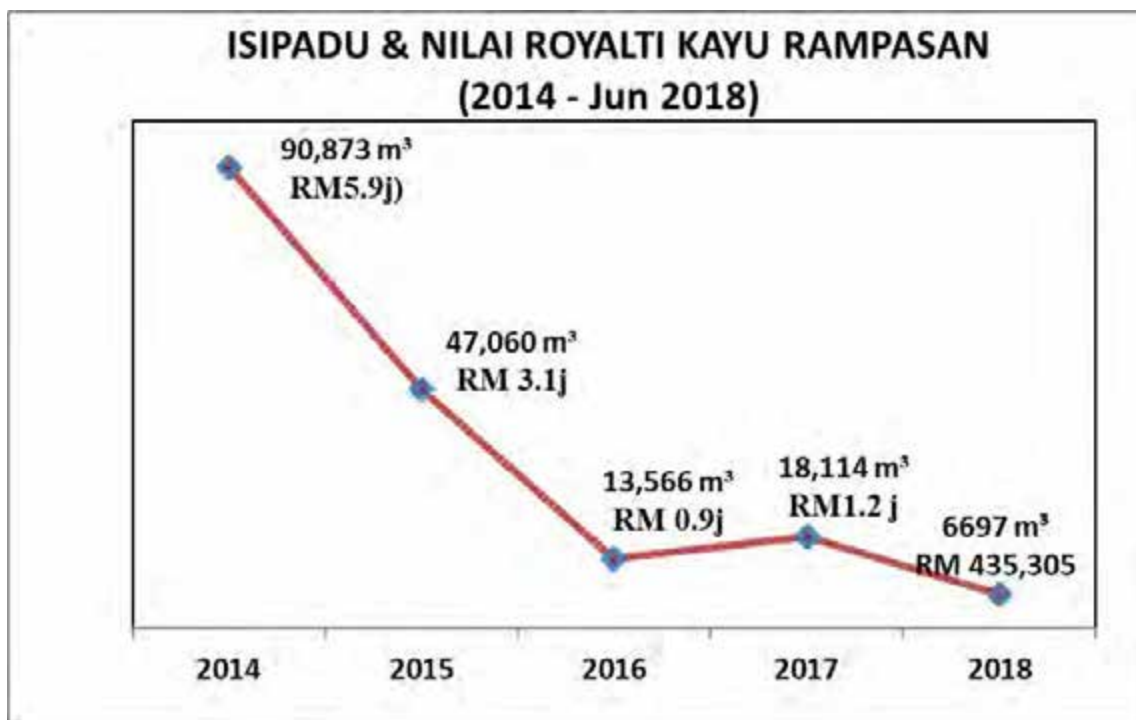
3.0 STATISTIK

Hasil daripada penguatkuasaan yang konsisten oleh Jabatan Hutan Sarawak dengan kerjasama agensi penguatkuasaan yang lain, jumlah kes dan isipadu kayu rampasan terus menurun semenjak pengisytiharan usaha memerangi pembalakan haram oleh Kerajaan Negeri pada tahun 2014. Namun, berdasarkan jadual di bawah, pada tahun 2017 didapati kenaikan dari segi jumlah kes dan isipadu kayu rampasan berbanding pada tahun 2016. Walau bagaimanapun, setakat Julai 2018, jumlah kes serta kayu rampasan dalam paras yang rendah berbanding tahun-tahun sebelumnya. Setakat ini nilai kayu rampasan berdasarkan royalti di Sarawak adalah berjumlah RM11.5 juta.

Bil	Perkara	2014	2015	2016	2017	2018 (sehingga Julai)	Jumlah
1.	Jumlah Kes	241	208	113	144	44	750
2.	Jumlah rampasan (m ³)	90,874	47,060	13,566	18,113	6,697	176,310
3.	Nilai kayu rampasan (RM65/m ³)	5,906,810	3,058,900	881,790	1,177,408	435,305	11.5 juta



Fig.4: Kategori kes menunjukkan kes pembalakan haram sebagai yang tertinggi direkodkan semenjak tahun 2014 sehingga kini.



Berdasarkan jadual di atas, sebanyak 33 buah kes telah dibawa ke mahkamah melalui Pejabat Peguam Besar Negeri Sarawak. 22 kes telah menang manakala 11 buah kes kalah.

JUMLAH KES MAHKAMAH 2014-2018					
Ordinance	Kes Tamat	Masih Dalam Perbicaraan	Menang	Kalah	Jumlah
Forests Ordinance & Forest Rules	20	0	10	10	20

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National Parks & Nature Reserves Ordinance	2	1	2	0	3
Wild Life Protection Ordinance	8	1	8	1	10
Total	30	2	20	11	33

4.0 CABARAN DAN KEKANGAN

Perkara	Jumlah
Keluasan Hutan Negeri (Termasuk PFEs, Hutan Stateland & TPAs)	7.9 Juta Hektar
Jumlah Kakitangan	859 Orang
Luas Kawasan Hutan Yang Perlu Dijaga Oleh Seorang Pegawai JHS	9000 Hektar

5.0 HALA TUJU PENCEGAHAN DAN PENGUATKUASAAN

5.1 Tambah Baik Tadbir Urus

- Mengurus dan melindungi Permanent Forest Estate (PFEs) (aset utama JHS) dengan sempurna.
- Wajibkan pelesen amal Sustainable Forest Management (SFM) dan perolehi Forest Management Certification (FMC).
- Galakkan pelesen dan pengilang perolehi persijilan Sarawak Timber Legality Verification System (STLVS).
- Mencadangkan kayu rampasan dimusnahkan (bukan dilupuskan melalui HTSB).
- Tingkat ketelusan, dokumen Permit to Enter Coupe (PEC) dan Removal Pass (Transit) dicetak melalui sistem REVLOG.
- JHS harus menjalankan rangkaian tugas pengeluaran lesen, meluluskan General Harvesting Plan, Detailed Harvesting Plan, PEC dan Coupe Clearance Certificate bagi pastikan inisiatif SFM tercapai.
- Audit hasil termasuk Document Audit dijalankan.
- Kuatkuasakan pelesen bertanggungjawab terhadap kawasan lesen.
- Penubuhan Pejabat Hutan Bahagian bagi mempercepatkan tindakbalas di lapangan.

5.2 Tingkatkan Operasi Pencegahan di Lapangan

- a. 360 kali operasi darat dan air diadakan di seluruh negeri.
- b. Semua 116 buah PFEs dengan keluasan 4.32 juta hektar dipantau melalui udara.
- c. Pemantauan aktiviti pembalakan ditingkatkan.
- d. Memantau Stateland Forest.

6.0 KESIMPULAN

Sepanjang lima tahun (2014-2018) Jabatan Hutan Sarawak telah berusaha memerangi pembalakan haram secara menyeluruh dengan kerjasama agensi penguatkuasa lain disamping penggunaan teknologi terkini. Semua ini digembleng bagi memastikan kegiatan haram ini dapat dibendung. Hasilnya sepanjang tempoh tersebut aktiviti pembalakan haram telah dapat dikurangkan dari tahun ke setahun. Komitmen daripada pihak atasan juga banyak menyumbang kepada kejayaan ini dengan mengeluarkan polisi bagi memantapkan lagi peraturan dan undang-undang hutan. Usaha ini akan terus dilaksanakan sehingga mencapai objektif meminimalkan kerosakan hutan akibat kegiatan haram.

PAPER 2: PRECISION OF ENFORCEMENT TO COMBAT FOREST CRIMES

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Abstract

Forests provide the fundamental foundation for sustainable development, our health, food security, our economies, energy and social stability. However, these natural resources being exploited are at risk of a new threat, namely forest crimes. The rise of forest crimes is an emerging issue around the world. The United Nations Office On Drug and Crimes (UNODC) reported that the total amount of illegal wood products from East Asia Pacific is USD\$17 billions. This new area of criminality had diversified and skyrocketed to become the world's fourth largest crime sector in a few decades, growing at 2-3 times the pace of the global economy, and depriving mostly developing countries of future revenues and development opportunities. Tackling forest crimes is of paramount importance. An enhancement of law enforcement response team could help address this worrying trend. Indeed, there is significant successful examples of cross-sectoral efforts or Joint Operation to crack down on forest crimes. Such collaboration, sharing and joining of efforts within and across borders, whether formal or informal, is our strongest weapon in fighting forest crimes. Nevertheless, to meet the scale of this threat, a broad-ranging, targeted effort must be put forward so that sustainable forest management could prevail. At Forestry Department Peninsular Malaysia (FDPM), new approach was introduced through the application of unmanned aerial vehicle (UAV) or drone. Drones were used to capture the latest multispectral imagery of forest cover. Analyses of data could be used to reveal, identify, monitor and crack down on forest crimes. There were significant successful examples of this approach since 2015.

Keywords: enforcement, forest crimes, unmanned aerial vehicle, drone, multispectral imagery, Joint Operation.

1.0 INTRODUCTION

Forest management at this time is quite different. Approaches in the management, development, conservation and preservation of forest resources were comprehensive and sustainably strengthened. Developing forest enforcement collaboration and commitment at regional and international levels are of imperative to ensure that national forest resources are maintained and preserved.

Until 2017, Forestry Department Peninsular Malaysia (JPSM) has managed to maintain a forested area of 5.7 million hectares. Of this, about 4.8 million hectares are Permanent Reserved Forests and managed sustainably under National Forestry Act (Act 313 of 1984), an Act to provide for the administration, management and conservation of forests and forestry

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development within the States of Peninsular Malaysia and for connected purpose. These PRFs were then classified into production forests and protection forests, and only production forests are allowed to be carry out activities to extract forest produces

As enshrined under National Forestry Act (Act 313 of 1984), forest produce are grouped into three main categories based on land status under National Land Code (Act 56 of 1965). These include Permanent Reserved Forest (PRF), State Land Forests (STL) and, Alienated Land, Mining and Reserved Land. Understanding the land status is imperative to enforce forest law in Peninsular Malaysia

Man are dependent on forest produce for food, security and shelter. Along this, forest produce taken legally and illegally against the local law, and timber is one of the most attractive forest produce traded worldwide. Feltham (2018) reported that illegal wood products from East Asia Pacific amounted to USD17 billion. Meanwhile, World Bank (2008) reported that Malaysia contributes up to 35 percent of forest crimes (illegal logging). The trend is expected to increase due to increase in cost of living and weakening currency.

The history of illegal timber known as a Global Forest Crime started during the first decade of the 20th century when it was recognized as a transnational crime by international law enforcement organizations and academic criminologists. In 2008 INTERPOL with the cooperation of the World Bank conducted a study on illegal logging from the perspective of international criminal justice under the Chainsaw Project.

Forest crimes referred to taking, trading (supplying, selling or trafficking), importing, exporting, processing, possessing, obtaining and consumption of flora, including timber and other forest products, in contravention of national or international law. In general, forest crime is the illegal exploitation of the world's flora and its ecosystem. Forest crime today is an emerging threat and has transformed into one of the largest transnational organized criminal activities alongside drug trafficking, arms, and human trafficking. Criminal syndicates are using the same routes and techniques for flora trafficking as for smuggling of other illicit commodities, exploiting gaps in national law enforcement and criminal justice systems. Illegal business generated money used to further nefarious ends and in certain case it went to financing terrorism and other illegal activities such as money-laundering, corruption, murder and extreme violence. It estimated that forest transnational organized crime is particularly acute in developing countries. One of the factor encountered is the lack of the capacity to regulate the exploitation of natural resources. This further leads to threatens biodiversity and endangered species, the livelihood of people, and severely impacts on national security, social and economic development.

The World Bank (2006) reported the worse scenario of forest crimes around the world particularly troubling in developing countries. It stated that forest crime, including illicit activities such as illegal logging, illegal occupation of forests land, woodlands arson, wildlife poaching, and encroachment on both public and private forests, and corruption was rampant throughout the world. Meanwhile, UNDOC (2012) reported that corruption was the most important enabling factor behind illegal timber trade. This factor alongside with the divergence of approaches in different country and inconsistency in international consensus of law enforcement.

Forest crime is destroying our fragile ecosystem. Some of our most cherished flora species are leaning towards extinction and some have disappeared. Law enforcement must play an aggressive role alongside conservation efforts because what is lost today cannot be regained tomorrow. Both FDPM and State Forestry Department were working together to ensure goals

are achieved, and they plan on doing much more in the future. The preventive message to the nation was that natural forests need our help and we have to act now to safeguard their future through precision of enforcement.

2.0 DRONE AND IT USES

The word “drone” had been around for years and has several different meanings. It originated from the old English word *drān* or *dræn* which means ‘male bee’. Old records showed that drones used as practice target by army. Generally, drone is an aircraft without a human pilot onboard. It can navigate autonomously, without human control or beyond the line of sight and is guided remotely. The component of an unmanned aircraft system including Unmanned Aerial Vehicle (UAV), ground-based controller and a system of communications between the two.

Drones are made from light composite materials to reduce weight, to improve performance, to lower electrical consumption and to increase maneuverability while flying. Various additional equipment including cameras, video, Global Positioning Systems (GPS), navigation systems, sensors and others can be equipped. Manufacturers produced drone in a broad range of shapes, sizes and with various functions. Today’s models can be launched by hand and controlled by remotes or from special ground cockpits. The commercial models come in small sizes and have simplified construction, so these drones are easy to control.

Drones are available at affordable prices and could be from several hundred to several thousand ringgit. Majority of drones are easy to control and use. Everyone can learn to fly in just a few days and it doesn’t require any license for lower specification. It requires a little bit more training and it is not very difficult to learn.

Drone used for different purposes and can be of useful on numerous occasions. It has become more popular in recent times and their application increases rapidly in various fields. Drones are used in many diciplines such as in search and rescue, security, science and research, aerial photography and video, surveying and GIS (mapping), unmanned cargo system as well in engineering, construction and pre-construction work, aviation, maritime, marketing, real estate, insurance, utilities, mining, meteorology, education and more.

For FDPM, forest monitoring and combating forest crime activities using drone technology started in 2015 to monitor and detecting illegal farming activities in Cameron Highlands in May 2015, landslide and mud flood areas in kilometer 52.4 KL-Karak Expressway in November 2015, monitoring of mangrove areas in Klang Coastal Area in December 2015, monitoring of forest fires in Tanjung Tuan Melaka on March 2016 and monitoring of illegal logging cases in HS Piah, Lenggong Perak on March 2016. For January until June 2018, drones used in several Joint Operations such as in Terengganu, Pahang, Perak, Kedah, Negeri Sembilan, Johor, Selangor and Kelantan.

The advantage of using drone in forest monitoring and detecting forest crimes included less manpower used, shorten monitoring time, covering monitoring area up to one km² per 30 minutes, real time data and further analyses on an aerial photograph/video could be taken for forest planning, administration, enforcement and so on.

3.0 ISSUES AND CHALLENGES IN MONITORING AND DETECTING FOREST CRIMES USING DRONE

Only trained pilot could fly the drone. In some cases, the pilot required to have a license from Department of Civil Aviation and have to pay fees as regulated under Civil Aviation (Fees and Charges) Regulation 2016 for each flight and it cost between RM200 to RM1,500. The main disadvantages of drones are a short flight time and can fly between 30 minutes to 45 minutes. In most cases, the pilot flies the drone for not more than 30 minutes and replace with another battery. Charging the batteries very often may be annoying for pilot and it takes about 90-120 minutes.

Control distance is also not impressive. In most cases, control distance just about several hundred meters and much depending on model. In fact, in tropical rain forests there are many obstacles to reduce the efficiency of flying distance. Our experienced showed that Phantom 3 and 4 may have efficiency control distance between 600m to 1000m. Nevertheless, the good thing about drone was it pollution free to the environment while working/flying, and hence more environmentally friendly.

Drone manufactured according to end use. High specification and more facilities are very costly and could up to million of ringgit. It was suggested that focusing on end use is very important in selection of appropriate drone for monitoring and detecting forest cover, forest change and forest crime.

Drone exposed to attack by eagle. Areas with eagle home ground are not suitable to fly drone. Incident had been recorded that drone attacked by eagle had crashing. Search and recuse is costly in areas of thick forests, valley or mountainous area.

Another factor that the pilot should consider are wind direction and wind speed. Wind speed at the rate of 20 knots or more is considered as strong wind and not advisable to fly the drone. Unfortunately, most of the drones available in the market are not equipped with accessories for wind speed-reading.

4.0 CONCLUSION

Forests are part of our livelihood and need new technology to safeguard from forest crimes. Precision of enforcing forest law depended on land status. Meanwhile, records showed that billions of illegal timber traded in Asia Pacific. Following this, application of drone in combating forest crime has enabled to detect forest crime at early stage and follow up action could be taken immediately. However, the approach had advantages and disadvantages in monitoring and detecting forest crimes. Focusing on end use is very important in selection of appropriate drone for precision of enforcement to combat forest crimes.

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PAPER 3: PREVENTION VS ENFORCEMENT: ONE-STOP COMPLIANCE CENTRES (OSCCs) EXPERIENCE

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Abstract

One Stop Compliance Centres (OSCCs) were established in 2016 as a platform for enforcement of compliance in timber harvesting activities in Sarawak. To date, 48 OSCCs are strategically located in proximity to logging activities. Their main functions are assessment of timber royalty and enforcement of compliance. Before the establishment of OSCCs, operational areas were monitored periodically due to large landmass and the remoteness of Sarawak. Most enforcement activities were reactive based on incidences that had occurred and heavy damages had been done. With the setting up of OSCCs, compliance in forest operations are enhanced through proactive actions by having management presence at operational areas. Results show that the frequency of monitoring of operational areas had increased by more than 8-fold. Non-compliances were detected at earlier stages resulting in reduced average logging damages by 23.4%. Major non-compliances associated with logging operations had reduced by 56.4%. The purpose of this paper is to present our experience in OSCCs establishment, implementation and their roles in preventing non-compliances from occurring in logging operations.

Keywords: Sarawak, One-Stop Compliance Centres, Enforcement, Compliance, Prevention, Forest Management

1.0 BACKGROUND

Enforcement and prevention are both types of policing strategies. Enforcement can be defined as a way to make an offence illegal and punishment to be meted out after offence had been occurred. Enforcement are usually carried out after damages had occurred, conversely, prevention is to reach out to prevent or minimize the impact of the offence at early stages. Prevention is the key to minimize damages. However, prevention strategy can be expensive initially but on the other hand, would be much more economical in the long run.

Prior to development of One Stop Compliance Center, State government of Sarawak had directed to increased efforts in curbing illegal logging, log smuggling and leakages in forest revenues. At the same time, the late Chief Minister of Sarawak, Pehin Sri Haji Adenan bin Satem directed to carry out royalty assessment at source and to strengthen enforcement of compliance. Effective regulation of forest practices is essential for sustainable forestry. In fact, studies have shown that forest with high levels of enforcement are more likely to have better regeneration capabilities and sustainability compared to those with no enforcement (Chhatre and Agrawal, 2008).

One Stop Compliance Center (OSCC) is a new concept of conducting forestry activities in the State and a practical approach to fulfil the requirement and directive from the State Government. OSCC is the response to demands for high standards of governance, accountability and transparency of forest regulations. Regulatory components are supported by monitoring and auditing not only from internal agencies but also third party stakeholders.

OSCC was a conception based on Beat Forest Stations that was set up in 70's to conduct only revenue collection but was now enhanced to include all forestry activities including enforcement. Due to the increase in the number of concession areas and their remoteness in term of locations, the checking stations need to be set up at various strategic locations to cover the whole State. Before the establishment of OSCCs, operational areas were monitored periodically due to large landmass and the remoteness of Sarawak. Most enforcement activities were reactive based on incidences that had occurred and heavy damages had been done. With the setting up of OSCCs, compliance in forest operations are enhanced through proactive actions by having management presence at operational areas. Expansion of forestry tasks at operational areas can be very demanding especially the remoteness of the area can be a limiting factor to conduct and effective compliance activity and the setting up of OSCC is the ideal and practical approach to overcome these limitations.

2.0 OBJECTIVES

2.1 Objectives of One Stop Compliance Center (OSCC)

The objectives for the setting up of OSCCs are:

1. To strengthen compliance in accordance to forestry rules and regulations;
2. To improve efficiency in revenue collection and monitoring of log movement;
3. To inculcate proper forest practice among industry front liners; and
4. To facilitate conducive working condition between industries and local communities.

3.0 DESIGN AND SETTING UP OF ONE STOP COMPLIANCE CENTER (OSCC)

3.1 Design and Concept

OSCC's concept is to have full time management presence inside operational areas (within forest concession area) for a more efficient and effective enforcement of compliance. This is expected to have shortened reaction time and provide efficient execution of tasks in conducting compliance activities. At the same time, OSCC can provide proactive action in conducting compliance activities following a schedule within the OSCC Management Toolkit.

OSCCs are provided with access to RevLog database to ensure immediate capture of logs harvested and enable comprehensive monitoring of movement of legal logs within the State near real time. Besides that, OSCCs are to be manned all year round and the staff rotated biweekly to uphold the integrity between OSCC staff and industries.

3.2 Locality of OSCCs

Fig. 1 below shows where the OSCCs are set up to ensure each concessionaire is serviced and monitored efficiently.

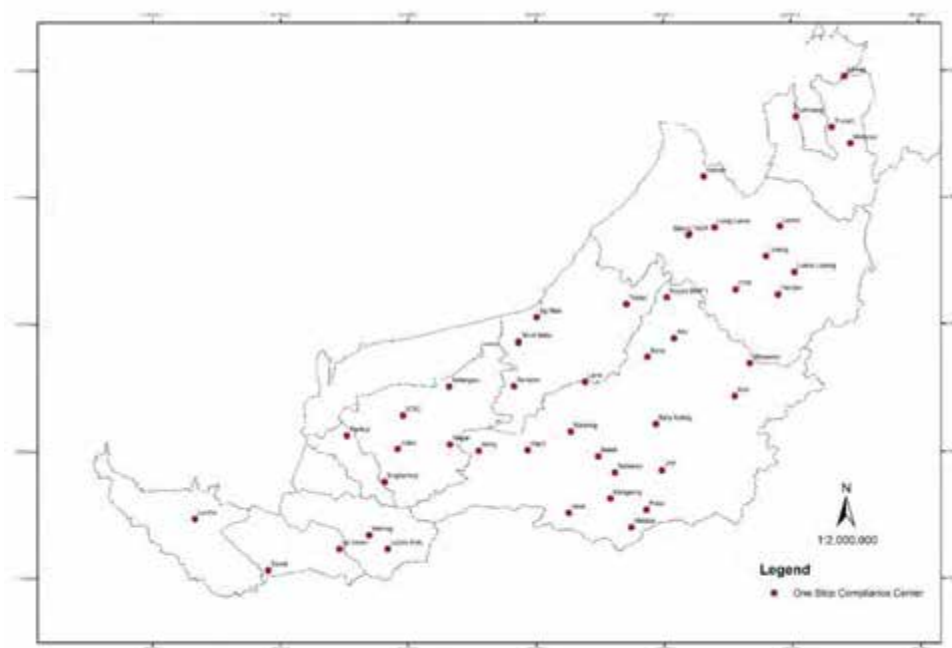


Fig. 1: Map showing the placement of OSCC throughout State of Sarawak.

A total of 48 OSCCs have been set up in two phases. Twenty seven (27) OSCCs have been operationalised since April 1st, 2016 while the remaining twenty one (21) since January 1st, 2017.

Table 1: OSCC center by management Districts and Administrative Region.

Region	District	No. of OSCC
Kuching (5 OSCC)	Sri Aman	3
	Serian	1
	Lundu	1
Sibu (19 OSCC)	Kapit	3
	Putai	6
	Song	2
	Sarikei	3
	Selangau	4
	Mukah	1
Bintulu (10 OSCC)	Tubau	7
	Tatau	2
	Bintulu	1
Miri (14 OSCC)	Marudi	1
	Beluru	4
	Limbang	2
	Lawas	4
	Long Lama	3
Total		48

3.3 Manpower and Training

Establishing OSCC following its concept requires major changes in workflow and more manpower. A total of 110 new recruits and 270 existing staff were trained from December 2015 to February 2017.

3.4 Function and Roles

General functions and roles of OSCC is summarised below.

I.Revenue collection and monitoring of Log Movement

- Royalty assessment and marking
- Monitoring of log movement through RevLog

II.Monitoring and control of harvesting

- Harvesting compliance
- Environmental compliance
- Protected and conservation area

III.Assessment of compliance to standard forest practices

IV.Stakeholders and communities' consultations.

3.5 Measurements and Criteria

To be effective in ensuring sustainable forestry regulations, there is a need to have performance based approaches to specify outcomes rather than specific forest practices. Lack of measurability and enforceability was an issue faced prior to establishment of the OSCCs. To address this, 13 main criteria and 52 sub criteria were developed for assessment of performance and effectiveness of OSCCs.

4.0 ACHIEVEMENTS

4.1 Management Presence and Coverage

OSCC were set up closer to operational area. This results in reduced travel time to the operational area and also increased frequency of monitoring. Figure 2 shows the coverage of management presence after setting up of OSCC.

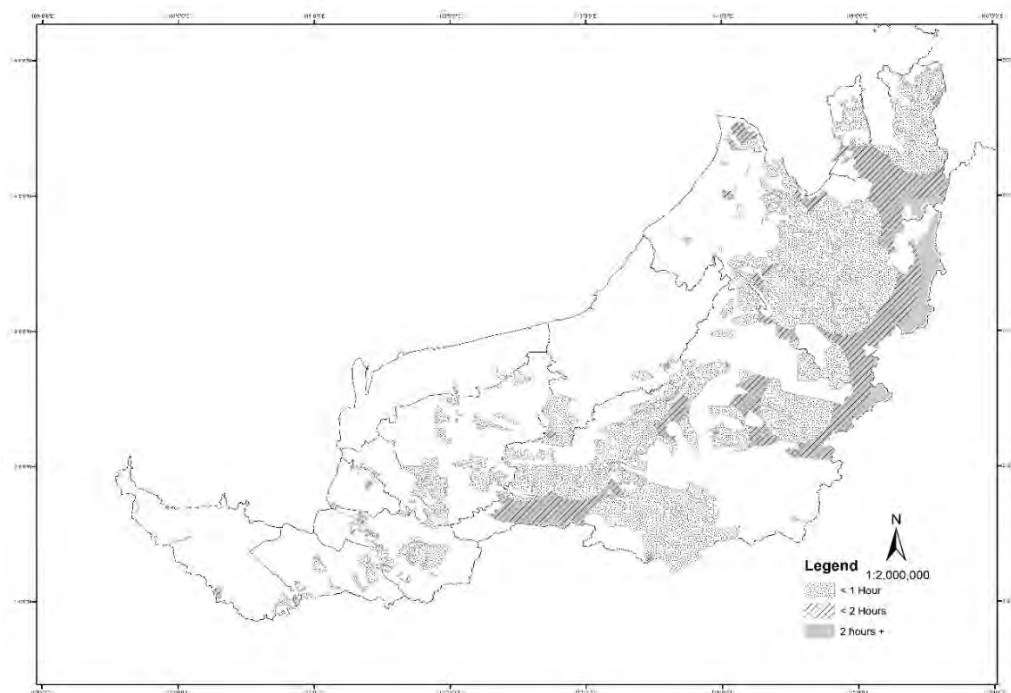
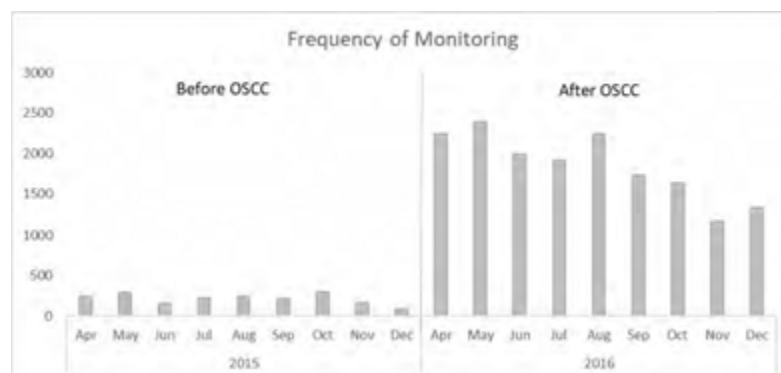


Fig. 2: The map showing the coverage of current set up of OSCC and access to the area within temporal travel distance.

Prior to establishment of OSCC, monitoring of compliance are conducted from Regional Offices located at Kuching, Sibul, Bintulu and Miri city. Approximately, only 1.4% of the operational areas can be reached within one-hour travel and 3.4% within two hours of travel time. Other areas are reachable after more than two hours of travel and would need a day wasted for travelling. Time required for planning and arrangement other essentials reduces the ability to be able to monitor operational area more frequently.

After establishing OSCC, the management presence coverage had improved to 72.3% of total operational area reachable from OSCC station within one-hour of travel and 95.9% of the operational area reachable within two hours travel. The closer distance allows compliance team to increase management presence in the vicinity and also frequency of conducting monitoring. Table 2 below shows the contrasting increase of frequency of monitoring activity before and after OSCC.

Table 2: Frequency of monitoring activity before and after establishment of OSCC.

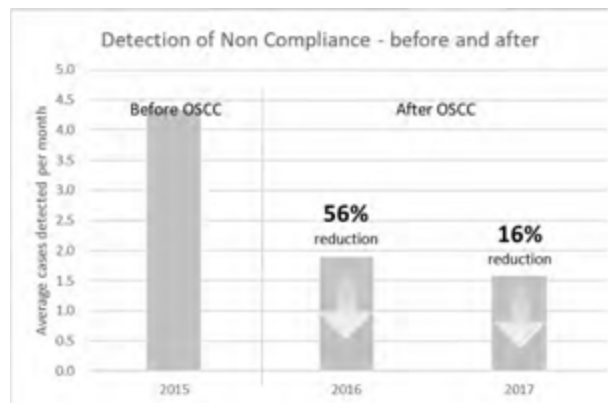


Frequency of ground monitoring had increased up to 8.6 times after establishing OSCC. The increased management presence and monitoring is a deterrent to forest concessionaires from committing non-compliance of the Forest Rules. Each forest concession area is ensured to be monitored at least once a month.

4.2 Detection of Major Non-Compliance

Major non-compliance is generally defined by breach of License Condition by felling outside of approved harvesting area within the logging concession area (table 3).

Table 3: Major non-compliance detected within logging concession area.

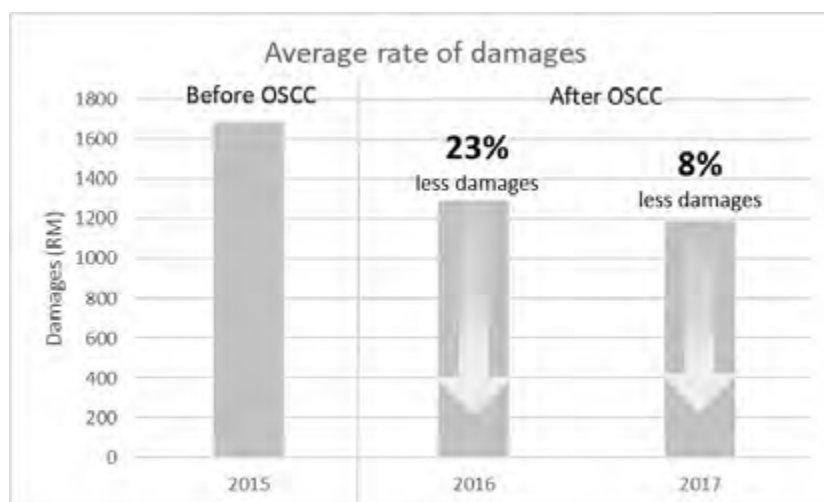


Average cases detected per month reduced from 4.3 cases before establishment of OSCCs to 1.8 cases in 2016 and further reduced to 1.5 cases in 2017. This downward trend after the establishment of the OSCCs shows that management presence acts as deterrence non-compliance.

4.3 Enhanced Compliance

Measurements on damages (RM) are based on offences related to compensation due to breaches of License Condition (Table 4). Damages to sustainability is normalized and presented in a form of value (RM) and similar temporal period.

Table 4: Comparison of average damages per case before and after establishment of OSCC.

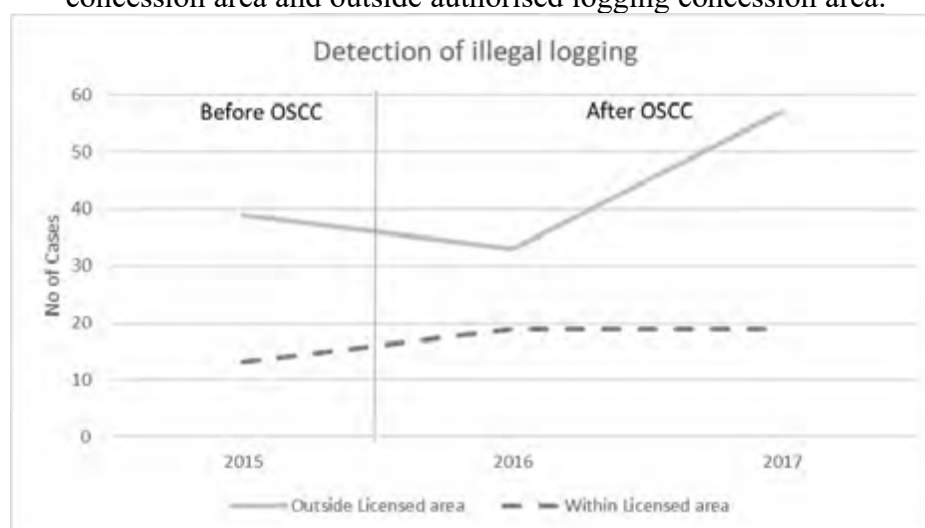


The average liquidated damages per case amounted to RM 1,689.05 prior to the establishment of OSCCs and reduce to RM 1,294.87 (23.3%) in 2016 and 8.45% in 2017 after the establishment. The continuation of the OSCCs is expected to reduce the cases detected and also the overall damages inflicted over time due to stricter monitoring. This indicates that higher management presence and frequent monitoring of operational areas actually had positive impact in ensuring prevention given time.

4.4 Detection of Illegal Logging

One of the roles of the OSCCs is to serve as a frontline to gather surveillance on any illegal logging activity and to act immediately upon any complaints or suspected illegal activities. Average detection rate of suspected illegal logging cases are 4-5 cases per month throughout the State in 2015 and 2016 (Table 5).

Table 5: Table showing illegal logging cases detected within authorized logging concession area and outside authorised logging concession area.



Number of suspected illegal logging cases detected within forest concession area are under control due to stricter monitoring and presence. However, the number of cases of

suspected illegal logging cases detected outside operational areas increased. Increased management presence is predicted to show positive impact in combating illegal logging activity in the State.

4.5 Community and Stakeholders Consultation

In addition to the activities above, the OSCCs also conducted Communication Education Public Awareness (CEPA) programs for the communities living in the vicinity of the operational areas and the industry front liners (ie: tree fellers, log skidder drivers). Awareness programs such as the “Wild life Protection Ordinance 1998 & Good Practice in Forest Management” are aimed at increasing awareness and to promote understanding in respect to conservation and sustainable use of biological diversity were also carried out. The effects and necessity of such program to ensure compliance and sustainability cannot be underestimated, but the impact would be difficult to measure.

5.0 CONCLUSION

The achievement of OSCCs to date has shown that it is more effective in preventing non-compliances from occurring in logging operations. The presence of OSCCs in the vicinity of operational areas has been an effective deterrent from non-compliance and illegal activities. OSCCs also ensures the highest possible revenue collected from production forests that are environmentally and socially acceptable.

6.0 REFERENCES

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APPENDICES



Engaging with local communities on logging



Collection of revenue



Assessment of infrastructure development



Verifying the river buffer Zone



Verification of enumerated trees



Assessment of logging compliance

**PAPER 4: FOREST ENFORCEMENT IN SABAH AND THE WAY
FORWARD**

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Abstract

Forest Laws and Enforcement are tools to combat the threats posed to forests from illegal logging, evasion of royalty, encroachments and other related offences. In Sabah, the Forest Enactment 1968, and Forest Rules 1969 are two prominent principle forestry laws, which provide provisions for forest offences, penalties, administrative power of the Forestry officers, etc. In the past, despite of the existence of the two strong Forest Laws, forest crimes continued to be a serious threat to the environment, social and economic aspects, biodiversity and habitats, political instability, income disparities, and market distortions. Lack of technical skills and knowledge in enforcement, especially in field raiding and investigation, often produced a weak, disarrayed, and non-reliable case for prosecution. With the help from the Police Department, and the State Attorney General's office, the Sabah Forestry Department had initiated training and short forest crime related courses, followed by internal prosecution succession plans for its officers, to counter the weaknesses in investigation and prosecution, and also in field raiding. To date, the Sabah Forestry Department has trained a number of forestry officers throughout the state and has brought about tremendous improvement in reducing forest crimes. The implementation of the Sustainable Forest Management License Agreement (SFMLA), and its underlying stringent policies and procedures, and sustainability principles, coupled with the gradual phasing out of short term licenses, has contributed to success in containing illegal felling, especially in FMU licensed forest reserves. However, illegal encroachment by villagers, who often use NCR issues as a right to access, cultivate, and own land, and occasional opening up of areas by immigrants in some parts of forest reserves, remain as a major threat to field enforcement work. Another threat is wildlife poaching, which has reached pandemic rate, and in some occasions, has become violent. To overcome these problems, the Forestry Department has initiated several initiatives such as the launching of K9 unit and SFD Protect Squad, intensifying field patrolling, erection of checking stations and gates at the entry point to FMU areas, periodical aerial surveys, and acquirement of permits to purchase, as well as, license to carry and use guns. In order to suppress forest crimes in a controllable trend, the Forestry Department is looking forward to continue training its officers, fostering a good inter governmental cooperation with other relevant authorities, reviewing existing laws and regulations for possible contemporary amendment, and solving the land complex that falls within forest reserves.

Keywords: Illegal Logging, Forest Encroachment, Forest crime, Enforcement, Forest Law, Investigation, Prosecution

1.0 INTRODUCTION

In the early history of the forest administration in Sabah, forest activities were confined to minimum extraction of forest resources by the local communities. When Sabah was ruled directly under the British Crown in 1946, forest reservation was intensified. With the “Sustained Yield” forest management system in place, logging started to intensify with the introduction of mechanized timber harvesting using tractors and chainsaws, which were first introduced in 1951 and in 1960s, respectively (SFD, 2007). After independence in 1963, timber harvesting became the main source of state income, playing a crucial role in the initial development growth of the state. Since then, the forest resources in Sabah have gradually continued to reduce as a result of heavy timber exploitation and large-scale conversion of forest areas to other uses, especially the oil-palm plantations (Jilimin et al., 2011). To remedy the problems, Sabah restructured her State Forest Policy in 1997 by introducing forest licensing system that focused on a total forest management approach (ibid). The Sustainable Forest Management License Agreement (SFMLA) was introduced as the legal binding agreement for all forest management operations in all Class II forest reserves to gradually replace the short term timber harvesting licenses. Meanwhile, The Forest Enactment, 1968 and the Forest Rules, 1969, continue to be two prominent forestry laws that govern all aspects of forest administration, management planning and development, regulation of forest harvesting, revenue collection and development of forest based industries, as well as penalties, and procedures in dealing with forest offences. Since the implementation of the SFMLA policy, and its stringent sustainability principles in 1997, coupled with continuous SFD’s strong commitment in pursuing laws and order, forest offences, as well as, forest administrative offences have been tremendously reduced. However, of late, forest offences have picked up to another level and forms, presumably resulted from stresses and desperation to find space for substantive farming, hunting grounds, and also from relentless claims over NCR land issues. Illegal poaching, illegal harvesting of Agarwood (“Gaharu” tree) in forest reserves, and Mangrove bark stripping, have been in an alarming rate. Illegal poaching and illegal cultivations, in particular have posed violent and hostile threats to Field Enforcement staff on duty. Despite the daunting tasks in field enforcement, the SFD has continued to pursue with its management enforcement strategies, covering aspects of skills in the field raid, investigation, prosecution, infrastructures building (gates), materials, airborne surveillance, weapons, etc. some of which, have been relatively very expensive in terms of cost and time.

2.0 OBJECTIVES

The aim of this paper is to share information on the evolution (progress and achievement) of forest law enforcement in Sabah, for the last ten years (2007-2016). This paper will highlight three main processes of law enforcement; field raiding, investigation, prosecution, and also the way forwards.

3.0 FOREST LAW ENFORCEMENTS IN SABAH

Law enforcement involves three core processes; field raiding, investigation, and prosecution. The following are the highlights on the SFD’s experience in every each of the processes.

3.1 Raiding

In any forest criminal proceeding, the most important step may start as early as in the setting up of a strong field raiding team. The team must comprise of a good leader, and staff with strong personality, experienced, and committed to the job. The leader must ensure all the necessary requirements, clear instructions of tasks, and any other

materials needed in the field raiding, are checked and prepared. A well planned field raiding operation may contribute to a successful arrest of suspects, and seizure of machineries and equipment. In the past, the SFD had conducted numerous field raiding operations in the state with limited technical skills and knowledge. The raiding operations often produced a weak, disarrayed, and non-reliable case for prosecution. Despite of all the shortcomings, the field raiding operation continued. Starting from 2001 onwards, and while forestry staff struggled to excel from the daunting field works, forest crimes had continued to escalate and became almost uncontrollable. The trend of forest crimes continued to move upwards. The collaboration between the Anti-Illegal Logging Unit and SFD was a big relief to the Department, when it showed significant results, with the surge in apprehending forest crime cases from 107 in 2001 to 372 and 299 in 2002 and 2003, respectively.

3.2 Investigation

Investigation of a forest case normally commences, when credible information, or reasonable suspicion is received. Arrest of suspects would immediately be done, when a strong ground of forest crime commission had taken place. During the course of investigation, the Investigating Officer and team members must keep good records of all the detailed information and findings obtained and gathered from the task assigned to them as they could be the key witnesses to testify in prosecution. The SFD had conducted a series of courses related to field investigation and procedures, whereby staff were coached with proper procedural handling of evidence and findings in field raid operations and investigations. On the 6th of August 2002, the Enforcement and Investigation Division (EID) was established. During the first 3 year of the establishment, the administration of the EID was not well documented. There was no proper data recording on forest offences, as well as, the recording of investigation data and procedures. It was perceived that the former Prosecution Division and the Enforcement Division worked in isolation, where, each division pursued their own cause, and only communicated extensively, during the court trials. This had caused major drawbacks in the court proceedings or trials, where the Prosecuting Officer (PO) failed to discharge legal and evidential burdens for the court to convict the accused. The department made a minor restructuring of the division in March 2013 to facilitate smooth running of the office administration.

3.3 Prosecution

The main functions of the SFD have always been to enforce the law according to enabling legislation, the Forest Enactment 1968 and Forest Rules 1969. Previously, prosecution of forest offences were conducted by 5-6 legal officers from the State Attorney General Chamber (AG). In the year 2000, S.40A of the Forest Enactment 1968, was amended to replace the power to prosecute and institute legal action to the Public Prosecutors under Section 377(b) of the Criminal Procedure Code [F.M.S. Cap. 6]. The amended provision authorized any **public officers, and authorized in writing** by the DPP to prosecute forest offences. The Deputy Public Prosecutor decided to issue written authority to qualified officers of the Sabah Forestry Department, to conduct prosecution pursuant to S. 376(iii), and S. 377(b) of the Criminal Procedure Code, F.M.S. Cap. 6. These authorities enabled the authorized officers to conduct prosecutions in the Session Courts and Magistrate Courts of Sabah. Currently, there are 47 Forestry Officers, who are given “the letter of authority” to prosecute cases of forest offences under the Forest Enactment 1968. Of the 47 Officers, 28 of them had, at least, appeared

in the Court for case mention, remand application under S. 259 CPC, inquiry under S. 37 of Forest Enactment 1968 (application for release or forfeiture of seized exhibits), and application for interim release (S.407/413 CPC). There are only 4 officers engaged in conducting full court trial for the whole State of Sabah.

4.0 CATEGORIES OF FOREST OFFENCES IN SABAH

Generally, there are 3 main categories of forest offences; The first category are offences that fall on breach of the Forest Enactment 1968. The second category are breaches of rules and regulation of the Forest Rules 1969, and The third category, are breaches of contractual, obligation and omission. The first category includes felling without license in the forest reserve (S.20) and state land (S.23), endangering forest by fire (S.19), encroachment in forest reserve for agriculture and settlement (S.20), evasion of royalty (30(A)(b), and illegal possession of forest produced (S.30(1)(g). The second category are, removal of timber without authority, unregistered machinery, operating sawmill without license, occupying forest reserve without authority. The third category are breaches of logging license conditions i.e. boundary, riparian reserve, steep area, etc.

5.0 CHALLENGES

The most renowned threats to forest resource are illegal logging, unlawful cultivation of forest areas, and exploitation of forest resource in an unmanaged manner. They pose threats, not only to the Sustainable Forest Management (SFM) implementation, but also contribute to rapid reduction of global forest resources, if not contained. However, in Sabah, threats to forest resources by virtue of illegal logging have reduced, tremendously. The gradual phasing out of short term licenses, and the implementation of long term Sustainable Forest Management License Agreement (SFMLA) in Class I Forest Reserves, had contributed to the reduction of serious forest offences, particularly in forest reserves. Of late, most of the forest offences detected are generally associated with administrative offences, such as minor non conformation to SFMLA conditions, and they often take place within the legal operational boundary of licensed Forest Management Unit (FMU) areas. The daunting challenges in the enforcement of forest law by the Sabah Forestry Department, however still remains within the context of illegal encroachment of forest reserves and state land by local communities and illegal immigrants; illegal cultivation, illegal harvesting of agarwood (gaharu), wildlife poaching, and occasional Mangroves bark stripping. Illegal poaching and illegal cultivation have, of late, become violent and hostile, and they pose dangerous threats to the safety of the Enforcement Officers. Illegal poaching, and the poaching menace remains as the biggest threat to wildlife conservation in Sabah, suggesting for a highly concerted effort from all quarters, especially SFD, Sabah Wildlife Department, Sabah Parks, Yayasan Sabah (YS), Sabah Forest Estate Stake holders (FMUs), Plantation Companies and also Communities to ensure this poaching menace is put to rest. Meanwhile, the SFD continues to execute its duties to ensure areas of conservation, especially forest reserves, buffer zones and wildlife corridors are free from poaching activities.

6.0 WAY FORWARD

6.1 Empowerment of Staff

6.1.1 Firearms

In 2009, The SFD proposed to re-enforce and re-arm its personnel with guns for protection and self-defense. This was in response to the growing safety threats to SFD

staff, the growing numbers of aggressive people disrespectful of laws, and violence, which had put government officers into great jeopardy. Application for permits to purchase, and license to carry and use guns were approved by the Inspector-General of Police (IGP). Subsequent to this, on the 30th July 2015, SFD launched its first armed Protect Team squad of its kind. The main purpose was to enforce the Forestry Enactment 1968 and Forest Rules 1969, and to deal with violent forest offenders and poachers, illegal loggers, and illegal immigrants involved in the stealing of Gaharu (incensed wood). To date, the SFD armed squad has 90 licensed personnel, 5 pistols, 25 shotguns (Benelli), 5 (CZ Scorpion EVO 3 S1), 10 MKA 1919 Shotguns, and 12GA shotguns. All officers and personnel with gun handling licenses have to undergo refresher courses and training sessions to familiarize with procedures, maintenance, and safe use and handling of the firearms. The use of firearms must strictly follow the protocols and regulations contained in the Firearm Standard Operating Procedures (SOP). Officers and Staff entrusted with a license to carry and use guns had also trained in target shooting practice, to help them with “target precision”. The Enforcement, Investigation and Prosecution Division (EIP), with the co-operation by the Sabah Shooting Association, Lokawi Kota Kinabalu had organized a number of shooting practices for SFD relevant (C & U License holder) officers and field staff throughout the state.

6.1.2 Special Unit (K9 & SFD Protect)

K9

It is notable that the nature of forest crimes, nowadays became increasingly organized, dangerous, sophisticated and transnational. Lack of equipment and tools, creates barriers and restrains good performance and safety measures in field surveillance and patrolling. Unexpected encountering with armed criminals, especially poachers, could be dangerous and fatal. On the 30th July 2015, The SFD launched the K9 unit. The main purpose was to enforce the Forest Enactment 1968 and Forest Rules 1969, and to deal with agarwood (Gaharu) thefts and smugglers. Initially, the K9 Unit started with 2 dogs, and now there are 4, all of which have intensively been trained for sniffing and attacking. To further strengthen the K9 Unit, The SFD had recently launched the construction of a RM450,000.00 office building for the Unit, located in Labuk Forest Reserve, Sandakan. To date, the total cost for training the four dogs has reached about RM200,000.00.

SFD Protect Team

On the 27th October 2016, The SFD launched its first new tactical team, The SFD Protect Squad. The objectives are; (i) to elevate the standard and capabilities of enforcement in the Department, (ii) to increase public confidence towards SFD's ability in enforcing the forest laws, and to provide capacity for rapid deployment of enforcement supports in any given situation. To start with, three Senior Forestry Officers were sent to Thailand in November 2015, to undergo a special training jointly organized by the US embassy and The Thailand Police Border Control Tactical Center, under the PROTECT PROGRAMME, and with the assistance of the World Wildlife Fund (WWF) Malaysia. The training focused on building skills on enforcement, which would be used in area of forests, protected by laws. The Coaches were experts from various backgrounds of enforcement, such as in planning, basic tactical formation, ambush drills, counter ambush drills, Rule of Engagement, weapon handling, and many

more. The Chief Conservator of Forests (CCF) wants the department to have a special and fully trained team to handle and carry out enforcement on poaching, illegal encroachment, illegal logging, and other illegal activities in forest reserves and other protected areas. The Squad was, then further expanded with an additional 25 SFD recruits, comprising of rangers and forest guards. More will be recruited.

6.1.3 Continuous Training (Enforcement, Investigation, Prosecution)

Since 2001-2011, the SFD had facilitated 8 separate courses on investigation and prosecution for the staff of SFD, YS, Lands and Surveys Department, Sabah Parks Department, Drainage and Irrigation Department and Environmental Protection Department (EPD). The objectives of the continuous training were to enhance the skills on investigation and prosecution, and to train more field staff to become proficient investigators and produce high quality investigation papers. There had been 302 participants comprising of Forest Rangers and Forestry Officers, who had trained successfully as Investigation Officers, and 25 as Prosecuting Officers (PO).

6.2 Enforcement Strategy

6.2.1 Aerial Survey

Aerial survey is one of the most effective means in enforcement. It is fast, precise, and it covers wider areas, in a given time. It makes a better surveillance tool to detect illegal activities, especially illegal felling and cultivation, fire occurrence, penetration of boundaries, and road networking potentially used for illegal activities. Poaching and hunting could also be detected by locating temporary camping huts, vehicles, and fire spots left by the poacher. In 2016 alone, the SFD had spent RM1.2 million or 350 flying hours of aerial survey using helicopters throughout Sabah. The aerial surveys had been conducted by District Forestry Officers and Monitoring, Controlling, Enforcement, and Evaluation (MCEE) Officers. Air surveillance normally focuses on checking areas of forest reserves, conservation areas, riparian and wildlife corridors, FMU boundaries, and areas prone to illegal encroachment. So far, the SFD had stipulated all Forestry Districts to carry out, at least 2 aerial surveys per year, depending on whether funds are still available.

6.2.2 Forest Checking Station & Gates

There are 56 Forest Checking Stations (FCS) throughout Sabah; 37 under Tawau Regional Office, 9 in Sandakan Region, 6 in Kota Kinabalu Region, 5 in Keningau Region, and 2 in Kudat Region. The function of the FSCs is to control unauthorised entry of both people and vehicles, and are always located strategically, at the entry points to each FMU area, Conservation areas, such as wildlife corridors, Buffer zones, and also Plantation Estate, adjacent to forest reserves. Forestry staff are stationed in each of the gates to check all the passing vehicles including the log laden lorries, to make sure they are accompanied with proper documents, such as Transit Pass, Removal Pass, Timber Disposal Permits, and other documents required within the administrative jurisdiction of each concessionaire, legally operating in the said forest reserves and conservation areas. The staff manning the gates must also carry out periodical field inspections to check on all the forest activities for compliance with administrative procedures, license conditions, Forest Enactment 1968 and Forest Rules 1969, and also poaching activities within that area. Proper recording of all the inbound and outbound movement of vehicles, etc. need to be reported to the Officers in charge of the gates. In

the Timber Legality Assurance System (TLAS) Audit, works on independent third party audit, the gates are one of the most important criteria and tools for resource security monitoring. That is why, the gates have also been audited for compliances for that purpose.

6.2.3 Manpower

The number of staff, especially those who are empowered under Section 36 (2A), of the Forest Enactment, 1968 is declining through the years. In the year 2006, there were 600 personnel with the rank of Foresters, Forest Rangers and Forest Conservators in the department, but the numbers have gradually reduced to only 550 in 2010, and the decreasing trend still continues. The lack of manpower to carry out constant enforcement vigilance is an issue, and has affected the capability of the SFD in managing and controlling the forestry activities, especially in dealing with forest enforcement. It was also noted that, the remaining personnel are mostly between the age range of 45-50 years old. Nevertheless, the problem will gradually be overcome, by focusing on a total forest management approach.

6.2.4 Honorary Forest Rangers

In 2010, the Section 3A of the Forest Enactment, 1968 was amended, empowering the Chief Conservator of Forests to appoint suitable person to be Honorary Forest Rangers. To date, there are 131 Honorary Forest Ranger appointed. It is hoped that the introduction and appointment of Honorary Forest Rangers will help eliminate, or reduce forest-related offences, and at the same time, improve public awareness on the importance of protecting the forest resources.

6.3 Forest Management and Policy

6.3.1 SFM

The introduction of SFMLA in 1997, by the Sabah State Government, had lessened the burden in managing the forest. Under the SFMLA, forest crimes had been reduced dramatically, especially in the FMU licensed forest reserves. One part of the agreement is that, the licensee has to survey their boundary, at least, by a Second Class Surveyor. Subsequently, apart from being monitored by the SFD, they are also being audited by Third Party Auditors under the TLAS program for compliances to the underlying sustainability principles, as well as, for activities conformation to the prescription as prescribed in the Forest Management Plan. Under the SFM, the communities living near the forests are also benefiting from the activities carried out by the FMUs.

6.3.2 Inter Governmental Cooperation

Apart from the SFD, other government agencies such as Chief Minister's Department, Army, Police, RELA, Police-Marine, Malaysian Maritime Agencies could play important roles to assist the State Government to combat forest crimes. The inter-governmental co-operation has proven to be very effective, based on the descending trend of departmental forest offences statistics.

6.3.3 Amendment of Forest Law

Forest Laws must be regularly reviewed, and amendment of less effective provisions need to be made. Stricter laws are essential to deter commission of offences. Therefore,

revision of laws must be done to suit the current needs, and updates of laws must be made available for use. From the year 2000, the Forest Enactment 1968, had been continuously amended by repealing and inserting certain provisions to suit the current needs and to prevent inconsistent interpretation of the provisions.

6.3.4 New Forest Legislation

A new form of legislation was enacted in 2015, known as Forest (Timber) Enactment 2015. It covers registration of timber products exporters, timber product importers, timber suppliers for export and jetty operators, and loading and unloading of timber products. The Enactment was enacted following the transfer of power to issue export and import licenses for timber products from Malaysian Timber Industry Board (MTIB), to the SFD. The principal law is supplemented by the Forest (Timber) (Registration) Regulation 2017, and the Forest (Timber) (Compounding of Offences) 2017.

7.0 CONCLUSIONS

Every year, a significant proportion of the world's timber is harvested, transported, processed and traded in violation of national, as well as, the state laws. Illegal logging, and other associated timber trade have far reaching environmental, social and economic consequences. These include the loss of biodiversity and habitats, political instability and market distortions. Strategies to address illegal forest activities must be specific to each country, or state if they are to respond to particular needs. Sabah state had embarked on new SFM policies, which brought about the full implementation of SFMLA in areas of Forest Management Unit. The SFM principles, a well-designed initiative and model for good forest management, enforcement, and conservation, and had been in effect for 2 (two) decades, will continue to succeed, depending on whether, there would be **“political will and commitment at the highest level”**. Improving Forest Law Enforcement will also require better collaboration across all sectors, and more stakeholder's involvement needed. Combating forest crimes would be the last sustainable option, compared to effective prosecution, because it almost inevitably means actions after destructive activities have occurred. **The damage has been done and cannot be reversed**. Safeguarding our forest resource by virtue of good forest management and enforcement is a continuous demand, while sustainability of forest values, as well, as retaining the physical existence of forest stands and distributions have been a crucial issue, globally. Some dare to pay high price for retaining the carbon stock, and some may have been battling to sustain them for inevitable income drives. However, when both forest resource sustainability and conservation are put into prime emphasis, some may have to pay the higher price for it, while others may have to consider exploring another pristine source of economic income.

Sub Theme 2:

Sustainable Forest Management: Technology, Innovation and Practices

PAPER 5: MANGROVES MAPPING AND MONITORING USING FREE ACCESS SATELLITE IMAGERY AS INPUTS DATA FOR MANGROVES INFORMATION SYSTEM IN SABAH

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Abstract

Sabah, which is one of the states in Malaysia, has among the largest extents of mangroves. Despite its extensive distribution of mangrove ecosystem, this forest faces inevitable threats from various land use activities. Therefore, knowledge on mangroves distribution and change is important for effective management and formulating protection policies. Although remote sensing has been widely used to characterize and monitor mangroves change over a range of spatial and temporal scales, studies on changes in mangroves extend in Sabah is still lacking. This study utilized Landsat images taken in the year 1990, 2000 and 2017 to identify, map and detect changes in mangrove forest in Sabah. The generated information was an input to update the mangroves information system which was internally used to store mangrove information for designated Permanent Forest Reserve (PFR). The process flow and protocols outlines in the study method will be useful reference for future detection of mangrove changes through mapping and monitoring. Several image variables were used, such as individual bands from visible and near infrared wavelengths, vegetation indices (VIs) and principle components analysis (PCA). The classification was performed by using Random Forest Classifier in R environment and the range analyses accuracy was 80% -85%. A number of comprehensive ground truth points were still necessary to validate the classification products for better accuracy and result. The study found that Sabah has about 378,195 ha of mangroves in 2017 which covers 60% of the total mangroves in Malaysia. The rate of mangroves deforestation was about 0.07% per year between 1990 and 2017. Most of the changes occurred mainly within state land. Expanding agricultural lands for plantations and aquaculture industries are the most prominent factors that cause mangroves deforestation. Other factors that cause deforestation are expansion of settlement and industrial areas, while impact caused by local consumption of mangrove stands for fuel, wood and coastal erosion are found to be negligible.

1.0 INTRODUCTION

Mangroves act as frontiers that protect the coastal land against destruction of ocean waves, tsunamis and storms. Mangroves also provide habitat for various aquatic life forms and function as natural filter, which improves the quality of water. Mangroves also play important roles as a significant carbon sink in coastal environment. It is an interesting fact that despite only 0.05% of plant biomass stored in the ocean and coastal areas out of the total plant biomass on land, it can absorb a comparable amount of carbon every year. A study demonstrated that primary productivity in mangroves is higher than other types of forests. Biomass carbon in mangroves stands is among the highest in the tropics. Mangroves can store up to four times more carbon (C) as compared to other tropical forests around the world (Daniel, C. D., et al., 2011).

A mangroves ecosystem has an ability to absorb carbon dioxide (CO₂) and store carbon 40% more than the dry land forest ecosystem. Due to this ability, the total carbon deposited in a square kilometre of mangrove ecosystem is 50 times faster than those of the same area in a dryland tropical forest ecosystem. The absorbed CO₂ is stored not only in the plants, but in layers of soils underneath (www.iucnredlist.org). Therefore, mangroves are playing a crucial role in global carbon budgets and thus mitigating climate change.

However, despite being realized the importance of mangroves in the global carbon cycle and climate change, the extents of mangroves have inevitably declined since the last few decades. Unfortunately, the declines are mainly due to human activities such as aquaculture expansion, coastal development, and over-harvesting (Giri, C., et al., 2015). Malaysia is one of the countries in South East Asia that has among the largest extents of mangroves. Despite its extensive distribution of mangrove ecosystem, this forest faces inevitable threats by various land use activities. The total area of mangrove forest was approximately 2% (650,000 ha) of the total land area in Malaysia in the 1990's (Azahar, M., et al., 2003).

Mangroves in Malaysia have been gradually diminishing, where the total area of mangrove forest has reduced to approximately 580,000 ha in the last decade (Roslan, A. & Shah, N. M., 2014). Other reports indicated that the extent of mangrove areas in Malaysia is decreasing, from about 700,000 ha in 1975 to 572,000 ha in 2000 due to the intensive harvesting and natural wave actions (Food and Agriculture Organization (FAO), 1997; Aizpuru, M., et al., 2000). Globally, mangroves have also declined from 18.8 million ha to 15.6 million ha between years 1980 and 2005 (Food and Agriculture Organization (FAO), 2007). Overall Asia was the largest net loss of mangroves since 1980 with about 1.9 million ha have loss, mainly due to conversion of mangrove forest to other land uses. However, there has been a slowdown in the annual rate of mangrove loss, from about 187,000 ha in the 1980s to 102,000 ha between 2000 and 2005. This reflects an increased awareness and an improved management system in mangroves ecosystem.

In Sabah, mangroves vegetation distribution is mostly found along the east coast either located within Permanent Forest Reserve or stateland. Mangroves are regarded as an important natural resource for the state and legally protected under the Sabah Forest Enactment, 1968 by the gazettement of land as forest reserve. Most of mangroves are classified as Class V, however this vegetation can be found in other forest reserve classes such as Class I, IV, VI and VII. The first Sabah statewide forest inventory was conducted from 1969 to 1972 under the Canadian Bilateral Aid Programme (Colombo Plan). Another statewide forest inventory of the disturbed forests had also been carried out during the period 1986 to 1987 by the Sabah Forestry Department with the assistance of UNDP/FAO. Based on the first inventory, there are ten (10) types of tidal (T) forests or mangrove species groups found in Sabah, such as (T1) Nipah palm, (T2) Bakau and Bangkita, (T3) Buta Buta, (T4) Beus, (T5) Tengar, (T6) Api-Api and Perepat, (T7) Nipah palm predominating and mixed with other mangrove species, (T8) Other or mixed mangrove species, (T9)-mangrove forest of non-commercial size and (T10) mangrove forest which has been logged (Canada Colombo Plan Programme Malaysia, 1973).

There are three broad mangrove zones in Sabah, such as seaward or riverine margins, main mangrove and back zone. Seaward or riverine margins of mangrove zone are the newly formed area where sediment from upper-stream settles and forms new land. In 2014, total mangroves forest of Sabah is estimated about 341,000 ha or 4.6% of Sabah landmass (7,362 sq km). Sabah maintains 90% of the original mangrove area with all the ecological zonations intact (Nilus, R., et al., 2010).

Based on Spalding, M., et al., 2010, major threats of mangroves that are triggered by human activities can be generalized into six, which are; (i) conversion to other uses; (ii) overharvesting; (iii) overfishing; (iv) pollution; (v) sedimentation and (vi) alteration of flow regimes. Direct conversion to other uses was identified as the major factor that changes the world's mangroves. This includes conversions to (i) urban and industrial areas, (ii) aquaculture, and (iii) agriculture. Additionally, natural phenomena such as coastal erosion, storm and lightning strikes are also the natural impacts that kill mangroves in Peninsular Malaysia, including the tragic tsunami on 24 December 2004.

In Sabah, modern threats to remaining mangrove forests are conversion into agricultural lands, large aquaculture ponds, illegal debarking of mangrove trees and coastline development. Severe coastal erosion can be found at various locations along the west-coast (Faisal, M. N., 2009). The coastal erosion of Karambunai Beach, which is located northwest of the Mengkabong-Salut Lagoon System was calculated to be about 3 meters per year (Hoque, M. A., et al., 2009).

Despite widespread concern and numerous case studies describing local issues and challenges, comprehensive information on the global extent of mangroves and trends of deforestation is largely lacking (Giri, C., 2016). It is because determining the precise area of mangroves is not always easy.

Measurement is affected by varying definitions of what constitutes mangroves; inclusion only on the basis of official recognition such as gazetted forest reserves; scattered or sparse areas considered too inconsequential for inclusion; and the accuracy of the returns made by the responsible authorities. Each of these can create uncertainty and produce significant variation depending on the timing and purpose of the assessment exercise.

Recently, remote sensing satellites have been widely used for mangrove monitoring. The greatest reasons why, is because the remote sensing can (i) acquire information over large areas, (ii) produce repeated measurement over a place, and (iii) make full use of electromagnetic spectrum for quantitative and qualitative measurements over mangroves (Cardenasa, N., et al., 2017). Satellites also provide information on spatial distribution and temporal changes of mangrove forests. When this information is gathered over decades, mangrove monitoring over the large area will become possible. There are studies on the assessment of mangroves changes and identifying threats, for example in Terengganu (Sulong, I., et al., 2002), Selangor (Khali Aziz, H., et al., 2009), and Peninsular Malaysia (Hamdan, O., et al., 2012). However, these studies are unable to represent the holistic conditions at sub national level especially Sabah. Therefore, this study was conducted to provide information pertaining the current status of Sabah's mangroves and changes that occurred since the last decade. The result is very important information and as a reference for mangrove ecosystem management in Sabah towards sustainability. The current mangroves information is use to update the mangroves information system which was internally uses to store mangrove information for designated Permanent Forest Reserve (PFR) under the management of SFD.

2.0 MATERIALS AND METHODS

2.1 The Study Area

The study area covers the entire mangroves ecosystem in Sabah. Forests in Sabah can be divided into three major types, which are inland, peat swamp and mangrove forests. Mangroves are found fringing the coast lines (up to 5 km landward), major estuaries of the regions, and they reside on wetlands ecosystem of not more than 20 m land altitude.

2.2 Satellite Data

Images from Landsat-5 Thematic Mapper (TM), Landsat-7 Enhanced Thematic Mapper (ETM+), and Landsat-8 Operational Land Imager (OLI) satellite were used in this study. Images from three different series of year, which are 1990, 2000 and 2017, were acquired to conduct the work. All images are available at <https://earthexplorer.usgs.gov/> and were downloaded free of charge. At least 8 scenes of Landsat images that cover Sabah, were used for a single epoch (Fig.1). Cloud cover are presence on some of the images, hence, more than one scene of images over the same year were acquired to select cloud free images.



Fig.1: Landsat scenes that were used for the classification. Numbers within the scene boundary indicates path/row ID of Landsat satellites.

2.3 Production of Seamless Mosaic Images

Cloud cover is inevitable on the images acquired by the satellites. However, cloud removal process can eliminate the cloud covers that appear on a single-date observation data. Images of particular scenes that were acquired on different dates were used for cloud patching process as shown in Fig.2. F_mask algorithm was used to perform this process (Zhu, Z. & Woodcock, C. E. 2012; Zhu, Z., et al., 2015). Seamless mosaics product (i.e. images without cloud covers and atmospherically corrected) were used as input for subsequent processes.

2.4 Images Classification

Appropriate enhancement techniques were applied to the images to make the mangroves appear better on the images (Hesham, A. M. & Smith, S. E., 2017). In addition to the individual spectral bands of Landsat images, vegetation indices such as Normalized Different Vegetation Index (NDVI), Green Atmospherically Resistant Index (GARI),

and Normalized Difference Infrared Index (NDII) were also derived from the images to improve quality of classification. The vegetation indices that were used in this study are summarized in Table 1.

Table 1: Vegetation indices that were used and derived from the images.

Vegetation indices	Formula	Description
NDVI	$NDVI = \frac{NIR - R}{NIR + R}$	Commonly used to delineate vegetation from other features on images and to measure vegetation vigour. It is sensitive to atmospheric effects.
GARI	$GARI = \frac{NIR - [G - 1.7 * (B - R)]}{NIR + [G - 1.7 * (B - R)]}$	Normally used for detection of green pigment concentration and differentiate chlorophyll levels. It is more sensitive to chlorophyll concentrations than the atmospheric effects.
NDII	$NDII = \frac{NIR - MidIR}{NIR + MidIR}$	It uses near- and mid-infrared bands to detect changes in plant biomass and water stress in wetlands like mangroves.

Note: NIR = near infrared, G = green, B = blue, R = red, and MidIR = middle wave infrared channels.

Most spectral-based image classifications are performed using traditional methods such as maximum likelihood, linear discriminant analysis, and spectral angle mapper classifiers. These methods are applied to the spectral bands to produce classified features in images (Matthew, L. C., et al., 2005). Instead of using these approaches, this study attempted a new approach to classify the images. R Package, which is free, open source software with the Random Forest algorithm (Liaw, A. & Wiener, M., 2002) was used.

RandomForest is assembler machine learning and it is very efficient in handling big data and qualified to outlier and over fitting. The use of RandomForest algorithm on remote sensing application has been found in many studies. It is a combination of a number of non-parametric classification and decision tree/CART (classification and regression trees). In simple word, Random forest builds multiple decision trees and merges them together to get a more accurate and stable prediction. (Jhonnerie, E., et al., 2015).

RandomForest implements Breiman's RandomForest algorithm, based on Breiman and Cutler's original FORTRAN code for classification and regression [Breiman, L., 2002]. It can also be used for assessing proximities among data points without necessarily a training set. All sampling points that were collected on the ground were connected to the corresponding pixels on the image through this algorithm. Classification was done by searching the most important variables i.e. which spectral bands are used in decision tree approach (Lawrence, R. L., et al., 2006; Adam, E., et al., 2012; Mansour, K., et al.,

2012). RandomForest applies four major steps of looking at the importance of variables as follow:

- 1) Step 1: To determine the significance of the m^{th} variable. In the left out cases for the k^{th} tree, randomly permute all values of the m^{th} variable. Put these new covariate values down the tree and get classifications.
- 2) Steps 2 and 3: For the n^{th} case in the data, its margin at the end of a run is the proportion of votes for its true class minus the maximum of the proportion of votes for each of the other classes. The 2nd measure of importance of the m^{th} variable is the average lowering of the margin across all cases when the m^{th} variable is randomly permuted as in Step 1. Step 3 then count the margin that was shrunk.
- 3) Step 4: The splitting criterion used in RandomForest is the gini criterion, a mechanism that can measure the most to least importance of variables used in decision tree. At every split, one of the m^{th} variables is used to form the split and there is a resulting decrease in the gini. The sum of all will decrease the forest due to a given variable, normalized by the number of trees.

All images have been classified to distinguish mangroves from the other forest types. The classification results were transformed into vector shapefile for further refinement and editing. The accuracy of the classification results were assessed by using a number of ground truth points. The GIS platform was used to carry out post-classification analysis. Post-classification analysis is usually used for quantifying changes of mangroves. Changes of mangroves were identified from the conversions of mangroves to other landuse classes, which are i) urban, settlement, and industrial areas, ii) agricultural, iii) aquaculture activities, and iv) coastal erosion.

2.5 Estimation of CO₂ Emission

Carbon dioxide (CO₂) is defined as natural, colorless and odorless greenhouse gas that is emitted when fossil fuels (i.e. natural gas, oil, coal etc.) are burnt. In this study, the CO₂ emission is expressed as C loss, assuming that the gas is emitted when deforestation occur. The units of metric tons C was converted to CO₂ by multiplying the ratio of the molecular weight of carbon dioxide to that of carbon ($44/12 = 3.67$) (Intergovernmental Panel on Climate Change (IPCC), 2006).

The CO₂ resulted from deforestation is one of the important elements in greenhouse gases emissions. Therefore, it is also essential to quantify the contribution of mangrove deforestation towards the CO₂ emission. Net emission as resulted from deforestation of mangroves can be estimated based on stock-difference method, which can be expressed as Eq. 1 as follow (Intergovernmental Panel on Climate Change (IPCC), 2006);

$$\Delta C = \frac{(C_{t1} - C_{t2})}{(t_2 - t_1)} \quad (1)$$

Where, ΔC is changes in carbon stock (Mg C yr⁻¹), C_{t1} and C_{t2} (Mg C) is carbon stock at time t_1 and t_2 (year), respectively. In this case, the C_{t1} and C_{t2} were quantified from the changes analysis that has been carried out earlier in this study.

3.0 RESULTS AND DISCUSSION

3.1 Seamless Image Mosaic

F_mask algorithm successfully removed almost 100% of cloud covers and their shadows on the images. The algorithm also managed to detect thin, low temperature clouds in the high altitude by thermal sensors onboard the Landsat TM, ETM+ and OLI. The algorithm somehow failed to detect small scattering clouds that occurred in small patches on the images. Nevertheless, the algorithm has facilitated the cloud removal process and made the mangroves mapping and monitoring work at landscape-level practically. Fig.2 shows a portion of mangroves on two different images that were captured on different dates with clouds. These images were used to produce seamless mosaic of cloud free image.

3.2 Images Classification

The study indicated that the suitable spectral bands for species discrimination varied with scale. However, near-infrared (700–1327 nm) bands were consistently important spectrum across all scales and the visible bands (437–700 nm) were more important at pixel and crown scales. By using the RandomForest algorithm the most important bands in the classification were represented by a mean decrease gini values. The most important bands in mangroves discrimination, from most to least, are; MidIR, NIR-2, NIR, Green, Blue, Red. Spectral profile of the images also showed that the NIR channels separate the mangrove from the other land covers very well (Fig.4). On the other hands, the vegetation indices that were used in this study played similar important role in mangroves classification.

The image classification approach that has been applied in this study was found to be effective only at large coverage of mangroves. The classification was performed by using Random Forest Classifier in R environment and the range analyses accuracy was 80% -85%. A number of comprehensive ground truth points were still necessary to validate the classification products for better accuracy and result. Mangroves are normally appearing dark on any combination of spectral bands of multispectral image. This is due to the natural ecosystem of mangroves, which is covered by swamps and sometimes inundated by tidal water. The chlorophyll content of the mangrove leaves, which is higher than those of trees and crops, tends to make them appear darker on satellite images (Hamdan, O., et al., 2016), as depicted in Fig.3.

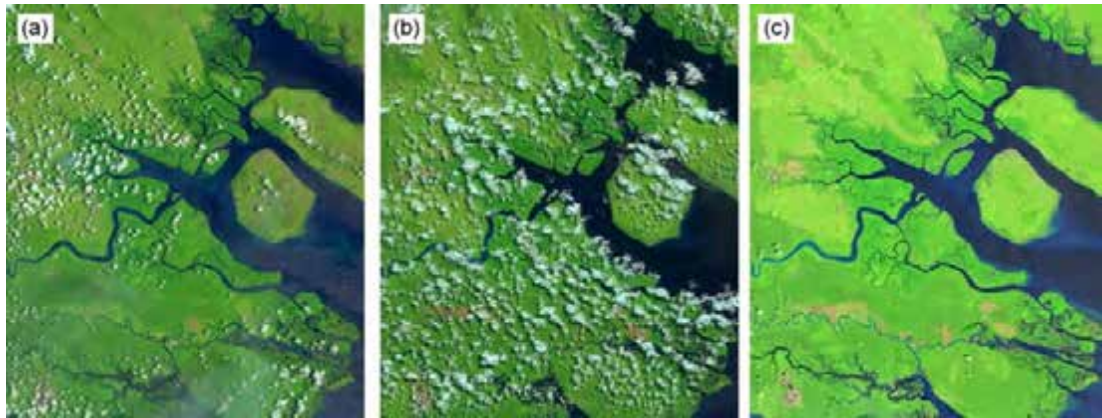


Fig.2: Cloud detection and removal process using F_mask algorithm. Individual Landsat scene that was captured on 26 January 2017 (a) was merged with scene captured on 14 June 2017 (b), where both produced a cloud free image for the year 2017 (c).

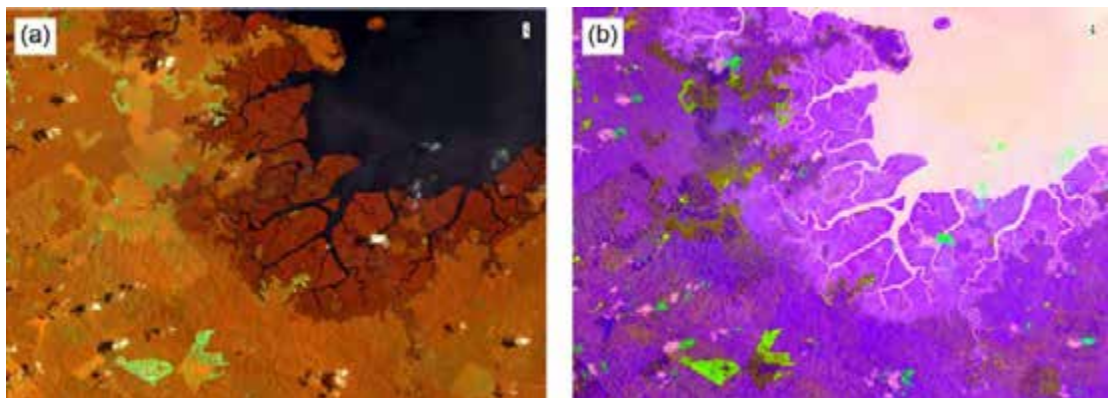


Fig.3: Images showing (a) combination of bands 5, 6 and 4 of Landsat-8 OLI and (b) combination of vegetation indices, NDVI, GARI and NDII. These images were selected for the classification process.

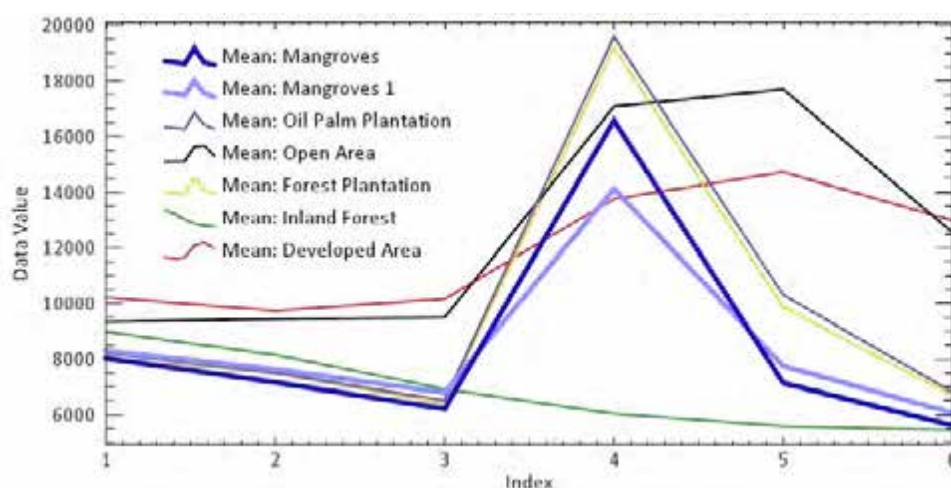


Fig.4: Spectral profiles of several land covers extracted from the images. Channel 1 through 6 on the y-axis is Blue, Green, Red, NIR, NIR-2 and MidIR, respectively.

3.3 Mangroves Distribution and Extent

The extent of mangroves in Sabah is shown in Table 2. It summarizes the total extents of mangroves for year 1990, 2000 and 2017 that have been produced from the classification. It is notable that the total extents of mangroves have been decreasing throughout the monitoring period. Fig.5 show spatially explicit map of mangroves distribution in Sabah. Mangroves are found mainly along the east coast of Sabah. It covers 60% of the total mangroves in Malaysia and 5.14% of the total landmass of Sabah.

Table 2. Extents of mangroves in Sabah

Region	Mangroves 1990 (ha)	Mangroves 2000 (ha)	Mangroves 2017 (ha)
Sabah	385,630	382,448	378,195

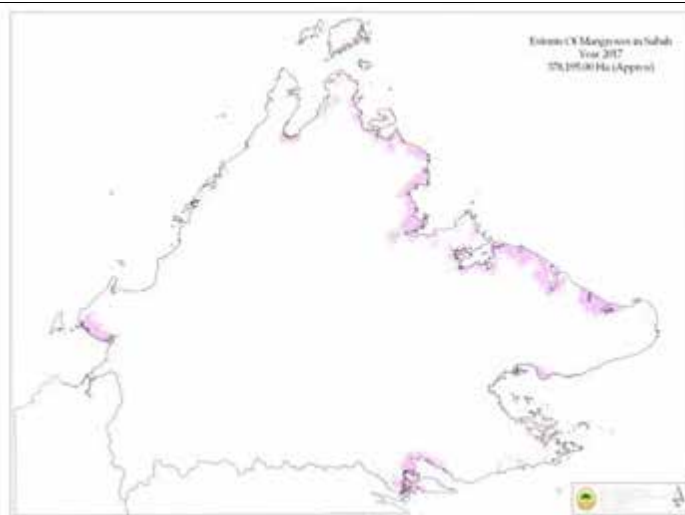


Fig. 5: Distribution of mangroves in Sabah over the year 2017.

3.4 Loss of mangroves in Sabah

Table 3 reports the changes of mangroves that have occurred over the three (3) series of monitoring period. The total loss of mangroves was about 7,435 ha where majority of the mangroves loss were outside the PFR or within the stateland areas. The study concluded that the annual decrease rate of mangroves was about 275 hectares per year or about 0.07% per annum since year 1990. Major factors that contributed to these changes have been identified as (i) direct conversion to other land uses, predominantly for aquaculture and agriculture, and (ii) coastal erosion.

Although coastal erosion was identified as one of the factors of mangroves loss, there were some accretions occurred in some other places. Erosion and accretion is a dynamic process and takes place along the coastlines and major estuaries, where suspended sediments are likely to settle. These phenomena also lead to species succession when the existing plant species die due to unsuitable soil and new species emerge. Besides, mangrove roots can act as wave breaker and promote flocculation and sedimentation,

eventually forming mudflats that allow positive accretion. Coastal erosion occurs when the waves hit perpendicular to the coastlines and when the rapid flow of sea currents washes away the sand or soil particles. The frequency and height of waves hitting the coastlines contribute to the harshness of coastal erosion. Thus, the presence of mangroves can reduce the coastal erosion significantly. This condition can be seen particularly in the areas facing the sea (Khairuddin, B., Yulianda, F., Kusmana, C. & Yonvitner, 2016 & Kanniah, K., Sheikhi, A., Cracknell, A., Goh, H., Tan, K., Ho, C., et al., 2015).

Table 3: Mangroves deforestation in Sabah between years 1990 and 2017.

Region	Mangrove loss 1990 - 2000 (ha)	Mangrove loss 2000 - 2017 (ha)	Rate of deforestation 1990 - 2000 (ha yr ⁻¹) (%) yr ⁻¹)	Rate of deforestation 2000 - 2017 (ha yr ⁻¹) (%) yr ⁻¹)	Average rate of deforestation 1990 - 2017 (ha yr ⁻¹) (%) yr ⁻¹)
Sabah	3,182	4,253	318 0.08	250 0.07	275 0.07

3.5 The Estimated Carbon Emission

A study has indicated that the average C stock (aboveground and belowground) in mangroves in Malaysia is about 181 Mg C ha⁻¹ (Ibharim, N. A., Mustapha, M. A., Lihan, T. & Mazlan, A. G., 2015). The extents of mangroves loss for each epoch were multiplied by this average carbon stocks. The study demonstrated that the total loss of carbon due to the loss of mangroves in Sabah was about 1.3 million Mg C. Subsequently, this has led to the CO₂ emission at about 4.9 million Mg CO₂, with an average of about 0.18 million Mg CO₂ emission per year, along the monitoring period. Table 4 summarizes the impact of mangroves loss in terms of CO₂ emission.

Table 4: CO₂ emission resulted from mangroves loss between years 1990 and 2017

Region	Mangrove loss (ha)	Carbon loss (Mg C)	CO ₂ emission (Mg CO ₂)	Rate of CO ₂ emission (Mg CO ₂ yr ⁻¹)
Sabah	7,435	1,345,672	4,938,617	182,912

4.0 CONCLUSION

This study has successfully assessed the current state of mangroves and determined the rate of mangroves loss in Sabah since the last decade. Total mangrove in Sabah has decreased from 385,630 ha in 1990 to 378,195 ha in 2017. Deforestation was accounted at 7,435 ha or 1.93% with the annual rate of deforestation of 275 ha yr⁻¹ or 0.07% yr⁻¹, between 1990 and 2017. The

study also quantified the C stock changes and estimated CO₂ emission due to the loss of mangroves in Sabah. Total emission caused by the mangroves deforestation was accounted at about 4.9 million Mg CO₂ with annual emission rate of around 0.18 million Mg CO₂ yr⁻¹.

The study found that the Landsat-based mapping and monitoring of mangroves was very practical. It provides reliable information on mangroves distribution. Landsat missions provide a very useful remote sensing data for monitoring of mangroves changes over time. The study suggests that appropriate actions should be taken by the Government of Sabah to protect and to keep the mangroves ecosystem intact forever. The most effective way to conserve the mangroves is to gazette the remaining stateland mangroves as Permanent Forest Reserve (PFR) for current and future generations, while contributing to the mitigation of climate change impacts at local level.

The study also provided some ideas for further studies, especially mapping on mangroves qualitative by species group, mangroves area accretion or additional extents and C stock by individual mangroves reserve using Landsat images. The results will be future inputs for the MIS of Sabah Forestry Department.

Overall, there is great potential in the application of Landsat-based data in the mapping and monitoring of mangroves in Sabah. Although there are cloud covers problems on some of the images, this has not hindered the assessment of mangroves at landscape and regional levels. The accuracy and precision also vary depending on the objective of the application. However, the ability to detect major changes in the ecosystem that can cause profound and irreversible damage far outweighs a perfectly or highly accurate and precise remote sensing based method at this point.

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**PAPER 6: DEVELOPMENT OF A GEOSPATIAL SOLUTION FOR
ASSESSING RESIDUAL FOREST STAND CHARACTERISTICS AND
TIMBER STOCKINGS TOWARDS SUSTAINABLE FORESTRY**

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Abstract

In order to sustainably manage our forests, it is important to quantify our forest resources. Due to the vast area and remoteness of our Permanent Forest Estate (PFE), it is costly and time consuming to conduct forest resource inventory using conventional methods. Hence, this project is implemented to assess forest resources using advanced remote sensing techniques. Forest density will be determined using the latest satellite imagery to select sampling plots. High fidelity optical imaging sensors are subsequently deployed to characterize the canopies of these selected sites and derive the stand volume estimates. The results of this study would form a basis of developing a tool to generate information on residual forest stand and timber stocking that would be of use in the stand valuation of a forested area.

Keywords: optical imaging sensors, remote sensing, stand valuation

1.0 INTRODUCTION

Historically, studies on forestry involved mainly assessment of timber resource and the management of forest focusing on the production for timber wood (Dutt, Udayalakshmt & Sadhasivaiah, 1994). With the diminishing forest resources observed globally, a paradigm shift is observed in forest management activities which at their core are focused on sustainability and preservation of biodiversity (Franklin, 2001). Increasingly, the Sustainable Forest Management (SFM) practice is adopted in many countries (Banerjee, Macpherson, & Alavalapati, 2009; Siry, Cubbage, & Ahmed, 2005; Siry, Cubbage, & Rukunuddin, 2005; Valente, Coelho, Ribeiro, & Marsh, 2015) as one of the solution to address such phenomenon. For SFM to be efficient and successful, the managers need to acquire detailed knowledge such as the species composition, stand structure and density. In the past years, we observed a significant shift in such forest resource assessment from the conventional forestry methods to include more advanced technologies to collect these empirical data (Mariz, Gianelle, Bruzzone, & Vescovo, 2009; Shamsoddini, Trinder, & Turner, 2013; St-Onge & Cavayas, 1995; Zhang & Ni-meister, 2014)

Sarawak is committed to sustainably manage its six million hectares of production forest, known as Permanent Forest Estates (PFEs), especially when much of the previous forested area has diminished due to anthropogenic threats such as urbanization and population growth (FDS, 2018). With its vast area and inaccessibility, it is difficult to produce a near-accurate assessment of the forest resources in PFEs using the conventional method which are more labour intensive, time consuming and involves extremely high cost (Grabarnik & Särkkä, 2011). Therefore, Sarawak Forestry Corporation (SFC) is working towards developing a rapid and accurate method to generate information such as residual stand characteristics and timber stocking using advanced technology to increase the efficiency of forest management. The purpose of this pilot project is to develop a detailed geospatial data acquisition solution to

provide more accurate data for timber stock and economic value estimation over forest timber licensed area. The resulting build-up geospatial analytics system will then serve as a tool for easy access and better presentation especially when comes to project tender for the licensed area. This will elevate SFC not merely as user of the advance technology but also as a technology provider to meet the State geospatial needs in line with Chief Minister's vision of a Digital Sarawak.

2.0 METHODS

The approach incorporated in this project involved a general stratification of the existing forest timber license T/0078 (Yong Khow & Sons Ltd). It was done based on land use and residual forest stand classes. The residual stands were then incorporated into Area of interests (AOIs) that are then sensed from airborne systems utilising both manned and UAV platforms.

Phase 1 of the project consist of two major components, the project site selection and optical imaging. The optical imaging was divided into two sub-components which comprised of mobilization of equipment and aircraft to the project site and to conduct aerial mapping (calibration and survey flights) using high-optical imaging sensor and UAV over AOI area.

Phase 2 of the project will include more detailed study as it will involve both ground and airborne scanning using LiDAR. The ground-based laser scanning will be deployed while our ground team proceed with the forest stand inventory inside the established sampling plots. Phase 2 of the project also features the application development (web-based virtual forest stand assessment) where the user can fully understand the role of each technology when combined data were packed into web-based presentation.

Two types of equipment were used in Phase 1 of this project: the high optical-imaging sensor, and the UAV platform. LiDAR system (laser scanning image) will be used in Phase 2.

Currently, Phase 1 of the project has been completed and Phase 2 will commence soon.

3.0 RESULTS AND DISCUSSION

3.1 Site Selection

The site chosen for this pilot project is at an existing forest timber licence no. T/0078 (Yong Khow & Sons Ltd), located near Bakam, Miri. The area is next to Lambir Hill National Park. The site selection was based on the availability of potentially merchantable timber, accessibility by road and the distance from airport for data collection and staff mobilization.

The licensed area was awarded to Yong Khow & Sons Ltd. for timber extraction. The total size of the licensed area is 2,173 ha with averaging altitude of below 200 feet. The forest condition can be categorized as secondary forest throughout the area. The area has been logged for 30-40 years and the latest entry was the third entry over licensed area. The contractor was permitted to operate inside the licensed area until 31 March 2018 before the licence permit expired. Conventional method for log extraction was applied here where only trees with the measurement for diameter at breast height above 30 cm were allowed to be cut. Some of the previously logged over area have emerged into secondary forest and have the potential for re-entry based on the pre-analyze from Satellite Imagery database and on-site visit.

3.2 Pre-Analysis, Land Use and Forest Cover Stratification for Area of Interest (AOI) Selection

A tiered approach as outlined by McRoberts, Nelson, & Wendt, 2002 was adopted in the study to determine the final AOIs within the project site. This involved the initial stratification of the residual forest stand based on interpretation of medium resolution (15m g.s.d*) satellite imagery (SI) as shown in Fig.1 followed by airborne flights over these areas to determine the stand composition.

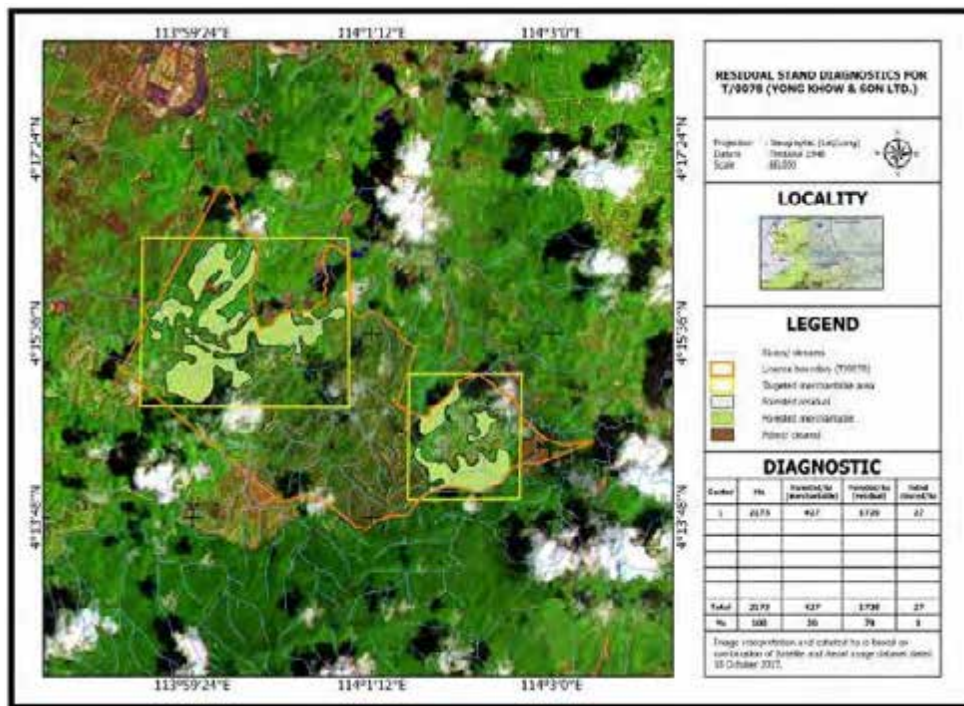


Fig.1: SI analytics to stratify land use and general forest cover type

Apart from having a minimum size of the area and contiguity of the residual forest stand strata, selection of the final AOI were also based on its proximity to areas that are environmentally (major streams, steep slopes) and socially (active agriculture or farmlands) sensitive. The final forested residual stand strata that was finally selected as the AOI has a total area of 427 ha (Fig. 2).



Fig.2: Final AOI and the respective view of their residual forest stand structure

* g.s.d = ground sampling distance

3.3 Field Sampling Plot Establishment and Forest Stand Inventory

After the AOI was established, the ground staff surveyed the area for merchantable timbers and identified potential areas for establishment of sampling plots. The potential sites were further analyzed with the satellite imagery to select the suitable sampling plots to conduct field data collection to complement the stand structure analysis at a later stage of this project. Two sampling plots of 1 hectare each were identified and forest stand inventory conducted in each plot.

3.4 Airborne Data Acquisition

3.4.1 Optical Imaging Sensor

The high-optical image sensing equipment was mobilized and fitted onto a NC22 aircraft at Miri preceding aerial sorties over the AOI. A total of 15 flight lines with 250m apart (55% overlap) were established to cover the whole area of the AOI (about 700 hectares).

The flight over the AOI area took 3 hours *in lieu* of the low cloud base (average ceiling of 2000 ft. bordering the Lambir Hills) and also due to the heavy air traffic next to the Miri airport approach path.

3.4.2 Unmanned Aerial Vehicle

A single rotor fixed-wing UAV was used for image acquisitions over the AOI project site. The image acquisition over AOI area was subject to heavy air traffic from the approach path of Miri airport. It took about three days, 28 flight line and flown at average of 400 ft. with 70% overlap between flight lines to complete the same AOI for the UAV which is about 700 hectares.

3.5 Calibration of flight instrument (high-optical imaging sensor)

The data was retrieved and undergo pre-processing using Envi software (Fig.3) before being run through another software (CaligeoPro) to generate the calibration report as shown on Fig 4.

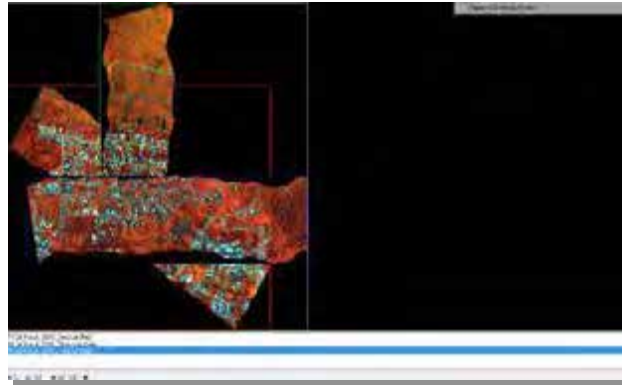


Fig.3: Processed data for the calibration flight

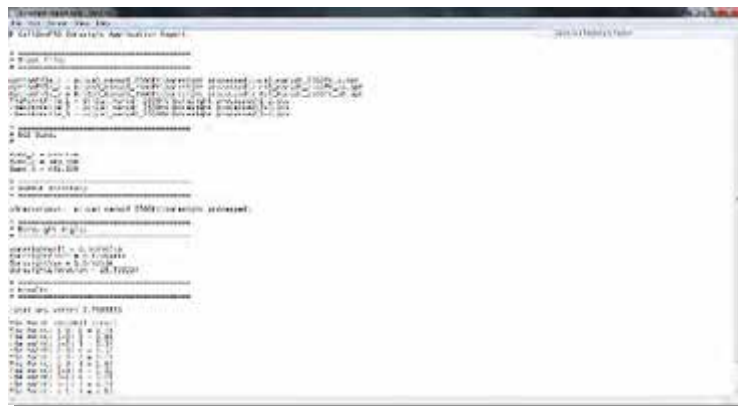


Fig. 4: Calibration Report

The calibration figure for the BoresightRoll, BoresightPitch and BoresightYaw (Fig. 4) were used as a new calibrations setting for Boresight angle upon processing the actual data acquisition.

3.6 Data acquisition and processing (high-optical imaging sensor)

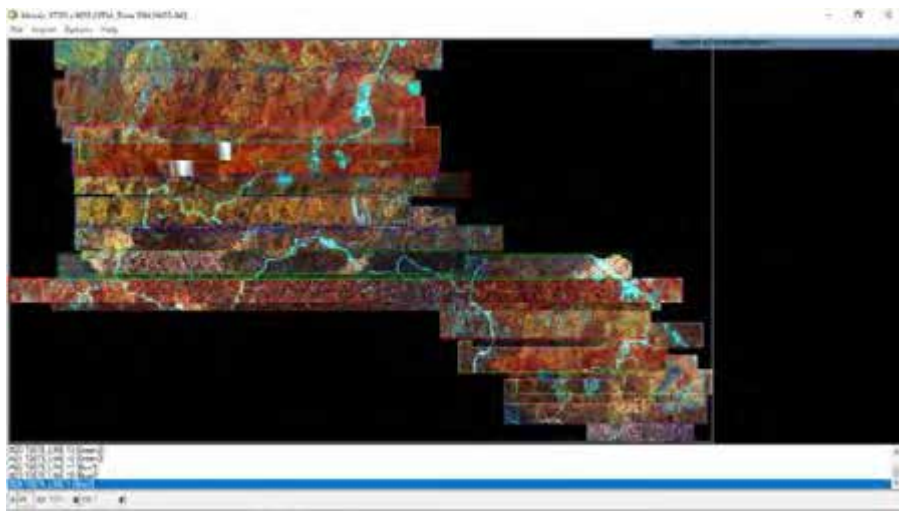


Fig. 5: Preliminary mosaic of the lines over AOI area

The result of processed data over AOI area before mosaic (image stitching) is shown in Fig. 5 which was then used to compose a map (Fig. 6) and perform other type of analysis involving tree mapping and forest stand inventory on the second phase of the project.



Fig. 6: Compose map over AOI area

The general composition of the residual stand could be clearly observed in the colour composite map. These information was the crucial point for selecting the sampling plot location to represent the different forest stand composition as observed in the colour composite map in Fig. 7.

The map in Fig. 7 depicts the locations of two 1 ha each sampling plots which have been chosen to conduct stand structure analysis in the next phase of the study.

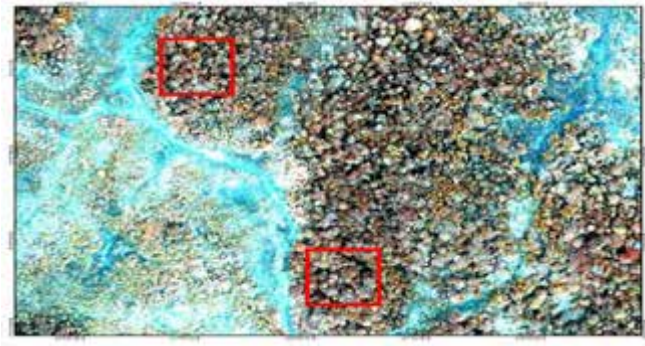


Fig. 7: Color composite image of the residual stand with locations of two sampling plots for conducting stand structure analysis

3.7 Data acquisition and processing (UAV)

The final result after stitching the aerial photos using Agisoft is shown in Fig.8. The image will be used as a based map reference over AOI area.



Fig. 8: Georectified image from the UAV datasets over AOI area

4.0 WAY FORWARD

Currently, the first phase of the project has been completed. More data are anticipated as the project enters its second phase. In the second phase, both airborne and ground laser scanning data using LiDAR and forest stand inventory inside the established sampling plots will be collected. When all the information needed are collected then we can start building the web-based Virtual assessment tool to fully access all the detail information on forest stand characteristic especially during the tendering process of selected re-entry on licensed area. One of the preview on web-based virtual assessment tool was the 3D stand structure. An example of such output is in Fig. 9.



Fig. 9: An example of 3D stand structure collected using high-optical imaging data sensor

5.0 CONCLUSION

This pilot project is building on the existing equipment and facilities of SFC. The usage of more advanced technology will allow SFC to respond immediately to request by providing rapid geospatial solutions to various forestry applications.

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**PAPER 7: SUSTAINABLE MANAGEMENT AND CONSERVATION OF
PEAT SWAMP FOREST IN PENINSULAR MALAYSIA**

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Abstract

Peninsular Malaysia is fortunate to be endowed with large tract of rich tropical rainforests. These forests are very essential and contribute significantly to the socio-economics and environmental aspects. In this context, Forestry Department Peninsular Malaysia (FDPM) has set aside sufficient forest areas and gazetted them as Permanent Reserved Forests (PRFs). About 5% of the PRFs constitutes of peat swamp forests. Despite of its limited distribution, this natural wetland forest has important key values for biodiversity conservation, climate regulation and support for the livelihood of the local communities. Rapid development and booming population have significantly put the peat swamp forests under threat. Adjacent peatlands near the peat swamp forests in the PRFs have been cleared for agriculture, plantations and other land use. These changes have altered the integrity and stability of the natural peat swamp forests. Given that peat swamp forests are more vulnerable to synergies between human disturbances than other forest ecosystems, their protection and restoration are conservation priorities that require urgent action. This paper highlights the coherent efforts undertaken by FDPM towards the sustainable use and conservation of the peat swamp forests in the PRFs. It also addresses the current issues and challenges face by FDPM in protecting this natural wetland habitat as well as way forward to overcome such obstacles.

Keywords: Peninsular Malaysia, Permanent Reserved Forests (PRFs), peat swamp forest, wetland, forest biodiversity, conservation

1.0 INTRODUCTION

Peat swamps are one of the most unusual and harsh wetland ecosystems in the tropical rainforest biome yet one of the most poorly understood biotopes (Ng et al., 1994). The importance of the peat swamps is underappreciated as they are regarded as wastelands and unproductive (Posa et al., 2011; Rijksen & Peerson 1991). Peat swamps occur inland just beyond coastal mangroves and often spread over some 3km to 5km on the floodplain of rivers. These swamps derive their name from their substrate of peat consisting of plant parts, which gradually release tannins and organic acids into poorly buffered water and contribute to its characteristically low pH values ranging 3.6 to 5.9 (Ng et al., 1994; Posa et al., 2011; Wantzen et al., 2011; Yule, 2010). Peat swamps are waterlogged areas that typically deficient in oxygen, which contributes to incomplete decomposition of the plant parts – roots, leaves, branches that were accumulated over thousands of years (Beamish et al., 2003). Peat swamps

are generally referred as 'black waters' because of their dark brown or tea-like waters, which is caused by a high content of organic matter and other phenolic acids (Goltenboth, 2006; Irvine et al., 2013). Before embarking upon a discussion about sustainable management and conservation of peat swamp forests in Peninsular Malaysia, it is necessary to define the common terms related to this wetland type. Peat is generally known as sedentarily accumulated material consisting high organic matter (more than 65%) in a soil layer at least 50cm deep (Ministry of Natural Resources and Environment, 2011). Meanwhile, a peatland is an area with or without vegetation with a naturally accumulated peat layer at the surface (D'Cruz, 2014). An area where natural or semi-natural forest types occur on peat deposits is called a peat swamp forest (D'Cruz, 2014).

1.1 Peat Swamp Biodiversity and Ecological Functions

Peat swamps harbour significant and highly specialised biodiversity (Page et al., 1997; Phillips, 1990; Yule, 2010) of which remain inadequately understood scientifically. According to Purwaningsih and Yusuf (2000) and Corlett (2009), about 30 to 122 tree species of more than 10cm diameter can be found in a one-hectare study plot in the peat swamp forests. The number of tree species is generally low compared to tropical inland forest due to the extreme chemical condition and hydrological regime of the peat swamps. Nevertheless, the tropical peat swamp forests are still considered as exceptionally high in flora diversity compared to all other types of peatlands in the world. The peat swamp forests in Peninsular Malaysia have important source of timber and non-timber products. Among the important tree species for timber are *Gonystylus bancanus* (Ramin melawis), *Shorea platycarpa* (Meranti paya), *Shorea uliginosa* (Meranti bakau) and *Kompassia malaccensis* (Kempas). In addition, this natural wetland also has various ornamental plants and ferns, resin producing trees, medicinal plants and scented species. The peat swamps are also home to variety of fauna species. A number of mammals were recorded and sighted in the swamp areas, namely *Tapirus indicus* (Tapir), *Helarctos malayanus* (Sun bear), *Hylobates lar* (White-handed Gibbon), *Presbytis obscurus* (Dusky-Leaf Monkey), *Panthera pardus* (black leopard) and many others. According to Wetlands International (2010), about 33% of freshwater fish species, 23% of amphibians and 18% of reptiles can be found in the peat swamp forests in Peninsular Malaysia. Peat swamp forests provide a wide range of valuable goods and services, yet these are often ignored when peat areas are considered for development. Nonetheless, there has been increased interest in the recent years about the important roles and ecological functions of peat swamp forests (Jaenicke et al., 2008; Page et al., 2004). Peat swamp forests are significant carbon stores and sinks. They are one of the few ecosystems which, in their natural state, accumulate carbon. The carbon dioxide is sequestered as organic carbon in the form of organic material in the peat and hence helps in reducing the greenhouse gas emissions and mitigate climate change (Wetlands International, 2010). The peat swamp forest also plays an important role in regulating the water resources. During periods of heavy rainfall, peat swamp forests act as natural reservoirs because they absorb and store water. The peat functions as a sponge, absorbing water during the wet season and releasing it gradually during dry periods. Peat swamps are important for flood control, regulating water supply and preventing saline water intrusion, of which are crucial to the agriculture and industry sectors. In some areas in Peninsular Malaysia, peat swamps play a vital role in the socio-economic and livelihood of the local communities, particularly in the fishery industry, ecotourism sector and recreation activities. In addition, this habitat has important attributes to the local communities, especially the cultural or spiritual values, historical values and

aesthetic values. The ecosystem services rendered by peat swamps are summarised in Table 1.

Table 1: Types of ecosystem services rendered by Peat Swamp Forests

Ecosystem Services	Benefits
Direct uses (Goods)	Forestry, agriculture, plant gathering, fishery, tourism, recreation, water supply
Functions (Services)	Water storage / retention, carbon storage / sequestration, flood mitigation, maintenance of base flow in rivers, sediment, nutrient and toxicant removal
Attributes	Biodiversity, cultural / spiritual value, historical value, aesthetic value

Source: Wetlands International (2010)

2.0 AN OVERVIEW OF THE PEAT SWAMP FOREST RESOURCES

As shown in Fig. 1, the distribution of peat swamp forests in Peninsular Malaysia is fairly limited at about 5% as compared to the dry inland forests (93%) and mangrove forests (2%). To date, 30% (852,363 hectares) of peatlands in Malaysia can be found in Peninsular Malaysia (Fig. 2). Approximately 70% (598,916 hectares) of these peatlands are State Land forests, Alienated Land and other land reserves which are owned by State Governments and private sectors respectively. Most of these peatlands are land banks set aside for development purposes, agriculture and plantations. Meanwhile 253,447 hectares (30%) of natural peat swamp forests are gazetted as Permanent Reserved Forests (PRFs) that fall under the jurisdiction of Forestry Department Peninsular Malaysia (FDPM). The largest tract of natural peat swamps can be found in Pahang with total area of 140,830 hectares (55.5%) followed by Selangor 82,890 hectares (33%), Terengganu 25,931 hectares (10%) and Johor 3,796 hectares (1.5%). The rapid depletion of wetlands, including the peat swamp forests especially over the last two decades has led to an unprecedented level of concern over the sustainability of the ecosystems. In Peninsular Malaysia, large area of peatlands have been cleared and drained to make way for land development, particularly for agriculture, plantation and aquaculture projects (Mohd Radhi Chu, 1998; Shamsuddin 1997). These changes completely alter the integrity of the peat swamp forests and eliminate many of the distinct flora and fauna associated with the ecosystem. Therefore, to strike a balance between conservation and development, an efficient and integrated approach has to be implemented to elevate the sustainable management practices and protection of peat swamp forests.

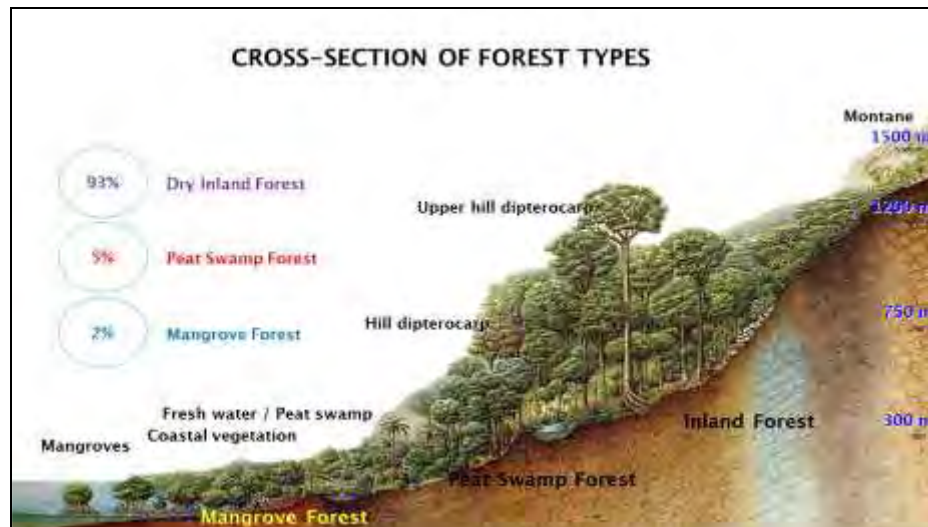


Fig. 1: The cross-section of forest types in Peninsular Malaysia

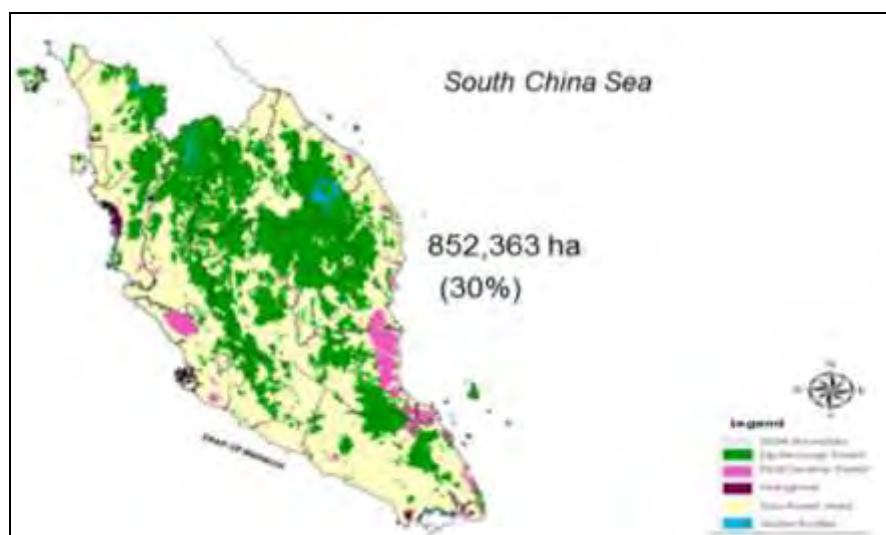


Fig. 2: The distribution of peatlands in Peninsular Malaysia

3.0 PEATLAND LEGISLATIVE, POLICY AND PLANS

Currently, there are three legislations that are considered of major importance to the forestry sector in Peninsular Malaysia, namely National Forestry Policy 1978, National Forestry Act 1984 (Amended 1993) and National Policy on Biological Diversity 2016 – 2025.

3.1 National Forestry Policy 1978

The development of forest resources is guided by the National Forestry Policy 1978, which is currently under second revision. This policy aims to conserve and manage the nation's forest based on the principles of sustainable management and to protect the environment as well as to conserve biological diversity, genetic resources, and to enhance research and education. The policy prescribes for a clear classification system for Permanent Reserved Forests (PRFs), with associated management standards. It also provides for the conservation of biological diversity and areas with unique species of flora and fauna, the development of comprehensive programmes in community forestry,

promotion of active local community involvement in forestry management projects and support for intensive research programmes in forestry and forest products.

3.2 National Forestry Act 1984 (Amended 1993)

The second most important legislation is the National Forestry Act 1984 (Amended 1993). This Act would enable the effective implementation of the National Forestry Policy as it was formulated to uniformed and update the various State Forest Enactments besides plays important role in the administration, management and conservation of forests for forestry development within States in Peninsular Malaysia. However, to further strengthen its provisions to safeguarding and protecting the forest resources from encroachment and illegal forest harvesting activities of forest areas and timber theft, the Act was amended in 1993.

3.3 National Policy on Biological Diversity 2016 – 2025

Last but not least, the National Policy on Biological Diversity 2016 – 2025 is yet another important policy related to peatland management and conservation. This Policy is a revised version of the National Policy on Biological Diversity 1998. The purpose of revision is to meet the current biodiversity management needs as well as to fulfil Malaysia's obligation under the United Nations Convention on Biological Diversity (CBD). The National Policy on Biological Diversity 2016 – 2025 specifies 17 national biodiversity targets to be implemented by all segments of stakeholder and society within a period of 10 years. This policy outlines five key principles on biodiversity management:

- i.P1: **Heritage.** Biological diversity is a national heritage. It must be sustainably managed, wisely utilised and conserved for future generations.
- ii.P2: **Precautionary.** The lack of full scientific certainty should not be used as a reason to postpone measures to minimise threats of significant loss of biodiversity.
- iii.P3: **Shared responsibility.** The conservation and sustainable utilisation of biodiversity are the shared responsibility of all sectors of society.
- iv.P4: **Participatory.** Planning and management of biodiversity must be carried out in a participatory manner.
- v.P5: **Good governance.** Good governance, including accountability and transparency, is crucial to biodiversity conservation.

3.4 National Action Plan for Peatlands

Apart from the three legislative mentioned above, FDPM also upholds the National Action Plan for Peatlands (NAPP). The objectives of NAPP are to enhance knowledge, awareness and capacity for sustainable peatlands management and development; conserve peatlands resources and reduce peatland degradation and fires; to promote the sustainable and integrated management of peatlands and to ensure effective multi-stakeholder cooperation. Under the NAPP, there are 13 focal areas and 78 national actions to be implemented by various stakeholders to achieve sustainable peatland management in Malaysia.

3.5 Integrated Management Plans

Todate, there are two Integrated Management Plans (IMPs) developed respectively for the peat swamp forests within the PRFs in the State of Selangor and State of Pahang (Fig. 3). The overarching objective of these IMPs is to maintain the geographical extent and integrity of the peat swamp forests in the PRFs in order to sustain and rehabilitate the functions of the ecosystem as provider of goods and services for the benefit of the local and global communities. The IMPs place great emphasis on protection and conservation of peat swamps within the PRFs. Nevertheless, its' implementation takes into consideration of the activities in the adjacent peatlands that are non PRFs. The IMPs elaborates the crucial aspects of legal and institutional framework, biophysical features, socio-economics, cooperative fire management plan, forest zoning management, buffer strips and boundary management, rehabilitation plan, as well as implementation. Although there are no specific IMPs developed for peat swamps in Johor State and Terengganu State, the management and conservation regimes are incorporated in the State's Forest Management Plan respectively. Other peatland related legislatives that are now in effect in Peninsular Malaysia are shown in Table 2.

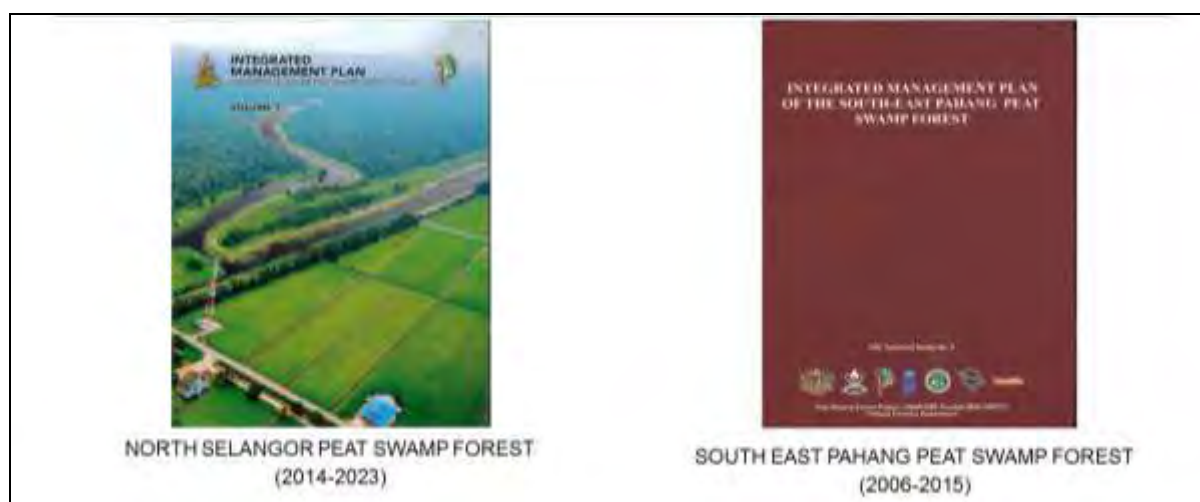


Fig. 3: Two Integrated Management Plans were developed each for North Selangor Peat Swamp Forest (left) and South-East Pahang Peat Swamp Forest (right).

Table 2: Other Peatland Related Legislatives

Policies	
1.	National Policy on Climate Change (2010)
2.	Common Vision on Biodiversity (2009)
3.	The National Physical Plan (2010)
4.	The National Wetland Policy (2004)
5.	The National Agricultural Policy (2003)
6.	The National Policy on the Environment (2002)
Plans	
1.	11th Malaysian Plans (2016-2020)
2.	ASEAN Peatland Management Strategy (2006-2020)
3.	ASEAN Programme on Sustainable Management of Peatland Ecosystems (2014-2020)

4.0 SUSTAINABLE MANAGEMENT AND CONSERVATION INITIATIVES

4.1 Hydrological Management

Hydrology is the single most important factor for the establishment and maintenance of peat swamps and the various processes that take place within it (Mitsch & Gosselink, 1993). The hydrological aspect influences the abiotic activities that are relevant for soil anaerobiosis and nutrient availability. All these factors yield to soil fertility and subsequently the overall intactness of the peat swamp forests, which would further determine the types of biodiversity that inhabit the ecosystem. FDPM places great emphasis on the hydrological management in the peat swamp forests. Regulating and maintaining good water table at the peat swamp forests not only helps to safeguard the natural characteristic of the habitat, it also assists in preventing wildfire occurrence. Active canals that were once built for forest harvesting are blocked to avoid constant outflow of peat water from the PRFs. Blocking of canals are implemented using materials such as sand bags, geotextile materials, mangrove poles, concretes, old tyres and so forth. More than 800 units of canal blockings are built in the peat swamps forests. In addition, FDPM has built a number of check dams and long stretch of clay dykes to avoid substantial water loss to the adjacent peatlands. Nevertheless, restoring hydrological regime is case by case basis depending on the site conditions, particularly the availability of alternative water resources. For instance, Raja Musa Forest Reserve in Selangor has adequate alternative water resources to facilitate rewetting and to restore water table. The water sourced from an ex-mining pond within the PRFs was channelled through a water piping system to peat swamp areas where water is scarce. Currently, the water piping system is being upgraded by increasing the length from 3km to 5km, reaching further in to peat swamps that are prone to wildfire. On the other hand, tube wells were built with the assistance of Department of Mineral and Geoscience Department Malaysia (Jabatan Mineral dan Geosains Malaysia – JMG) at peat areas with severely limited water resources. Today, there were 5 units of tube wells available at peat swamp forests in PRFs.

4.2 Cooperatives Fire Management

Fire prevention is one of the crucial aspects to be considered in the peatland management. According to Langner et al. (2007) as well as Langner and Siegert (2009), tropical peat swamp forests are more vulnerable to destruction by fire compared to other forest types due to high organic matter in the peat soil and by characteristic it is extremely flammable when dry. Previous disturbance greatly exacerbates the severity of fire damage. Peat swamps that were burnt multiple times have dramatically low tree densities and biodiversity relative to the areas that have burnt only once (Page et al., 2009; Yeager et al., 2003). Based on studies conducted by Page et al. (2009) and Siegert et al. (2001), peat forest that has been exposed to fire incidence has high risk of fire reoccurrence because of the accumulated unburnt dead biomass and the presence of fire-prone regrowth vegetation that act as fuel for the next fire.

Cooperatives fire management plan developed by FDPM for peat swamps includes all activities such as reducing the number of unwanted, uncontrolled, escaped wildfire incidences and recovery plan. It is noted that peat fire occurrence is most frequent during prolonged dry spells all over the year or during the dry seasons. Although there is a lot of concern among local communities about peat fire incidences, there is still a minority of individuals who are not concern about the use of fire and cause mostly

unintentional wildfires. Most of the wildfires in the peat swamp forests were caused by manmade fires outside of the PRFs boundaries that got out of control. More rarely are the fires triggered inside of the reserve areas. In the efforts to reduce forest fire, Malaysian Meteorological Department (MMD) has developed Fire Danger Rating System (FDRS) - a peatland fire prediction and warning system since 2003. This system has extensive application of satellite technology to detect the ground conditions of hotspots and obtain weather data (e.g. rainfall, temperature, humidity, wind speed, etc.) at Automated Weather Stations (AWS). Currently, there are more than 200 AWS built by MMD across Malaysia to monitor the hotspot areas (Fig. 4). A peatland layer was incorporated into the FDRS for easy reference and to guide land managers to determine the probability of fire occurrence due to weather conditions. The data from the AWS is used to analyse ground conditions and provide fire risk indices and codes through FDRS (Fig. 5). The indices are displayed to the public members through the FDRS signboards installed at the peat swamp forests (Fig. 6). Based on the fire risk indices, the land managers will then take necessary preventive measures such as allocating resources, facilitate patrolling and warning actions and lastly, prepare for firefighting. In addition, FDPM also developed a manual on Forest Fire Suppression Manual. The manual addresses key aspects on fire watch, fire disaster response, tools use for fire-fighting, fire recovery and public awareness on fire risks.

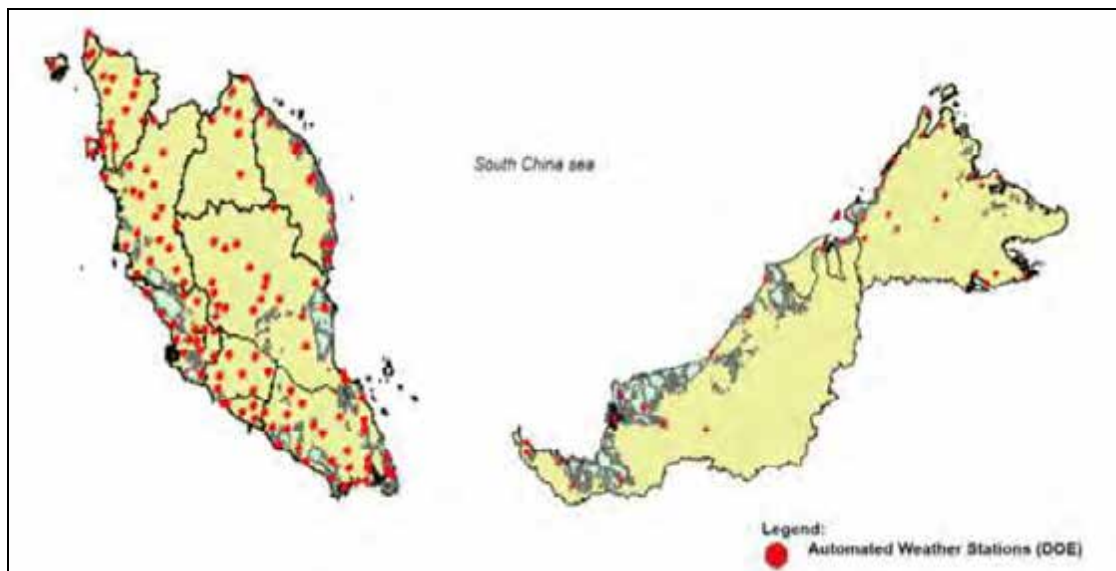


Fig. 4: The distribution of Automated Weather Stations (AWS) in Malaysia.

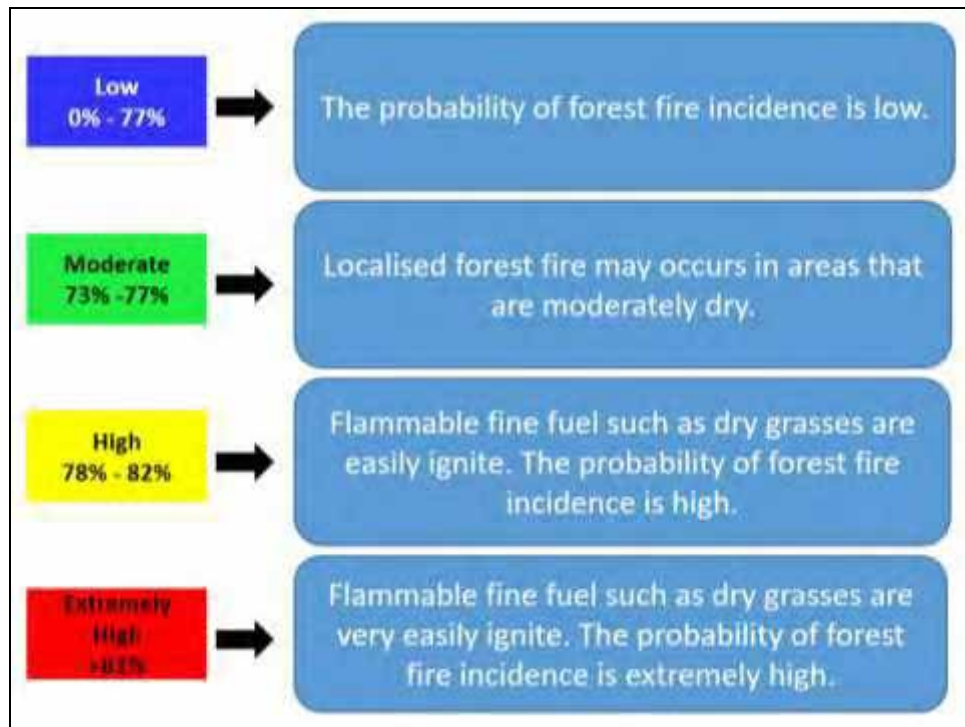


Fig. 5: The Fine Fuel Moisture Code used for Fire Danger Rating System (FDRS).



Fig. 6: The Fire Danger Rating System (FDRS) signboard installed at the peat swamp forest.

4.3 Rehabilitation of Degraded Peat Swamp Forest

Some degraded peat swamp in Peninsular Malaysia are in dire need of rehabilitation. Without rehabilitation efforts these peat swamp areas will take a longer time to recover through a normal succession processes, especially for forest complexes which are highly fragmented where the seed dispersal process is disrupted. The existing degradation of some areas has left them unproductive and in a state where their environmental functions is not maintained. Although replanting of degraded peat swamp forests may not the ultimate priority for FDPM, the department still undertakes rehabilitation programme with the Community Based Organisations (CBOs), Non-Governmental Organisations (NGOs) and local communities who live adjacent to the peat areas. The rehabilitation programme also attracts several private companies from the manufacturing sector, plantations sector and banking services who contributed towards peatland conservation efforts in Peninsular Malaysia through Corporate Social Responsibility (CSR). Re-greening of the degraded peat swamp forests requires a proper rehabilitation regime starting from site selection, species selection, planting method as well as treatment and protection. Planting of mixed species, especially the pioneer species such as *Eudia* spp. (Tenggek Burung) and *Macaranga* spp (Mahang) are highly favourable. The fast growing pioneer species will facilitate natural growth by covering the degraded peat areas and reducing soil pressure. Apart from the two species mentioned, FDPM also planted a number of other key peat swamp tree species, namely *Shorea platycarpa* (Meranti paya), *Anisoptera marginata* (Mersawa paya), *Intsia palembanica* (Merbau) and *Gonystylus* spp. (Ramin) (Ismail, 2014).

4.4 Communication, Education and Public Awareness (CEPA)

There are a number of communications, education and public awareness (CEPA) programmes undertaken by FDPM to fortify public awareness on peat swamp forest and its resources as well as to bring into light the concept of Sustainable Forest Management (SFM). CEPA is implemented in various forms, such as public talk and awareness campaigns, exhibitions, tree planting activities, publications and so forth. These programmes are conducted with the collaboration of CBOs and NGOs. One of the CBOs who is actively involved in CEPA is the Friends of North Selangor Peat Swamp Forest. The members of this CBO are the local communities who live nearby to the peat swamp forests in the Hulu Selangor District Forest. In addition to their supporting role, this CBO also serve as the “eyes and ears” of FDPM and other related agencies in forest fire monitoring, enforcement and rehabilitation activities.

4.5 Mobilisation of Financial Resources

Substantial financial resources are needed to ensure the peat swamp forest and its resources are prudently managed and conserved. In this regards, FDPM has involved in various peatland related projects since 1996, where most of the funds were sourced from international organisations. In addition, FDPM and State Forestry Departments in Peninsular Malaysia also seek to secure project development funds respectively from Federal Government and State Governments to support the initiative on sustainable management of peat swamp forest. Table 3 summarises the peatland related project funded by various international organisations.

Table 3: List of Peatland Related Projects

No.	Project	Funder	Amount	Project Year	Project Sites
1.	The Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest in Peninsular	Danish Cooperation for Environmental and Development (DANCED)	Danish Kroner 13.3 million	1996 - 1999	• Peat swamp forests in Selangor • Peat swamp forests in Pahang
2.	Conservation and Sustainable Use of Tropical Peat Swamp Forests and Associated Wetland Ecosystems	United Nation Development Programme / Global Environment Facility (UNDP/GEF) Subcomponent: Danish International Development Agency	USD 13.6 million	2002 - 2007	• Loagan Bunut National Park, Sarawak • Klias Peninsula, Sabah • South-East Peat Swamp Forest, Pahang
3.	Rehabilitation and Sustainable Use of Peatland Forests in South-East Asia (Malaysia Component)	International Fund for Agricultural Development / Global Environment Facility (IFAD/GEF) In close collaboration with ASEAN Secretariat (ASEC)	USD 880,000	2010 – 2015	• North Selangor Peat Swamp Forest, Selangor • South-East Peat Swamp Forest, Pahang • Klias Peninsula, Sabah • Loagan Bunut National Park, Sarawak
4.	Sustainable Management of Peatland Ecosystems in Malaysia (SMPEM)	International Fund for Agricultural Development / Global Environment Facility (IFAD/GEF)	USD 9.43 million	4-year project is expected to start in 2018 (currently reviewing the draft Financing Agreement)	• North Selangor Peat Swamp Forest, Selangor • North Kuala Langat and South Kuala Langat Peat Swamp Forest • South-East Peat Swamp Forest, Pahang • Klias Peninsula, Sabah • Loagan Bunut National Park, Sarawak

4.6 Other Related Initiatives

Apart from the four major aspects mentioned above, FDPM also implemented the following activities to strengthen the protection and management of peat swamp forests. This includes the upgrading of infrastructure such forest roads, building watch towers, PRF boundary demarcation and maintenance, aerial and ground surveillance and management of buffer zones.

5.0 ISSUES AND CHALLENGES

5.1 Forest Fire Incidence

Most wildfire outbreaks that spread to the peat swamp forests are originated from the adjacent peatland to the PRF areas. Private companies, small plantation holders and local communities often resort to open burning to discard plantation and orchard waste as the method is more cost-saving. The forest fire risk is multifold during prolong extreme dry weather, especially when water resources is depleting. Furthermore, former logging canals which remain actively draining peat waters add on to the vulnerability of the fire-prone peat areas. Most of the existing canals can be found in the former State Land area. These compounding effects contribute to the degradation of peat swamp forests in the PRFs. Although fire incidence recorded in the PRFs area is reducing year by year, the outbreak of wildfire remains one of the most critical issues to be addressed by FDPM.

5.2 High Cost of Hydrological Rehabilitation

Restoring the water table at the peat swamp forests remains a huge challenge to the FDPM, this scenario is particularly true to areas that experience water shortage. Hydrological management in the peat areas requires huge sum of expenditure as it involves construction and maintenance of much needed infrastructures such as clay dykes, canal blocks, check dams, water retention ponds, tube well and water piping system.

5.3 Costly Rehabilitation Works

The cost of rehabilitating and restoring degraded peat swamp forests also require an enormous sum of investment. With limited source of peat species saplings, expensive treatment cost, logistic conditions, high mortality rate and exposure to fire risk, the fund incurred for re-greening the peat areas will only become more expensive and unaffordable surpassing the cost of maintaining the habitat at its originate state.

6.0 WAY FORWARD

6.1 Fortify and Accelerate Hydrological Restoration Initiatives

Restoring good water table at the peat swamps in the PRFs remains the utmost focus for FDPM. The water outflow from canal outlets and seepage at the landscape level must be regulated accordingly to promote re-wetting of the peat surfaces. Large canals with heavy water outflow should be blocked to divert the peat waters into the PRF areas.

6.2 Security Tenure of Peatlands

While maintaining its commitment to retain current distribution of PRFs in Peninsular Malaysia, FDPM is constantly seeking new peatland areas to be gazetted as PRF under the National Forestry Act 1984 (Amended 1993), particularly those of State Land Forests. Securing the tenureship of other peatlands will help FDPM to conserve the habitat at the landscape level in an integrated manner.

6.3 Upscaling Forest Enforcement Activities

Frequent enforcement and monitoring activities are very important in protecting the peat swamp forests. This can be done through collaboration of enforcement teams from various Government departments and agencies, CBOs as well as NGOs. Enhancing the use of high technology equipment is much needed to ensure effectiveness of forest enforcement.

6.4 Promote Best Management Practices (BMP)

Promoting and instilling Best Management Practices (BMP) among the stakeholders of adjacent peatlands is highly prerequisite to conserve and protect the peatland at the macro level. The BMP encompasses hydrology management, fire prevention, rehabilitation and sustainable use of peatland resources. The sensitisation of BMP through CEPA will facilitate paradigm shift among the stakeholders so that they can become responsible custodians.

7.0 CONCLUSIONS

The societal and ecosystem values of the peat swamp forests should be protected and conserved for the sake of environment integrity and livelihood of the local communities. Also, the involvement of the general public in the conservation, rehabilitation and sustainable use of peat swamp forest resources should remain relevant and be fortified. It is important that the policy makers should understand the importance of peat swamp forests and the important role it plays in rendering multiple ecosystem services. Therefore, it is essential to institutionalise and integrate close collaboration between governmental agencies, CBOs and NGOs to elevate the sustainable management and conservation of peat swamp forests. On that note, FDPM is committed to protect the peat swamp forest resources by upholding Sustainable Forest Management (SFM) practices in accordance to the national commitments and in relation to Forest Beyond Timbers concept.

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PAPER 8: STRENGTHENING SUSTAINABLE FOREST MANAGEMENT THROUGH FOREST MANAGEMENT CERTIFICATION

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Abstract

The State Government of Sarawak had regulated a policy for all long term timber licenses to obtain Forest Management Certification (FMC) in order to ensure the perpetuity sustainability of forest resources in Sarawak. The requirements under the FMC strengthens the Sustainable Forest Management (SFM) in Sarawak by (i) advocating responsible forestry, (ii) self-regulatory and (iii) embracing comprehensive approach which balance economic, environment and social aspects. A step-wise planning and management procedures was developed and implemented by the State Government in order to facilitate the process of FMC by integrating the use of technology and database management such as GIS Forest Information System (FOMISS) and Forests Growth and Yield Simulation Model, (FORMIND). Challenges and gaps such as land and social issues, as well as limited skilled and technical capacities will continue to be addressed through the enhancement of capacity building and training, use of up-to-date technologies and continuous engagement with various stakeholders.

Keyword: Sustainable Forest Management, Forest Management Certification, technologies, engagement of stakeholders

1.0 INTRODUCTION

Systematic management of forest resources in Sarawak begins with the establishment of Forest Department Sarawak in 1919. Under the administrative of the first conservator, J.P. Mead, a code of rules was drafted based on the rules in force in Malaya. The Forest Rules came into force in 1920, essentially to administer and regulate: (i) exploration and demarcation of forest reserves; (ii) works of improvement of forests; (iii) research; and (iv) collection of revenues (Kaur, 1998). These rules were followed by the Forest Reservation Order, 1920 which covers the constitution and maintenance of reserve forest; and Forest Order, 1934 to govern protected forest (Smythies, 1961).

The Forest Policy Statement was first gazetted in 1924 emphasizing the native customary rights of the people and social and environmental functions of forestry (Bruenig, 2017). The Statement was subsequently revised in 1954 which requires the government to manage the forest resources “in perpetuity for the benefits of the people of Sarawak by maintaining a balance between protection and commercial use”, as well as preserve sufficient forest lands for the benefit of the people, ecosystem and economy. The Policy is still relevant until now and currently being updated to include current forestry practices and issues.

1.1 Sustainable Forest Management in Sarawak

Sustainable Forest Management (SFM) is a key component of sustainable development agenda of the Sarawak Government. The SFM requires adherence of striking a balance between commercial use of the forest and environmental protection, which necessitate

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the involvement of local stakeholders, cross-sectoral approach and partnerships in the management of forests.

A land-use policy was drawn up by the State Government which covers all aspects of economic development, social well-being and environmental balance and integrity. Under the policy, Sarawak's land area is categorized to cater for three main sectors namely forestry, agriculture and other land uses such as the following:

- a. Permanent Forest Estates (PFEs) comprising protected forest (PF), forest reserves (FR) and communal forest (CF).

Forest gazetted or sustainable timber production. The forest operation within the PFE is based on the Selective Felling System which comprises:

- i. Forest Engineering Plan which consists of General Harvesting Planning and Detail Harvesting Planning;
 - ii. Diameter cutting limits and 25 years cutting cycle for HMDF and 45 years for swamp forest were imposed;
 - iii. Environmental Impact Assessment (EIA) for re-entry area of more than 500 ha;
 - iv. No harvesting in terrain class IV except for helicopter logging;
- b. Totally Protected Areas (TPAs) consisting of national parks, nature reserves and wildlife sanctuaries.

The TPAs are mainly reserved for conservation of biological diversity, protection of forest ecosystems and research. These areas are of immense conservation value because they have been deliberately chosen to cover a complete range of forest ecosystems and habitats of Sarawak. Whilst eco-tourism development is allowed in national parks and nature reserves, wildlife sanctuaries have limited public access and are strictly for conservation and research purposes. Although have similar function with national parks, nature reserves are areas gazetted less than 1,000 ha.

No timber harvesting is allowed in these areas.

- c. State Land

State Land is for miscellaneous development and not reserved permanently as forests. The area can be alienated for other land uses such as agriculture plantations, settlements, etc.

2.0 STRENGTHENING SUSTAINABLE FOREST MANAGEMENT IN SARAWAK

The following steps were taken by the State Government to ensure that Sarawak's forest resources are managed in a sustainable manner.

2.1 Policy Reform

Restructuring of policies are necessary to include current issues on forestry either locally and globally to strengthen management of forests and wood-based industries in the State. There are six policies that currently being reviewed and introduced namely:

- i. Sarawak Forest Policy;

- ii. Forest Management Certification;
- iii. Development of Planted Forest;
- iv. Wood Industries Development Plan;
- v. Raw Material for timber industries; and
- vi. Forest Revenue especially cess from downstream products.

2.2 Policy on Forest Management Certification

Due to the growing global concern on environmental issues, SFM became the main requirements for timber and timber product buyers, as well as key interest for environment and social conscious society. During the Heart of Borneo (HoB) Seminar in 2013, the state government had announced for all Forest Timber Licences within the Heart of Borneo area to obtain Forest Management Certification (FMC). This was later re-emphasized, making FMC mandatory for all Long-term Forest Timber Licences (FTL) in Sarawak to be certified. Since the announcements, several initiatives and activities had been taken towards realizing the State Government target. A Policy of FMC has been drafted and currently at the final stage of preparation before being endorsed.

2.3 Revision of Ordinances, Rules and Regulations

The Forest Ordinance (1958) was revised to strengthen enforcement and incorporate current forestry issues. Major amendments to the Ordinance were stiffer penalties for forest offences and incorporating Payment for Ecosystem Services (PES). Revision of Forest Rules and License Conditions are on-going.

2.4 Enhance Standard Operating Procedure for Timber Legality and Verification

The *Log Tracking System* (LoTS) developed in 1989 was enhanced to *Sarawak Logs Tracking and Forest Revenue System* (REVLOG) to include information detailed information timber license, log production and royalty assessments, log tracking, export and milling as well as billing or revenue collection.

The *Sarawak Timber Legality Verification System* (STLVS) based on the *Inter-Agency Standard Operating Procedures (SOP) for Performance of Forestry Functions in Sarawak* was structured into a formal due diligence system for Sarawak. The STLVS is a legality system covering the process of licensing, harvesting, transporting, manufacturing and trading of logs and timber products in accordance with the existing laws, regulations and procedures governing forests and timber trade (including the importation of logs and timber products) in Sarawak. Its objectives are to support the control of forestry operations and supply chain of forest products based on a formal due diligence system to monitor and document compliance against Principles 1 to 6 of the *Sarawak Timber Legality Verification System* (STLVS) *Standard* for forestry and the timber industry.

3.0 WHY FOREST MANAGEMENT CERTIFICATION?

3.1 Strengthening SFM in Sarawak

The requirements under FMC strengthen the Sustainable Forest Management (SFM) in Sarawak by:

- i. *Advocating Responsible Forestry* – compliance to the international recognized standards, addressing issues instead of avoiding, third party auditing for check and balance as well as managing the forests sustainably;
- ii. *Incorporating the Self-Regulatory approach* – the FMU has to ensure compliance to obtain and maintain certification. Development of SOP to comply with standard, Internal auditing, all level of staff/operations are closely monitored by the Forest Management Unit Licence Holders; and
- iii. *Comprehensive Approach* taking into account the economic viability, environmental sound and socially acceptable forest management thus striking the balance.

3.2 Growing Concern for Good and Responsible Forest Management

The growing concern by the local and international communities on good and responsible forestry is one of the factors requiring the mandatory certification for all long-term FTLs in Sarawak. The stringent requirements under the certification standard offer the opportunity for FMUs to improve and to prove that the forest management is conformed to the internationally recognised management standard.

3.3 Market Demand

The FMC is the main requirement for buyers to ensure timber or timber products came from sustainably managed forests. Most big companies like IKEA, LEGO, McDonalds, etc. have sustainable timber/paper sourcing policies, of which requires timber and timber products sourced from the well-managed forests.

Thus, FMUs in Sarawak need to change their mindsets in managing the forests and adapt their forest operations to these conditions in order not to miss out business opportunities and gain access to wider markets.

3.4 Reputational Benefit

Timber industry played a pivotal role in the development and economic growth of the state. However, throughout the years Sarawak's reputation has been tarnished by allegations of illegal logging and corruption (Borneo Post, 2015).

The State Government has a very clear Land Use Policy in which 6 million hectares and 1 million hectares of the land area are allocated for Permanent Forest Estate and Totally Protected Area respectively. With this clear policy, FMC should be seen as opportunities for the State Government to improve the State image in managing forests. The FMC would enhance transparency and strengthen the State's credibility in pursuing long-term improvements.

4.0 STEP-WISE APPROCH TO FOREST MANAGEMENT CERTIFICATION

The State Government is taking a step-wise approach in planning and executing the action plans in order to facilitate the process of FMC. This was done by preparing a roadmap for FMC which incorporating the followings:

- i. Integrating the use of technology and database management such as GIS Forest Information System (FOMISS) and Forests Growth and Yield Simulation Model, (FORMIND);
- ii. Continuous engagement with all relevant stakeholders is given emphasis so that important issues are addressed to ensure smooth implementation of FMC;
- iii. Capacity building and awareness programmes especially the technical aspects; and
- iv. Continuous monitoring of the progress of implementation.

5.0 GAPS AND CHALLENGES IN PURSUING FOREST MANAGEMENT CERTIFICATION

The followings gap and challenges faced in pursuing FMC in Sarawak:

5.1 Manpower with Necessary Skills

Technical-know-how is the most important element in implementing FMC. This shall be acquired through well trained, quality, knowledgeable and dedicated human resources at all level namely planning, implementation and monitoring and control from both the industry and implementing agencies. Human resource development therefore, is extremely important to further develop the capacities of all stakeholders in achieving a higher level of individual and organizational performance and effectiveness.

At this point, there are still insufficient local professionals, skilled and experienced manpower in both FMUs and implementing agencies. Some of the FMUs are still employing operational workers who have little knowledge about SFM and FMC.

Based on our personal observations, preparing and implementing the Forest Management Plan (FMP) are the most critical part, in which both FMUs and implementing agencies are lacking.

5.2 Migration from the Conventional Logging to Reduced Impact Logging (RIL)

The conventional forest management system is still the standard management practices widely adopted in the management of natural forest resources in Sarawak. Migration from the old system of conventional logging to Reduced Impact Logging (RIL) is a major challenge to the licensees/logging contractor. Stringent requirements of the criterias and indicators of most certification schemes such as tree tagging, 100% pre-felling inventory, etc. requires technical knowledge and change of mind set (Manggil, 2002).

Despite the directive to implement RIL, many of the FMUs are still struggling to move on from their business as usual practices to RIL which require careful techniques and skilled manpower.

5.3 Land Issues

Shifting cultivation has long been a way of life for the Sarawak's indigenous communities as a source of food supply, religious belief as well as traditions and customs. In the past, areas affected by shifting cultivation were small and clearings were done manually and confined to the lowland areas along rivers and streams that are easily accessible by boats. In recent years as there are more access through the numerous networks of logging roads, shifting cultivators began to move to logged over areas. The practice of shifting cultivation is in serious conflict with the principles of FMC and hence would be the main constraint and limitation that could undermine its effective implementation in Sarawak (Manggil, 2001).

Besides the areas cleared for shifting cultivation, another issue that affect the implementation of FMC is the Native Customaries Right (NCR) land claims within the PFE and Stateland Forests. Although the local communities do not have right under the law over areas claimed within PFE, they are depending on the forest resources in the area and therefore have the right over livelihood. This issue cannot be ignored and need to be addressed to avoid conflicts. Any engagements with local communities should also be documented future reference

5.4 Change of Mindset

The most arduous tasks in pursuing FMC is to change the attitude and the behaviour of all levels of society and various stakeholders involved. The Resistance to Change (RTC) attitude or "RTC syndrome" of these stakeholders is the most difficult and could take years to achieve, before the concept of SFM could be finally accepted and our vision to implement it on a wider scale could be realised.

6.0 WAY FORWARD

Despite the gaps and challenges faced, the State Government is committed to ensure that our forest is managed in a sustainable manner. The Government realized that the process to obtain forest certification takes time and requires a full commitment from the timber operators and other stakeholders, but the immense benefits can be derived from these efforts to the industry, the community in terms of environment and well-being and to the State as a whole.

As a way forward towards FMC, the following steps or strategies are needed to ensure smooth implementation of FMC.

6.1 Continuous Engagement with Relevant Stakeholders

Stakeholders' consultation forms a very crucial component of the certification process. Continuous engagement through platforms such as Forest Management Certification Technical Committee Meeting, Forest Management Certification Liaison Committee Meeting etc. should be carried out periodically and when necessary. These platforms will be used to discuss issues and serve as the venue for awareness programmes on FMC and forest operations within the affected areas.

6.2 Enhance Capacity building

Training in particular, should be organized along with three major functions of management, namely planning, implementation and monitoring and control. The Forest Department being the technical and lead department in forest management should take

the lead in providing and facilitate the training through “Trainers of Trainers (TOT)” for the other stakeholders.

Collaboration with other stakeholders such as Natural Resources Environmental Board, higher learning institutions, Malaysian Timber Certification Council and other agencies in Sabah and Peninsular Malaysia could also be explored in providing training in the fields needed in FMC in particular and SFM in general.

6.3 Use of Up-To-Date Technologies

Current available technologies such as hyperspectral and remote sensing should be fully utilized and explored to improve regulations and policies for better forest management.

6.4 Intensify R&D to Support Decision Making

Forest dynamics, regrowth, appropriate silviculture treatment and rehabilitation of logged over forests should be continuously studied and developed to better understand and facilitate the management of disturbed forests.

8.0 CONCLUSION

The state government is all out for FMC implementation which is pivotal in ensuring that all timber produced and exported meet the international sustainability standards in the very near future.

FMC is the only way forward in attaining sustainability of forest resources. This is the opportunity for the State Government to demonstrate its sincerity in advocating responsible forestry for the betterment of mankind and future generation.

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Sub Theme 3:
Forest Biodiversity:
Conservation, Restoration, Rehabilitaion
and Protection

**PAPER 9: CONSERVING OF RAFFLESIA IN KELANTAN,
PENINSULAR MALAYSIA: ISSUES, CHALLENGES AND WAY
FORWARD**

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Abstract

The Rafflesia is the most magnificent and largest flower in the world. In Southeast Asia, it is rapidly becoming an icon for tourism attraction and prominent symbol for nature conservation. Most of the populations of Rafflesia found in Kelantan were situated in the forest reserves under the administrative of the Kelantan State Forestry Department (KFD), such as in Lojing, Mt. Chamah and Mt. Stong. A lot of efforts have been taken by KFD in conserving this gigantic flower through scientific expeditions and establishment of the High Conservation Value Forest (HCVF). In July 2011, the State Government of Kelantan declared an area of 404 ha (1,000 acres) bordering Sg. Berok Forest Reserve in Lojing Highlands as the Rafflesia Preservation Area. This recognition by the state government results from collaboration efforts of Universiti Malaysia Kelantan, KFD and South Kelantan Development Authority (KESEDAR). To date, KFD has established a total of two HCVFs in Kelantan and a new area of 50 ha in Compartment 1, Lojing Forest Reserve has also been dedicated for conservation of Rafflesia. This paper also will discuss on several issues and challenges in conserving Rafflesia in Kelantan such as; (i) Expansion of large-scale agricultural plantation, (ii) Participation of local community, (iii) Tourism and income generation, (iv) International and internal funds for conservation works, and (v) Provide an integrated tourism and management plans. Hopefully, this effort will lead to the establishment of centre of excellent in nature conservation, ecotourism and scientific research of Rafflesia in Lojing Highland, Kelantan.

Key words: Rafflesia, Conservation, Kelantan State Forestry Department.

1.0 INTRODUCTION

Malaysia hosts a portion of the important tropical rainforest belt known as West Malesia, and has a uniquely rich and diverse flora and fauna (Whitmore, 1984) with an estimated number of plant species of more than 25,000 (van Steenis, 1971). Malaysia's rain forests are a source of timber and other products, such as rattan, medicinal plants, resins, food and fertilizer and support the livelihoods of numerous communities. They also provide ecosystem services, maintain a steady supply of freshwater, protect soils against erosion and nutrient loss, regulate local climate and serve as carbon sinks. They are a reservoir for biodiversity and increasingly attract visitors and tourists. In view of its exceptional species diversity and richness, Malaysia is recognized as one of the world's twelve megadiversity countries, or 'hot spots', needing special attention to arrest rapid habitat loss (Myers, 1988). Kelantan especially in the southern part of the state is very rich with biodiversity. Most of the areas are still covered by hill dipterocarp and sub-montane forest. From the previous surveys by Zulhazman et al. (2010), it

was believed that this area contains among the highest population of *Rafflesia* from the species of *Rafflesia kerri* Meijer in the world. It is becoming one of the popular sites for tourists, especially international tourists to visit and appreciate the *Rafflesia* flowers in wild. Lojing Highlands is also riched of other diversified plant species like mosses, ferns, wild orchids, gingers, pitcher plants, wild flower, bamboo and ethnobotany. For fauna, many interesting species of insect can be found beside the diverse of bird species and other small as well as big mammals. Some of the insect families noted in this area are Reduviidae (Hemiptera), Vespidae (wasp), Asilidae (robberfly), Coreidae (Hemiptera), Lycaenidae (butterfly) and Praying Mantis (Mantidae). For bird species, Lojing has interesting birds' population like swallows, grey throated barbbler, Magpie Robin and White Chested Barbbler. Thus, some of the common mammals sighted include monkey, slow loris and bats (Ibrahim & Zulhazman 2010). In this regard, the Kelantan State Forestry Department (KFD) has always strived to ensure that forests especially in Lojing Highlands and generally in Kelantan continue to contribute to biodiversity conservation, environmental protection and socio-economic development as enshrined in the National Forestry Policy of 1978. Forest conservation efforts are always prioritized in state forest management of Kelantan. Through KFD efforts, until now the forested area in Kelantan still remains at 800,986.60 ha or 53.3% of the total area. Of this total, 623,848 ha have been gazetted as Permanent Forest Reserve (PFR) area of which 477,508 ha is production forest and the balance of 146,341 ha is protected forest areas. Several networks protected forest areas have been established for the purpose of conservation, research, education and information gathering including an area categorized as High Conservation Value Forest (HCVF). Forest areas exceeding 1,000 meters above sea level and slope above 40° as well as those areas exposed to soil erosion risk, flash floods, landslides, deposition and nutrient losses are classified as Land Protection Areas.

2.0 RAFFLESIA IN KELANTAN

To date, an estimated of 35 species of *Rafflesia* were recorded in all over the world. From there, a total of 11 species noted in Malaysia, which seven species of *Rafflesia* (*Rafflesia azlanii* Latiff & Wong, *Rafflesia cantleyi* Solms-Laubach, *Rafflesia kerri* Meijer, *Rafflesia sharifah-hapsahiae* Adam, Mohamed, Juhari, Ariff & Wan , *Rafflesia sumeiae* Wong, Nais & Gan, *Rafflesia parvimaculata* Sofiyanti, Mat-Salleh, Khairil, Zuhailah, Mohd-Ros & Burslem, *Rafflesia tuanku-halimii* Adam, Juhari, Mohamed, Azilah, Syamsurina, Paiz, Firdaus & Kiew-Lian) found in Peninsular Malaysia and the rest four species were found in Sabah and Sarawak (*Rafflesia pricei* Meijer, *Rafflesia keithii* Meijer, *Rafflesia tengku-adlinii* Mat-Salleh & Latiff, *Rafflesia tuan-mudae* Beccari) (Wong et al., 2009; Mat Salleh et al., 2006; Wong & Gan 2003; Wong & Latiff, 1994). In Kelantan, there are only three species of *Rafflesia* were recorded and mostly distributed in the southern part of the state. They are *R. cantleyi*, *R. kerri* and *R. sumeiae*. The distributions of *R. cantleyi* are restricted to a few areas nearby and in the Kuala Koh National Park. The existence of *R. sumeiae* was only found in Mt. Chamah, Kelantan and is very likely endemic. However, the distributions of *R. kerri* are widely distributed throughout the Main Range of the Kelantan State. The high populations of *Rafflesia kerri* in Lojing Highlands has attracted many tourists especially the tourist from abroad to visit Malaysia. *Rafflesia kerri* is only distributed within the range of tropical rain forest from the southern part of Thailand to the borders of Perak, Kelantan and Pahang in Peninsular Malaysia. In Malaysia, the flower was firstly discovered by Forest Gan and Matthew Wong in 2002. After a year, new population were observed in Lojing Highlands (Wong & Gan, 2003). This finding has attracted Zulhazman and his team to locate the flowers, where in 2008, during the Lojing Scientific Expedition; they had discovered 26 populations of *Rafflesia* (Zulhazman et al., 2011). All of 26 populations are situated in the statelands, however, further surveyed found many more

populations in nearby forest reserves; Sg. Berok and Lojing Forest Reserves. The findings have led the KFD to establish an area of 50 ha as HCVF in the Compartment 1, Lojing Forest Reserve in 2015, dedicated of conserving this gigantic flower.

3.0 ESTABLISHMENT OF HIGH CONSERVATION VALUE FOREST (HCVF) IN KELANTAN

The concept of High Conservation Value Forest (HCVF) is a classification of forest management used for forests that meet the criteria and principles introduced by the Forest Stewardship Council (FSC), a world certification body for forest management and production sustainability. HCVF has been defined as a brilliant or critical in terms of biological, ecological, social and cultural values and should be protected for the interests of the nation, region and world. The concept of HCVF was first introduced in 1996 and accepted by all FSC members as the Principles and Criteria in 1999 aimed at providing a framework for identifying forest areas with attractive and unique features and high value for biological diversity. The suitability of HFCV in forest management is that it maintains the value of local conservation and the use of the principle of prevention. Therefore, this method is suitable for forest management, in order to ensure that HCVF does not deteriorate as a result of unsustainable development. Undoubtedly, HCVF has interests that encompass various aspects. The use of the HCVF assessment is a process capable of taking into account critical security such as the need to fulfill national laws, conserving the endangered species, respecting the Orang Asli community as stipulated in the Orang Asli Affairs Act and land use rights. HCVF also has a mechanism to refer to a management plan established to maintain and enhance values implemented. To date, KFD has set up two HCVF areas in the State of Kelantan to protect two threatened and endemic tropical rainforest plant species, namely:

- (i) **Protection of *Licuala stongensis*** – The first HCVF in Kelantan and was established in 2015. This HCVF is located in Compartments 11, 17 and 19 of the Gunung Stong Forest State Park with a total area of 15 ha. *Licuala stongensis* was identified as a hyper-endemic plant and only found in Gunung Stong area; and
- (ii) **Protection of *Rafflesia kerri*** – This HCVF was established in 2016 in Compartment 1, Lojing Forest Reserve, involves an area of 50 ha. *Rafflesia kerri* is a unique plant species, threatened and international icon for tourism. This species is the second largest flower species after *Rafflesia arnoldii* in Bengkulu, Indonesia. The latest surveyed by KFD (Anon, 2015) shows that six *Rafflesia* populations are in the category of active noted in this area. The roots of the *Rafflesia*' host plant was also identified from the species of *Tetrastigma hookeri*.

4.0 ISSUES AND CHALLENGES

There are several issues and challenges facing by KFD in conserving *Rafflesia* in the State of Kelantan, as follows:

- (i) **Large-scale agricultural development** – The HCVF's *Rafflesia* in the Compartment 1, Lojing Forest Reserve is surrounded by large-scale agricultural development. There are no clear buffer zone between the conservation area and the rest of others. If no action is taken immediately, it will disturb the survival of *Rafflesia*. As we know, the ecosystem of *Rafflesia* is very sensitive and depend on insects and small mammals as pollination and seed dispersal agents;

- (ii) **Formulation of management plan** – A comprehensive management plan for Rafflesia need to be formulated. To date, no specific directions and guidelines on conservation, ecotourism, involvement of local community, etc. of Rafflesia in Lojing Highlands. Observation nearby this HCVF area shows that several habitats of Rafflesia are seriously disturbed due to improper tourists planning and other human activities;
- (iii) **Scientific research in Rafflesia** – Rafflesia is biologically unique and inspires scientific research for academic and educational purposes. Much are still unknown about these plants; for example, their evolution, co-evolution with the host, reproductive ecology, physiology, genetic variation, medicinal properties, and many other aspects. These are the academic challenges for the future. Establishment of a Rafflesia conservation area provides opportunity for research for both local and international scientific communities;
- (iv) **Ecotourism** – Rafflesia in Lojing Highlands has great potential to be promoted as a tourism attraction. Many people are willing to come a long way to see and appreciate the largest flower on earth in its natural habitat. Presently, in Kg. Jedip, Lojing an average of two vans or 20 to 25 international tourists mostly from vicinity tourism area, i.e. Cameron Highlands, Pahang was noted to make a stop-over to this area on a daily basis. At present, a total of four tourist operators based at Cameron Highlands aggressively promote Rafflesia in Lojing as one of their main activity. A proper tourism management plan needs to be prepared before the HCVF is promoted and opened to tourists;
- (v) **Involvement of local community** – Conservation of Rafflesia will generate sustainable income and provide opportunity for alternative livelihood for the local community. It will educate locals that the flowers are more valuable left growing for sustainable income generation rather than being chopped down for instant benefits. The local community especially those who are involved in tourism such as tourist guides should be given knowledge and awareness on conserving Rafflesia through regular workshops and seminars; and
- (vi) **Funding for Rafflesia** – Rafflesia is also one of the “international icons for nature conservation” that will bring in international and internal funds for conservation works. Thus, KFD should collaborate with related government agencies, local universities and NGOs to jointly develop this HCVF area. Big conglomerate companies in Malaysia such as Petronas, Shell and Sime Darby should also be invited to contribute in this conservation work. A comprehensive conservation proposal should also be prepared in order to seek for international funds such as from World Wide Fund for Nature (WWF), United Nations Development Programme (UNDP) and Japan International Cooperation Agency (JICA).

5.0 WAY FORWARD

In Future, hopefully, the conservation works on Rafflesia in Kelantan will be recognized locally and internationally and this HCVF will becoming an international centre of excellent in nature conservation, ecotourism and scientific research.

6.0 CONCLUSION

As a conclusion, there are a lot to gain by conservation of Rafflesia – both tangible and intangible. Definitely, the image of KFD and Kelantan as a state concerns with the protection of natural resources will be clearly portrayed in Malaysia and the world.

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**PAPER 10: DIVERSITY OF APHYLLOPHORACEOUS FUNGI AT
KUBAH NATIONAL PARK**

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Abstract

Fungi represent a large part of diversity but they have not been well studied particularly wood inhabiting fungi. This group of fungi mainly utilizes fallen logs, twigs and woody materials as substrate. Aphyllophoraceous fungi commonly being used to study the effects of forest use in tropical region because the basidiocarps are long lasting and taxonomically well described. There are two objectives of this study. Firstly is to record the diversity of aphyllophoraceous fungi at Kubah National Park. Second objective is to reveal the relationship between fungal composition and the environmental variables which are the substrate size and the amount of coarse woody debris (CWD). 85 samples of wood decaying fungi belonging to 7 families were recorded. Most abundant family recorded was Polyporaceae with 44 fungal samples and the lowest family was Streareaceae with only 3 samples. Dominant species found was *Microporus affinis* with 16 records.

Keywords: Aphyllophoraceous, Fungi, Diversity

1.0 INTRODUCTION

Fungi are non timber forest product that plays important role to maintain optimum forest condition. There are several functional groups that fungi can be divided such as ectomycorrhizal, parasitic and saprophytic fungi where each of the group plays important roles in forest ecosystem processes such as carbon and nutrient cycling.

Study done by Hawksworth (2012) reported that fungi are the second most diverse living organisms on earth after insects and global fungal diversity is estimated at 1.5-3 million species. Meanwhile, Mueller et al. (2007) estimated the species of macrofungi in tropical Asia to be in the range between 10,000 and 25,000. However, 70%-80% of fungi are yet to be discovered in Malaysia (Corner 1996; Lee et al., 1995).

Fungi represent a large part of diversity but they have not been well studied particularly aphyllophoraceous which is a group of wood inhabiting fungi. This group of fungi mainly utilizes fallen logs, twigs and woody materials as substrate. Aphyllophoraceous fungi commonly being used to study the effects of forest use in tropical region because the basidiocarps are long lasting and taxonomically well described.

There are two objectives of this study. Firstly, is to record the diversity of aphyllophoraceous fungi at Kubah National Park. Fungi are important decomposers of dead organic materials, recycling nutrients through litter decomposition. Therefore, it is very crucial to record and identified tropical fungi before them disappearing. Moreover, published record on tropical fungi in Malaysia especially Sarawak is very limited.

Second objective is to reveal the relationship between fungal composition and the environmental variables which are the substrate size and the amount of coarse woody debris

(CWD). Fungal flora and their species diversity are affected by the forest's age, plant species composition and substrate condition (Yamashita & Hijii, 2006). It is expected that the amount of woody debris and substrate size affected the community structure of aphyllporaceous fungi that mainly inhabit woody debris.

2.0 MATERIAL AND METHODS

2.1 Sampling Sites

Kubah National Park is one of the most accessible national parks in Sarawak as it was located about 22km at the western part of Kuching city. The park was gazetted in 1989 and it was opened to public in 1995. Kubah covers an area around 22 sq. km that comprises of Gunung Serapi and Gunung Selang. Matang Wildlife Center is located on the western boundary of Kubah National Park. This park was opened to public in 1998 and it has exhibits of a selection of Sarawak's mammals and birds. The animals that kept at this park were placed in large cages or enclosures so that the animals can move freely.

Samples of aphyllporaceous fungi were collected along existing trail at Kubah National park until the western part of the park which is Matang Wildlife Centre. The trails covered during this study were Gunung Serapi Summit Trail, Palmetum Trail, Waterfall Trail, Bukit Trail, Rayu Trail, Pitcher-Plant Trail, Sungai Buluh Waterfall Trail and Viewpoint Trail.

2.2 Fungal Collection

Fungal basidiocarps were collected in 2015. Location of collection and type of woody debris the basidiocarps grow were recorded. Woody debris was classified into 7 types: rotten log, rotten stump, rotten twig, rotten root, living tree, living tree root and on soil. Each of the class will determine the size of the substrate. Multiple basidiocarps of the same species growing on individual substrate were considered as one collection.

2.3 Identification

Fungal specimens were identified to species or morpho-species level by using macromorphological characters. Almost all of the specimens were identified according to the macromorphological traits but detail examination under microscope were needed for confirmation some of the species. Identification was based on keys in Ryvardeen and Johansan (1980) and Hattori (2005). The basidiocarps were then preserved as oven-dried specimens at Forest Department Sarawak Fungarium.

3.0 RESULTS AND DISCUSSION

A list of identified aphyllporaceous fungi that were collected at Kubah National Park is given in Table 1. A total of 28 species from 7 families of aphyllporaceous fungi were collected during 3 field surveys in 2015 at Kubah National Park.

Table 1: List Aphyllophoraceous Fungi at Kubah National Park

Family	Species	No. Of Samples Collected
Polyporaceae	<i>Cf. Coriolopsis asper</i>	1
	<i>Cf. Polyporus dictyopus</i>	1
	<i>Coriolopsis</i> sp.	2
	<i>Earliela scabrosa</i>	7
	<i>Microporus affinis</i>	16
	<i>Microporus carneoniger</i>	3
	<i>Microporus vernicipes</i>	1
	<i>Microporus xanthopus</i>	9
	<i>Nigrofomes melanoporus</i>	1
	<i>Trametes menziezii</i>	1
	<i>Trichaptum durum</i>	1
	<i>Trichaptum sprucei</i>	1
Ganodermataceae	<i>Ganoderma australe</i>	10
	<i>Ganoderma lucidum</i>	1
	<i>Amauroderma leptopus</i>	1
	<i>Amauroderma subrugosum</i>	1
Fomitopsidaceae	<i>Daedalea dochnia complex</i>	6
	<i>Daedalea aurora</i>	2
	<i>Fomitopsis rubidus</i>	1
Hymenochateceae	<i>Cyclomyces tabacinus</i>	1
	<i>Phellinus</i> sp.	2
	<i>Phellinus lanaensis</i>	2
	<i>Cyclomyces fuscus</i>	1
Meripilaceae	<i>Rigidiporus microporus</i>	4
	<i>Rigidiporus defibulatus</i>	1
	<i>Rigidiporus</i> sp.	1
Steccherinaceae	<i>Nigroporus vinosus</i>	4
Stereaceae	<i>Stereum ostrea</i>	3
Total no. of samples collected	85	
Total no. of species collected	28	

Polyporaceae is the most abundant family recorded with a total of 44 fungal samples. *Microporus affinis* is the highest species found in this family (16 samples), *M. xanthopus* (9 samples), *Earliela scabrosa* (7 samples), *M. carneoniger* (3 samples), *Coriolopsis* sp. (2 samples) followed by *Cf. Coriolopsis asper*, *Cf. Polyporus dictyopus*, *M. vernicipes*, *Nigrofomes melanoporus*, *Trametes menziezii*, *Trichaptum durum*, *Trichaptum sprucei* with each of the species only recorded 1 sample.

M. affinis appear 12 times at rotten twig (<10cm diameter). Based on field surveys, this species usually colonizes fine twigs. Fungi have different preference for substrate diameter. *M. affinis*

prefer to grow on small substrates. Hence, abundance of rotten twig at sampling area is one of the factor that contribute to high growth of *M. affinis*.

Ganodermataceae is the second highest family with 13 samples recorded from 4 species. *Ganoderma australe* (10 sampels), *Ganoderma lucidum*, *Amauroderma leptopus* and *Amauroderma subrugosum* each with 1 sample recorded.

Out of 10 basidiocarps of *G. australe* recorded, 9 of it were found on rotten log. Distribution of this species is affected by thin and thick woody debris as this species colonized large woody debris (Yamashita et al., 2009). Hence, less availability of large woody debris during the surveys contribute to less distribution of *Ganoderma australe*.

G. australe is a dominant wood-decaying fungus in primary forest of East Malaysia (Yamashita et al., 2009). Hence, study done by Yamashita et al. (2009) reported that *G. australe* is dominant compared to other *Ganoderma* spp might be due to the fact that it is an early colonizer on coarse woody debris (CWD). It is also suggested that *G. australe* might have a large effect on the decomposition process as a possible early colonizers in tropical rainforest.

Only 1 basidiocarps of *G. lucidum* was collected in this family. *G. lucidum* have a worldwide distribution in both tropical and temperate regions. It is one of the lingzhii mushrooms and for centuries lingzhii mushroom has been used in traditional Chinese medicine for its medicinal properties. Consumption of this mushroom is to boost immunity and few researches shows that it can help to prevent and treat cancer.

Amauroderma subrugosum grow on different substrate because it colonizes soil rather than the above ground woody debris. Low distribution of *A. subrugosum* basidiocarps might be due to low availability of its preferred resources, which may be dead/alive root or buried debris.

Third highest family recorded in this study is Fomitopsidaceae with 9 samples of basidiocarps collected. *Daedalea dochnia complex* (6 samples), *Daedalea aurora* (2 samples) and *Fomitopsis rubidus* (1 sample).

Hymenochataceae and Meripilaceae both recorded 6 samples of basidiocarps collected. 4 species in the family Meripilaceae recorded with *Rigidiporus microporus* (4 samples), *Rigidiporus defibulatus* (1 sample) and *Rigidiporus* sp. (1 sample). *R. microporus* which was found on rotten twig, log and stump is also known as plant pathogen that cause white root rot disease on various tropical crops.

Hymenochataceae recorded 3 species with 2 unidentified basidiocarps. *Phellinus lanaensis* (2 samples), *Cyclomyces tabacinus* (1 sample) and *Cyclomyces fuscus* (1 sample). *P. lanaensis* and *C. fuscus* grown on rotten log while *C. tabacinus* was found on rotten twig.

4 basidiocarps of *Nigroporus vinosus* from the family of Steccherinaceae was recorded. The least found family during this sampling period was Stereaceaea with only 3 samples of *Stereum ostrea*. *S. ostrea* is a saprobic fungi and it will caused white rot of the heartwood.

The dominant species, *Microporus affinis* can easily be found because of the availability of favourable habitat which is small woody debris (<10cm) was high. The least recorded species, *Stereum ostrea* also colonized small woody debris but based on unrecorded surveys this species prefer to grow on habitat where the canopy of the forest is not so dense.

4.0 CONCLUSION

In conclusion, Kubah National Park has a rich diversity of aphyllloporaceous fungi. It is a good place to conduct study on this group of fungi because accessibility is easy so more frequent survey is possible to see variation on their distribution and growth as the annual variation of fungi is high.

Distribution of basidiocarps during this survey revealed that substrate size and amount of coarse woody debris play a major role on the distribution of species. Substrate is important factor that determines which wood-inhabiting fungi occur on particular trees, and studies have shown that these fungi have different preferences for substrate diameter (Yamashita et al., 2010). Species diversity of aphyllloporaceous fungi increased with increasing abundance of coarse woody debris.

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**PAPER 11: APPROACHING A DECADE OF IUCN RED LIST
ASSESSMENT IN SABAH: THE WAY FORWARD**

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Abstract

In the 5 goals set down within the National Policy on Biological Diversity 2016-2025, goal 3 was set to “*ensure the resilience of our key ecosystems, species and genetic diversity and that they are managed in an effective and integrated manner*”. One of the targets of the goal is to prevent extinction of known threatened species and improve their conservation status. In order to achieve this target there is a need to generate baseline data on species distribution and conservation status.

Since 2009, surveys and data compilation were initiated to gather species distribution data across the state for both Dipterocarp and Sabah endemics, with the aim to provide a regional threat status assessment using the IUCN Red List Assessment Criteria. Initial in-house assessment across different plant families (125 species) have not just yielded information on plant species threat category based on field inventory data, but with the application of Species Distribution Modelling (SDMs) which combines field data and environmental predictors one can generate species habitat suitability maps across Sabah’s landscape. The advantages of the information generated are: (i) support the state plant species conservation programme, (ii) increase the conservation value of existing Totally Protected Areas (TPAs), (iii) efficiency in the implementation of best management practices in forest management unit that functions as production and conservation management areas and (iv) identify critically high conservation value habitats that require urgent conservation decision on landuse policy.

Keywords: IUCN Red List assessment, conservation status, Sabah.

1.0 INTRODUCTION

Sabah, a Malaysian state within the island of Borneo is one of the megadiversity hotspots in the world. It harbours an estimated 8,000 taxa of vascular plants (Sugau & Yusof, 2014) of which about half are endemic to Borneo and an estimated 13% are endemic to the State (Maycock et al., 2013). There has been a rapid decline in the extent of the natural forests, from about 86% in 1953 to less than 50% currently, due to landuse change (McMorrow & Talip 2001 & Maycock et al., 2012). In 2009, around 1.4 million hectares of Sabah’s fertile lowlands were already covered with oil palm plantations and another 150,000 hectares were planted with other industrial crops (rubber, paddy, coconut, etc.) (Borneon Biodiversity and Ecosystems Conservation, 2012). With this rapid deforestation and landuse change, especially in the lowland dipterocarp forests in Sabah, many plant species will be affected and eventually will be threatened or extinct if conservation actions are not taken.

Under the Convention of Biological Diversity (CBD), which Malaysia ratified in 1994, Aichi Biodiversity Target 12, Strategic Goal C of the United Nation's Strategic Plan for Biodiversity 2011–2020, requires that parties to the CBD improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity. It also targets by 2020, the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained (CBD Secretariat, 2010). To achieve this target within the time frame, there is a need to conduct assessments and assigning IUCN status to the plant species within the state. In parallel with the CBD Strategic Plan for Biodiversity 2011–2020, the National Policy on Biological Diversity 2016-2025 (Goal 3, Target 9) also aims to prevent extinction of known threatened species and their conservation status improved and sustained by 2025 (NRE Secretariat, 2016). At the national level, the Malaysian Plant Conservation Strategy has made a national commitment to have an assessment of the conservation status of all known plant species for Malaysia (Target 2) (Saw, Chua & Nik, 2009). The Sabah Biodiversity Strategy 2012–2022 (Goal 4, Target 4.1) at the state level also addresses the need to improve the understanding of the biodiversity and ecosystem services to enable a more effective management of our resources by 2022 by carrying out effective biodiversity research and long-term monitoring, including monitoring population distribution, numbers and conservation status (Borneon Biodiversity and Ecosystems Conservation, 2012). Hence, there is a need for the state of Sabah to adhere to these global, national and state commitments, including Sabah's commitment to sustainable forest management

The Sabah Forestry Department, together with the University of Aberdeen and Universiti Malaysia Sabah had spearheaded an initiative to address those goals and targets by initially focusing on the commercial species, such as the Dipterocarp species which are commercially important and potentially the most at risk from over exploitation. The endemic flora in Sabah, also known to be a potential extinction risk factor due to its restricted distribution. This initiative has been loosely called “The Sabah Plant Red List” project or initiative which not only aims to prevent extinction of species and improve conservation status of species through strategic species endangered and threatened programme but also enhance capacity of local institution (Pereira et al., 2015). The immediate objectives of the project are to procure and geo-reference vague points to produce valid and reliable species collection points in order to assess the conservation status of plants using IUCN standard protocol.

2.0 METHODOLOGY

Below is a summary of the methods that are used to do the assessment:

2.1 Establishing Species Database

It is essential to first establish a species database (e.g., for the Dipterocarps and endemic flora), which is based on information compiled from various sources such as the Sandakan Herbarium database (BRAHMS), GBIF (Global Biodiversity Information facility), scientific expedition voucher collections, various forest ecosystems survey and permanent sample plots established throughout Sabah. All cleaned data are digitized into spreadsheets using Microsoft EXCEL application.

2.2 Georeferencing Species Collection

Georeferencing is the process of assigning a latitude and longitude to points without GPS coordinates using the GBIF's standard protocols by using 1:50,000 topographic maps and Google Earth (Chapman & Wieczorek (eds.), 2006). Recent data collection came with reliable global geographical positioning information that is crucial for the species conservation assessment and also in the production of species distribution map. However, older specimens require georeferencing process to produce highly reliable global geographical position. There are two ways of georeferencing: 1) manual georeferencing requires human interpretations of site description and direct assigning coordinates using google earth and 2) use georeference calculator, a computer algorithms designed to estimate geographic coordinates. Online open source application were referred to acquire coordinates with error radius from online source (GeoLocate–<http://www.museum.tulane.edu/geolocate/web/webgeoref.aspx>.) and physical maps (Georeferencing Calculator – <http://manisnet.org/gci2.html>).

2.3 Regional Level Species Conservation Assessment

All reliable georeferenced-species data were used to calculate the extent of occurrences (EOO) and area of occupancy (AOO) using tools provided in GeoCAT (<http://geocat.kew.org/>). Subsequently, these data underwent reduction analysis by simulating removal of potential data that are considered to be lost or removed due to land use change to non-forest (agricultural, residential, urban development, mining, dam, etc.) or forest degradation due to wildfire or conversion to tree plantation. Through a series of quantitative criteria, the remaining species occurrences are assigned to one of nine Red List Categories based on currently available data on population trends, population size and structure, geographic range, habitat requirements and availability, and threats using the IUCN Red List Assessment Criteria and Categories (Version 3.1) (IUCN, 2012).

The methodology for the species conservation assessment presented here is the most current and has previously undergone many modifications. Previously, ENM (Ecological Niche Modelling), a method utilizing computer algorithm in predicting species distribution based on the species locality data and environmental information that have been previously entered into the system. The software Maxent 3.3.1 was used where environmental data such as soil, altitude, rainfall, temperature and precipitation are inserted into the program. The predicted distribution sites generated from ENM can be used as a means for ground truthing purposes. Hence, ENM can also aid in locating new populations that have not been recorded before (Khoo et al., 2011). It can also estimate habitat loss for conservation assessments by overlaying current land-use map (Maycock et al., 2013). The conservation status for the endemic, threatened and rare dipterocarps were initially assigned based on information obtained from ENM. However, in the last two years we have resorted to using GeoCAT with the Reduction Analysis option for all the species we are assessing.

3.0 HISTORY, ACHIEVEMENTS AND PROGRESS OF THE INITIATIVE

The onset of this initiative started in 2009 when the Department had a project funded by state funds under the 9th Malaysia Plan to devise genetic markers for the assessment of population genetic diversity of the Dipterocarp family in Sabah. This was done concurrently with the IUCN Dipterocarp Red List Assessment. The project's initial focus was the endemic (6 species) and rare dipterocarps of Sabah which later included all other dipterocarps occurring in Sabah.

Most of the initial field and assessment work was headed by Dr Colin Maycock who was attached to the University of Aberdeen, who then transferred to the Universiti Malaysia Sabah in 2013. Dr Maycock also initiated the compilation of the Checklist of Borneo plants and Sabah endemic plants database in 2012. To date, the database has recorded almost 8000 taxa of seed plants in Sabah with about 1057 taxa endemic to Sabah. This checklist is still expanding and much work is in progress.

Prior 2015, most of the assessments (including georeferencing) were done by Dr Maycock and researchers or research assistants from several sections of the Department. Also, this work was made possible through sporadic assistance or contributions from foreign volunteers and local or foreign students who were doing their post-graduate studies in the Department. This *ad hoc* working arrangement produced assessments at a slower rate. Post 2015, there was a significant contribution by student interns and local post-graduate students registered with the Universiti Malaysia Sabah, especially in the georeferencing procedures and this has shown a marked increase in the number of assessments completed. This is also due to more regular discussions being held with experts of the Department (Botanists, Ecologist and Conservationist) during the Reduction Analysis procedures and assignment of the conservation status of the species.

In the last one year, a priority list of species to be assessed, consisting 1315 species of various families, was put forward. This constitutes 16% of the total estimated number of seed plants that occur in Sabah. This list includes species that are Rare, Threatened and Endangered (RTE) with 228 species, RTE and Sabah Endemics with 49 species and also Sabah Endemics with 1057 species. As of 30 June 2018, a total of 125 species (9.5% of the priority list) have been assessed and 1.6% of the total estimated number of seed plants in Sabah. From the 125 species, 43 species are from the Dipterocarp family.

The data from the conservation assessments, done through the IUCN standard protocols could further be used with the application of Species Distribution Modelling (SDMs) which combines field data and environmental predictors to generate species habitat suitability maps across Sabah's landscape. The SDMs and heat maps (combination of SDMs) produced from this modelling will contribute to the state-wide HCV (High Conservation Value) initiative that the Department is undertaking and which will contribute to forest management and conservation of species.

In a time span of almost a decade, some achievements could be highlighted below:

3.1 Intensified Field Exploration of Dipterocarps Around Sabah

Participation in the scientific expeditions under the Heart of Borneo (HoB) project and Ramsar site expeditions organized by the Department and other expeditions organized by other agencies was to cite and locate dipterocarps in those expedition areas. In addition, specialized ground-truthing trips to locate populations of the rare and endemic dipterocarps were also carried out in the early years of the project.

Those organized trips led to new discoveries of dipterocarp species in areas that have not been encountered before. The rediscovery of keruing jarang, *Dipterocarpus lamellatus* in Siangau FR, Klias Peninsula in 2011 was a major discovery as the species was thought to be extinct. It was previously known from only two records, i.e., Beaufort Hill (1955) and Labuan (1951). Since then, no other record or sighting of the species has ever been mentioned until its rediscovery in 2011. Another species is keruing Ranau, *Dipterocarpus*

ochraceus, encountered in Sg. Bole, Ulu Segama in April 2017. The species was previously only known to occur in the Ranau district but after this new discovery, its distribution has extended to the Lahad Datu district. Work is currently underway to investigate the genetic differences between populations of this species in the different districts.

With the vast field work conducted, it was possible to monitor phenological observation for the Dipterocarp family in the event of flowering or mass flowering events, where fruits were harvested and raised for restoration purposes. A total of 5840 seedlings have so far been sent to various districts and forest reserves, e.g., Bukit Hampuan FR, Timimbang-Botitian FR, Ulu Segama-Malua FR etc. for restoration exercise (Lee et al., 2015). In 2015, one mature individual of *Dipterocarpus lamellatus* had bear fruits in Siangau FR and the fruits were collected and currently about 50 seedlings are thriving at the Forest Research Centre nursery.

3.2 Training and Workshops

Most of the training on the assessments were conducted in-house by Dr Colin Maycock as the main resource person. Trainings were done mainly in introducing the Ecological Niche Modelling (ENM) techniques and its application and also on the actual assessing of species based on IUCN protocols. A total of at least 5 trainings were done since 2012 until now at the Forest Research Centre. Some of the trainings also included actual assessment being done and written up for a particular group of plants, which were then reviewed by the internal experts. In 2018, two of the research officers from the Department attended the Indonesian Red List Training and Workshop held in Bogor, Indonesia. In the last one year or so, frequent discussions amongst Ecologist, Botanists and Conservationist were conducted, in particular, on the Reduction Analysis procedure in the GeoCAT tool, in order to assign the conservation status of the species.

3.3 Dissemination of Information Through Paper Publications and Presentations

Since 2009, there is a significant number of scientific papers published and presentations delivered locally and internationally. In terms of local publications, there were 6; oral presentations 11 and poster presentations 3. In international level, 4 papers have been published, and 9 oral and 3 poster presentations. The international papers were published in reputable scientific journals, i.e., *Biotropica*, *Journal of Forest Science*, and *Nature*, while the local publications include Proceedings of the Malaysian Forestry Conference and Compilation of Presentation – HoB Conference. For the oral presentations, these were presentations delivered during conferences, seminars, or workshops, meetings and also training course. Some of the oral presentations were delivered in the Flora Malesiana Symposium, Annual Meeting of the Association for Tropical Biology and Conservation (ATBC), and Meeting of the IUCN/SSC Global Tree Specialist Group.

Preparation for the publication of the first volume of the *Sabah Plant Red List: Dipterocarpaceae* is currently in the pipeline and expected to be published in the next one year.

3.4 Project Collaboration with Other Research Institutions or Universities

This initiative has also seen several collaborative research with other research institutions, particularly on molecular work that have been carried out with Aberdeen University (UK), *Eidgenössische Technische Hochschule Zürich* (ETH, Zurich, Switzerland), Forest Research Institute of Malaysia (FRIM, Malaysia) and Forestry and Forest Products Research Institute (FFPRI, Japan) on more common and widespread Dipterocarp species, and hence have produced many scientific reports (Lee et al., 2015). In 2015, the Department embarked on a research investigating fragmentation genetics on three species of dipterocarps, *Dipterocarpus ochraceus*, *Dipterocarpus lamellatus* and *Shorea kudatensis*, to understand how species specific patterns of pollen flow and mating are affected by the degree of isolation at multiple scales and how this affect the outcrossing rate. This research is done in collaboration with University of Aberdeen (UK), University of ETH (Switzerland) and Universiti Malaysia Sabah.

4.0 CHALLENGES

Although the Department has taken this initiative for almost a decade now, there are several challenges that the Department has to face. Two of the key challenges are:

4.1 Insufficient Trained Personnel

There is a lack of trained personnel at all levels in the project. The existing manpower for the coordinating work and also the expertise input in the “reduction analysis” procedure rely greatly on the senior research officers who are overladen with their own research programs and administrative work. In addition, there is no special unit within the Department that deals solely with conservation management issues, including conducting conservation assessments for the flora and fauna in Sabah. Currently, this initiative is under the auspices of the Herbarium with collaboration from several sections. In addition, existing manpower for undertaking georeferencing, which constitute the most time-consuming procedure in the assessment, rely mainly on postgraduate students and student interns who are stationed at the research centre for a short period of time.

Although getting the assessments done is the priority of the Department, monitoring of the species that have been assigned as threatened has also to be considered in the near future. This whole work procedure in a conservation programme, need full-time and sufficient manpower from various level of expertise in order for the programme to be successful.

4.2 Insufficient Funding

The project has been funded by state fund under the 9th and 10th Malaysia Plan for the last 6 years (2009–2015). The Federal fund that was channeled to the Heart of Borneo Project has also supported staff who are involved in the conservation assessment and who participated in the scientific expedition organized under the Heart of Borneo Project. In the recent years, due to competitiveness in sourcing out funds for more innovative projects, it has been difficult to get funders who support projects in fundamental plant sciences and conservation. One has to be creative and innovative in drawing up funding proposals to meet the current funding procedures. Funding is needed for employing staff to assist in the initiative and also for operational cost, such as for maintenance of equipments etc.

5.0 THE WAY FORWARD

With the current challenges and constraints faced by the Department, we are progressing at a slow rate. We have only assessed 9.5% of the total list of species that we have prioritized and 1.6% of the estimated total of seed plants occurring in Sabah. Nonetheless, we are confident that we will be able to produce the *Sabah Plant Red List: Dipterocarpaceae* in the near future.

The immediate step would be to address the key challenges of the Department. In terms of funding, initiative should be taken to source out local funds, e.g., the federal funds through the Ministry of Natural Resources and Environment or any other funds that are available to support staff employment. Currently, a small grant from BGCI (Botanical Gardens Conservation International, Kew, U.K.) is being negotiated for this year to fund the conservation assessment of tree species from Sabah for the Global Tree Assessment initiative led by BGCI and the IUCN/SSC Global Tree Specialist Group. However, efforts to source out long-term funding (at least for 5 years) should be a priority for the continuity of the initiative.

In terms of manpower, the short-term strategy would be to have continuous collaboration with local institutions, such as Universiti Malaysia Sabah and other local academic institutions to get assistance from student interns to help out mainly with the georeferencing procedures. As a long-term measure, permanent trained staff should be employed and a designated unit in the Department to handle the conservation programme.

The data obtained from this project can be utilized for the state-wide HCV initiative that would provide bigger outcomes i.e., (i) support the state plant species conservation programme, (ii) increase the conservation value of existing Totally Protected Areas (TPAs), (iii) efficiency in the implementation of best management practices in forest management unit that functions as production and conservation management areas and (iv) identify critically high conservation value habitats that require urgent conservation decision on landuse policy.

6.0 CONCLUSION

This project is vital in the Department, as it not only will contribute to the global Aichi Biodiversity Target 12, Strategic Goal C of the United Nation's Strategic Plan for Biodiversity 2011–2020 but also to the national and state commitments, i.e., National Policy on Biological Diversity 2016–2025 and Sabah Biodiversity Strategy 2011–2020, respectively. In addition, it will also contribute to the sustainable forest management, which is the goal of the Department. Lack of trained staff and funding have been identified as key challenges faced by the project and measures need to be taken to address these challenges. In spite of the challenges, the project has made some significant achievements that directly contribute to the plant species conservation programme in Sabah.

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PAPER 12: RESEARCH FOR INTENSIFIED MANAGEMENT OF BIO-RICH AREAS (RIMBA) OF SARAWAK

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Abstract

Research for Intensified Management of Bio-Rich Areas of Sarawak also known as RIMBA Sarawak was launched in August 2016. The objective is to provide a platform for international and regional researchers to carry out collaborative research. The findings from this research will be used for better management and conservation of the state's rich biodiversity. Four (4) Totally Protected Areas were selected as RIMBA sites namely; the Lanjak Entimau Wildlife Sanctuary (LEWS), Batang Ai National Park (BANP), Sebuyau National Park in Sarawak and Miri-Sibuti Coral Reef National Park (MSCRNP). To-date, RIMBA has collaborated with sixteen (16) renowned international and local institutions such as the Smithsonian Institutions (SI) the USA; Louisiana State University (LSU) the USA, National Institute of Environmental Studies (NIES) Japan, Hornbills Research Foundation (HRF) Thailand. Among the projects conducted are the Sarawak Hornbill Conservation Project (SHCP), Mammal Camera Trapping project and Birds Ecology and Bio-inventory. RIMBA Sarawak will highlight Sarawak's effort in conserving its biodiversity and at the same time contribute to capacity building of local researchers.

Keywords: RIMBA Sarawak, collaboration, conservation, Totally Protected Areas

1.0 BACKGROUND

Research for Intensified Management of Bio-rich Areas for Sarawak or RIMBA Sarawak was launched by the late former YAB Chief Minister Datuk Patinggi Tan Sri (Dr) Adenan Satem on 20th August 2015. The launching of RIMBA Sarawak marks the new scientific initiative and commitments by the Sarawak government to collaborate with international institutions to intensify the management of forest estate especially the Totally Protected Areas.

SARAWAK FORESTRY Corporation (SFC) being entrusted with the RIMBA Sarawak, has taken steps to implement and operationalize RIMBA using its own funding. The State Government, through Sarawak Forestry Corporation, has committed to the international institutions through the signing of Memorandum of Understanding (MoU) to provide a platform for scientific research collaboration in Totally Protected Areas in Sarawak.

2.0 OBJECTIVES

Three (3) objectives have been set by RIMBA to achieve its target: -

- i. To provide a platform for international collaborative research in developing intensive, practical conservation management procedures for bio-rich areas;
- ii. To provide trained scientist as well as scientific data for forest management certification; and
- iii. To showcase Sarawak's conservation efforts in the international arena.

3.0 SITES

Five (5) specific field sites have been selected for empirically guided and intensified research programmes for RIMBA projects. Each sites representing different ecosystems, hill dipterocarp forest, lower dipterocarp forest, mangrove and peat swamp forest and water bodies.

- i. Nanga Segerak, Lanjak-Entimau Wildlife Sanctuary (LEWS);
- ii. Nanga Bloh, Lanjak-Entimau Wildlife Sanctuary;
- iii. Nanga Delok, Batang Ai National Park (BANP);
- iv. Ulu Sebuyau National Park (USNP); and
- v. Miri-Sibuti Coral Reefs National Park (MSCRNP).



Map 1: Map showing the locality of the existing RIMBA site



Photo 1: Ng. Bloh station, LEWS, Ulu Katibas, Song. Photo taken by Nickson JR, SFC.



Photo 2: Ng. Segerak station, LEWS, Ulu Engkari, Lubok Antu. Photo taken by Nickson JR, SFC.



Photo 3: Ng. Lubang Baya station, BANP, Lubok Antu. Photo taken by Khairul Khuzaimah, SFC.



Photo 4: Temporary camp, USNP, Ulu Sebuyau. Photo taken by Tinna Wound, SFC.



4.0 OPERATING PRINCIPLES

RIMBA operates based on four (4) operating principles: -

- i. Institutions come on board RIMBA by invitation to conduct specific scientific studies at designated RIMBA sites;
- ii. All collaboration shall be formalized with simple MoUs;
- iii. All research project by the institutions are self-financial support; and
- iv. RIMBA will support in terms of local logistics.

5.0 AREA OF COLLABORATIONS

To ensure that both collaborated parties gained mutual benefits under this platform, RIMBA has specified its area of collaborations with the institutions as listed: -

- i. Collaboration in research projects to promote knowledge and management of flora and fauna of Sarawak;
- ii. Exchange of research materials, forms, documentation and other information;
- iii. Establishment of joint research programs and joint publications of research results;
- iv. Handling of specimens and ancillary materials associated with researches carried out;
- v. Enhancement of research competencies; and
- vi. Organising workshops, symposia, and other academic activities.

6.0 COLLABORATORS

Sixteen (16) Memorandum of Understanding (MoU) has been signed with international and national renowned institutions and agencies namely:-

- i. Smithsonian Institution of Washington D.C. (SI), USA;
- ii. Royal Botanical Garden of Edinburgh (RBGE), Scotland, UK;
- iii. Wildlife Conservation Society (WCS), New York, USA;
- iv. Louisiana State University (LSU), USA;
- v. University of Bristol (UB), UK;
- vi. Royal Ontario Museum (ROM), Canada;
- vii. New Mexico State University (NMSU), USA;
- viii. Van Hall Laurenstein University of Applied Science, Holland;
- ix. Spanish National Research Council (CSIC), Spanish Natural History Museum, Spain;
- x. Hornbill Research Foundation (HRF), Thailand;
- xi. National University of Singapore's Lee Kong Chian Museum of Natural History (LKC), Singapore;
- xii. Singapore Botanic Garden and Herbarium (SBGH), Singapore;
- xiii. National Park of Singapore (NPark), Singapore;
- xiv. Curtin University Sarawak Campus;
- xv. University Malaysia Sarawak (UNIMAS); and
- xvi. Grand Perfect (GP) Pusaka, Sarawak.

7.0 PROGRESS UPDATES

RIMBA has been implementing a number of research projects in most of its sites in reference to the approved research permit given by the authority:-

7.1 Short Terms Research Projects (Implemented)

- i. *Floral Diversity Survey* – a pilot study by Singapore Botanic Garden and Herbarium;
- ii. *Acoustic communication and tracking methods testing for population assessment of endangered crocodilians* – University of Bristol, United Kingdom;
- iii. *Site surveys and equipment testing for acoustic monitoring of anuran (frogs)* - Spanish National Research Council (CSIC), Spanish Natural History Museum, Spain; and
- iv. *Diversity study of vascular trees/assessment of the potential for the bio-indexing project* - National Institute of Environmental Studies (NIES), Japan.



Photo 6: Floral Diversity Survey by SBGH and RBGE in Ng. Segerak.
Photo taken by Roslina Ragai, SFC.



Photo 7: Acoustic Monitoring of Anuran by CSIC. Photo taken by Jenifer Sheridan, Yale-NUS.

7.2 Long-Term Research Project (On-Going)

- i. *Survey on Borneo Mammals (Camera trapping project) in LEWS - Smithsonian's Institution; Sarawak Hornbill Conservation Project - Hornbills Research Foundation, Thailand; Based line survey of Aquatic Organism in LEWS - Lee Kong Chian Natural History Museum, Singapore; Survey of the inland region of Sarawak for terrestrial mollusk in LEWS - Lee Kong Chian, Natural History Museum, Singapore; Survey and exploratory study on assassins bugs in LEWS - Lee Kong Chian, Natural History Museum, Singapore;*
- ii. *Botanical Survey in LEWS – Singapore Botanic Garden and Herbarium and Royal Botanic Garden Edinburgh, United Kingdom; Assassin's bugs (Hymenoptera) Study in LEWS - Royal Ontario Museum, Canada; Birds Ecology study in Sarawak - Louisiana State University, USA; Asian Forest Turtle Inventory in Sarawak - Smithsonian's Institution.*



Photo 8: RIMBA Field Assistant repairing the potential cavity of a hornbill nest, part of Sarawak Hornbill Conservation Project with HRF Thailand.

Photo taken by Tinna Wound, SFC.



Photo 9: Two (2) RIMBA Field Assistants setting up the camera trap for project with SI. Photo taken by Olivia Cosby, SI.

7.3 New Research Projects in the Pipeline

Evaluation of Project: Mapping the effects of Japanese logging on ecosystem services within local communities - University Tokyo, Japan; *Resource use study in fragmented forest, Bukit Kana & Bukit Arip, Bintulu* - National Institute of Environmental Studies, Japan; *Birds Bio-Inventory, Samarakan & Bukit Mina Wildlife Corridors, GP Pusaka* - Smithsonian's Institution (Birds Division); *Inventory of reptiles & amphibians in LEWS* - Smithsonian's Institution; *A Holocene Mulu Cave stalagmite molecular record of El Nino-controlled precipitation variability and its impact on cave microbial communities and regional vegetation* - Curtin University Sarawak Campus; *Microbial biodiversity, biogeochemical and biotechnological properties of Mulu Cave systems* - Curtin University Sarawak Campus.

8.0 EXPECTED OUTPUTS

RIMBA Sarawak is expected to catalyse Sarawak's conservation efforts by producing research outputs on: -

- i. A comprehensive database of credible and accurate scientific information on the status of flora and fauna in TPAs;
- ii. Effective strategies for managing our forest, especially the natural populations of endangered species within the bio-rich areas;
- iii. The next generation of trained scientist having the highest level of technical discipline and practical conservation management; and
- iv. Sarawak's conservation efforts being showcased in the international arena.

9.0 ACHIEVEMENTS

RIMBA Sarawak has gradually achieved most of its objectives especially in-terms of new research findings and publications. Capacity building to produced trained local scientist under the RIMBA Sarawak is progressing with numbers of trainings and series of talks to be organized and implemented. The preliminary achievements of RIMBA Sarawak are discussed below: -

9.1 New Research Findings

- i. 12 new Wild Life species (plants – Begonia, Hoya, ginger and orchid) discovered by a RIMBA team (SARAWAK FORESTRY and the Singapore Botanical Gardens). One of the Begonias, *Begonia jamilahanuiana* was named after the wife of the late former Chief Minister of Sarawak;
- ii. One new species of dragonfly, *Drepanosticta adenani* sp. nov. from the family of Platystictidae was discovered in Lanjak Entimau Wildlife Sanctuary by a group of researchers from various institutions and was later named after the late former Chief Minister of Sarawak; and
- iii. Three new genera of wasps (Hymenoptera) was described with two (2) new species of wasps (Hymenoptera), *Leucospis palungi* and *Monacon gawai* was discovered in Ng. Delok, Btg. Ai by Royal Ontario Museum.



Photo 10: *Begonia jamilahanuiana*, new species of *Begonia* discovered at Ng. Segerak, LEWS. Photo taken by Julia Sang, SFC.

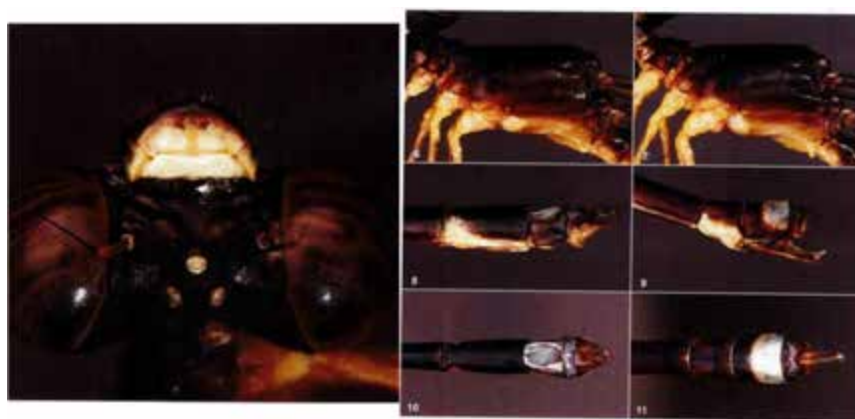


Photo 11: Combination photos of *Drepanosticta adenani* sp. newly discovered in LEWS. Photo by Rory Dow, Sarawak Museum.

9.2 Publications

- i. Publication of two (2) books reporting on Sarawak Plant Red List Series I & II with very significant findings for the timber trade and conservation planning in Sarawak, 2016;
- ii. *A preliminary forest survey of Lanjak-Entimau Wildlife Sanctuary and Batang Ai National Park in Sarawak* by SBGH, Gardenwise Magazine 2016;
- iii. *Six interesting plants encountered in Ng. Bloh of the Lanjak-Entimau Wildlife Sanctuary* by SBGH, Gardenwise Magazine 2017;
- iv. *Odonata of Lanjak Entimau Wildlife Sanctuary* by Rory et. al, 2018, Journal of International Dragonfly Fund, ISSN1435 3393 (print edition);
- v. *Lecanorchis sarawakensis* (Orchidaceae, Vanilloideae), a new mycoheterotrophic species from Sarawak, Borneo by NIES, 2018, Phytotaxa, ISSN 1179-3155 (print edition);
- vi. *Biodiversity conservation values of fragmented communally reserved forests, Managed by indigenous people, in a human-modified landscape in Borneo* by NIES & SFC, PLOS One, Online Journal 2018;
- vii. A poster on *Conservation Internship Program of RIMBA Sarawak* was displayed and presented during the 3rd NIES Symposium on Sustainable in January 2018, Kuala Lumpur; and

- viii. *Drepanosticta adenani* sp nov., from the Lanjak Entimau Wildlife Sanctuary in Sarawak (Odonata: Zygoptera: Platystictidae), Zootaxa, ISSN 1175-5326, 2018 by Rory & T Reels.

9.3 Capacity Buildings

- i. Conservation Internship Program (CIP) 2017 was completed on 14 January 2018. Fourteen (14) graduates were presented with Certificate of Completion. Currently, thirteen (13) were employed by timber industries as focal person to look into matters related to Forest Management Certification. The second batch of CIP was launched on 16 April 2018 with thirteen (13) interns undergoing a nine (9) months training program.
- ii. Sarawak Hornbill Conservation project:-
 - Three (3) Field Assistants (locally hired) were trained by Hornbill Research Foundation, Thailand in tree climbing, hornbill's nest survey, maintenance & repairing since April 2018.
 - One (1) SFC staff was sent to train on hornbill research & management in Khoa Yai National Park & Budo Sg. Padi National Park, Thailand, 12-24 May 2018.



Photo 12: A group photo of the International Hornbill Research Training in Thailand. Photo by Lily Sir, SFC.

- iii. Two (2) public talks organized on RIMBA updates:-
 - Louisiana State University, Dr. Alison Styrling - *Bird Diversity in Native Forests and Tree Plantations in Sarawak: What Different Survey Methods Tell Us*, 17 March 2018.
 - Royal Ontario Museum, Dr. Christopher Darling - *Discovering the Smallest Majority: What do we know about the parasitic wasps of Sarawak after a decade of field work and research?* 15 May 2018.



Photo 13: Dr. Alison Styrling of Louisiana State University, USA deliver her talk on Bird's ecology. Photo taken by SARAWAK FORESTRY.



Photo 14: Group photo with Dr. Christopher Darling from Royal Ontario Museum.

10.0 CHALLENGES AND GAPS

After three (3) years of its implementation, RIMBA Sarawak has identified some of the challenges and gaps that need to be addressed:-

- i. Lack of scientific data, especially the natural population of endangered species within the bio-rich areas;
- ii. Shortage of expertise for flora and fauna conservation practices;
- iii. Negative perception by international NGOs especially on the state's effort to protect and conserve the wildlife habitats and ecosystem; and
- iv. Research expertise required in Permanent Sample Plot (PSP) establishment and data analysis on growth and yield modeling, biodiversity indexing, canopy indexing, cryopreservation of genetic resources, innovative design and development of value-added forest products, wood drying technology and studies on zoonotic diseases.

11.0 WAY FORWARD

Since its launching in 2015, RIMBA Sarawak has proven to be an effective platform for collaborative scientific research and discovery. Despite many gaps and challenges that need to be overcome by RIMBA, a number of interesting and encouraging new research findings have been recorded since its implementation. Hence, an indication of the numbers of new species yet to be discovered and waiting to be discovered through this project.

RIMBA Sarawak has also contributed to the capacity building of local expertise through the implementation of Conservation Internship Program, international training, on-job training by the international scientist, etc. As at to-date, RIMBA Sarawak can proudly mention that the state now has expertise being trained on hornbill research.

Sarawak is now being showcased as one of the states in Malaysia that is serious in conserving and protecting its bio-rich areas through the collaboration of research projects with renowned international institutions, international and national level conferences, publications, etc.

As a way forward, RIMBA Sarawak will continue to collaborate with international scientific institutions and to seek help to address the gaps and challenges in conserving the state's bio-rich areas.

Also, in supporting the state's move on data sharing, some of the published data has been deposited and updated in the Sarawak Big Data.

Sub Theme 4:

Plantation Forestry/Industrial Forest:
Sustainable Wood Production and Wood Based
Industry

**PAPER 13: PLANTED FOREST RESEARCH PROGRAM TOWARDS
VIALE INDUSTRIAL FOREST ESTABLISHMENT IN SARAWAK**

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Abstract

Sarawak has targeted to establish one million hectares of industrial forest (IF) by 2020. As of December 2017, only 400,000 hectares have been planted. Most of the IF have been established on a 'trial and error' basis based on R&D findings carried out individually by Licenced Planted Forest (LPF) holders or by adopting practices from other countries. It has been observed that industry does not know what species to plant, where and how to plant, hence resulting in high mortality rate and low productivity of about 90 m³ per hectare. The lack of R&D findings and support had been identified as one of the critical impediments. As such, SARAWAK FORESTRY with funding from the State has embarked on R&D project namely, High Quality Planting Materials (HQPM) and Planted Forest Research Program (PFRP) to fast track R&D to provide support to the industry. To date, shortage of HQPM has been addressed. State-wide establishment of taxa and progeny trials has been established under PFRP with the objective to show the industry that IF is economically viable with the site-species matching, good silvicultural practices and proper management in place. This paper will highlight the progress and results of the PRFP, issues and challenges and the way forward.

Keywords: Industrial Forest, Licensed Planted Forest, High Quality Planting Materials, Planted Forest Research Program

1.0 INTRODUCTION

Sarawak Government has set a target to establish one million hectares of Industrial Forest (forest plantation / planted forest) by the year 2020. As of 31 December 2017, 42 Licence for Planted Forests (LPFs) has been issued with plantable areas of 1,308,531 ha hectares. To date, the total area planted is about 400,000 hectares. The main species planted are Acacia, Batai, Kelampayan, and Eucalyptus.

Industrial forest (IF) is an essential component in the strategic development plan to ensure sustainable forest management policies are achieved in Sarawak. It is a long-term strategy to supplement timber production for wood-based industries of Sarawak. In addition, it will relieve pressure from natural forests. Timber productivity of the planted forests which is 25-30 m³/ha/yr is very high as compared to the natural forests which is only 2.0-2.5 m³/ha/yr. Therefore, if we can achieve a million ha of forest planation, an estimated annual production of 10-15 million m³ of timber could be realized and this is sufficient to cater for the industry needs. Simultaneously, there would be less harvesting pressure on the natural forests and hence the protection and conservation functions of the natural forests could be enhanced.

The target of 1 million ha of industrial forest is definitely not achievable by 2020. Many reasons were given by LPFs for the slow establishment of IF. Among these reasons are land disputes, shortage of labour, lack of high quality planting materials, lack of R&D support and others. In order to address the issue of shortage of high quantity planting materials (HQPM),

Sarawak Forestry Corporation was given a R&D grant of RM 4.5 million by the State Government to carry out a project entitled 'High Quality Planting Materials For Forest Plantation In Sarawak' from 2014 to 2015. The project had been completed and we are now able to supply or source-match HQPM for the above four plantation species to LPFs upon request.

This project was continued in RMKe-11 since 2016 with an approved budget of RM 10 million under the 'Planted Forest Research Program (PFRP)' with an extended scope. This project is designed to address issues pertaining to R&D that are faced by the LPF holders. Among these are, the uncertainty and lack of knowledge on what species to be planted, unsure of what are the proper plantation management, absence of improved planting materials that would perform best under local condition, and inability to predict volume production from planted forests in Sarawak.

This program is a collaborative program with MoUs signed between SARAWAK FORESTRY and 11 Licensed Planted Forest holders. PFRP is a shared R&D program that focusing on establishment of planted forests besides to be in track with research development to support timber industry. In conjunction, it aims to achieve same main objectives which is to improve the productivity of planted forests in Sarawak through development of improved germplasm and the best practices of forest plantation for the species of interest.

1.1 Program Focus

The PFRP covers various field of forest plantation research; mainly tree breeding and others such as forest management, tree health and data management. The four main species of interest are *Eucalyptus pellita*, *Acacia mangium*, *Falcataria moluccana* and *Neolamarkia cadamba*. In aiming to overcome the shortage of high quality planting materials of these species, the tree breeding component under this program has embarked on significant activities in establishing research trials across Sarawak regions. In addition, there are research have been outlined to support the R&D program such as to establish of good silvicultural practices, state-wide pest and disease monitoring, and wood property studies.

The research program was outlined to deliver long-term objectives:

- Selection of best species and clones which suited to sites;
- Develop improved planting materials;
- Determine and recommend best silviculture practices; and
- Address pests and disease occurrence.

In extension, this program aims to establish tree breeding platform by establishment of tree improvement orchards; such as seedlings seed orchards and clonal seed orchards. As a way forward, this on-going project has high potential in research value and prospects of R&D, particularly through the implementation of tree breeding roadmap.

1.2 Research Approaches

The PFRP has significantly established a state-wide taxa and progeny research trial plots, which amounting to over 60 research trials for these four species. The taxa trials were established to investigate the potential of seed-bulk attained for each species on local conditions. It is also aiming to have greater understandings on the site requirements based

on the growth performances for the species of interest, knowing that different species would prefer dissimilar site conditions. Seed Production Area (SPA) can be developed from these trials for commercial deployment which then become beneficial for the industry as their resource of seeds locally.

Further to this program, progeny trial plots were likewise being established at local conditions representing many known individual stand from other tree improvement program of other countries. Seedlings Seed Orchards (SSO) can be developed from these progeny trials through selections of best performing individual progenies. This program meaningfully forms proper tree improvement foundation for industry through the development of tree breeding activities.

2.0 MATERIALS AND METHODS

2.1 Industry Collaborations

The program provides platform for research collaboration with industry players, the License for Planted Forest (LPF) holders to expedite the establishment and development of research trials. Technical Committee, comprised of representatives from each participating organization was formed to interact where progress and knowledge can be shared.

The companies that agreed to participate in the program are:

- Polima;
- Limba Jaya;
- ZedTee;
- Billion Venture;
- Jaya Tiasa;
- Subur Tiasa;
- Tanjong Manis;
- Samling;
- Ta Ann;
- WTK; and
- Shin Yang.

2.2 Seed Sources

Under this research program, various seed sources of difference provenances were obtained from other commercial seed orchards on each species of interest from various countries including China, Australia, Vietnam, Indonesia, and Philippines. The seed sources comprised of both improved and unimproved materials; which some represent commercial orchards. Once received, these seeds were registered and stored appropriately at Seed Laboratory of Forest Tree Seed Bank, Semenggoh Kuching.

Taxa-seed sources trial plots that have been established are represented by bulk seedlots of 16 *Acacia mangium*, 19 *Eucalyptus pellita*, 22 *Falcataria moluccana* and 5 *Neolamarkia cadamba*. Bulk seedlot for *N. cadamba* were attained from natural environment in different areas in Sarawak.

Progeny trials were established to field-testing on genetic materials representing various families for *E. pellita* and *F. moluccana* at local condition. Thus far, approximately a total of 170 *E. pellita* and 290 *F. moluccana* seedlots established in progeny trials across sites.

Germination count of seeds sown was needed to determine the estimation of trial size and only plant-able count of seedlings used in generating the trial planting design. These seedlings were prepared by properly packing them out in the nursery according to the design prior to planting activity. Ready-to-be planted seedlings were labelled and trays were arranged accordingly.

2.3 Trial Establishment

The preferable and suitable sites selected must be accessible and sufficient area for planting including buffer zones. These sites were those with sufficient area for planting including for buffer zones, minimum soil compaction and disturbances during the land preparation and contained layer of organic materials. It should have a suitable litter layer, limited skid trails and minimal soil compaction or disturbances by harvesting equipment.

In addition, the site must with good drainage, not excessively deficient in nutrients and are free from water logged areas. Intensive site preparation that contribute to soil disturbances and mixing of soil layers can affect the site productivity in a long-term (Smith, Little, & Norris, 2013). Soil compaction itself typically alters the soil structure and hydrology and may cause physiological dysfunctions in plants, thus reduced the absorption of major mineral nutrients (Kozlowski, 1999). In considering that there would be possibility of unsuitable areas where seedlings should not be planted, therefore larger total area needed, at approximately twice the proposed trial size. Seedlings were planted at as far as possible from skidded trails and extraction routes.

Site debris was broken down and all weeds were sprayed with a recommended herbicide prior to planting. The areas within the site which are suitable to accommodate the trial were determined. The planting lines were 3 m apart and each planting point was marked out every 3 m in straight rows. Then, an assessment of the total number of suitable planting points was conducted, and the positioning of all skid trails and other unsuitable areas were mapped. Trial replications were positioned across the slope and between skid trails or away from other obstacles as far as possible. Individual plots were run down the slope. Subsequently, the trial layout was marked out in the field and the final positioning of the trial was confirmed.

Planting operation has great effects on survival and tree growth. Therefore, planting activities were carried out in accordance to establishing research trials guideline. A proper pitting tool was needed to make planting holes. The planting holes were prepared as 25 cm deep and 30 cm wide. In addition, all planting spots were avoided from a compacted area, skidded track or near any stumps. On the other hand, planting materials were screened to ensure only healthy and plant-able seedlings for planting; with 20-25 cm tall and root collar diameter of 3-4mm. These seedlings, which representing each treatment, were planted at the planting pits in accordance to the trial design. Most of bulk seed-lots in taxa-seed source trial plots were represented by 35-40 seedlings at planting. These seedlings were established in 5 trees per row in each plots and the research design were replicated at least 6 replications.

Fertilizer then was applied immediately after planting. The fertiliser should be in a granular water-soluble form as it able to supply nutrients over a short period when it is needed at the early stages of seedlings growth. Application was placed around each seedling, or on opposite sides of the seedling, at a distance approximately 20 cm from the seedling stem. Dead seedlings were replaced at least 2-weeks after planting. A durable peg was placed at the first tree of each plot with a label indicating the treatment details. Later, a trial sign board was erected at the roadside displaying the trial number, location, planting date and type within one month from planting. All established trials were maintained from weeds competition as possible through chemically weed-control using herbicide in every three months for the first year or longer if needed. Weed-control maintenance is crucial especially within the first year of planting.

2.4 Trial Design

The experimental designs provide a structure in which different treatments can be arranged to compare their performance. The tested materials for taxa-seed source trials representing treatments of bulk seed sourced from various provenances. A randomised complete block design (RCB) is used for designing small trial size such as taxa-seed source trials. The RCB contains all the treatments with at least 20 healthy trees randomized and established as plots; blocks were replicated at least 6-8 replicates across the site. In most cases, treatments were represented by 30-40 seedlings in each trial at planting. The progeny trials established using a randomised incomplete block design which refers to a design where sub-set of treatments involved has been grouped into smaller blocks within the replications. This is a preferable design as a progeny trial involves testing of many families thus to be planted at sites which are highly variable.

2.5 Trial Assessments

The trial was documented in electronic and hard-copy format. An information file, containing the details of each trial such as planting date, treatment list, objectives, maps, layout and others was available immediately after establishment. Besides, an assessment sheets, in which survival and growth data, and any other information that should be recorded, were generated. Finally, an annual plan of operations was documented for each trial.

A survival assessment was performed approximately at 10-days after planting and those dead seedlings were replaced during the survival assessment. Trees were then measured for height growth at age 6 months after planting. Subsequently, assessments of 1-year age were carried out for tree height and diameter growth; and tree volumes were calculated. In 2-year of tree age, assessments were conducted for tree growth, appearances, and wood quality. Each assessment was incorporated with any additional remarks on tree stand observation such as pest and disease occurrence, soil condition, nutritional deficiencies, and others. These additional information is essential to understand the reason of measured tree growth.

3.0 RESULTS

3.1 Total Trials Established

There are 61 trials established for the four species; comprises of 48 taxa-seed source trials and 13 progeny trials. The distribution of these two type of trials for four species across Sarawak is illustrated in Figure 1. It is worth to note that there are two on-going of *A. mangium* Seed Production Area (SPA) which have been initiated from taxa-seed source trials. Taxa-seed source trials were intentionally established at a near proximity for each species so that an elementary comparison on performances between species at similar sites can be evaluated.



Fig. 1: State-wide distribution of taxa-seed source and progeny trials for 4 species

3.2 Data Analysis

Data collected for each trial was analysed using statistical software package Statgraphics Centurion version 17 (Statpoint Technologies, 2014). A general linear model was used to analyse the variation between and within treatments; considering the data was unbalanced with reason that not all treatments represented by same number of trees across sites. Treatments were selected as random effect while replications as the fixed effect. Trial means were presented as least square means; prediction value based on the performance of the other trees representing the same treatments.

In this paper, only taxa-seed source research plots which have been assessed for 2-year and with sufficient representation of treatments across sites for each species were analysed. Trials which not yet reaching 2-year are excluded from analysis. Differently for *N. cadamba* trials as this species has been planted with limited scale and were not planted at all sites. This with reason that *N. cadamba* is known as site specific and the mortality rate assessed on trials established is considerably high at early growth.

3.3 Species Survival Performance

The mean survival performance for each species of trial established is essential in evaluating the stocking of trees planted. The survival performance also resolves as

reliable indicator of any issues during establishment and maintenance of trials. Survival assessments were conducted after 10-days of planting and trees were scored as either dead or alive. Percentage mean survival of each species over time at different trial sites is summarized in Table 2.

Table 2: Percentage (%) mean survival of each species over time across different sites.

	<i>A. mangium</i>				<i>E. pellita</i>				<i>F. moluccana</i>				<i>N. cadamba</i>			
	Planted	6-mths	1 yr	2yr	Planted	6-mths	1 yr	2yr	Planted	6-mths	1 yr	2yr	Planted	6-mths	1 yr	2yr
Site 1	420	73%	66%	59%	140	86%	86%	86%	207	76%	74%	74%	250	86%	82%	58%
Site 2	270	74%	70%	68%	252	94%	83%	74%	70	79%	74%	73%	-	-	-	-
Site 3	405	67%	61%	45%	220	94%	88%	75%	229	55%	46%	45%	200	80%	76%	48%
Site 4	465	77%	67%	63%	380	88%	79%	75%	280	40%	37%	35%	125	93%	86%	82%
Site 5	470	93%	87%	81%	172	74%	47%	47%	240	84%	84%	84%	200	82%	48%	48%
Site 6	415	85%	84%	68%	330	99%	99%	92%	245	69%	69%	67%	200	99%	%	76%
Site 7	240	88%	88%	86%	210	98%	93%	78%	180	78%	78%	78%	-	-	-	-
	2685	80%	75%	67%	1704	90%	82%	75%	1451	69%	66%	65%	975	88%	73%	62%

Overall survival performance of *A. mangium* is declining gradually over time at most sites, with mean survival only 67% at age 2-year. Similarly to *F. moluccana* with mean survival percentage across 7 sites of 65% at age 2-year. While the percentage mean survival for *E. pellita* is better compared to those two species, which was 82% in 1-year and 75% in 2-year. Thus, this indicates that *E. pellita* is more productive compared to the other two species due to better stocking. Based on the survival percentage trend between *A. mangium* and *F. moluccana*, be predicted that *A. mangium* have the possibility to contribute far worse stocking in several years from now. *N. cadamba* performed an uneven survival rate across different sites, which could be due to its highly site-specific characteristic where poorest mean survival at 2-year for trial established at 2 sites. Furthermore, one trial established at peat condition had resulted the worst survival rate, which was less than 5% at 6-month and thus trial was discontinued.

3.4 Species Growth Performance

Early growth performance, based on 2-year assessment demonstrated amomentous preliminary findings. A cross-site analysis shows different growth response towards different sites for each species, Table 3.

Table 3: Mean of 2-year height growth (m) for four species across seven sites in Sarawak.

Treatments that do not share a common letter (at each assessment age) are significantly different.

	<i>A. mangium</i>	<i>E. pellita</i>	<i>F. moluccana</i>	<i>N. cadamba</i>	Mean	
Site 2	13.1	11.6	10.8	-	11.8	F
Site 1	12.5	11.3	9.8	10.0	11.2	D
Site 4	11.0	11.4	14.3	8.2	12.2	E
Site 5	12.1	8.6	11.8	3.6	10.8	D
Site 7	10.2	7.6	8.4	-	8.7	B
Site 3	9.6	7.7	12.4	6.8	9.9	B
Site 6	8.6	5.2	4.9	3.5	6.2	A
Mean	11.0	9.1	10.3	6.4		

In comparison across the seven sites, *A. mangium* with its mean 2-year height growth of 11.0m seems to perform better than *E. pellita* and *F. moluccana*, 9.1m and 10.3m respectively. In species comparison, the mean growth of trials for three species established at Site 4, Site 2 and Site 1 offered highest ranking in trials mean; exceeded

11m. Table shows the lowest rank derived from Site 6, with only 6.2m in average which indicates the possibility of poorest site.

On the best site, *F. moluccana* appeared to outperform *A. mangium* while on poorest site both *E. pellita* and *F. moluccana* performed poorer than *Acacia* species. *E. pellita*, and particularly *F. moluccana* are highly sensitive to changes of site conditions. This can be understood by the variation in 2-year height growth for trees representing each species across seven sites illustrated in Figure 2.

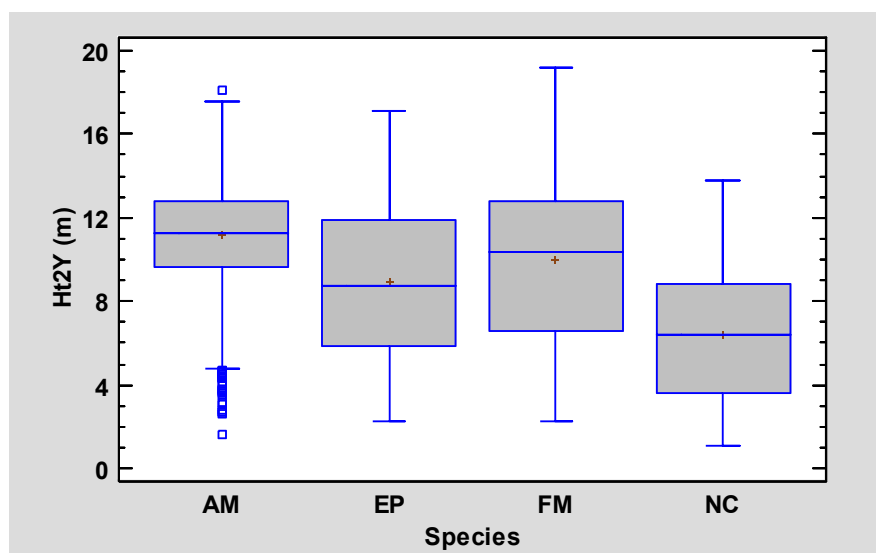


Fig. 2: Box-and-Whisker plot for tree height (m) at 2-year for each species

On many sites, *A. mangium* demonstrated an increase in 2-year height, with highest at Site 1 and Site 2 among species tested. However, the survival of this species at these sites had performed the lowest survival performance and thus poor stocking indeed influence the overall productivity. The understocked stands due to tree mortality will affect the individual tree sizes and growth rate and consequently the stand yield. In contrast, the increase of stocking can lead to an increase in productivity in forest stands (Reyes-Hernandez & Comeau, 2015).

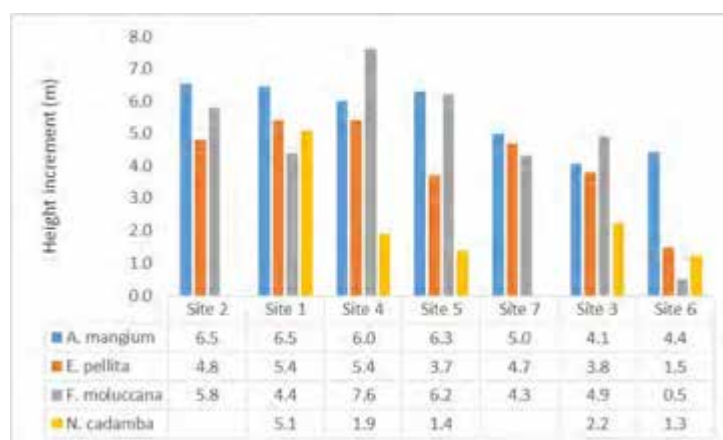


Fig. 3: Species-site and height increment (m) for four species across sites

The influence of sites on species and height increment at 2-year for the four species is illustrated in Figure 3. It is clear that growth performance for each species is dependant over the site variable. Generally, different site composed different soil conditions and nutrients composition. Each species indicates height growth across sites where *F. moluccana* performed the highest increment at Site 4 but the lowest at Site 6. Another evidence showing that *F. moluccana* is highly sensitive on site conditions and thus represented high variation on heights. Although *E. pellita* showed lower increment when compared to *F. moluccana*, it does indicate almost similar sensitivity towards poorest site. Unlike *A. mangium*, the species performed almost uniform across different sites. *N. cadamba* was not completely tested across all sites, therefore result for this species restricted to only five sites. However, the height increment for *N. cadamba* performed worst amongst other species.

Diameter of tree trunk was also measured at breast height level during the assessment. This is another method of measuring tree dimension apart from tree height as growth monitoring of standing trees. The DBH measurement has been taken into consideration on other studies for its relationship with tree crown radius, crown densities, spacing, stocking relationships, and volume estimations (Lockhart, Weih, & Smith, 2005). The ratio between height and diameter have also been used to predict the stability relationship against natural damage such as wind and storm (Wonn, 2001).

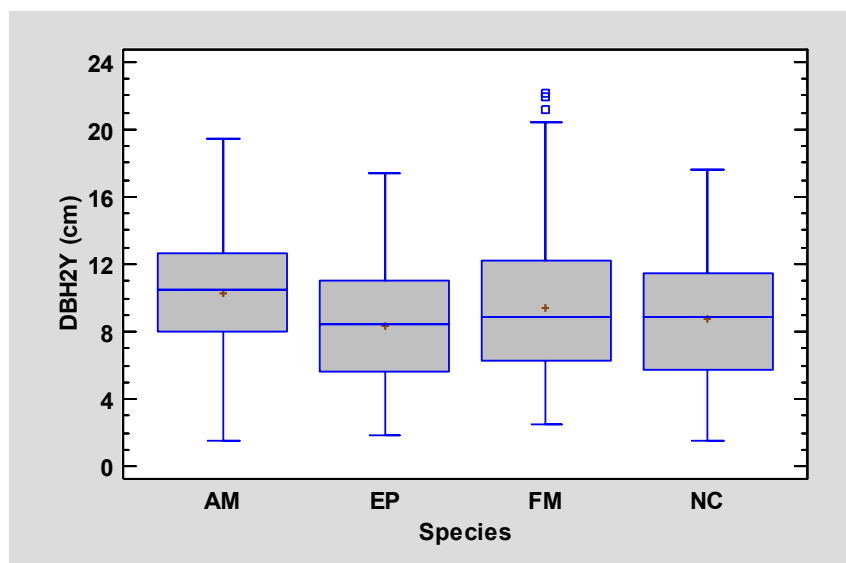


Fig. 3: Box-and-Whisker plot for tree DBH (cm) at 2-year for each species

The observed mean diameter at 2-year for all species were in range of 8.3cm to 10.2cm in Figure 3. The mean average DBH are statistically different from each species with *A. mangium* ranked top (10.2cm) and *E. pellita* smallest (8.3cm). However, *E. pellita* represent lowest range of variation as indicated by top and bottom lines of widest and thinnest diameter. In contrast, *F. moluccana* represent highest range of variation in diameter at 2-year.

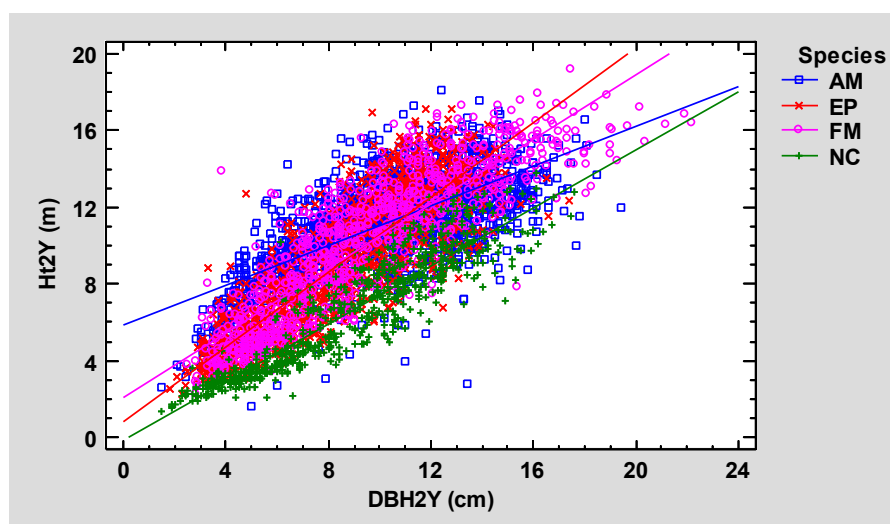


Fig. 4: Linear relationship between stem diameter and tree height of four species.

The relationship between stem diameter and tree height for all stands of four species was linear. The increase in height growth is relative to stem diameter growth shown in Fig. 4.

3.5 Documentation on Manuals / Guidelines

This program has successfully developed significant documentations on Standard of Procedure (SOPs) pertaining planted forests which covering various aspects such as nursery practices, silviculture, research trial establishment, and many others. These SOPs in Table 4 were documented and disseminated to the collaborative partners, the LPFs as guide and reference.

Table 4: Documentation of Standard of Procedure under PFRP.

Field / Area	Title of Standard Operating Practice
Nursery	Guidelines to Produce Good Quality Seedlings in Sarawak Raising Seedlings for Research trials under the Planted Forest Research Program
Trial establishment	Establishing Research Trials under the Planted Forests Research Program Trial assessment guidelines Guidelines to design and layout trials under Planted Forests Research Program
Silviculture and Fertilizer	A review of nutritional requirements for <i>Eucalyptus pellita</i> Silviculture guidelines to establish seedlings in Sarawak
Pests and Diseases	Field guide to identify pests of Eucalyptus Guidelines to service insect traps and collect and store specimens Guidelines to detect and monitor Pests and Diseases in Planted Forests
Grafting	Guidelines to graft research material under the Planted Forests Research Program
Growth and Yield	Growth and Yield Manual for Planted Forests in Sarawak

4.0 DISCUSSION

The preliminary results of each species performance across sites has shown an early indication that some species performed better than others at different sites at 2-year. This means, species that performed well at which site can be described accordingly; and vice versa another species can be recommended as alternative species for the same site. Additionally, survival factor is an important assessment to be continued in order to note the mortality rate over time and species productivity at each sites. Knowing that sites variability has great influence over the species performance, therefore a depth understanding of soils at each sites is essential.

In time, a comprehensive land capability study covering each sites should be the priority in providing broad information prior finalizing most suitable species to be planted on local condition. Relatively, incorporation of alternatives species development such as *A. crassicarpa*, *A. auriculiformis*, *E. brassiana*, and others should be embarked to evaluate the species prospective on different site condition.

Field operations in trial establishment and maintenance should remain as highest quality as possible and this includes planting materials. Monitoring and assessment should be continued until trials at age 5-year to achieve conclusive outputs such as choosing the right sources for operational deployment, development of tree breeding orchards, wood property, pest and disease monitoring, species productivity value, and other valuable findings.

5.0 ISSUES AND CHALLENGES

PFRP is a long term R&D project and the success of the project will certainly contribute to the success of industrial forest establishment in Sarawak. There are many issues and challenges faced by this project, both at management level and technical.

Among issues and challenges at management level are:

- Sustainable source of project funding. This project is funded by the State Government until 2020 and funding may not be available beyond 2020;
- Change of direction and priority. The change of government policies on industrial forest will affect the funding and priority of R&D;
- Lack of local expertise and interest towards research; and
- Change of species of interest.

Some issues and challenges at technical level are:

- Site variation and suitability;
- Logistical arrangements;
- Lack of technical staff;
- Poor weed control at post-planting;
- Pests and disease; and
- Nutrients deficiency and toxicity.

6.0 CONCLUSION

Log production from natural forest will stable at about 3 million m³ from 2020. The shortfall of raw materials for timber industry in Sarawak with an operating capacity of 12 million m³ must be coming from industrial forest. LPFs must accelerate their planting so that the issue of lack of raw materials can be addressed. However, industrial forest establishment is a long term and huge investment. LPFs will only continue to plant if industrial forest is economically viable. his can only be achieved through applied R&D project such as PFRP. We hope that the government will continue to support this project.

7.0 ACKNOWLEDGEMENT

First and foremost, we would like to express our gratitude for funding support granted by State government to develop and implement the project under Planted Forest Research Program (PFRP). We also would like to acknowledge an appreciation to Dr. Richard Glen Mitchell, as the founder of the Planted Forest Research Program, thus for initiating and implementing the research plan for the program. We are highly grateful to the management and field representatives of Licence for Planted Forest (LPFs) as research collaborators for their commitments and great hospitalities. Moreover, we are also very thankful to our dedicated colleagues who are very much involve with the development of this program, particularly for their great support in fieldwork.

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**PAPER 14: FOREST PLANTATIONS AND THE NEED FOR
DEMONSTRATION PLOTS FOR LOCAL TIMBER SPECIES IN SABAH**

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Abstract

Timber plantation establishment is not a foreign concept in Sabah, with some of the plantation species trials set up as far back as the 1920s. Since then although plantations have been established on the greater part of the Eastern side of Sabah, much of the preferred plantation species are generally dominated by exotics species such as *Acacia mangium*, *Falcataria moluccana* and just recently *Eucalyptus pellita*, *Eucalyptus* hybrids and etc. Undeniably, these species are fast growing; short rotation and have a strong adaptation to local environmental conditions. However, one of the short falls of these species is it's resistance to local pests and diseases. In 2012, with the emergence of a wide spread attack by the plant pathogen 'Ceratocystis spp.' on acacia plantations, much of the planted areas in Sabah were replanted with *E. pellita* or *E.* hybrid in an effort to minimize the financial damage caused by the lost of *Acacia* plantations. The incident has also generated greater interest in the suggestion of using native species such as *Octomeles sumatrana*, *Terminalia copelandii* and *Neolamarckia cadamba* for plantation establishment. Under the 11th Malaysia Plan Federal funding, a 5 hectare demonstration site has been set up for some of the native species to enhance the preliminary studies conducted previously in other areas on the following species aspects: site adaptability; germination and nursery requirements; planting and tending techniques; growth performance and fertilization regime. Initial results have shown that aside from being fast growing, post one year plant establishment, the native species have great potentials to be utilized in the plywood and veneer industry.

1.0 INTRODUCTION

For the past decade, the State has managed to expand the hectarage of Totally Protected Areas (TPAs) from a mere 12% in 2007 to 26% (1,906,896.20 ha) of our total land mass, with the vision of meeting the State's target of having 30% of the land area classified as TPAs. This vision has brought to light some of the challenges and potential opportunities to the forestry sector, especially in the plantation industry. Since the 1960s, timber production from natural forest has been one of the primary contributors to the State's economy, however, this supply is not an inexhaustible. A study of the past decade trend of log production (*Fig.1*) shows that although at one point in time, log volume production from natural forests managed to stay within an average of 5 million cubic meter in the 2000s, the supply was greatly reduced to an average of 2 million cubic meter per annum post 2011. Therefore, with more forest reserves classified as TPAs, the continual decline of timber supply from such sources is inevitable. This presents a challenge to the forestry sector in addressing the growing need for raw material supply in face of the growing global population, but as mentioned it is also an opportunity to look towards the plantation industry in maximizing plantation production and processing efficiency.

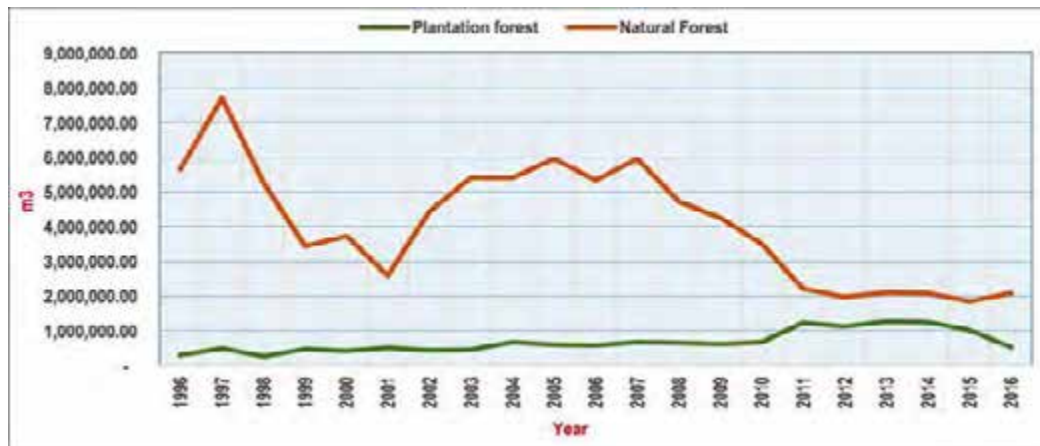


Fig. 1: Log Production Trend. Adapted from “Forest Industries and Statistics”, by Sabah Forestry Department’s 2016 Annual Report.

2.0 PLANTATION IN SABAH

Timber plantation is not a foreign concept in Sabah, the earliest recorded planting trial was in the 1920s. Although not at a large scale, the initial experimental planting of teak during that time, could be due the general economic depression that was experienced in the American continent that lead to the plunge of tobacco demands, therefore rendering local tobacco to carry out trials seeking for an alternative commodity.

Large scales commercial plantations came into the scene in the 1970s, prior to that a number of species demonstration and progeny trials were conducted (Ibbotson. R, 2014). All these while, the preferred species for large scale plantations are usually exotics species such as *Acacia mangium* and *Falcataria moluccana*. This general preference for exotic species over native species is a direct result of the extensive research that has been done in areas of: site establishment requirement; inter rotation management requirements; silvicultural management; tree improvement; availability of planting material and etc.

The Eucalyptus group was not greatly utilized as planting trials conducted in 1970s showed that in comparison to the other exotic species, it has a much slower growth and at the early onset of commercial plantation, planting this group was not economically viable. Around 2012, species from this group is once again utilized in the State’s plantation scene. The group’s increasing popularity as a plantation species is due to the fungal outbreak of “*Ceratocystis* spp.” in acacia plantations that lead to dieback incidences caused by vascular wilts, such incidences seems to be prevalent in younger stands (Maid and Wickeswari, 2014). In order to curb potential financial losses due to diebacks, some of the acacia plantations were cut down and replanted with Eucalyptus. Aside from that, much studies has been undertaken in terms of tree breeding and plantation management routine in enhancing productivity thus making it one of current favoured plantation species.

3.0 OPPORTUNITIES IN PLANTATION

Sabah State has set aside 670,000 ha of its land mass for plantation forestry. For the last decade, the plantation log production has rarely produced more than 100,000m³ and maintained an average of 84,000m³ per year. Several factors could have contributed to this scenario:

1. Over dependence on natural forests for logs production; and
2. Existence of research gaps in plantation silviculture management especially in that of the lesser known plantation species.

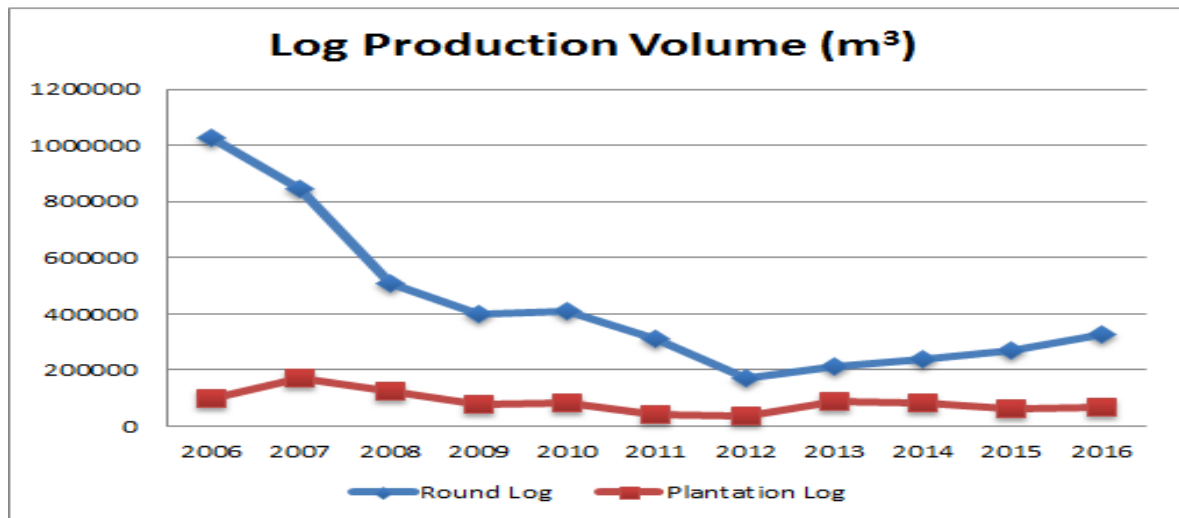


Fig. 2: Comparison of log production volume (m³) from natural forest and plantation sites.

In any form of investments, the 3 economic elements to be considered are reward; risks; and time. For the State to maximize its tree plantations efficiency in order to be rewarded in the shortest time, yet reducing the risks involved, the key would be “Plantation Sustainability”. There is a need for sustainability within this industry as this is a high risks business investment. Even if we factor out the rise/fall in demand due to buyers preference or market price fluctuation for the various timber product due to lack of/ saturation of the supply market (*Fig. 3*), there is still the potential investment risks leading to heavy financial losses that can be caused by either biotic or abiotic factors.

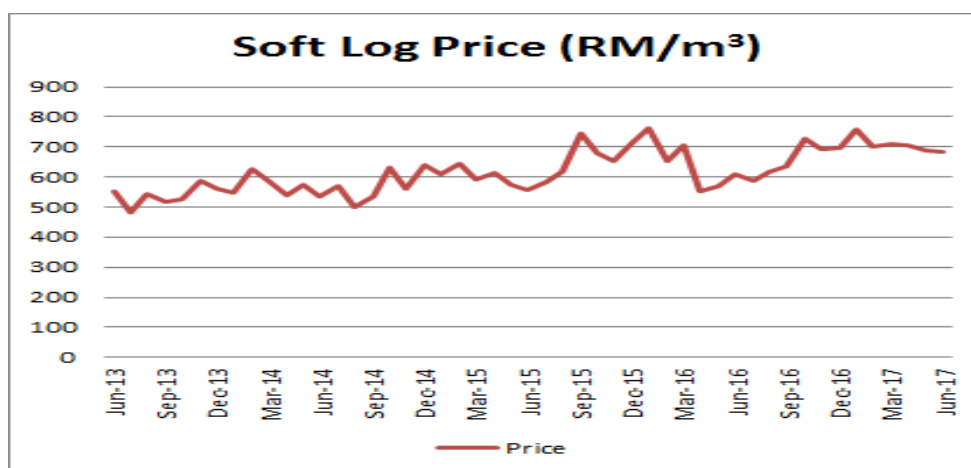


Fig. 3: Soft Logs, Average Export price from the U.S. for Douglas Fir, Malaysian Ringgit per Cubic meter. Source: <https://www.indexmundi.com>

Regarding this, the Borneo Forestry Cooperative is actively promoting research on exotic species in the areas of tree breeding, silviculture, solid wood studies, last but not least pest and disease management. Information gathered from their research will be shared with the members within the cooperative in improving plantation stand performances and sustainability during their annual. This is definitely the way forward, however the research conducted is still limited to the few exotic species. Therefore, the department has undertaken the initiative to conduct studies on some of the lesser known species (inclusive of native species) under the 11th Malaysia Plan to diversify candidate plantation species selection and improve plantation resilience.

As of current, a total of 37 hectare demonstration site is being set up to enhance preliminary studies conducted previously in other areas on the following species aspects: site adaptability; germination and nursery requirements; planting and tending techniques; growth performance and fertilization regime.

In this paper, the focus will be on some of the existing native and lesser known species plantation research gaps within the State, wherever possible experiences gained in relation to native species planting will be briefly discussed.

4.0 RESEARCH GAPS

4.1. Site Capacity

The ideal scenario for the plantation industry is to have uniform growth across the planted site and harvest within the species rotation length at an expected stem volume. Such ideal can be enhanced with improved planting materials and silviculture management, however one of the challenges aspect in the industry is site quality. Although site conditions are generally a fixed environmental condition, but the understanding of it in terms of available organic matter, nutrients, soil structure, pH and *etc.* will help to enhance the overall productivity.

In the report by Hardwood and Nambiar, 2014, the authors have listed out 3 different studies on how site conditions and other biological factors affects the productivity of *Eucalyptus*. One example was the study conducted by Mendhem et al., 2008 on how water and nutrient availability has greatly affected of *Eucalyptus globulus* productivity

and lead to a four fold differences wood volume production planted at 2 different sites (Table 1).

Table 1: Source: C.E. Harwood and E.K.S. Nambiar (2014) Sustainable plantation forestry in South-East Asia

	Red Earth	Grey Sand
Rainfall (mm y-1)	1028	825
Pan evaporation (mm y-1)	1091	1143
Soil (0–10 cm)		
<i>Total Soil Organic Carbon (g kg-1)</i>	49.8	27.7
<i>Total N (g kg-1)</i>	2.3	1.4
<i>Bray P (mg kg-1)</i>	0.19	0.06
Wood Volume		
<i>First rotation – age 8 y (m³ ha-1)</i>	366	96
<i>Second rotation – age 10 y (m³ ha-1)</i>	324	70

Apart from water and nutrient availability, site quality is inclusive of soil structure as well. When compaction occurs in any given area, it changes the soil structure and such changes will affect not only plant root growth but also cause a decline in soil stability and fertiliser efficiency. In a recent study conducted, preliminary result has shown that response towards soil compaction varies between species. Results showed that site compaction has a significant effect on the growth of 2 years old sapling of *Terminalia copelandii* whereas not much on *Neolamarckia cadamba*. (Fig. 4a and Fig. 4b).

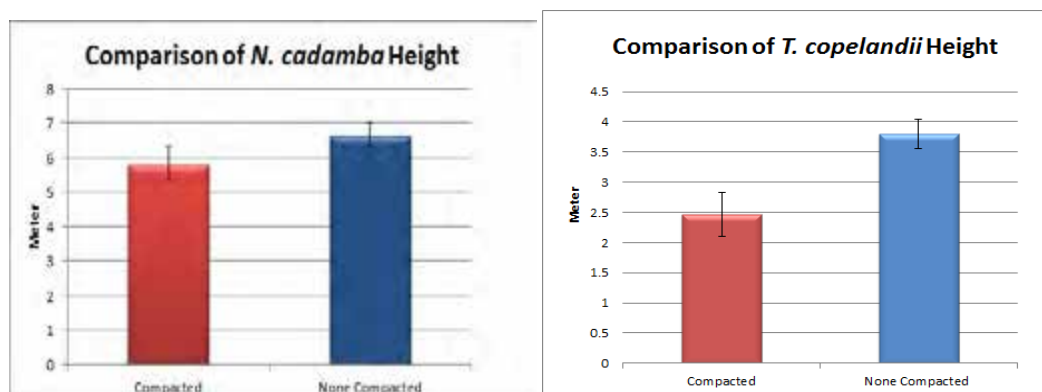


Fig. 4a and 4b: Mean tree height (m) difference for species planted on compacted and non-compacted sites.

The difference in response towards compaction could be due to species' habitat preference. *T. copelandii* has a preference for light soil such as sand or loamy sand as its natural habitat is usually flat areas. Given the right condition, such as good soil drainage, it will perform well in loam or clay soils, as well. As for *N. cadamba*, since it is an early succession species, it can grow well in most soil types inclusive of permanently flooded or heavy clay soils. Therefore, it came as no surprise it was not as affected by soil compaction as *T. copelandii*. Of course, the results shown are based preliminary studies,

as to how this will affect stem wood volume in the long term, further plot data needs to be acquired.

Therefore, the understanding of site quality and species response to it is essential, as there are bound to be varying site qualities within an area set aside for plantation establishment. Given Sabah's varying land topography, conditions and soil types, species site matching would not only maximize land utilization efficiency but provide opportunities for increase productivity.

4.2. Plantation Species Selection

In any plantation establishment, great considerations would be put into the planning process. Since site quality is on site parameter that is not exchangeable, therefore the other option is enhance planning and management regime, this is inclusive of addressing site issues.

Knowledge of site quality and environmental parameters will be a good basis for species selection and subsequent management practices implemented. Different plant groups has different nutrient and physiological requirements, such preference for soil type, nutrient requirement, shade tolerance and etc. Take for example Eucalyptus (Myrtaceae) and Acacia (Leguminosae), the latter fixes nitrogen therefore it's growth performances in nitrogen deficient areas will be much better than Eucalyptus. Therefore, if Acacia is planted in nitrogen deficient areas, the cost of applying nitrogen fertilizer can be directed into other areas that increase productivity rate. However, if there are no other choice but to plant Eucalyptus, then consideration should be frequency of fertilization process to be carried out to maintain productivity and ensure economic profitability.

Within South East Asia alone, the total of Eucalyptus and Acacia plantation was reported to be 7 million hectares for short rotation management (Hardwood and Nambiar, 2014). The predominance of these 2 species in the plantation industry instead of native species is governed by these 3 factors: availability of improved planting materials; adaptability to different environment and last but not least vast great understanding of the species from initial establishment to downstream processing. The hesitation of using native species in the monoculture plantation is the huge knowledge gap in regards to their biological requirement and potential economical values. However, this is a gap that needs to be addressed, as one of the potential risks of current monoculture plantation is that they are generally dominated by several exotic species that have narrow genetic base. One of the potential problem is that in the event of pests or plant pathogens attack, the damage caused to the planted exotic species is unknown.

Previous studies conducted in acacia plantations located in Kota Belud, Pitas and Sipitang have shown that the prevalence symptom of the *Ceratocystis* attack reaches a staggering 50-60% in 2 of the plantation sites assessed (Maid and Wickneswari, 2014). During the time of record, the symptoms has reached either the chronic or critical stage. One of the solution is to replace Acacia with another candidate plantation species, however there is only a limited number of candidate tree species available at present and they are generally exotics. The problem caused by *Ceratocystis* is becoming more widespread, recent studies have reported it to have caused severe wilt and tree diebacks in some of the eucalyptus species in Congo, China (2014) and Pakistan (2017). This thus removes another potential plantation candidate species.

4.3. Silvicultural Management

In maximizing plantation productivity, the management process is critical as final marketable timber volume is dependent upon the optimal growth of the plantation. Some of the process involved in optimization of the plantation growth would be silvicultural treatment, optimal tree density, species composition and understanding of the structural characteristics of tree stands. When it comes to tree stand density, the general guideline for decision is to decide what the tree stand is grown for and its anticipated end use. In a comparative studies of 6-years old *Neolamarckia cadamba* and 5-years *Octomeles sumatrana* (Fig. 5) planted at difference sites with different spacing regiments, results shows that lower density planting like that at Kenangan Manis has a near 50% increase in mean dbh (cm). Based on this result, current plan is to start planting some of these lesser known native species at different spacing regime to further study how plantation management can maximize timber volume for sawn timber production.

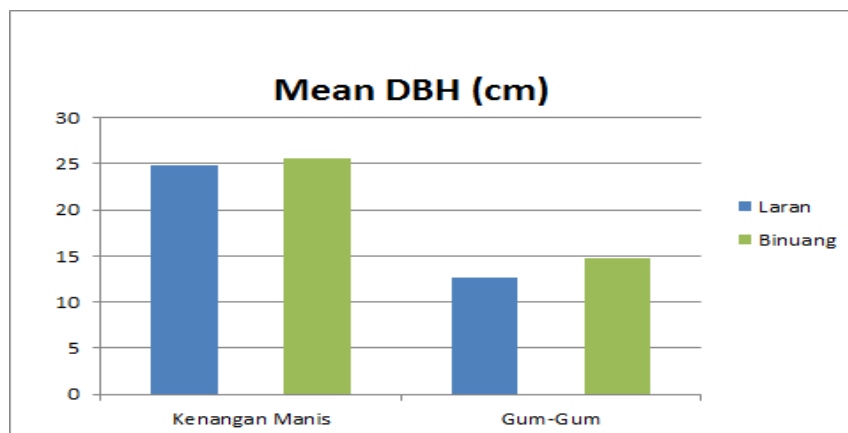


Fig. 5: Comparison of mean dbh (cm) for 6-years old Laran (*N. cadamba*) and Binuang (*Octomeles sumatrana*) planted at Kenangan Manis and Gum-Gum.

The interest in this aspect, is because when comparing the price for sawn timber to that of wood chips, it is noted that the price per unit has increased from RM1460/m³ to RM 1865/m³, whereas wood chips is from RM 360/tonne to RM480/tonne (SFD Annual Report 2006-2016). Taking 2016's record into account, a difference of two fold increase in term of volume production can give rise to more than six folds increase in FOB value (ref Fig. 6a and Fig. 6b)

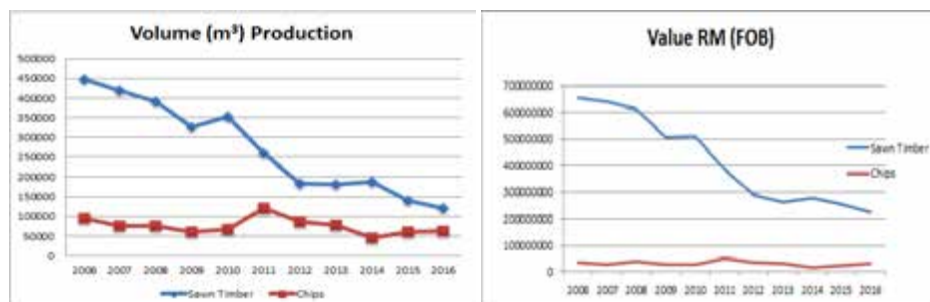


Figure 6a-b: Volume and FOB value comparison between sawn timber and wood chips.

Therefore, if a plantation company would like to decrease their investment risk, the wiser option is to introduce 2 different density stands targeted for different end use. This course of diversification of the end products have shown to improve financial aggregate return and at the same time reducing investment in the South Africa scenario (Griessa et al., 2016).

On another aspect of stand density, in a study conducted on *Pinus resinosa* in Huron National Forest in Michigan, USA (Magruder et al., 2012) the researchers found that climatic resilience of the species is stand density dependent, whereby the higher the stand density, the more sensitive it is to climatic changes rendering it to be less resilient towards drought stress and ice damaged. Aside from that, although stand level productivity is high but the actual tree level productivity is lowered. This is not the only study that showed such results, Pinkard and Bruce (2011) has shown that in the event of climatic changes, although *Eucalyptus globulus* is a drought tolerant species, its productivity will be affected by water limitation. Although, this might not be a general rule across the board, but there is a possibility of a cascading effect whereby planting density might affect species' climate resilience and in turn affecting productivity in the face of global climate change. To round it off, from the investment perspective it would make economical sense to diversifying end use timber product through mixed species plantations, variation in density planting and application of suitable silvicultural management regimes.

4.4. Harvesting and Inter Rotation Challenges

The common trend among many of the plantation companies is the practice of planting at a shorter rotation cycle (8 to 10 years) and harvesting at the minimal cost with maximal output. Such practices present a conundrum in the moving towards plantation sustainability, as it leads to higher rate of degradation of soil structure. During harvesting, the site is subjected to 2 different types of impact: nutrient removal due to biomass production; soil organic matter displacement and compaction from heavy machinery used for harvesting.

A paper published by Liao et al., 2012, showed that through a meta analysis study of 73 research, they have found that plantation has a negative impact on soil bulk density, whereby the increase evaporation rate due to site clearing coupled with heavy machinery compaction led to the increase of soil bulk density. As density increases, it makes it harder for root establishment during second rotation planting. Soil carbon and nitrogen concentration on site also experienced a decrease of about 36% and 26.5% respectively in relation to natural forest.

The effect of available nitrogen concentration during second rotation planting might not have an obvious effect initially if a legume species is planted, however productivity of the area is still subjected on the management practice implemented in the second rotation. The success of the management regime will be reflected in subsequent years where the soil nutrients will poses a more serious growth limiting effects.

If the assumption that with the plantings of improved planting materials, soil nutrient deficiency can be overcome and productivity will be similar to that in the first rotation. Studies showed that although this genetical advantage is prominent in the first rotation, however it might not be the case in the second rotation plantings due to soil water availability. In Australia, it was estimated that in a blue gum plantation, productivity

decrease can range from approximately 0.015 m³ /ha to 12 m³ in secondary plantation as a direct result of soil water unavailability. This decrease in productivity can even be higher in cases of secondary attacks by pest or in the event of a drought season (Michael et al., 2015).

Decrease in productivity during second rotation plantings are inevitable, but as to how this effects can be lessen, good practices has to be applied during initial site establishment, silviculture management and harvesting, instead of the usual short rotation and minimal cost harvesting methods. This would be exceptionally essential in poor sites that are vulnerable to productivity decline in second rotation.

5.0 FINAL THOUGHTS

The topics discussed within the scope of this paper is only limited to several aspects, there are other aspects where there exist knowledge gaps and are of great research interests such as efficiency in harvesting and downstream processing, maximal timber yield utilization and others.

Sustainability within any context cannot be achieved by the offer of a single solution, but instead it is the application of an integration of scientific process. In other words, sound science management is needed to increase or maintain productivity in the face of limiting factors to ensure the plantation industry sustainability. The current work carried out is not about reinventing the wheel but is about what can be done to improve the current plantation industry, lowering the risks involved, at the same time broadening the species range by looking into native/lesser known plantation species and how silviculture management can diversify plantation logs end use.

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**PAPER 15: PRELIMINARY STUDY ON TRIAL PLANTING OF RAMIN
(*Gonystylus bancanus*) AT BUKIT LIMA NATURE RESERVE, SIBU,
SARAWAK**

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Abstract

Gonystylus bancanus of the family Thymelaeaceae or locally known as ramin is a tropical timber species which are highly valued for its wood uses. *G. bancanus* is a site specific species which commonly grows within mixed swamp forest and peat swamp forest however depletion of these forest type and exploitation of this species leads to reduction of ramin in the wild. Trial planting of ramin seedlings is conducted at Bukit Lima Nature Reserve, Sibu as an effort to increase the density of this species outside of its natural habitat and to rehabilitate the area with noteworthy swamp species. The planting of ramin is done by establishing a 1-ha permanent sample plot as a model to study the survival and growth of ramin seedling within a secondary degraded swamp forest and also in a control area within Bukit Lima Nature Reserve. Currently, there are a total of 882 ramin seedlings in Bukit Lima planting plots and each plot contains 441 seedlings.

Keywords: ramin, trial planting, seedlings

1.0 INTRODUCTION

Gonystylus bancanus (Miq.) Kurz is a tropical hardwood species that belongs to the family Thymelaeaceae and is locally known as ramin or ramin telur. It is regarded as commercially valuable timber as it possess unique wood characteristic for its easy workability and durability. Ramin distribution pattern is documented in Sumatra, Peninsular Malaysia and extending to the Borneo region. A mature ramin tree can reach the height of 25-50 m tall and reaching 100 cm dbh (Tawan, 2004). Ramin is a species which is site specific confined to but locally gregarious in mixed swamp and peat swamp forest at altitude of 100 m (Tawan, 2004). This species thrive well in areas with a uniform rainfall and has a mean annual rainfall of 2000-4000 mm, a mean annual temperature of 24°C – 27°C and on heavy, seasonally waterlogged and sometimes infertile soils with impeded drainage (Van der meer et al., 2004).

Sarawak's peat swamp forests were the first forest to be logged commercially and systematically for its timber especially the valuable ramin wood since 1946. Ramin was the main source of round log production for the timber industry in Sarawak from 1950–1970 (Earnest, 2004) which contributed greatly to the State's economic development. However, *ramin* logs were no longer exported in 1980 as the source of ramin has become scarce due to over-exploitation. The habitat for ramin which is peat swamp forest is also degraded in most part of Sarawak due to logged over, conversion to oil palm and also forest fire. Subsequently,

ramin population is slowly decreasing in the wild due to over-exploitation and depletion of peat swamp forest.

Ramin is studied to be a slow growing species and disturbances such as logging shows that the species regenerate poorly in logged-over forest. Previous study found that even after 20 years of logging there is very few *ramin* stems with <20 cm dbh which shows that regeneration of *ramin* in peat swamp forest is very low (Earnest, 2004). This is because *ramin* seedlings are unable to compete with other light demanding species in open forest gap.

Ramin is classified as Vulnerable in IUCN Red List of Threatened Species and Appendix II of the Convention of International Trade in Endangered Species (CITES) to ensure a sustainable management and protection for this species from the timber trade activities.

The trial planting of *ramin* seedlings at Bukit Lima Nature Reserve, Sibul was initiated in 2016 as a conservation effort to restore a degraded peat swamp landscape with a native swamp species. Planting of *ramin* seedlings within the area will help to enrich the species and to determine factors that influences on the species regeneration which will contribute greatly for outlining conservation plan for both species and degraded swamp landscape.

1.1 Objective

The objective of this study is to investigate the experimental trial planting of *ramin* regeneration in secondary peat swamp forest of Bukit Lima Nature Reserve.

2.0 METHODOLOGY

2.1 Study Site

Choosing a suitable site for trial planting of *ramin* seedlings plays an important role in ensuring the success of transplanting of this species outside of its natural habitat. *Ramin* is a site specific species therefore the main criteria for the site for replanting that it must be a peat swamp forest. Generally, most PSF in Sarawak are either converted to agriculture land or logged over and are already in degraded/secondary form. Trial planting is best to be carried out in a protected area and is particularly relevant to Bukit Lima Nature Reserve in Sibul.

Bukit Lima, Sibul nickname as the “green lung of Sibul” was gazetted as a nature reserve back in April 2012 and covering a total land area of 219.22 hectare. Located about 6km from Sibul town, Bukit Lima Nature Reserve is described as a remnant of logged over and disturbed peat swamp forest surrounded by local housing areas. It is considered as the largest PSF Park in the state and enjoyed by the local communities as a recreational ground.

In July 2014, about 70 acres of the forest was burnt down which was caused by sudden bush fire. In an effort to rehabilitate the area, Ta Ann planted *Kelampayan* seedlings at the burnt patches of the reserve. This provides an opportunity to restore the degraded landscape with an indigenous species such as *ramin* by conducting trial planting as an effort of restoration of the landscape and enrichment of the species.

2.2 Trial Planting

Trial planting is an experimental attempt to determine the adaptation of a species of site specificity to a different locality and with different environmental condition. This experiment will observe the growth and regeneration of the species on a small piece of land outside of its original habitat. The area where trial planting applied is line planting in a 1-hectare plot. The trial consists of two plots set up in different part of Bukit Lima Nature Reserve remnant PSF.

2.2.1 Plot Establishment

- A baseline was established on the north-south orientation across the selected area within Bukit Lima function as reference point and starting point.
- Two (2) plots were established along the baseline at random. Each plot was established at different part within Bukit Lima and of equal sizes as the soil fertility gradient of the area is not known. The size of the plot is 1 hectare with the shape of equal square sizes measured 100 m x 100 m where the fertility gradient is the same at both directions.

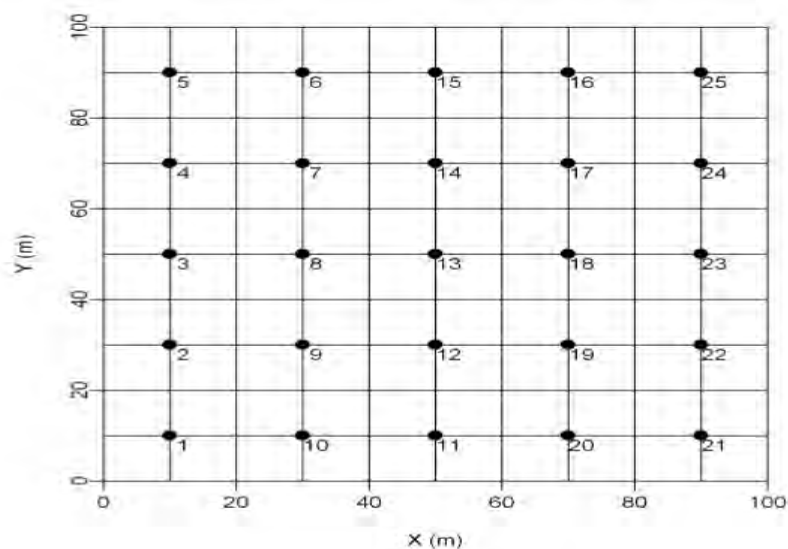


Fig 1: Layout of the ramin trial plot

2.2.2 Planting Methods

Planting lines are aligned in east-west direction to allow planted *ramin* seedlings to obtain maximum exposure to sunlight. Seedlings are planted in rows at 5 m x 5 m interval. Plot boundaries were marked with pvc pipe while subplots were marked with wooden stake. Seedlings are tagged with serial number. There were no pre or post treatments done on the plot or *ramin* seedlings.

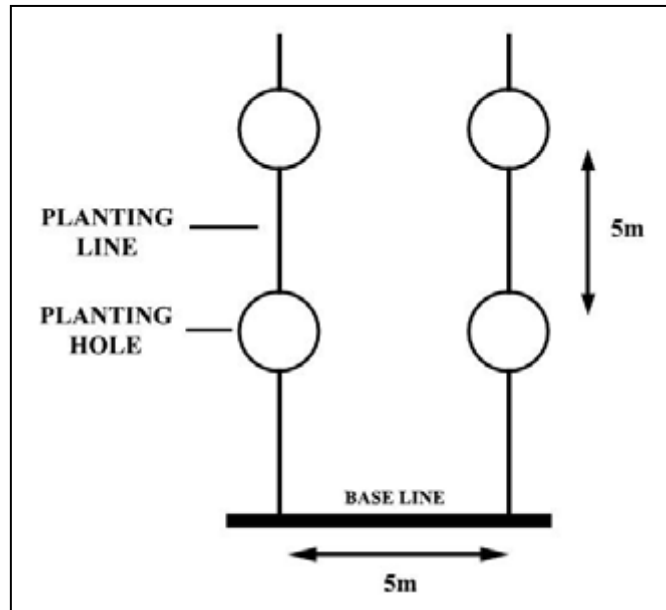


Fig 2: Line Planting System

2.2.3 Maintenance of Planting Material

Prior to planting, the plots were cleared for accessibility and to decrease the seedlings of competition. Weeding was done three (3) times in a year.

2.3 Experimental Design

This trial planting experiment was conducted on two (2) different forest area which is the patches of burnt area and the remnant PSF of Bukit Lima N.R. to study on how *ramin* seedlings survival rate within environments that is not the ideal landscape for the species regeneration. Survival or mortality rates of seedlings will give an outlook on the future outcomes of the study.

For the study of survival, environmental condition (soil pH, rainfall and light intensity) of the trial planting plots are also compared to determine the factor that contributes to seedlings survival. No cutting was allowed within the plot.

3.0 PRELIMINARY RESULTS AND DISCUSSION

The planting of *ramin* seedlings were initiated at Bukit Lima N.R in April, 2016 and chose two (2) sites within the area for trial planting plot establishment. Each micro site has a total number of 441 seedlings. The total of *ramin* seedlings planted within these two (2) micro sites are 882 seedlings.

3.1 Survival Rates

Based on a two (2) year observation in 2016 and 2017, *ramin* seedlings planted at the canopy gap area had the highest survival rate of 98% in a moderate light condition of 30-

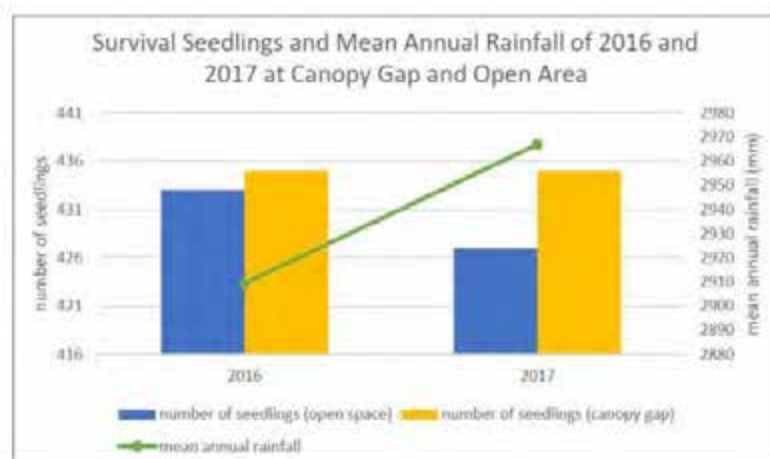
40% light intensity compared to the survival rate shown in open space area (burnt patch). The open space area shows just a small difference in survival rate of about 96% in a high intensity light condition. Both micro sites exhibit high percentage in survival rates and shows that the *ramin* seedlings are able to grow well in both light conditions.

YEAR \ CONDITION	OPEN SPACE	CANOPY GAP
2016	433	435
2017	427	435

Table 1: Total number of *ramin* seedlings survival in two (2) different micro sites

However, the adaptation of the seedlings within these micro sites are different as seedlings in canopy gap area are observed to have new shoots and more leaves with healthy deep green colour compared to seedlings in open area shows that there are no new shoots and minimal and yellowing of leaves. Observation from the study showed that seedlings within the open areas have poor growth response which indicates to competition from pioneer vegetation as the bushes occurrence and growth generates at a fast rate. Exposure to full sunlight was also a contributing factor to growth response of seedlings as the seedlings require shade within the initial planting for it to establish itself before shade can be removed. In the canopy gap area, the understorey where seedlings were planted is surrounded with minimal vegetation growth and sunlight exposure was also minimal as the area is covered with remnant swamp trees and *Macaranga* species that pioneer the canopy gap. Therefore, sufficient spacing between the seedlings and partial shade of the planting site shows a positive growth response and adaptation for the *ramin* seedlings.

Bukit Lima Nature Reserve was chosen based on the ecological requirements which are directly relevant to the species biophysical limits. Based on the graph, *ramin* seedlings survival was compared with the mean annual rainfall for two (2) years within the area of different micro sites show that 2016 has 2909.5 mm mean annual rainfall slightly less compared with 2967.0 mm for 2017. Year 2016 shows higher mortality rates in both micro sites and low mortality rates in 2017. The mean annual rainfall might not directly affect the species mortality as the biophysical limits for the species range of mean annual rainfall are between 2000 mm to 4000 mm per year. The soil ph range for both micro sites is 3.6 to 6.0 while the water table for the area is between 10 cm to 84 cm.



Graph 1: Seedlings survival and mean annual rain (2016 & 2017) in two (2) different micro sites

Ramin seedlings showed positive rehabilitation capacity with relevance to the environmental functions of Bukit Lima Nature Reserve. The line planting system appears to be suitable for the species in providing suitable space for growth and amount of sunlight. Partial shade condition shows a positive adaptation of the species with minimal competition from other species. More time, observation and data record is needed before concluding that the growth of *ramin* seedlings within Bukit Lima to be conclusive and truly successful.

4.0 CONCLUSIONS AND RECOMMENDATION

The trial planting of *ramin* seedlings showed positive rehabilitation capacity with relevance to the degraded environment of Bukit Lima Nature Reserve. Planting in an open space of burnt patches did not yield good result on the adaptation of species due to growth competition from pioneer species and extreme sunlight condition. Light condition and space competition are factors affecting the species adaptation in the trial planting.

Few recommendations are put forward with the aim of improving the effectiveness of *ramin* trial planting in Bukit Lima Nature Reserve. Among them are:

1. A comprehensive study on the growth performance of *ramin* seedlings at Bukit Lima N.R.;
2. To design and refine trial planting method and treatments based on the data of *ramin* planting in Bukit Lima and understanding the regeneration of this species for future development of enrichment planting;
3. To obtain more comprehensive information on the peat soil (nutrients, etc), hydrology and other variations within Bukit Lima N.R; and
4. To monitor and collect data on the environmental condition of Bukit Lima with the of data logger.

5.0 ACKNOWLEDGEMENTS

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**PAPER 16: PEMBANGUNAN LADANG HUTAN DI SEMENANJUNG
MALAYSIA-ISU DAN CABARAN**

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Abstrak

Ladang Hutan adalah kawasan yang ditanam dengan pokok atau tumbuh-tumbuhan hutan, sama ada daripada spesies tempatan atau dagang, dengan kaedah tanaman secara terbuka yang luasnya tidak kurang daripada 50 hektar merangkumi kawasan yang terletak di dalam atau di luar Hutan Simpanan Kekal (HSK). Ladang Hutan di Semenanjung Malaysia telah mula diperkenalkan sejak 1920an menerusi penanaman pokok Jati di Kepong dan Cameron Highlands sehinggalah tertubuhkan Projek Ladang Hutan Kompensatori pada tahun 1981. Walaubagaimanapun, projek tersebut diberhentikan berikutan kejadian penyakit (*heart rot*) khususnya pada spesies *Acacia mangium* pada tahun 1992. Tanaman Ladang Hutan Komersial diperkenalkan menerusi Dasar Perindustrian Kayu Negara (NATIP) meliputi luasan 375,000 hektar dibangunkan dalam tempoh 15 tahun mulai 2006 sehingga 2020. Sehingga kini, seluas 113,112 hektar kawasan ladang hutan telah dibangunkan di dalam HSK bagi tujuan tersebut. Kertas kerja ini merangkumi sejarah pembangunan ladang hutan di Semenanjung Malaysia serta memaparkan status pembangunan ladang hutan pada masa ini. Kertas ini juga menerangkan isu-isu dan cabaran yang dihadapi di dalam aktiviti pembangunan ladang hutan di Semenanjung Malaysia serta penjelasan mengenai pelaksanaan langkah-langkah menangani setiap isu tersebut.

Kata Kunci: pembangunan ladang hutan, pengurusan hutan, cabaran ladang hutan

1.0 PENDAHULUAN

Ladang hutan didefinisikan sebagai kawasan yang ditanam dengan pokok atau tumbuh-tumbuhan hutan, sama ada daripada spesies tempatan atau eksotik yang ditanam secara terbuka di kawasan yang luasnya tidak kurang daripada 50 hektar. Ladang hutan boleh merangkumi kawasan yang terletak di dalam atau di luar Hutan Simpanan Kekal (HSK). Penubuhan ladang hutan bukan sahaja sebagai satu usaha untuk mendapatkan bekalan kayu yang berterusan, malah untuk menggantikan kawasan miskin dan terosot kepada kawasan yang lebih produktif. Sehingga tahun 2017, kira-kira 4.924 juta hektar keluasan keseluruhan kawasan Hutan Simpanan Kekal di Semenanjung Malaysia. Daripada keluasan tersebut, kira-kira 2.70% iaitu bersamaan 113,112 hektar merupakan kawasan Ladang Hutan yang telah ditubuhkan.

Dasar Perhutanan Negara 1978 (Pindaan 1992) menjelaskan terhadap kepentingan untuk menubuhkan kawasan ladang hutan bagi menampung bekalan kayu dari hutan asli serta untuk menggalakkan pelaburan swasta dalam pembangunan hutan melalui penubuhan hutan atas kawasan persendirian. Sehubungan dengan itu, penubuhan ladang hutan dengan mengenalpasti spesies cepat membesar dan bermutu tinggi amat digalakkan khususnya daripada pihak swasta di dalam penubuhan dan pembangunan ladang hutan mereka.

Penubuhan kawasan ladang di Semenanjung Malaysia bermula pada 1950an terhadap spesies pokok tempatan seperti Meranti (*Shorea* sp.) serta spesies eksotik seperti Jati (*Tectona grandis*) bagi tujuan penghasilan kayu gergaji. Pemilihan spesies pokok Jati amat sesuai ditanam di negeri-negeri sebelah utara Semenanjung Malaysia seperti Perlis dan Kedah kerana mempunyai keadaan cuaca musim kering yang nyata berbanding dengan negeri-negeri lain.

Pada awal tahun 1960an, pihak Kerajaan telah merancang untuk mewujudkan industri pulpa dan kertas bagi menampung peningkatan penggunaan kertas di mana pada ketika itu semua produk kertas kegunaan negara adalah diimport. Sehubungan dengan itu, projek ladang hutan perintis spesies cepat membesar dengan penanaman spesies pokok pine (*Pinus caribaeavar hondurensis*) telah dimulakan di negeri Pahang, Johor, Selangor dan Negeri Sembilan untuk menghasilkan pulpa yang diperlukan untuk industri kertas tempatan. Projek ini telah menerima bantuan kewangan daripada Pertubuhan Makanan dan Pertanian Bangsa-Bangsa Bersatu (FAO). Oleh itu, sehingga akhir tahun 1980, seluas 4,500 hektar ladang pine telah ditubuhkan. Walaubagaimanapun, projek ladang pine telah dihentikan kerana ianya tidak berdaya maju dan telah menunjukkan pertumbuhan yang tidak memberangsangkan.

Pada tahun 1982, Projek Ladang Hutan Kompensatori telah dilancarkan dengan tujuan menambah bekalan bahan kayu melalui penanaman pokok jenis cepat membesar seperti Akasia (*Acacia mangium*), Yamane (*Gmelina arborea*) dan Batai (*Paraserianthes falcataria*). Projek ini telah mensasarkan seluas 180,000 hektar ladang hutan dengan unjuran hasil 180 meter padu sehektar untuk kegunaan am pada pusingan tebang 15 tahun.

Projek Ladang Hutan Kompensatori ini mula dilaksanakan di Negeri Pahang, Johor, Selangor dan Negeri Sembilan dan kemudian dilanjutkan ke negeri Perak, Terengganu dan Kelantan. Projek ini telah dibiayai sebahagiannya melalui pinjaman Persekutuan dan sebahagian lagi melalui *Asian Development Bank (ADB)*. Sehingga akhir 1997, seluas 57,980 hektar Ladang Hutan Kompensatori telah ditubuhkan di seluruh Semenanjung Malaysia. Walau bagaimanapun, hasil kajian yang dijalankan oleh Institut Penyelidikan Perhutanan Malaysia (FRIM) telah mendapati terdapatnya kehadiran *heartrot* yang tinggi dalam kebanyakan ladang hutan yang ditubuhkan.

Pada tahun 1996, pembangunan perladangan hutan di Malaysia telah diputuskan untuk diteruskan oleh Majlis Perhutanan Negara ke 12 di mana kawasan Projek Ladang Hutan Kompensatori di semua negeri yang terlibat akan diswastakan di bawah Penswastan Ladang Hutan dan Kerajaan tidak terlibat lagi secara langsung dengan penubuhan kawasan ladang hutan yang baharu. Walau bagaimanapun, keputusan tersebut kurang mendapat sambutan daripada pihak swasta khususnya bagi penubuhan ladang hutan baharu. Ini adalah berpunca daripada tiga perkarautama iaitu 1) masalah utama berkaitan pelaburan dalam ladang hutan iaitu pelaburan awal yang tinggi; 2) tempoh pusingan tebang (*gestation period*) yang panjang (minima 15 tahun); dan 3) risiko tinggi terhadap insiden kebakaran hutan, serangan penyakit oleh kulat dan serangga.

Pada 2009, Dasar Perindustrian Kayu Negara (NATIP) bagi tempoh 2009 hingga 2020 dilancarkan oleh Kerajaan dengan mensasarkan penubuhan sejumlah 375,000 hektar ladang hutan di seluruh Malaysia menjelang tahun 2020 dengan kadar produktiviti 200 meter padu/hektar.

2.0 OBJEKTIF PENUBUHAN LADANG HUTAN

Penubuhan ladang hutan bertujuan untuk menambah bekalan kayu-kayan bagi mengurangkan kebergantungan kepada bekalan sumber asli dari hutan. Antara objektif utama adalah sepertimana berikut:-

- a. Mengeluarkan kayu-kayan yang bermutu tinggi;
- b. Menggantikan kawasan hutan miskin yang telah diusahakan dengan penubuhan ladang hutan bagi meningkatkan daya pengeluaran kayu; dan
- c. Mengurangkan import kayu-kayan.

Selain itu, tujuan penubuhan ladang hutan juga adalah menghasilkan kayukayan bagi kegunaan am pada harga yang berpatutan bagi mengurangkan beban rakyat yang berpendapatan rendah, mengurangkan import kayu-kayan untuk menjimatkan pertukaran mata wang asing, menghijaukan alam sekitar serta memberikan persekitaran yang lebih bersih dan meningkatkan kualitinya serta mengurangkan tekanan pembalakan di kawasan hutan asli.

3.0 KRITERIA PEMILIHAN SPESIES POKOK LADANG HUTAN

Pemilihan spesies tanaman ladang hutan dipilih dari kategori spesies cepat membesar berdasarkan beberapa aspek penting iaitu kadar tumbesaran, permintaan pasaran, kegunaan kayu, tempoh matang, teknik-teknik pengurusan dan rawatan silvikultur.

Kategori Kadar tumbesaran iaitu pemilihan terhadap spesies pokok yang cepat membesar merupakan aspek yang utama. Oleh yang demikian, beberapa ciri-ciri spesies cepat membesar adalah sepertimana berikut:-

- a. Mempunyai kadar pertumbuhan yang tinggi, cepat membesar dan berupaya mencapai saiz diameter sekurang-kurangnya 30cm (kayu balak kecil) dalam tempoh 15 tahun;
- b. Dapat menghasilkan kayu yang berkualiti, pelbagai guna dan mempunyai nilai pasaran yang baik;
- c. Ianya mudah dan sesuai ditanam secara terbuka di kawasan ladang; dan
- d. Mempunyai bekalan bahan tanaman yang mencukupi dan mudah diperolehi.

Manakala, bagi aspek permintaan pasaran dan keperluan bahan mentah, beberapa spesies eksotik seperti Akasia (*Acacia mangium*), Batai (*Paraserianthes falcataria*), Getah (*Hevea brasiliensis*) telah dipilih. Beberapa spesies tempatan yang bermutu tinggi juga diberikan pertimbangan untuk ditanam sebagai strategi penanaman jangka panjang. Spesies-spesies tempatan yang sesuai adalah seperti:

- a. Jelutong (*Dyera costulata*);
- b. Kapur (*Dryobalanops aromatica*);
- c. Meranti sarang punai (*Shorea parvifolia*);
- d. Meranti temak nipis (*Shorea roxburghii*);
- e. Meranti tembaga (*Shorea leprosula*);
- f. Merawan siput jantan (*Hopea odorata*); dan
- g. Sesendok (*Endospermum malaccense*).

4.0 DASAR PERINDUSTRIAN KAYU NEGARA (NATIP)

Selaras dengan penubuhan Kementerian Perusahaan Perladangan dan Komoditi (KPPK) pada Mac 2004, Mesyuarat Majlis Perhutanan Negara Ke-20 telah bersetuju bahawa KPPK menerajui pelaksanaan Program Tanaman Ladang Hutan Komersil dengan penanaman spesies balak cepat tumbuh dan berskala besar.

Sehubungan dengan itu, KPPK telah mewujudkan tabung pinjaman berjumlah RM1.045 billion untuk membiayai program tersebut. Di bawah program ini, seluas 375,000 hektar dijangka akan dibangunkan dalam tempoh 15 tahun mulai 2006 sehingga 2020 yang bermatlamatkan penanaman 25,000 hektar setahun dengan penghasilan 5 juta meter padu kayu balak setahun. Sehingga kini, beberapa negeri di Semenanjung Malaysia, Sabah dan Sarawak telah mengambil bahagian di dalam program ini. Bersesuaian dengan ini, Dasar Perindustrian Kayu Negara (National Timber Industry Policy, NATIP) telah dilancarkan oleh Kerajaan pada tahun 2009.

Program Tanaman Ladang Hutan Komersial yang berskala besar menggunakan dana yang diperuntukkan adalah menumpukan kepada tanaman lapan (8) spesies yang dipilih seperti berikut:-

- a. Akasia (*Acacia mangium*);
- b. Getah (*Hevea brasiliensis*);
- c. Khaya (*Khaya ivorensis*);
- d. Jati (*Tectona grandis*);
- e. Kelempayan (*Neolamarkia cadamba*);
- f. Sentang (*Azadirachta excelsa*);
- g. Binuang (*Octomeles sumatrana*); dan
- h. Batai (*Paraserianthes falcataria*).

Walau bagaimanapun, program Tanaman Ladang Hutan Komersial ini pada kebiasaanya memberi perhatian khusus kepada spesies Getah (*timber latex clone*) dan *Acacia mangium*. Kedua-dua spesies ini dipilih atas dorongan pengalaman R&D yang telah lama dilaksanakan.

Sehingga tahun 2017, sejumlah 113,112 hektar kawasan Hutan Simpanan Kekal (HSK) di Semenanjung Malaysia adalah kawasan pembangunan ladang hutan. Selain daripada ini, terdapat juga kawasan baru di dalam HSK yang sedang dalam pelbagai peringkat pembangunan. Pecahan mengikut negeri bagi keluasan kawasan yang ditanam adalah sepertimana **Jadual 1** di bawah.

Jadual 1: Jadual Keluasan Ladang Hutan dengan Tanaman

Negeri	Keluasan Kawasan Ladang Hutan di Tanam
Johor	36,212.88
Kedah	3,900.00
Kelantan	35,096.62
Negeri Sembilan	1,281.11
Pahang	22,890.06
Perak	3,987.43
Perlis	671.00
Selangor	6,164.92
Terengganu	2,908.00
JUMLAH BESAR	113,112.02

Berdasarkan **Jadual 1** di atas, spesies pokok getah dan *A. mangium* merupakan spesies pilihan sebagai spesies pokok tanaman ladang iaitu 57.42% dan 25.47% masing-masing berbanding keseluruhan jumlah keluasan tanaman. Pecahan mengikut spesies pokok tanaman ladang adalah sepertimana **Jadual 2** di bawah.

Jadual 2: Jadual Keluasan Ladang Hutan mengikut spesies

Spesies	Keluasan Kawasan Ladang Hutan di Tanam
Getah	64,948.23
<i>A.mangium</i>	28,813.85
Khaya, Teja, Merawan, Batai, Kelempayan,	35,096.62

Jelutong, Kapur, Yamane, Buah-buahan.	
Jati	2,791.83
Karas	478.53
Sentang	380.93
Pine	84.37
JUMLAH BESAR	113,112.02

5.0 LANGKAH KAWALAN DAN PENGURUSAN LADANG HUTAN

Di dalam memastikan pembangunan kawasan ladang hutan di Semenanjung Malaysia dapat diuruskan dengan baik dan mencapai matlamatnya, beberapa langkah telah diambil iaitu:-

5.1 Pekeliling Ketua Pengarah Perhutanan Semenanjung Malaysia Bil. 1/2010: Panduan Penilaian Ke atas Kawasan Dalam Hutan Simpanan Kekal yang dipohon untuk Pembangunan Ladang Hutan

- i. Pekeliling ini dikuatkuasakan untuk memberikan panduan mengenai prosidur yang betul semasa melaksanakan penilaian kawasan Hutan Simpanan Kekal yang dipohon untuk menubuhkan kawasan pembangunan ladang hutan.
- ii. Pekeliling ini turut menggariskan beberapa kriteria kawasan HSK yang layak dipilih sebagai kawasan pembangunan ladang hutan. Di antara kriteria kawasan adalah seperti berikut:-
 - a. Kawasan berhutan yang belum dibalok mempunyai purata isipadu kasar berjumlah 153 meterpadu / hektar bagi pokok-pokok bersaiz 30 cm perepang ke atas;
 - b. Kawasan hutan yang telah diceroboh dan telah diteroka secara haram;
 - c. Kawasan hutan terosot akibat aktiviti tanaman pindah; dan
 - d. Kawasan hutan terosot disebabkan oleh insiden kebakaran hutan, penyakit dan serangan serangga dan perosak.

5.2 Pekeliling Ketua Pengarah Perhutanan Semenanjung Malaysia Bil. 1/2017: Format Rancangan Pengurusan Ladang Hutan

- i. Pekeliling ini dikuatkuasakan untuk menyelaraskan penyediaan buku Rancangan Pengurusan Ladang Hutan (RPLH) oleh Syarikat / Pengusaha Ladang Hutan;
- ii. Penyediaan buku RPLH ini merupakan syarat yang perlu dipenuhi oleh Syarikat/Pengusaha Ladang Hutan bagi tanah Hutan Simpanan Kekal, Tanah Kerajaan dan Tanah Bermilik;
- iii. Penyediaan buku RPLH ini juga akan membantu Syarikat / Pengusaha Ladang Hutan semasa menguruskan dan membangunkan kawasan ladang hutan mereka dengan cekap dan berkesan; dan
- iv. Penyediaan buku RPLH ini adalah keperluan di dalam memenuhi kriteria dan pertunjuk Prinsip 10 *Malaysian Criteria and Indicators for Forest Plantation Management Certification (MC&I Forest Plantation v2)*.

5.3 Penerbitan buku garis panduan penubuhan ladang hutan

- i. Buku garis panduan ini diterbitkan bagi menyediakan panduan lengkap kepada Syarikat / Pengusaha Ladang Hutan terhadap penubuhan ladang hutan; dan
- ii. Secara keseluruhannya, garis panduan ini memberikan penjelasan lengkap terhadap setiap proses yang terlibat semasa penubuhan ladang hutan seperti pemilihan tapak tanaman, pemilihan spesies, keperluan infrastruktur ladang serta selenggaraan yang perlu dilaksanakan sehinggalah kepada kawalan dan pemantauan yang perlu dilaksanakan bagi mengurangkan risiko.

5.4 Penerbitan Buku Panduan Pencegahan dan Kawalan Serangan Perosak Pokok Hutan

- i. Buku panduan ini diterbitkan untuk memberikan panduan kepada pegawai dan kakitangan JPSM untuk mengenalpasti, menilai dan mengawal perosak dan penyakit pokok;
- ii. Secara keseluruhannya, buku ini perlu digunakan semasa melaksanakan operasi pencegahan dan pengawalan serangan perosak dan penyakit pokok selain ianya dapat digunakan sebagai latihan bagi meningkat kemahiran pasukan pengawalan serangan perosak dan penyakit pokok; dan
- iii. Dengan adanya buku ini adalah diharapkan dapat mengurangkan risiko serta kerosakan serius akibat serangan perosak dan penyakit pokok.

6.0 ISU DAN CABARAN

Pembangunan ladang hutan di Semenanjung Malaysia turut mempunyai pelbagai isu dan cabaran. Di antara isu dan cabaran adalah seperti berikut:-

6.1 Kos Pelaburan Yang Tinggi

Keperluan kos yang tinggi bagi pembangunan ladang hutan iaitu sekitar 15,000 -20,000 / hektar serta sekitar RM10,000 / hektar bagi kos penyelenggaraan menyebabkan syarikat/pengusaha beralih kepada pelaburan yang lain.

6.2 Tempoh Pengeluaran Hasil Yang Lama

Anggaran hasil yang boleh diperolehi daripada aktiviti pembangunan ladang spesies hutan adalah lama iaitu di antara 7 hingga 15 tahun dan ini boleh menjejaskan aliran tunai dan menjadikannya kurang menarik buat syarikat/pengusaha.

6.3 Kerosakan Terhadap Ekosistem Hutan

Pembukaan kawasan pembangunan ladang hutan boleh mendatangkan kerosakan terhadap ekosistem hutan sekiranya tiada kawalan dan penguatkuasaan yang rapi dilaksanakan. Tambahan pula, ianya boleh menjejaskan alam sekitar sekiranya prosidur penubuhan ladang tidak dipatuhi sepenuhnya.

6.4 Kesesuaian Spesies Yang Terhad

Program Tanaman Ladang Hutan Komersial yang berskala besar hanya menumpukan kepada tanaman lapan (8) spesies yang komersil sahaja dan pemilihan spesies lain lebih memerlukan kajian dan penyelidikan lanjutan dilaksanakan yang akan mengambil tempoh masa yang panjang dan kos yang tinggi.

6.5 Kekurangan Tenaga Kerja

Kerja-kerja di sektor peladangan terpaksa bergantung kepada pengimportan pekerja asing. Syarikat/pengusaha perlu melaksanakan proses permohonan yang rumit selain memperoleh pekerja asing yang mempunyai tahap kemahiran yang tidak dapat dikawal.

6.6 Risiko Serangan Perosak Dan Penyakit Pokok

Tanaman pokok spesies hutan secara ladang sememangnya terdedah kepada serangan perosak dan penyakit pokok. Sehubungan dengan itu, Syarikat / Pengusaha Ladang Hutan perlu memberikan perhatian khusus terhadap faktor-faktor yang menyebabkan serangan perosak dengan melaksanakan pelbagai langkah kawalan.

6.7 Penyelidikan yang Terhad

Kekurangan terhadap penyelidikan mengenai perolehan biji benih yang terbaik, kaedah penanaman yang baik, pembajaan yang tepat menyebabkan syarikat/pengusaha perlu melaksanakannya sendiri.

7.0 LANGKAH PENYELESAIAN

Bagi memastikan setiap isu dan cabaran pembangunan ladang hutan dapat ditangani dengan sewajarnya, beberapa langkah penyelesaian boleh diamalkan sepertimana berikut:-

- a. Menyediakan skim pinjaman kepada syarikat / Pengusaha yang Berkelayakan dan komited membangunkan kawasan ladang hutan. Menerusi skim yang diperkenalkan ini, tarikan syarikat / pengusaha di dalam membangunkan kawasan ladang hutan dapat dipertingkatkan dan ini secara tidak langsung akan menyebabkan sasaran Kerajaan untuk mencapai seluas 375,000 hektar pembangunan ladang hutan selama 15 tahun tercapai;
- b. Memberikan galakan penggunaan tanah yang lebih cekap. Salah satunya adalah pelaksanaan perhutanan-tani bagi membolehkan syarikat/pengusaha menjana hasil sampingan bagi memperbaiki pusingan modal dan aliran tunai syarikat/pengusaha;
- c. Mengenalpasti spesies-spesies tempatan dan eksotik yang berpotensi tinggi untuk dijadikan spesies ladang hutan. Usaha-usaha ini melibatkan kajian berterusan R&D baka spesies-spesies yang cepat membesar dan tahan lasak khususnya terhadap serangan penyakit dan perosak selain mengenalpasti terhadap kaedah penanaman yang terbaik;
- d. Pemantauan berterusan dan konsisten dijalankan di ladang hutan merangkumi penguatkuasaan rapi terhadap syarat-syarat sedia ada dan menyemak semula / memperbaharui syarat-syarat penubuhan kawasan ladang hutan. Selain itu, melaksanakan penilaian impak alam sekitar (EIA) dan penyediaan buku Rancangan Pengurusan Ladang Hutan bagi semua kawasan pembangunan ladang hutan; and
- e. Mengadakan kursus-kursus kepada pihak syarikat/pengusaha ladang terhadap amalan perladangan baik seperti kaedah penanaman yang baik, pembajaan yang tepat.

8.0 KESIMPULAN

Secara keseluruhannya, permintaan terhadap sumber kayu bagi memenuhi industri berasaskan kayu di Semenanjung Malaysia semakin meningkat. Oleh yang demikian, pembangunan ladang hutan tentunya dapat menjamin sumber kayu bagi kegunaan industri berkenaan. Pembangunan ladang hutan juga merupakan alternatif yang baik bagi mengurangkan kebergantungan kepada sumber kayu dari hutan asli di Semenanjung Malaysia.

Peranan penting yang dimainkan oleh institusi penyelidikan di dalam mengenalpasti baka-baka spesies pokok ladang hutan yang cepat membesar dan tahan lasak akan menarik lebih banyak syarikat / pengusaha ladang hutan terlibat di dalam pembangunan ladang hutan. Ini akan secara

tidak langsung akan menarik syarikat / pengusaha ladang hutan memasuki program pinjaman yang diperkenalkan oleh kerajaan yang akhirnya akan menjadikan hasrat program penubuhan ladang hutan yang melibatkan kawasan seluas 375,000 hektar di dalam tempoh 15 tahun tercapai.

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Sub Theme 5:

Forest Ecosystem Services: Food, Water,
Energy, Climate and Recreation, PES &
REDD+

PAPER 17: FROM DEGRADED TO FUNCTIONAL FOREST: A SUCCESS STORY

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Abstract

Bukit Piton Forest Reserve is one of the most critical orangutan habitats in Sabah. Past conventional forest harvesting practices and forest fires have degraded the quality and value of the forests. Despite of the degraded condition, a previous wildlife census study estimated about 172 individuals of orangutan inhabitants within the area. Geographically, this population was totally isolated due to vast expanses of oil palm plantations at the surrounding area and separated from the main forested area of Ulu Segama Forest Reserve by the Segama River. Translocation was not the best option, due to survival issues and very costly in operation. In situ management through intensive forest rehabilitation was implemented instead, with active participation from several partners. Good governance has encouraged technical and financial supports from local and international experts and philanthropist. Forest restoration techniques for wildlife habitat were improvised through several regimes of planting. Operationally, local communities have been actively involved and contributed in the progress of habitat restoration. After a decade, the ecological functions of the forest as a wildlife habitat enhanced. With more even distribution of the orangutan population throughout the restored forests, Bukit Piton Forest Reserve has become very attractive for nature-based tourism, especially for orangutan sighting in the wild environment.

1.0 FOREST RESTORATION INITIATIVE BACKGROUND AT BUKIT PITON FOREST RESERVE

Bukit Piton Forest Reserve (previously known as Northern Ulu Segama Forest Reserve) is located at the south east of Sabah, which covers about 11,612 hectares of degraded forests due to forest fires incident and past conventional timber harvesting practice since the 80's. Extensive areas have only grasses, creepers or gingers as cover. The pioneer trees that thrive are heavily infested by creepers of vines and climbing bamboo, leading to eventual suppression. Despite of its degraded condition, Bukit Piton Forest Reserve serves as vital habitat for orangutan (*Pongo pygmaeus morio*). The remnant trees were isolated, thus not much crowns were connected for the ease of orangutan arboreal movement. In 2007, the Kinabatangan Orangutan Conservation Project (KOCPP) executed orangutan study in Bukit Piton Forest Reserve via ground and aerial survey, and the study shows that the estimate orangutans population is about 172 individuals, even though the forest was heavily degraded (Ancrenaz M. et al., 2010ⁱ). The orangutan population is uneven and isolated from the main Ulu Segama Forest Reserve by Sg. Segama and surrounding oil palm plantations, which not only limits their ranging habitat, but also may lead to their eventual extinction. Translocation of orangutan is not the management option to secure the population, due to cost effectiveness and survival ability of the orangutan in the new habitat.

Since 2007, multiple partners i.e. Sabah Foundation, Yayasan Sime Darby and WWF-Malaysia, had entered a long term agreement with the Sabah State Government to support and rehabilitate degraded orangutan habitats in Bukit Piton Forest Reserve.

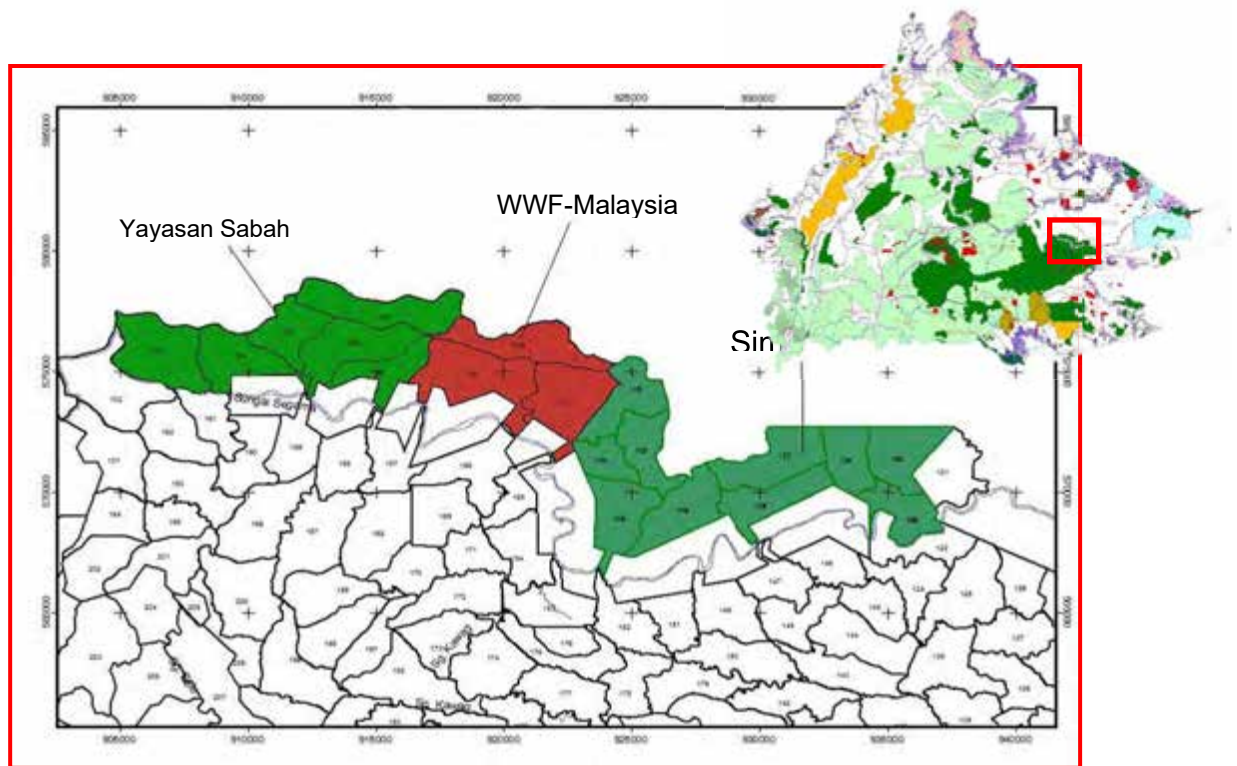


Fig. 1: Location of Bukit Piton Forest Reserve and partners involved in the forest restoration project.

The initiatives from the several partners share similar objective and goal i.e. to restore degraded forest to its ecological functions as well as to enhance the biodiversity quality; and to re-create a healthy vital habitat for wildlife, in particular orangutan, as the umbrella species of Borneo.

2.0 FOREST RESTORATION OPERATION AT BUKIT PITON FOREST RESERVE

Operationally, the activities involved are site preparation, intensive vegetation census (comprehensive restoration plan), silviculture tending, raising and planting of seedlings, maintenance of planted trees and wildlife monitoring programme. Prior to tree planting, comprehensive restoration is a prerequisite as to provide appropriate site-species matching information. Intensive planting programme is executed at very open-treeless area (dominated by weeds, wild gingers and shrubs) using hardy pioneer and wild fruit indigenous species. While enrichment planting using dipterocarp and non-dipterocarp species is executed at area with poor forest condition. The remnant forest condition with moderate vegetation quality is liberated from competitor, such as climbing bamboo and woody lianas by executing manual climber cutting practice for better natural regeneration growth.

2.1 Site Preparation

Site preparation involves three main activities i.e. site recce, preparation of planting line and silvicultural treatment.

It is always important to do site recce before carrying out tree planting activities to understand the overall condition of the planting area. This is done by studying and ground truthing of forest composition against procured map (preferably at 1:5000 scale), verify working block boundary, identifying existing access road into planting plot and network within planting plot, and establishing alignment of planting base lines with respect to nearest access road. The next consecutive lines were marked with 8 or 10 meters intervals.

Preparation of planting line was executed subsequently after the recce whereby two (2) activities are involve such as preparation of base line and line opening (Figure 2).

In the preparation of base line, it is recommended to adopt road as boundary, as it is the most convenient for planting line to start from the road side, for the purpose of seedlings transportation and distribution. But if it is not, a straight block boundary can be adopted as base line provided there is available road network for transporting seedlings, as seedlings distribution is the most bulky restoration component. Each corner shall be marked with compartment ID and block ID, while line opening should be 1-2 meters wide.

While in the planting line opening, distance between planting line (either 8 or 10 meters horizontal) must be straight and parallel to each other, and cleared with 2 meters width and 2 meters height parameters, from weeds, creepers, climbing bamboo, and any debris such as fallen tree limbs or any loose impediment. It is also crucial to ensure that there is no potential natural regeneration or Potential Crop Tree (PCT), including wild fruit trees is removed. Every planting line opening is marked with stake and ribbon, and indicated with block ID, line ID, running meter distance and planting point ID.



Fig. 2: Aerial view of planting line in Bukit Piton Forest Reserve

2.2 Comprehensive Restoration Plan

Comprehensive Restoration Plan (CRP) is a collection of information of site-species matching based on shade conditions, topography, soil condition and general soil type, via ground truthing or census activity (Figure 3). This activity involves skills and knowledge of tree identification and forest ecology, for better and



Fig. 3: CRP assessment was conducted to identify appropriate tree species for planting

accurate planting assessment. Two areas were identified in the CRP assessment i.e. planting area and non-planting area.

Planting in the open canopy area which is exposed to at least 95% to 100% of sunlight should be planted with pioneer species (i.e. Binuang, magaslaran), sentang and wild fruit species by using ‘single planting’ method. While for semi canopy area which is exposed to at least more than 20% and less than 95% of sunlight should be planted with shade-tolerance species, preferably dipterocarp and the more popular non-dipterocarp species by applying ‘cluster planting’ method. In wet area (not water logged) with more than 20% and less than 100% of sunlight exposure, it is recommended to plant wet-tolerance species such as Sepat, Putat, Bangkal, Pulau Raya, or any other species known to grow well under wet conditions.

For some forest areas, it is recommended that no planting activity be conducted if the area consist features such as abandoned and existing logging road having compacted surface, water logged such as ponds, streams, creeks, lakes etc., and stone/stony boulder such as escarpment, on big boulder and large stone pavement. No planting is necessary if the forest area has good quality of natural regeneration or Potential Crop Tree (PCT) and wild fruit species. However, macaranga and bayur should not be taken as natural regeneration if they dominate any particular area.

2.3 Silviculture

Silviculture is the tending of trees. However in the context of this project, it is merely the shade adjustment so that the planted and tended trees would be able to get sunlight penetration for their growth (Figure 4). It is an important activity to ensure light penetration to the forest floor is enhanced for the essential light requirement of the planted seedling and selected regeneration to attain rapid growth. The treatment mainly focused on climber cutting, such as climbing bamboos, wadan and veins whereby only climbers below ($<$) 5 cm in diameter were removed to allow wildlife i.e. birds, orangutan etc. to get a source of food from larger climbers ($>$ 5cm). The climbers should be cut to 2 cm – 3 cm stump height, and the hanging end at 1 meter above ground, with one exception i.e. Serapit (*Willughbeia* sp.) are to be preserved if one recognizes this species.



Fig. 4: Silviculture activities were carried out to ensure planted seedlings able to get enough sunlight for their growth.

2.4 Seedlings Nursery

Establishment of the seedlings nursery is very important to ensure enough seedlings stock for the planting. There are several components to look at in setting up seedlings nursery such as water source, location, topography and soil.

A nursery should be supplied with clean (free



Fig.5: Site nursery in Bukit Piton Forest Reserve

from pollution; agrochemicals, household waste), reliable and enough volume of water which is available throughout the year. The pH of the water should be from 5.5 to 7. Water with pH higher than 7 favors attacks of ‘damping-off’ fungi, causing outbreaks in the seed beds, usually killing of fine germinant (laran, binuang, etc), and often raises the pH of the soil which in turn can reduce the growth of seedlings (suppressing the nutrients intake of the plant). A nursery must be set on the central location as near as possible to the planting site to avoid the transportation of seedlings over long distances. It is also recommended to set it on a gentle slope sufficient to allow excess water (about 4-5 degree slope) to run off without causing soil erosion. Where necessary, a proper drainage system must be built to avoid water logging and damage during periods of heavy rainfall. Soils are the most important in the preparation of the potting mixture and to a lesser extent for seed beds. Five (5) important soil properties that will affect plant production are particle size, organic matter content, soil porosity, moisture content, and pH. Although each can be evaluated separately, they are all interrelated. The presence of organic matter is perhaps the most obvious indication of a healthy soil and is an essential ingredient in maintaining satisfactory moisture relationships necessary for plant growth. Soil that is not porous encourages water-logging, hence oxygen, which is essential for root development and respiration, becomes unavailable to the plant.

The quality of seedlings can be observed based on their maturity sizes at 35 cm or above (14 inches or above) in height with apparently mature stem and species variety (with ratio of 70:30:10) with 100% survival during the verification process after planting. Only hardened seedlings with mature leaves should be selected for planting, and the stem must be straight and not twisted or damaged.

2.5 Planting

The common planting space that was implemented in Bukit Piton Forest Reserve is 8 meters x 8 meters (156 planting points per hectare) and 10 meters x 10 meters (100 planting points per hectare), depends on funds provided by the partners.

The selection of seedlings is based on the CRP assessment whereby only specific species can be planted at the specific site in each planting line, and only vigorous healthy seedling will be selected. Any unhealthy seedlings must be set aside for reconditioning. The seedlings must reach mature sizes of 35cm – 45 cm (14 – 18 inches) in height with apparently mature stem.



Fig.6: Planting activity of tree seedling

Preparation of planting hole must be as appropriate as possible according to the size of poly bag. It should not be too deep and too wide. The hole then applied with The Christmas Island Rock Phosphate (CIRP) and NPK green/yellow fertilizer (10 grams each). Before placing seedling into the hole, the polythene bag must be removed by tearing or cutting the material and carefully pulling it out to expose the soil attached to the roots of the seedling before it can be placed inside the hole. The seedling should be placed in the center of the planting hole in

vertical position, any gap between the wall and seedling medium should be filled with loose top soil. The fill should then be firmed by pressing with both hands. Some seedling may have thin and weak stem, thus it needs support to make it upright by pegging it with wooden stick or twig.

Each planted seedling should be tagged with bright lasting tagging materials, so that it would be easier for it to be seen during maintenance to avoid an accidental chopping. Circle weeding can be done before or after planting. Clearing must be about one meter radius around the planted seedling. All vines and stump must be cut to the ground. A period of approximately 1(one) week is required for the newly planted seedlings to acclimatize before conducting ground verification. Point of each planting line is recorded for whatever its status including every seedling planted and the natural selection.

2.6 Maintenance

Maintenance is very important and crucial stage to ensure survival of the planted seedlings from weeds competition, as weed growth is more rapid than the planted seedlings, at the early stage. The activity involves are as follows:

2.6.1. Circle weeding

- Clearing around the planted seedling, which is 1 meter radius around and weed slashing is to the ground. For open area which is heavily over grown by weeds, the application of herbicide (Sentry) is used in accordance to Forest Stewardship Council's recommendation.



2.6.2. Cutting and removal of liana around the planted seedling

- Woody liana found along the planting line must be cut and removed. The process must take extra precautions not to break or chop off the planted seedling.

Fig. 7: Application of herbicide (Sentry) was used in an open area



2.6.3. Crown liberation

- Any vegetation obstructing the crown of the planted seedling must be eradicated or trimmed to not less than 1 meter from the shoots (the lateral or orthotropic).

Fig. 8: Removal of liana around the planted seedling

2.6.4. Planting line clearing

- Planting line must be cleared for ease of monitoring the planted seedling. Weeds along the planting line must be cut closer to the ground with the width of 1.5 meters.

2.6.5. Tending selected natural regeneration/PCT

- Selected natural regeneration has the same status as the planted seedling, thus it must be tended with liberation from woody liana and growing space opening.

2.6.6. *Replanting or resupplying*

- Any missing or dead seedling at planted point must be replaced if there is any within three months or during the second maintenance after planting. Species for replanting must be the same group as the initial planting.

2.6.7. *Fertilizer application*

- Fertilizer applied during maintenance round is 15 grams to 30 grams of NPK yellow/green on 10 cm circle from the planted seedling base.

2.6.8. *Maintenance round*

- Maintenance round is basically referring to the physical condition of surrounding planted point and degree of weeds cover. However, as to guide the field implementation, recommended maintenance rounds are as follows:-

Year	Number of rounds	Interval between round
1	4	3 months
2	4	3 months
3	3	4 months
4	2	6 months

3.0 IMPACTS OF RESTORATION INITIATIVES TO FOREST FUNCTION

Since the initiative kicked off in 2007, the project has restored about 11,253 hectares of degraded forest in Bukit Piton, and planted over 1.5 million seedlings with more than 95 species such as indigenous dipterocarps, non-dipterocarps, pioneers and fruit trees. The natural regeneration also grows with better quality with the forest restoration intervention, which has contributed improvement of ecological function in the Bukit Piton Forest Reserve.

With great efforts and supports were put in the restoration works by the Sabah State Government and local philanthropies, Bukit Piton Forest Reserve was re-classified from Class II Commercial Forest to Class I Protection Forest, in 2012ⁱⁱ. This is the most important milestone of the project, as the area received a Totally Protected Area (TPA) status. This means, it will not be used or converted for other land use purposes. With this recognition, all forest intervention efforts done are fully dedicated to restore the ecological functions and protection of vital orangutan habitats in Sabah.

The restoration work in Bukit Piton Forest Reserve has provided an opportunity for the partners especially WWF-Malaysia to conduct study of orangutans distribution and estimate population in Bukit Piton Forest Reserve. Way back before the initiative, Bukit Piton Forest Reserve was highly degraded as a result of over-logging and forest fires back in the 80's and 90's. In most areas, the canopy was completely disrupted, few trees were left standing, logging roads and open areas were common, and pioneer trees such as *Macaranga* spp. dominated the landscape. Approximately 40% of the aerial transects were flown over lands devoid of trees, considered as unsuitable habitat for orangutans. Although orangutan nests were found throughout the entire Bukit Piton area, they tended to be concentrated in compartments with the best forest stands or in isolated patches of trees found in the middle of

over degraded and open areas. Nests were slightly more abundant in area with no active logging (Ancrenaz M. et al., 2010ⁱⁱⁱ).

WWF-Malaysia had carried out series of surveys and studies to observe the impact of forest intervention activities to the wildlife densities and population. The relevant activities were carried out such as aerial and ground orangutan nest survey, night spotting survey, camera traps and creation of artificial salt licks. Based on WWF-Malaysia survey in 2014, the preliminary monitoring information revealed that the orangutan distribution is not only concentrating at natural canopy covered areas, but also recorded at rehabilitated and planted area, which was previously treeless and dominated by weeds, creepers and wild ginger (Figure 9). The result also shows that after 8 years of restoration work, about half of the survey segments in Bukit Piton FR has high abundance of orangutan nests. The low abundance of nests in the remaining areas was probably at forest gaps (with low canopy coverage) in substantial parts of Bukit Piton which was being restored. The study suggested that with eventual restoration practices over the whole area will expand orangutan use of the area (WWF-Malaysia Report, June 2014^{iv}). The game species such as sambar deer, wild boar, and mouse deer are also more frequently sighted, in comparison with its previous natural condition (Figure 10).



Fig. 9: (Left) Pattern of orangutan nest distribution along transect segments in Bukit Piton Forest Reserve, from the aerial survey conducted in June 2014; (Right) evidence of orangutan nest built on planted talisai tree



Fig. 10: Other wildlife such as (from top left) sambar deer, wild boar, mouse deer and elephant are frequently sighted in Bukit Piton Forest Reserve.

In 2016, WWF-Malaysia had estimated population of orangutan using the Marked Nest Count (MNC) method whereby 19 plots were distributed in a stratified random sampling manner across the Bukit Piton Forest Reserve, and the population estimated using Bayesian approach and Markov Chain Monte Carlo (MCMC) method. Previously, Distance Sampling Method (DSM) was used to estimate population of orangutan back in 2008 and 2009 whereby the estimation of 264 and 307 populations were recorded respectively. Both MNC and DSM methods have their own advantages and disadvantages. The MNC method eliminate the use of nest decay rate as needed in the DSM as it often gives major errors and bias if not done properly. The MNC method is also more favorable as it requires shorter time and less intensive data collection compared to the DSM thus lowering the cost of field survey. As for the MNC results, the estimate population of orangutan in Bukit Piton Forest Reserve was about 387 individuals which are still within the range of previous population estimates and above the minimum viable population which is 250 individuals (Figure 11). The estimated population is considered as stable as no major catastrophe such as forest fire, habitat conversion or killing has been reported. Instead, more sightings of mother and dependent young below 6 years of age were seen roaming around from 2012-2016 (WWF Malaysia Report, May 2016').



Fig. 11: (Left) The posterior distribution of orangutan population estimate in Bukit Piton Forest Reserve; (Right) orangutan was spotted on the 5 years old planted laran tree.

Besides ecological benefit especially to orangutan, the restoration project has contributed social benefits to the local community at surrounding area. The restoration projects have employed about 40 local people mostly from Segama community, who are living about 30 kilometres along downstream of Sg. Segama. The project also provides economic activity to the villagers by offering 'contract for them to do forest restoration, such as planting and maintaining of the planted trees. In the aspect of capacity building and enlarging participation of local community to this conservation project, about 30 people of the Segama community were trained in managing small scale nursery (Figure 12).



Fig. 12: Local Segama community involved in managing small scale of nursery

The restoration project is managed transparently and recognized by the international body through annual assessment audit which is carried out by the Scientific Certification System (SCS) to ensure the effectiveness and improvement of field operation, and in compliance with the principle and criteria of the Forest Stewardship Council (FSC) standard. Bukit Piton Forest Reserve, which is part of the 242,884 hectares Ulu Segama-Malua Sustainable Forest Management project, was certified under the well managed forest since June 2011^{vi}.

4.0 CHALLENGES AND LESSONS LEARNT

Throughout the project implementation, several challenges were encountered in the efforts to restore forest and ecological wildlife habitat. In the initial stage, forest restoration works are very labor intensive, thus inadequate capacity could easily jeopardize the progress of planting and maintenance quality of planted trees. However, the overall performance was restored with the intervention and support from partners to facilitate the appointment and payment of contractors.

Higher mortality rate of planted seedlings due to competition of weeds and creepers was a big problem back then since most of the project area is open and less canopy, as at early stage, weed growth is more rapid than the seedling planted. Through application of controlled herbicides such as Sentry (active ingredient is glyphosate isopropylamine, Class III), and short maintenance rounds interval have contributed to a better survival rate. Besides competition of weeds and creepers, water stress due to prolonged drought has also impeded the progress of planting and caused higher mortality. For some severe case, ‘stop planting orders’ were imposed to avoid ineffective operational practice and further loss of the seedlings. Problem with accessibility could also contribute in mortality percentage, when transporting seedlings that are too far from the main access. With proper planning of maintenance of the existing or old logging roads to the planting areas has increased survival of the transported seedlings.

In the first 2 years of the project implementation, insufficient number of seedling stocks has impeded the planting progress due to inadequate size of space in the nursery and extreme weather condition which has impacted the pattern of flowering and fruiting season, thus limiting the availability of planting material, especially dipterocarps species. Improved nursery management with appropriate space of seedling stocks has resulted bigger capacity in collecting and keeping of dipterocarps seedlings, especially during mass fruiting occasion.

5.0 WAY FORWARD

Ten (10) years since the restoration project was initiated, most of the works that were funded by partners i.e. Sabah Foundation, WWF-Malaysia and Sime Darby are now coming to an end. As of to date, a total restored area has reached about 11,253 hectares whereby 1.5 million seedlings were successfully planted with over 95 species of indigenous dipterocarps, non-dipterocarps, pioneers and fruits. Tree canopies can now be seen standing tall straddling across Bukit Piton Forest Reserve. However, continuation of restoration supports are still very much needed to fill up fragmented gaps for example planted trees that were outgrown and covered by weeds and creepers.

Findings from the orangutan survey that was carried out by WWF-Malaysia had shown positive outcome whereby the orangutan distribution is now well spread all over Bukit Piton and not only concentrating at canopy covered areas, but also at rehabilitated and planted area. In addition, more sightings of mother and dependent young orangutan below 6 years old were also seen roaming around after 10 years of the project implementation. As such, it is recommended that the monitoring and further study on orangutan is continued to further understand their behaviors, needs and foods that could be used to improvise restoration management for a better functional habitat for orangutan and other wildlife.

The restoration work has also provided important lessons learned to the State Government and its partners, to improvise management and operation of tree planting more efficiently, which can be duplicated as a model at other degraded forest, to turn it from degraded forest into a functional one.

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PAPER 18: SPATIAL VARIATION OF DISTURBED SOIL IN A MANGROVE ECOSYSTEM BASED ON THEIR PHYSICAL AND CHEMICAL PROPERTIES

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Abstract

Spatial assessment of soil characteristics is an important step in agricultural, forestry and natural resource management. The variation of physical and chemical soil properties significantly influence the vegetation, species composition and forest structure of the mangroves. In this study, the objectives are to observe the variation of the soil in mangroves rehabilitation using airborne hyperspectral image dataset, to explore the relationship of the soil properties with the spectral response derived from hyperspectral image dataset, and to determine the spatial distribution of the different types of soil applying both field and image spectroscopy data in Sungai Lemidin. The results were analysed by using ENVI Classic 5.1 software. Therefore, it is essential to understand the spatial distribution of the soil properties for future planting practices.

Keywords: Spatial variation, Hyperspectral remote sensing, Mangrove rehabilitation, Spectral Information Divergence

1.0 INTRODUCTION

Knowledge on the spatial variation of soil properties may be beneficial for forestry management practices while minimizing environmental damage. Spatial variability in soils occurs naturally as a result of complex interactions between geology, topography and climate. The properties of soil change continuously over time and space (Rogerio et al., 2006). Precise information of the variation in soil characteristics is essential to recover the homogeneity of the soil (Bocchi et al., 2000). Therefore, hyperspectral remote sensing serves as a tool for rapid assessment of soil characteristics as it provides narrow band wavelengths with high frequency of spectral response that are suitable for studies regarding site-specific planting.

According to Goetz et al. (1985), the definition of hyperspectral imaging spectroscopy is “the simultaneous acquisition of images in many narrow, contiguous spectral bands”, across the electromagnetic spectrum which covers the electromagnetic region of the Visible (VIS) (400-700 nm), Near Infra-red (NIR) (700-1100 nm), and Shortwave Infra-red (SWIR) (1100-2500 nm) spectral region. These spectral regions provide a medium to identify and discriminate components such as soil, vegetation, rock and mineral (Malavath et al., 2017).

Kuching Wetland National Park (KWNP) is one of the protected areas currently involved in a mangrove restoration project. Initially, Kuching Wetland National Park was known as „Sarawak Mangroves Forest Reserve“ with the area size of 17,153 hectares in 1924. However, about 6,610 hectares of the KWNP was gazetted as totally protected area in 2002 after undergone many excision for agricultural lands, settlements and industrial areas

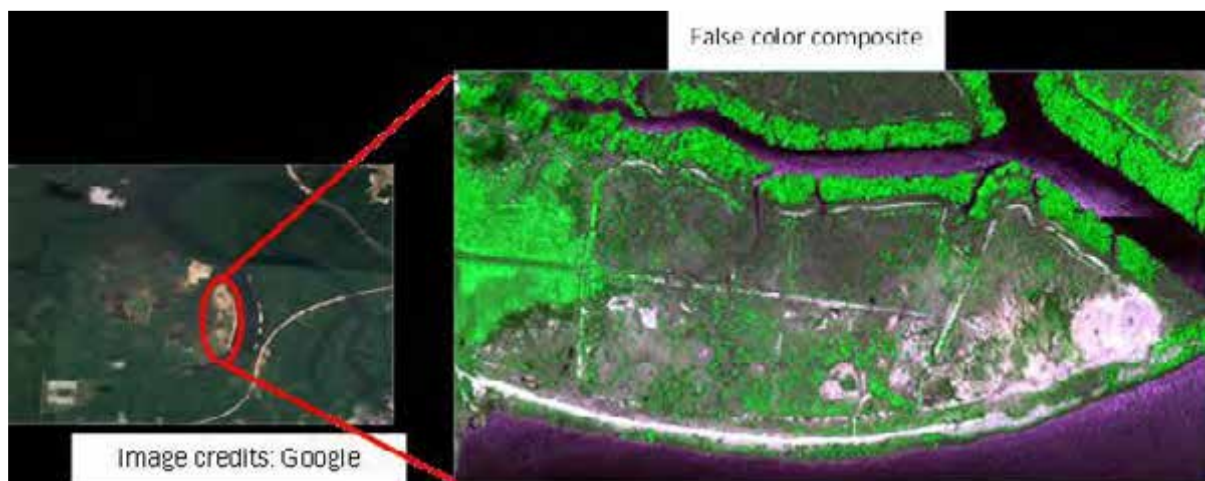
(Andrew et al., 2010). This park is the only protected site in Sarawak where a range of mangroves can be seen such as *Rhizophora* species and *Avicennia* species. It is also a habitat for notable wildlife including estuarine crocodiles and Irrawaddy dolphins.

Majority of the nutrient availability of mangrove forests is not contained in the tree but in the soil (Alongi et al., 2003). The rate growth of mangrove plant may not be the same at different types of soil. Consequently, their vegetation, species composition and structure may differ significantly at the global, regional and local scales (Vilarrubia, 2000; Sherman et al., 2003). The objectives for this research study are to observe the soil variation in mangrove rehabilitation using airborne hyperspectral image dataset, to explore the relationship of the soil properties and spectral response derived from hyperspectral image dataset and to develop a map that illustrate the spatial distribution of the different soil types applying both field and image spectroscopy in Sungai Lemidin.

2.0 MATERIALS AND METHODS

2.1 The Study Area

The present study is carried out at Sungai Lemidin in Kuching Wetland National Park (KWNP) which formed between two main rivers; Sungai Sibul on the western side and Sungai Salak on the east about 15 km north of Kuching, Sarawak (Figure 1). KWNP is a saline mangrove ecosystem which made up of estuarine deltas with well-developed dendritic deltaic channels and streams (Andrew et al., 2010). This study area was selected due to the area of exposed soil that has been disturbed as the soil is excavated from the river banks for the development of river diversion channel. Following that, mangroves restoration and rehabilitation project has been introduced by the RAMSAR Unit.



2.2 Fieldwork Design

Field survey was conducted in Sungai Lemidin, from May, 2017 to June, 2018 respectively. A total of 63 soil samples were collected with 3 replicates obtained 15 cm depth from the ground surface. The soil samples were air-dried, crushed by hand and filtered with a 2.00 mm sieve to eliminate grass roots and litters. The sampling points were recorded using AtlatLink. The coordinates of the point for soil sample collection

was recorded using AtlasLink™ GNSS Smart Antenna receiver. The physical and chemical properties of the soil were analysed and conducted at the soil laboratory of Faculty Resource Science and Technology, Universiti Malaysia Sarawak (UNIMAS). The content of sand, silt and clay were determined using hand feel method. The determination of the soil moisture and bulk density was calculated by gravimetric method and core method respectively. The analysis of pH is tested according to 1:5 glass electrode method.

2.3 Image Acquisition, Processing and Analysis.

The airborne hyperspectral imaging spectrometer used in this study was Specim's Aisa KESTREL 10 with spatial resolution of 0.5m per pixel. It measures irradiance in 184 spectral channels between 377.06 and 1003.21 nm, at 2500 m altitude with a ground speed of 166.68 km h⁻¹, on 25 February 2018 between 13:00 and 15:00 hrs.

2.4 Spectral Data Processing.

The images were analysed through ENVI Classic 5.1 software. The first step begins with collection of spectra from pure pixels of each object of interest such as bare soil, water body and vegetation. In order to classify the hyperspectral image based on spectral similarity and distinguishably, spectral information divergence (SID) is a method of classification of the hyperspectral image that calculates the divergence measure to compare each pixel spectra with reference spectra. A map is developed to illustrate the spatial distribution the various soil types and other cover types.

3.0 RESULTS AND DISCUSSION

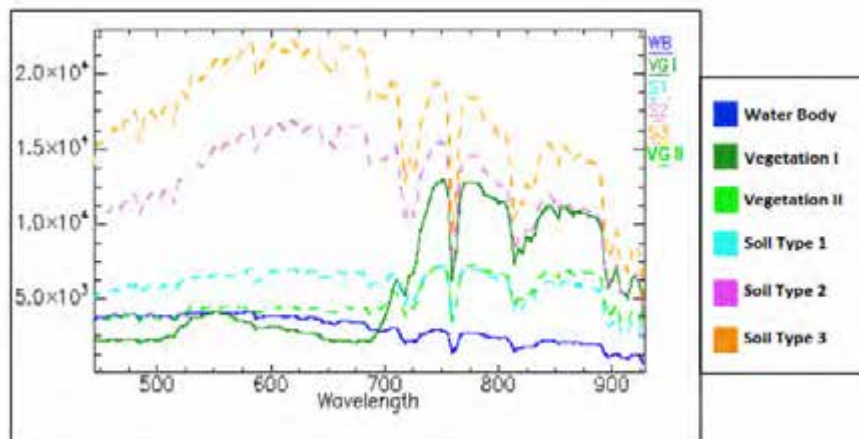


Figure 2. Comparison of spectral response curve for soil types and other cover types

There were three types of soil that are successfully identified in Sungai Lemidin. Each of the three soil types is different in physical characteristics, and consequently, its spectral response patterns. Spectral response pattern is defined as the magnitude of energy of an object that is reflected across the electromagnetic spectrum. Figure 2 showed the spectral response pattern for each of the soil types and other cover types.

The spectral reflectance of soil is affected by the chemical and physical properties of the soil. The soil properties that investigated in this study are chosen as they are known as edaphic constraints in mangroves restoration sites.

The soil properties of Soil Type 1; soil texture of silty clay loam, high water content (Range:4.43-8.53%), low bulk density (Range: 0.71-0.91g/cm³) and pH value of 5.05-5.71. As for Soil Type 2; soil texture of silty clay loam, low water content (Range: 2.23-3.83%), high bulk density (1.04-1.43 g/cm³) and pH value of 4.19-4.23. Soil Type 3 has almost similar soil characteristics (water content; range from 1.40 to 3.43%, bulk density: 1.24 - 1.58 g/cm³) with Soil Type 2 but different in soil texture, where it has soil texture of loamy sand and pH value of 2.65-2.96.

The spectral reflectance of the soil increases as the content of sand in the soil increases throughout the visible and near infrared region. Conferti et al. (2015) reported that the highest reflectance intensity was loamy sand because of the high presence of quartz in sand proportion. Sandy soil also affects water potential and overall biotic activity in the soil. On the other hand, the spectral reflectance of clay shows a linear relationship, as clay decreases the spectral reflectance. This is largely attributed to the high content of organic matter.

Fig. 3 (c) showed the highest reflectance of the soil, followed by Soil Type 2 in Fig. 3 (b) and which tallies with the ground data on Soil Type 3 and its texture of soil texture of loamy sand, whereby Soil Type 3 has higher percentage of sand compared to Soil Type 2 and Soil Type 1. Conversely, Soil Type 1 (Fig. 3a) has lowest reflectance intensity among the others and its soil texture is silty clay loam and has higher in clay content.

Soil water content is another factor that affects the spectral reflectance of the soil. The spectral reflectance of the soil decreases as the water content in the soil increases (Cierniewski & Kuśnierek, 2010). This is due to the higher the water content in the soil particles as it increases the absorption of the incident energy, resulting in lower reflectance intensity of the soil. Soil water content decreases for light colour soils with a low content of organic matter, compared to the dark colour soils. Soil Type 1 has the lowest soil reflectivity among the others and has higher water content in the soil.

There are no particular spectral response characteristics for soil pH and it cannot be identified by direct spectral analysis (Baghdadi & Zribi, 2016). Despite that, soil pH is one of the driving factors that affects growth rate of the mangroves same goes to the other soil properties. The difference in soil types corresponds to the growth rate of the planted mangroves, *Rhizophora mucronata* (Fig. 3e) in the Sungai Lemidin.

The growth performance of mangroves planted at Soil Type 1 is better compared to Soil Type 2 and Soil Type 3 as the mangroves are bigger in size (Fig. 4a) and they have pH value of 5 which is suitable for the plant growth. For Soil Type 2, the growth rate of the mangroves is lower compared to Soil Type 1 as the roots of the planted *R. mucronata* are unable to penetrate into the soil (Fig. 4b), due to the high bulk density in Soil Type 2.

Soil bulk density is an indicator for soil compaction. The high values of soil bulk density accounts for the high soil compaction. It is evident that the roots of planted *R. mucronata* are unable to penetrate into the ground. This has resulted in a stunted growth of the planted mangroves. For Soil Type 3, the planted mangroves also shows stunted growth, compared to

the *R. mucronata* that were planted in the same timeframe (Fig. 4c). Moreover, the low soil pH could account for the stunted growth of planted *R. mucronata*.

Vegetation II is area covered with sedges-- *Cyperus rotundus* (Fig. 4f). This area has similar soil characteristics of Soil Type 1. However, Vegetation II has the soil texture of loamy sand. The mangrove seedlings of *R. mucronata* planted in the area shows extremely poor growth (Figure 4d).

To illustrate the study sites aforementioned, the following map is created to elaborate the spatial variation of the all soil types that are identified in this study as shown in Figure 5.

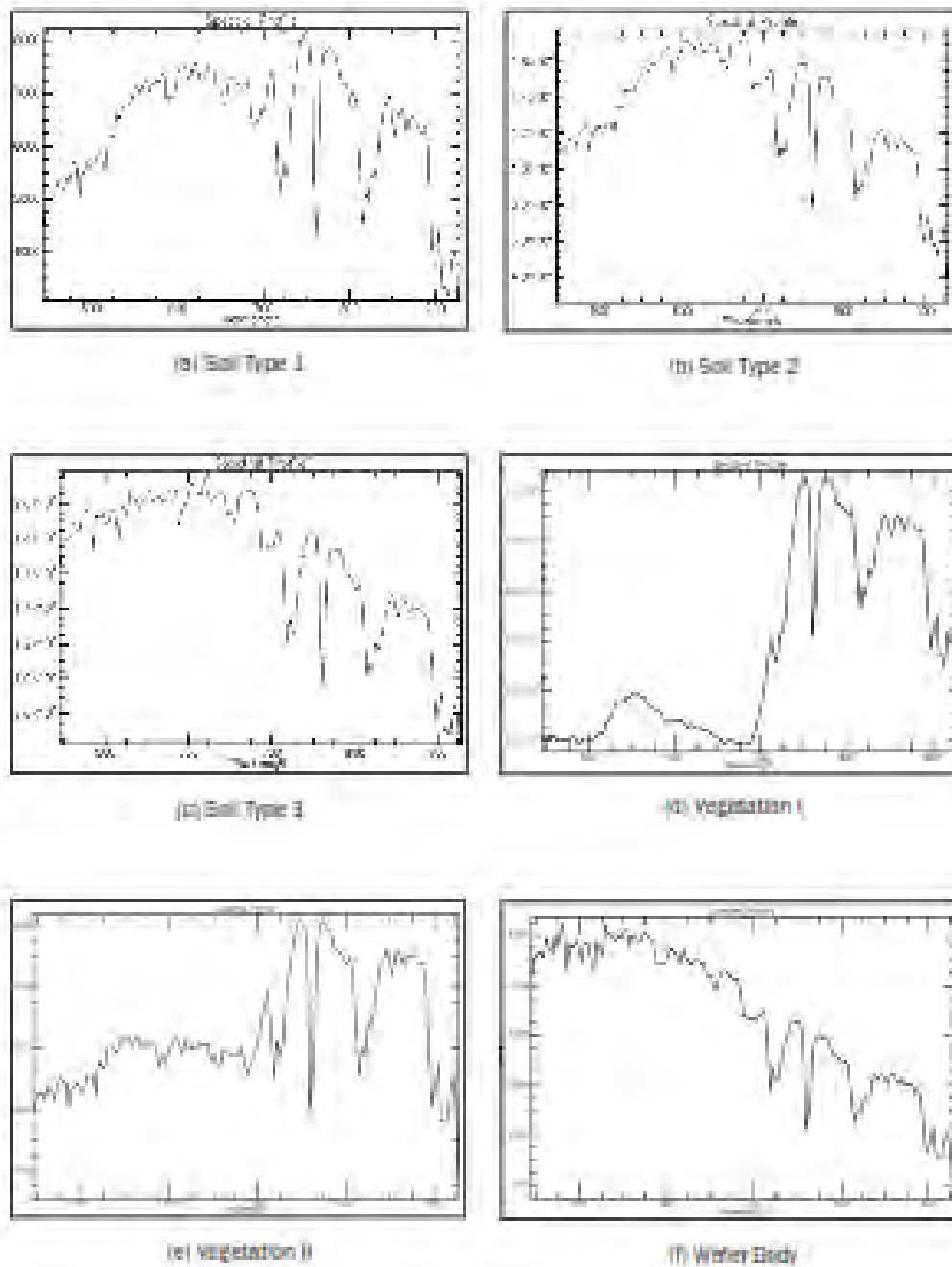
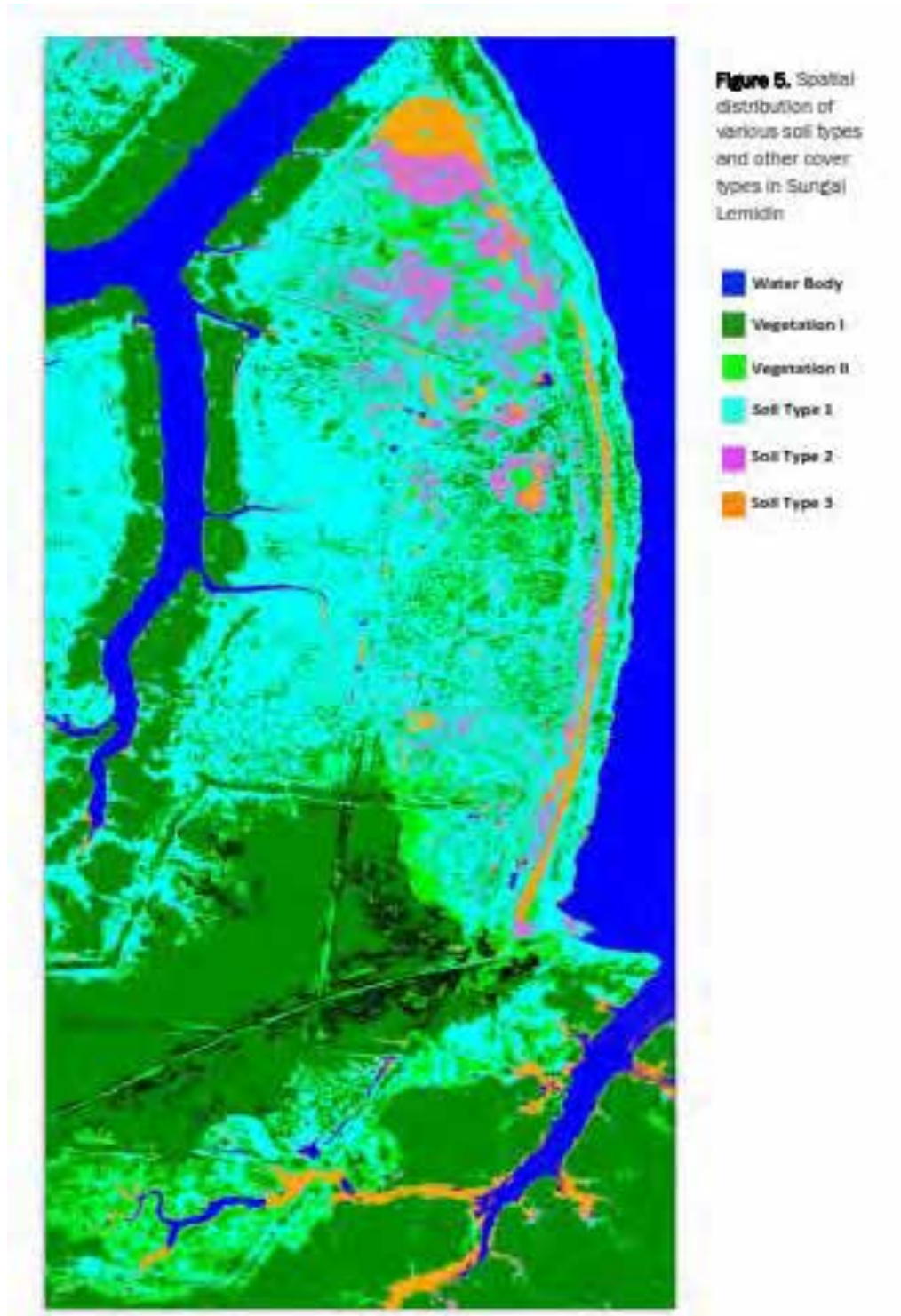


Figure 3. Spectral response patterns for all soil types and other cover types; (a) Soil Type 1, (b) Soil Type 2, (c) Soil Type 3, (d) Vegetation I, (e) Vegetation II and (f) Water Body (River)



Figure 4. The condition of the mangrove growth at different types of soil: (a) normal rate growth of the mangrove at Soil Type 1, (b) Slower rate growth at Soil Type 2 compared to Soil Type 1, Stunted growth (c) and (d), (e) Planted mangroves (*Rhizophora mucronata*) and (f) sedge known as *Cyperus rotundus*.



4.0 CONCLUSIONS

In a nutshell, an observation on the variation of the soil in Sungai Lemidin based on airborne hyperspectral image dataset is illustrated. Apart from that, the relationship between the soil physical and chemical properties and their spectral response curve derived from the hyperspectral image dataset is established. Hence, both of the information can be used as a guide for mangroves replanting project to determine suitable planting sites. As this study is still at its initial stage, it is suggested that Soil Type 1 is the most suitable site (high moisture

content, low bulk density, pH: 5-6 and silty clay loam) for mangroves replanting site in Sungai Lemidin.

5.0 RECOMMENDATIONS

Future works are considering the development of spectral vegetation indices that aims to identify the optimal planting sites of *Rhizophora mucronata* in Sungai Lemidin based on its functional soil properties, as a continuation research study to the primary soil properties that are identified in this study.

Acknowledgement

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PAPER 19: PES SCHEMES THROUGH MINI HYDRO PROJECTS IN FOREST RESERVES OF PERAK STATE, MALAYSIA

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Abstract

Our natural environment, particularly water, provides a variety of services to the wellbeing and economic prosperity. Payments for Environmental Services (PES) are praised as innovative policy instruments and influence the governance of forest conservation goals. One way to promote positive conservation goals is to value the ecosystem services from forested watersheds. Hydroelectric developers tend to neglect that the conservation and protection of watershed forests carried out by the Forestry Department that play essential part in their business. Water, which is sourced from dedicated watershed forest areas, has been undervalued as compared to the value of timber because of the lacking of formal market. Hydroelectric developers often compromise incomes from timber from productive forest. In order to supply sustainable flow of water, both in term of quality and quantity to the hydroelectric plant, watershed areas situated in productive forest become opportunity cost to the Forestry Department. Payment for Ecosystem Services (PES) mechanism implemented by Perak Forestry Department (FD) and Perak Hydro Renewable Energy Corporation (PHREC) is a win-win situation for both parties. Perak FD will ensure water quality (evenness of stream flow and quantity) to generate PHREC's mini hydro turbine, while generating sustainable and predictable income from the protection and conservation of river. The PES mechanism works on the logic of "compensating land users who adopt practices that generate environmental services", (Pagiola, et al., 2005). PES payments from PHREC's profits will be directly channelled through Perak FDs' Cess Fund. This payment will enable Perak FD to finance Sustainable Forest Management (SFM) projects such reforestation, maintenance of watershed and conservation of biodiversity. This paper will highlight the execution of PES schemes through Mini Hydro Projects in forest reserves of Perak.

Keywords: PES, Central Forest Spine (CFS)

1.0 INTRODUCTION

Payments for Ecosystem Services (PES) is a market-based instrument mechanism for conservation of environmental resources. This instrument also acts as a payment mechanism for environmental services that the forest provides to human. Through this mechanism, users have to compensate forest owners in the uplands who protect the forest and provide services such as water regulation, soil protection, flood control, biodiversity protection and landscape protection. In this mechanism, service providers are the organizations, people, or households who participate in forest protection activities or forest owners, and the users are the

individuals or organizations who benefit from the environmental services. In other words, PES is an incentive payment for the environmental services that the forest provides to human.

There are many definitions of PES, however Payment for Ecosystem Services (PES) can be broadly defined as a voluntary formal/informal contractual transaction between a buyer and a seller for an ecosystem service, or a land use/management practice likely to secure that service. United Nations Economic Commission for Europe (UNECE) (2014) describes that PES has a range of financing arrangement for the conservation and sustainable use of natural ecosystem, such as forests, to ensure that the cost to the environment is paid for. There is no universally applied PES model can be considered for any applications, to particular circumstances, but they share a provision of an appropriate compensatory mechanism for ecosystem service. In general, the services are linked to land use practices such as forest conservation, reforestation and sustainable utilization. Nevertheless, the key characteristics of PES scheme deal with maintaining/ensuring a flow of specified services such as clean water, biodiversity habitat or carbon sequestration capabilities (Matta, 2014).

Matta (2014) listed that PES is more than one-time finance contributions sourced from state subsidies, taxes, user fees, grants or loans or donation. A PES payment often reflect the amount enough to compensate the cost of conservation or the opportunity cost of forgone land uses or practices. To ensure the smooth running of a PES Scheme, a compliance mechanism or governance structure should be developed. The compliance mechanism should include negotiations, specifying eligible activities and payment levels as well as monitoring and evaluation. At the global level, Matta (2014) noted that the payments towards various ecosystem services of tropical forests in 2011 were up to the tune of USD1.25 billion, with payments to watershed services dominate, followed by carbon. Among the tropical forest countries, high share of forest areas under private ownership and better clarity of forest tenure are some of the factors that contribute to PES schemes.

2.0 BACKGROUND OF PERAK PES

In 2017 the total forested area in Perak was estimated to be 1 million hectares of which 997,871.27 hectares or 47.45% of the total land area of the state has been gazetted as Permanent Reserved Forest (PRF). In terms of forest conservation, 47.6% or 474,838.78 ha of PRF are totally protected for conservation, research, education, water catchment and environmental protection purposes of the total permanent reserved forest, while 52.39% or 522,581.15 ha are for sustainable timber harvesting purposes.

Perak Forestry Department (FD) manages about 159,866 hectares of the Forest Reserves gazetted as Water Catchment Forest on 20 August 2007 to ensure steady and consistence of water quantity supply for domestic, agriculture and industrial usage as well as to reduce sedimentation and biodiversity conservation. Today, the state government of Perak had up to last June 2016 gazetted 295,401ha of permanent forests reserve as water catchment areas making it the largest Water Catchment Forests coverage in Peninsular Malaysia.

Perak Hydro Renewable Energy Corporation Sdn. Bhd. (PHREC) is concessionaire or a private company that serves both as a developer and coordinator for private companies venture in mini hydro projects in Perak. PHREC carry out mini hydro projects under the Sustainable Energy Development Authority Malaysia (SEDA), which is established under the Sustainable Energy Development Authority Act 2011 [Act 726], under the Ministry of Energy, Green Technology and Water, Malaysia. It is made possible as Malaysia has passed

legislation intended to promote the use of renewable energy resources and has provided for a Feed-in Tariff (FiT) system which gives priority of purchase and distribution by the distribution licensee of renewable energy from Renewable Energy Installation(s) owned by Feed-in Approval Holder. The FiT, a 21-year fixed premium price 4 (RM0.24/kWH [<10 MW]; RM0.23/kWH) to be sold to power utilities, Malaysia's mechanism to catalyse the generation of Renewable Energy (RE) and to avoid the generation of CO₂ from power generation sectors. Conceptual diagram of a mini hydro in Perak appears in Plate A.

PHREC enters the Water Rights Agreement with Perak State Government to abstract, extract and/or utilize raw water for the operation of renewable energy installation. Perak Government promotes the usage of renewable energy and they facilitate PHREC in the construction, maintenance, ownership and management of 25 small hydro-electrical power generating plants in the State. As a return, PHREC agrees to make annual contributions of five percent (5%) of its net profit after tax (i) 2.5% to Corporate Social Responsibility activities identified Perak State Government; and (ii) 2.5% to Corporate Zakat responsibility. Twenty five potential mini hydroelectric projects identified by PHREC are shown in **Annex I**.

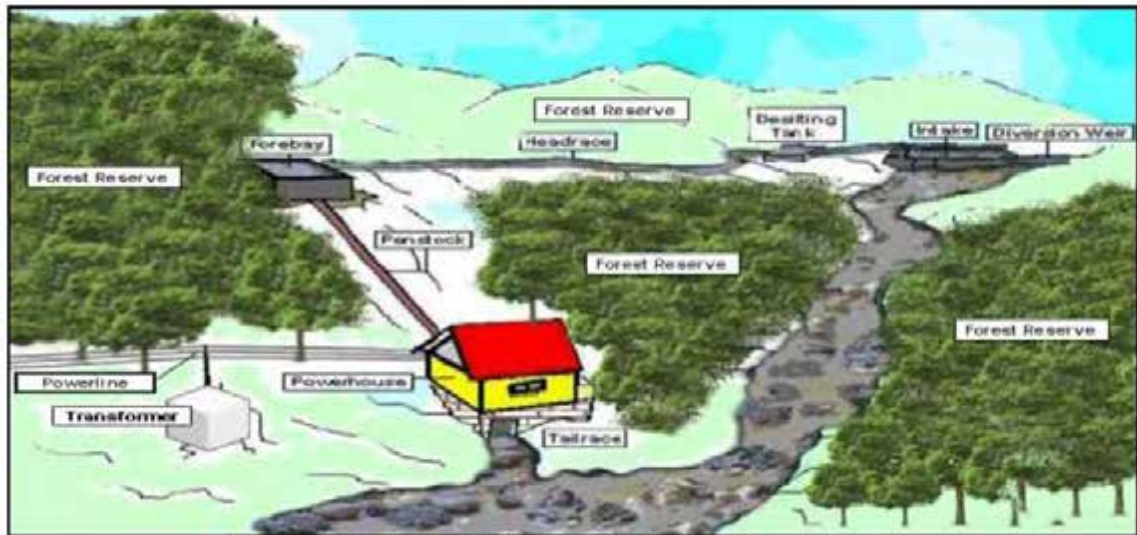


Plate A: Conceptual diagram of a mini hydro in Perak

3.0 DRIVERS TO PERAK PES

It is widely perceived that there are mismatch in term of incentives between upstream and downstream forestry activities. Perak FD realizes that sustainable and predictable fund sourced from forest compensation is needed to be used to carry out sustainable forest enforcement and management activities such as to manage, rehabilitate and reforest degraded forests in the State. On the other hand, as the manager for forest in the state, Perak FD has to play important role to supply the demand of raw water and the need to protect water resources and balance it to the sustainable income from timber extraction from the vast production forest within the forest reserves in the state.

From existing studies, it is estimated that the stumpage value for inland forests at RM10,000/hectare and the average annual water resource from a forest stand at 12,614 m³/hectare/year (Lai FS, 2004), giving that the value of water based on opportunity cost (stumpage equivalent) stands at RM0.82/m³. Based on the value, it is realized that FD deems to get appropriate compensation for water usage from the forest reserves to recover some of

the opportunity costs as some of the project areas are situated in productive forests that up for commercial extraction.

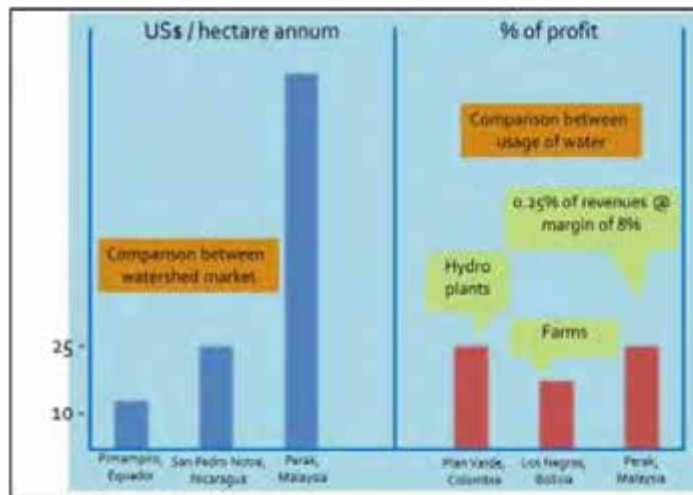
The management of water catchment has impacts on the quality and quantity dimension of water supply. Both quality (evenness of stream flow) and quantity (steady water flow) dimension are essential for PHREC. Those dimensions are crucial in their operations as they need steady quantity of water, evenness of flow and tolerable water quality (i.e. siltation) to optimize their cost of maintenance and smooth hydro turbine operation. Thus, FD and PHREC agree to a certain quantum of “opportunity cost” payment has to be made by PHREC to ensure optimum operation of the power house, with the cooperation of FD to implement an appropriate level of protection to the upstream of the project areas.

4.0 PES PAYMENT DERIVATION

Perak FD and PHREC agree that in order to get a suitable Perak PES payment quantum, a benchmark price (supply and demand level) has to be developed. To do this, PHREC engages Mandel Capital consultant firm to carry out comparison study and recommend a viable price for Perak PES. The price is derived through the comparison of usage of forest land and percentage of profit between existing internationally renowned PES projects, hydro projects and agriculture projects, notably located at the Central and South American continent. Summary of benchmark price derived from the study is shown in Table A.

From Mandel Capital’s comparison study, it is found that PES Perak has to be made voluntary if it is linked to the success of hydro projects in the other parts of the world (**Table 1**). Comparative study by Mandel Capital also found that a voluntary 0.25% of PHREC net revenue is appropriate to be charged under Perak PES as the proposed quantum exceeds the benchmarks as shown in **Graph A**. Salient points of the benchmark study are as follows:

- (i) The figure 0.25% of net revenue is similar to 3% share of the profit on electricity sales for other PES scheme (Colombian hydroelectricity producers, assuming revenues margins of 8-9%);
- (ii) Comparison between watershed markets in term of annual price gained for every hectare shows that the proposed 0.25% contribution for Perak PES is more than 3 times higher than both Pimampiro and San Pedro 6 Notre PES projects which stand at approximately USD12/hectare and USD25/hectare respectively;
- (iii) In term of comparisons between water usage reveal that 0.25% payment from revenues at the margin of 8-9% for Perak PES is comparable to Plan Varde, Columbia PES for hydroelectric but higher than Los Negros, Bolivia that carried out PES for agriculture; and
- (iv) In cognizant that all 25 proposed PHREC projects in the forest reserves (~155MW take-up), PES Perak has a potential annual contribution of RM500 thousands to the Cess Fund (**Graph B**).



Source: Mandel Capital



Source: Mandel Capital

Graph A:
Comparison between Perak PES and other PES projects in term of annual revenue per hectare and percentage of profit

Graph B:
Potential annual contribution of Perak PES compared to other PES projects (~ 155 MW take-up)

Table 1: Comparison of Selected Existing Payment for Ecosystem Services Payment

Project (Country)	Stakeholders (sponsor/beneficiary)	Objectives of project	Structure	Raise service offering	Monitoring and compliance
Plan Verde (Colombia)	Hydroelectric producers, farmers/Private land owners	- Reduction in sedimentation - Constant water supply	3% share of returns from hydro-electricity sales - Government funding via reallocation and agricultural users - Payment administratively determined (one-off and in kind) by a body under Ministry of Environment	- Increase in forest cover - Rehabilitation of micro watershed - Reforestation/Restoration	N/A
Compania Nacional de Fuerza y Luz - CNFL (Costa Rica)	Hydroelectric producers/Private land owners	- Reduction of flashfloods - Reduce sedimentation - Maximum/consistent water quantity throughout the year	- Periodical payment in cash - Managed by government intermediaries (FONAFIFO) - Private sector voluntary contribution - Local government budget	- Forest conservation - Protection of existing eco-system	Examine land management practices
San Pedro del Norte (Nicaragua)	Local municipal, domestic water user/Private land owners	Increase in water flow	- Payment of USD 25 per hectare per year - Municipal body take charge - PES contracts - Water tariff collections - Management of funds NGO (PASOLAC) provides technical assistance	- Improves agricultural practices - Reduction in deforestation - Alternatives to slash and burn practices	- Measurement of average water flow (i.e. cubic metres per day) - Conversion of seasonal water sources to permanent

Source: Mandel Capital

5.0 PERAK PES PAYMENT

PHREC's involvement in Perak PES is voluntary. The annual payment quantum is stipulated in Letter of Approval/Permit to Use issued by Perak FD to PHREC. The quantum will be reviewed from time to time. As reciprocal, Perak FD will maintain contiguous buffer zone at the upper of water intake points for mini hydro project. FD also allows flexibility to PHREC to expand donors to include NGOs and corporates.

PES transactions is intermediated through Forestry Cess Fund mechanism managed by Perak FD to promotes efficiency and transparent in transactions as well as to ensure allocation spent on forestry activities. Forestry Cess Fund is stipulated in the National Forestry Act (1993) and can only be used for forest management activities such as reforestation, silvicultural practices, forest patrolling, monitoring and enforcement.

6.0 PERAK PES SERVICE OFFERING

FD will undertake conservation of the identified within the Perak PES areas. In order to do this, FD will identify and protect catchment areas against rezoning by other relevant authorities, step-up surveillance and monitoring of logging activities within catchment zones to ensure strict adherence to sustainable state forestry practices. Appropriate enforcement activities or/and awareness programs for illegal forest occupants will also be carried out by FD. Limit of use in the water catchment will also be enhanced by FD by identifying buffer area (each side of stream/river) in the catchment protection, riparian conservation and strategic recharge zone conservation areas to achieve PHREC objectives as appears in Table 2.

Table 2: Limit of Use within Perak PES Areas

Service Offering	Perak FD Activities	PHREC Objectives
Catchment protection	- Identify and protect catchment areas against re-zoning by authorities - Stepped-up surveillance and monitoring of timber extraction activities to ensure strict adherence to sustainable state forestry practices - Appropriate enforcement or/and awareness program for illegal land Orang Asli occupants (if any) with the promotion of agroforestry and ecological farming techniques (i.e. avoid slash and burn)	- Water yield - Evenness of stream flow - Water quality
Riparian conservation	- Special zoning of riparian areas (each side), defined as: 5m buffer zone for stream width of <1m 10m buffer zone for stream width of 1-2m 20m buffer zone for stream width of >2m - Stepped-up surveillance to promote conservation	Water quality (siltation)

Service Offering	Perak FD Activities	PHREC Objectives
	Replanting of heavily degraded areas	
Strategic recharge zone conservation	- To identify special areas (i.e. areas surrounding wetlands) within catchment areas - Stepped-up surveillance and monitoring of timber extraction activities - Replanting / protection of areas	Evenness of flow – maximum buffering

7.0 PERAK PES COMPLIANCY

It is agreed that periodic cash payment based on performance to ensure compliance. There are 3 level of monitoring mechanisms in the implementation of Perak PES. They are visual inspection of land use, forest cover via satellite imaging and sediment monitoring. There are also joint site visits to monitor land use by FD and PHREC. It will be instituted that non-compliance will end to PES payment suspension.

8.0 CONCLUSIONS

PES is a useful model for enhancing the sustainable management of forest for watershed protection and also to provide compensatory mechanism to the services provider that generate environmental services. The compensation is arranged as a deal offered to service providers by land users to continue generating the environmental services to the later, but the contractual arrangement has to be clearly defined and established between both parties.

PHREC's involvement in PERAK PES is voluntary. PHREC or hydro developers to pay 0.25% of their revenues to Perak FD. The payment quantum is stipulated in Letter of Approval/Permit to Use issued by Perak FD to PHREC. The payment quantum will be reviewed from time to time.

Transactions intermediated through Forestry Cess Fund mechanism managed by Perak FD to promotes efficiency and transparent in transactions as well as to ensure allocation spent on forestry activities.

Perak FD will maintain contiguous buffer zone at the upper of water intake points for mini hydro project and carry out forest management activities such as reforestation, silvicultural practices, forest patrolling, monitoring and enforcement.

Perak PES quantum of payment reflects the amount sufficient to compensate the cost of conservation or the opportunity cost of forgone forest land uses in the project area. Although there is no precedent, a benchmark price (supply and demand level) developed by consultant through comparison of usage of forest land and percentage of profit between existing internationally renowned PES projects, hydro projects and agriculture projects around the globe.

Perak PES implementation is made possible with the combinations of drivers such as appropriate Federal Government incentive and policy, State Government supports and deep understanding among managers in PHREC. It is believed that PES from water usage sourced from Forest Reserve will become a major revenue contributor in the future if synergistic policy, fair incentive, sound legislation and good pricing put in place. Thus Perak PES rejects conventional wisdom that a PES scheme can only be done with community-owned forest.

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PAPER 20: CREATING GREEN LUNG FOR MIRI THROUGH THE “BRING BACK THE RAINFOREST” PROJECT

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Abstract

Sarawak is blessed with plentiful species of flora and fauna which are not only can be seen in rural areas, but also in urban areas like Piasau Nature Reserve (PNR). PNR was previously known as Piasau Camp and served as the housing estate for SHELL expatriates. This area has been one of the notable breeding habitats for Oriental Pied hornbills in Miri City and was successfully gazetted as a nature park in 2013 to protect the wildlife habitat especially the hornbills. In 2016, Bring Back the Rainforest Project (BBTRF) was implemented in line with the approaches in Gensler Masterplan to create green lung for Miri City. The five approaches include conservation, optimization, diversification, research and community. This project aims to rehabilitate degraded areas as well as enhancing wildlife habitat in PNR through enrichment planting of native plant species and to extend ownership of the project to public in wildlife conservation through adoption programs. Through this project, PNR not only serves as recreational area and social centre, but it also provides refuge area for the wildlife to ensure their survival.

Keywords: Piasau Nature Reserve (PNR), hornbills, conservation

1.0 INTRODUCTION

Piasau Nature Reserve (PNR) is one of the protected areas established under the National Parks and Nature Reserves Ordinance 1998. Of fourteen nature reserves found in Sarawak, six including PNR are considered as urban forest park. The aim of establishing urban forest park in Sarawak are to promote multiple uses and benefits of forest through encouraging outdoor recreation, nature conservation education and nature-based tourism as well as to create reserve and refuge for wildlife. These parks serve as the "green lung" for the city and provide green corridor for the city dwellers.

2.0 PIASAU CAMP

The Piasau Camp (PC) was a housing estate, built in the 1970's for the Sarawak Shell Berhad. It was located within the vicinity of Miri City and held approximately 175 houses.

In close proximity to the Camp's northern perimeter is a Casuarina plantation and dense native undergrowth which functions as a wind break for the Camp. Casuarinas also dominate much of the vegetative landscape throughout the Camp, thus providing suitable microhabitat for the Oriental Pied hornbills (OPH) *Anthracoceros albirostris*. In 2013, PC was turned into a nature reserve with strong support from the local government to protect wildlife habitat especially the hornbills, *A. albirostris*.

3.0 PIASAU NATURE RESERVE

Piasau Nature Reserve (PNR) is located 5km north of Miri City with a size of 88.6 hectare. It was gazetted as a nature reserve on 31st December 2013. Taking cognizance of the importance of PNR to the ecology and also conservation of flora and fauna, the Piasau Nature Reserve Masterplan has been formulated to target at the followings:

- (i) **Conservation** – Define and restore areas of biodiversity protection;
- (ii) **Optimisation**– Manage access to recreational users with existing infrastructure;
- (iii) **Diversification** – Offer immersive educational experiences to increase awareness;
- (iv) **Research**– Strengthen the unique conservation mission through research and study; and
- (v) **Community** – Engender community pride and sense of ownership.

In PNR Masterplan, the reserve is divided into three zones including Zone 1, Zone 2 and Zone 3. It is divided in such way that the effort to conserve PNR's biodiversity and the multi-utilisation of PNR as a conservation education facility as well as recreational area can be fully maximised. The Zone 1 (Wilderness Area, 33.9 ha) is used solely for conservation with no public access is allowed, Zone 2 (for Visitor Use, 30.9 ha) is accessible by the public especially for bird watching activity and in Zone 3 (for High Density Use, 23.7 ha), there are facilities that have been improved as a learning centre for conducting public awareness program. Other public facilities include connected public path for cycling and jogging that have been developed on deconstructed existing roadways.

In line with the Government effort in conserving wildlife, Sarawak Forestry Corporation (SFC) has outlined nature restoration and recreation development initiatives to further develop PNR. One of the initiatives is the 'Bring Back the Rainforest' Project. This project is part of the bigger nature restoration initiatives where various native plant species have been planted on barren areas in PNR.

4.0 BIODIVERSITY IN PIASAU NATURE RESERVE

The biodiversity of PNR has conservation and ecological values.

4.1 Flora

There is a total of 31 tree species from 18 families recorded. For shrubs and bushes group, there are 16 species types from 8 different families. There is a total of 9 species of palms and 11 species of ferns and fern allies from 5 different families. There are 12 species of climbers and creepers recorded from 5 families. Some 22 species of grasses and herbs from 9 different families were recorded in the study area. Only three species of bamboo were recorded and one of it was planted as ornamental (UNIMAS, 2013).

4.2 Fauna

In the REA Report on Piasau Camp prepared by ERM in 2006, 12 species of trees, two species of mammal and 39 species of birds, including the Oriental Pied Hornbill (OPH), were recorded (ERM 2006). UNIMAS, 2013 reported forty five species of bird, 3 species of mammals, 5 species of amphibian, 12 species of reptile and 10 species of butterfly were recorded. The common birds seen and heard include Yellow-vented

Bulbul, Eurasian Tree Sparrow, Asian Glossy Starling and Pink-necked Green Pigeon. The White-collared Kingfisher can be heard all over the Camp. One hundred and one species of plant comprising mainly mostly trees and treelets (47 species), climbers and creepers (11 species), ferns (11 species) and grass and sedges (14 species) were also recorded. Sixteen fauna species are protected under Wild Life Protection Ordinance 1998 and therefore have high conservation values; these include 12 species of bird, one mammal and three reptiles.

5.0 PIASAU NATURE RESERVE MASTERPLAN

In Gensler's Masterplan, the 5 main approaches that were adapted include conservation, optimization, diversification, research and community. Through biodiversity studies of the reserve, Zones have been defined into three and its respective features, Zone 1 (Wilderness area), Zone 2 (Visitor Used) and Zone 3 (High density used). Refer to map of zoning area by Gensler (Fig.1).



Fig.1. Zonation by Gensler

6.0 BRING BACK THE RAINFOREST

'Bring Back the Rainforest' (BBtRF) Project is an initiative by SARAWAK FORESTRY as part of the habitat rehabilitation efforts to bring back the rainforest landscape to Piasau Nature Reserve (PNR). A total of 64.8 hectares have been identified for replanting. High intensity planting will be conducted in Zone 1 covering 33.9 hectares while selected planting will be conducted in Zone 2 covering 30.9 hectares.

6.1 Project Components

The project aims at rehabilitating degraded forest areas in Piasau Nature Reserve through the two following components:

6.1.1 Enrichment Planting

Various native plant species have been planted at PNR to provide sufficient food sources and a conducive environment for the wildlife residing within the Nature

Reserve. These trees will grow and start to bear fruits in many years to come. Under the BBtRF Project, five gardens, namely, Piasau Garden, Mixed Species Garden, Fruit Tree Garden, Ficus Garden, Piasau Garden and Herbal Garden have been established in 2016.

6.1.2 Adoption Programme

The adoption programme has been developed to provide a platform to engage stakeholders, i.e., general public, NGOs, learning institutions, government agencies, private companies and others to participate and contribute in the habitat restoration and wildlife conservation efforts at PNR. Apart from that, the programme is envisaged to promote awareness on wild life conservation and foster a sense of environmental stewardship amongst adopters.

6.2 Objectives Of The Project

The BBTRF gardens will serve similar roles as the botanic garden in plant conservation and education such as:

6.2.1 Develop Horticultural and Cultivation Skills

Species diversity can be conserved in the gardens as horticultural and cultivation skills allow original species that were once at Piasau to be planted back. Apart from that, restoration and rehabilitation of degraded habitats would be made possible through the development of these skills.

6.2.2 Living Collections of Plants

The collections of the various plant species in the gardens will serve as gene pools where plant genetic materials are conserved.

6.2.3 Education

The gardens would provide avenues for outdoor learning experiences through thematic interpretation.

6.2.4 Providing suitable habitat for Oriental Pied hornbills

PNR is now renowned for the breeding Oriental Pied hornbills (OPH) residing within the Nature Reserve. The planting of food trees will provide shelter and supply sufficient food to not only hornbills but also other wildlife species at the Nature Reserve.

6.2.5 Transforming PNR as a Major Birding Area

When the trees mature and produce fruits, PNR will be a haven for the birds and other wildlife species. The congregation of the birds and other wildlife will be a sight to behold and this will surely attract birders and nature lovers to the Nature Reserve.

7.0 CHALLENGES

PNR is located between South China Sea and Miri River. This topography factor cause inconsistency micro-climate in PNR. The open area will dry up very fast during dry season and could be flooded in few days, during raining season. This situation is cause difficulty for new planted plant seedling to grow, especially species that is not originally grow in this area.

Another problem in planting tree seedling in PNR is the condition of the soil in this area. PNR have been degraded since 1950, the soil condition in this area is categories in poor condition and additional of that, Piasau also cover by sandy beach forest. One of the major problem in this project is to plant tree species that found in other forest type.

8.0 RESEARCH AND DEVELOPMENT

Database for planted tree in project areas, e.g. gardens and adoption plots have been established to monitor and recording the growth rate of each plant and also species suitability for PNR condition. Based on data based analysis, some research have been conducted to improve the growth rate and also reduce seedling mortality rate. Research and development that conducted to improve the survival of the plant seedling such as:

8.1 Soil Condition Improvement

Planting methodology that adopted and applied in this project is the method that is frequently used for poor soil condition such as kerangas forest and sandy area. In this method, planting hole with size 2' x 2' had filled up with a mixture of top-soil with organic fertilizer and charcoal chip.

8.2 Irrigation and Drainages System

Dripping irrigation system had been installed to supply sufficient water for new planted seedling. The plant species that need more humid condition such as *Eugenia* spp. and *Pometia* spp., additional water will be supplied manually.

Main drainage surrounding the area have been improved and maintained to reduce the area size that frequently flooded.

8.3 Retain Micro-Habitat

The buffer stripes between the houses during Piasau Camp, bushes and grasses in open area are still retain to conserve micro-habitat in the reserve. This is not only conserve the wildlife, is also to maintain the humidity and provide shade to new planted seedling.

8.4 Species Matching

Plant species selection not only based on the garden term but also on the suitability of species in PNR topography and soil condition. Priority is to species that found grow in the reserve such as *Ficus microcarpa*, Luis and Bintangor Laut. Other food plant that growing well in PNR are Sentang, *Eugenia* sp. and *Artocarpus* sp.

8.5 Other Conservation Efforts

Information are gathered from various organisations including local universities and institutions such as Forest Research Institute Malaysia (FRIM) to improve and ensure plant survival.

9.0 OTHER PNR'S VALUE SERVING AS GREEN LUNG FOR MIRI TOWN

9.1 Nature Recreational

PNR is located at strategic location in Miri, 5 km north of Miri City Centre in the suburb of Piasau, on the beach side of Miri River. The network of access roads and flat terrain makes Piasau Camp excellent for leisure walking, jogging or cycling for all age groups and gender.

9.2 CEPA

PNR is a centre of Conservation Education Program with school children and college's student in Miri town.

9.3 Interpretation Centre

The Interpretation Centres is a facility equipped with information of PNR.

9.4 Volunteer work

PNR is a manifestation of an active participation and strong support from local communities in re-planting activities and conservation of wildlife. Program such as tree planting, establishment of Community Trail and Hornbill Run have been organised by NGOs in Miri to promote conservation of OPH.

10.0 CONCLUSION

Bring Back the Rainforest program is habitat rehabilitation effort that transform PNR to Urban Forest Park and acts as a 'green lung' for Miri citizen.

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Sub Theme 6:

Forest Beyond Timber, Social Forestry,
Ecotourism, Education Programmes, Non
Timber Forest Products (NTFP)

**PAPER 21: SPORT FISHING FOR SUSTAINABLE NON-TIMBER
FOREST PRODUCT (NTFP) AT PUAH RESERVOIR, TERENGGANU:
A CASE STUDY AND PRELIMINARY ASSESSMENT**

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Abstract

Lake formation that resulted from dam development/impoundment may impact natural forest resources. However, this reservoir forms new aquatic ecosystem enriched with fishery resources hence creates new potential for Non-Timber Forest Products (NTFPs) such as sport fishing. A preliminary assessment was conducted at four fishing spots within Puah Reservoir with the aim to determine the impact of sport fishing programme on fish population and to assess the potential of sport fishing as component of the NTFP. The preliminary assessment was carried out from March to October 2017 (non-commercial trial) and from November 2017 to May 2018 (commercial trial). The highest average of fish strikes per angler was recorded in November 2017 with the value of 11 hence it was set as a benchmark for good strikes at Puah Reservoir. Based on the fish strikes population, Sebarau fish had the highest with 71.5% of the strikes belong to this species. The total net income for six months of the commercial trial was RM35,560.00 from a total of 292, indicating a promising product in the future. As a conclusion, the sport fishing at Puah Reservoir supports the NTFP that can play as forest conservation, sustainable environment and improving the livelihoods of related local communities.

Keywords: Non-timber forest product (NTFP); potential economic, Puah Reservoir

1.0 INTRODUCTION

Puah Reservoir formation that resulted from impoundment for hydroelectric generation and water supply resulting the changes of natural forest resources. However, this reservoir creates new aquatic ecosystem enriched with fishery resources. This new resources will replenish during early formation of the reservoir hence creates new potential for Non-Timber Forest Product (NTFP). Information on knowledge and product value of the NTFP may provide idea to the management of tropical forests to benefit of local people. One of the NTFP initiatives that was created is catch and release sport fishing at Puah Reservoir, Tembat Forest Reserve. This NTFP is a collaborative work of Jabatan Perhutanan Negeri Terengganu (JPNT) and Tenaga Nasional Berhad Research Sdn. Bhd (TNBR). With the project of “*Research on Wildlife And Habitat Ecosystem Adaptation With Hulu Terengganu Hydroelectric Project Development For Sustainable Lake And Catchment Management*” from 2016 to 2019. The approval of this project was given with special permission

according to Section 47 (1) (e), National Forestry Act (Adoption) Enactment 1994 Terengganu State. This project was implemented with local community involvement through In-house Guide where they will appointed to monitor, observe and informer to the department for any illegal fishing within the Puah Reservoir, Tembat Forest Reserve. Besides, this project will strengthen their capacity in the sustainable management of natural resources and to create income generation at Puah Reservoir. A preliminary assessment of the sport fishing was carried out with the following objectives; to ensure sustainability of fish population and promoting catch and release sport fishing as one of non-timber forest products (NTFP). **Figure 1** shows a timeline of sport fishing implementation as NTFP.



2.0 METHODOLOGY

The assessment of the sport fishing programme was carried out from March to October 2017 (non-commercial trial) and from November 2017 to May 2018 (commercial trial) but was temporarily closed from December 2017 to mid-January 2018 due to rainy season. During the assessment, three boats were deployed by six appointed In-house Guide which from the trained local community. The activity was carried out three days every week; Thursday, Saturday and Sunday. Five initial locations were selected such as Sg. Terengganu Mati, Sg. Limbang, Sg. Pelagong, Sg. Sireh and Tembat Outlet (Sg. Jalang) (**Fig. 2**). After the non-commercial trial, only four locations except Tembat Outlet were selected for the commercial trial. Anglers were charged RM350/boat for all the locations where one boat can occupy a maximum of three person including a guide. During the assessment, most of the technique used was casting. All the fish catch will be recorded their species, length and weight, and tagged before being released to the reservoir. Meanwhile, the most dominant species will be analysed their length-frequency data to estimate the current fish population using Fishery Stock Assessment Tools (FiSAT II) software.

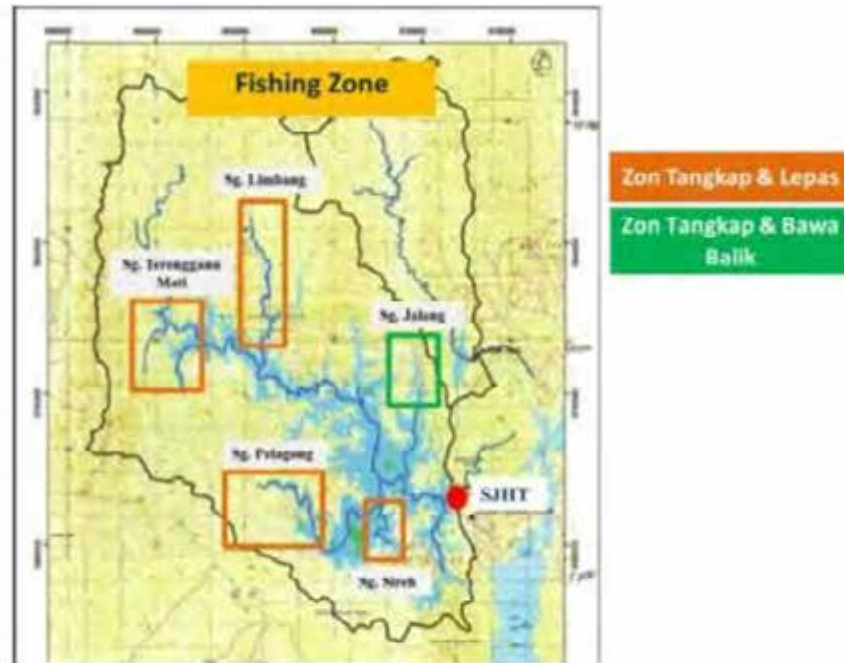


Figure 2: Sport fishing location at Puah Reservoir, Terengganu.

3.0 RESULTS AND DISCUSSION

Six fish species were recorded namely Sebarau (*Hampala macrolepidota*), Tengas (*Neolissochilus soroides*), Tengas daun (*Poropuntius smedleyi*), Baung (*Hemibagrus capitulum*), Haruan (*Channa striata*) and Bujuk (*Channa lucius*). **Figure 3** shows sebarau had the highest strikes with 71.5% followed by Haruan (11.2%) and Bujuk (9.6%). Among all locations, Sg. Pelagong had the highest strikes compared to others (**Fig. 4**). Based on fish strikes per angler, the highest was recorded in November 2017 with an average of 11 strikes per angler in which most of them were professional anglers. Thus, it was set as benchmark or reference for best strikes at Puah Reservoir (**Fig. 5**). The result also showed the encroachment (overexploitation) had influenced the average of fish strikes during the assessment. The encroachment had also one of the factors impacted the population status of the most dominant species, Sebarau as it exceed the sustainable limit of this species (Actual exploitation rate – 0.78 > sustainable reference – 0.56) (**Fig. 6**). Based on revenue, there is an increase of the value indicating an increasing demand and willingness to pay from the anglers (**Fig. 7**). The income per month (part time basis) is based on the numbers of anglers registered for the Sport Fishing programme. The total net income gained by the In-House Guide was RM35, 560.00 and the operational cost comprised of boat fuel, forestry entrance permit and maintenance fee (30% of gross income). The programme had received major supports from anglers where more than 90% of them support the idea of catch and release, willing to pay with the current fees and satisfied with services from the In-House Guide (**Fig. 8**). Future potential commercial value of sport fishing as NTFP at Puah Reservoir was estimated from the total number of tourists at Terengganu National Park (**Fig. 9**). It was estimated that the target of gross income is RM245, 000.00/year or RM24, 500/month.

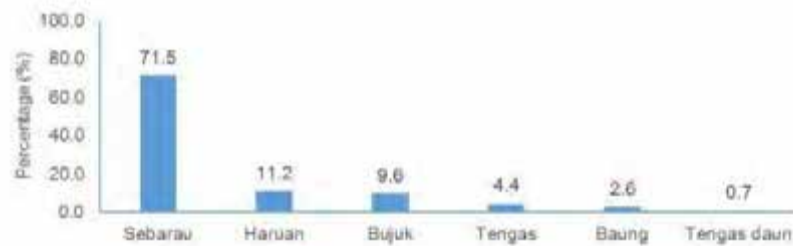


Figure 3. Percentage by species of fish strikes by anglers from the sport fishing at Puah Reservoir, Terengganu.

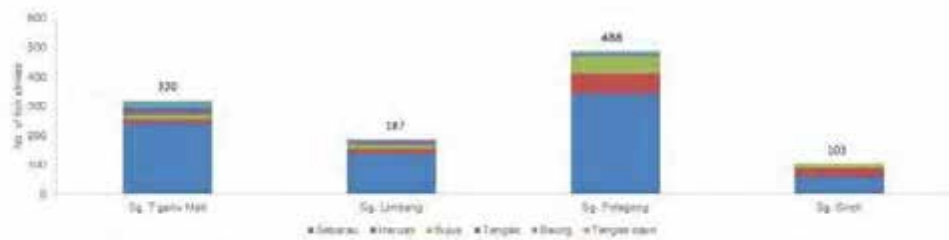


Figure 4. Fish strikes composition by sport fishing location of Puah Reservoir, Terengganu.

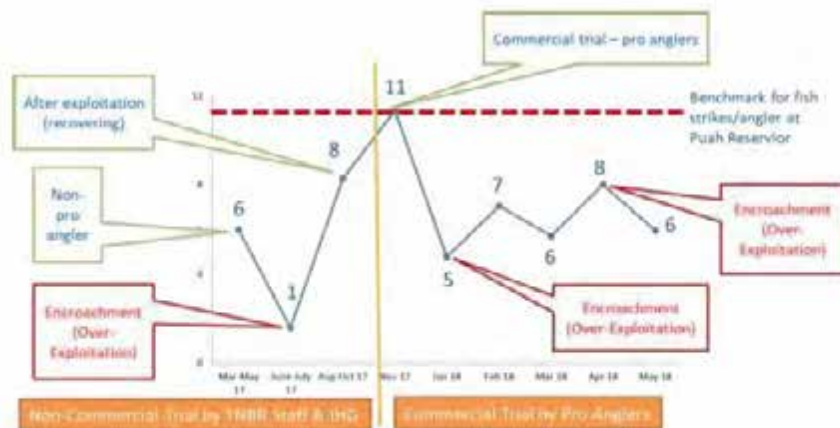


Figure 5. Average of fish strikes per angler during non-commercial and commercial trials at Puah Reservoir.

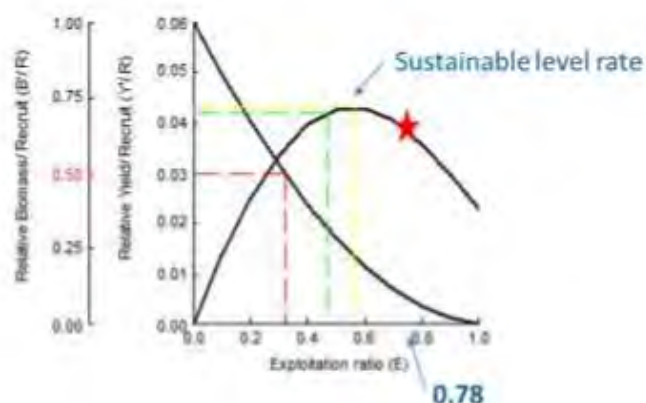


Figure 6. Estimation of current status of Sebarau population at Puah Reservoir.

Month	No. of Anglers	Gross Income	Operational cost	Net Income	Average Income/Guide
Nov	50	8,750.00	2,650.00	6,100.00	1016.67
Dec	-	-	-	-	-
Jan	30	5,250.00	1,750.00	3,500.00	583.33
Feb	74	12,950.00	3,730.00	9,220.00	1536.67
Mac	62	10,850.00	3,190.00	7,660.00	1276.67
April	56	9,800.00	2,920.00	6,880.00	1146.67
Mei	20	3,500.00	1,300.00	2,200.00	366.67
Total	292	51,100.00	15,540.00	35,560.00	5926.67

Figure 7. Sport fishing financial report (November 17 – May 2018).

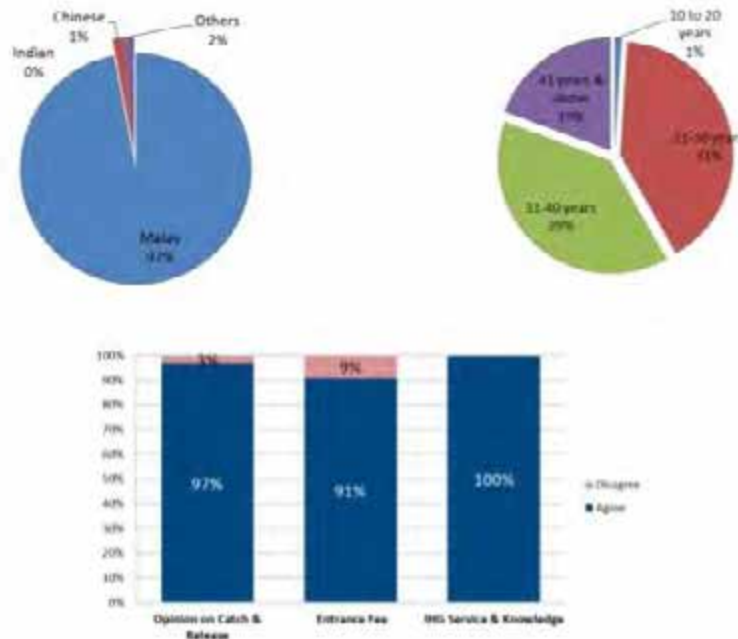


Figure 8. Feedbacks from anglers.

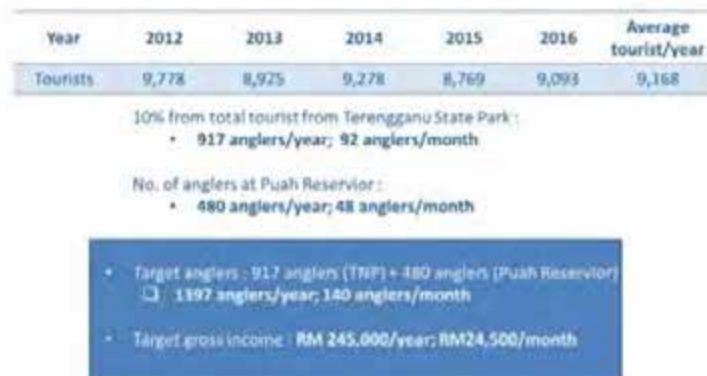


Figure 9. Total number of tourists at Terengganu National Park from 2012 to 2016 and estimation of future potential commercial value of sport fishing as NTFPs at Puah Reservoir.

4.0 CONCLUSION

The sport fishing project had good potential to expand as NTFP and can be a new source of income to local community and the government based on the preliminary results. This project also help the department to cooperate with local community to patrol and monitor against trespasser of the forest reserve. For way forward of sport fishing programme, all suggestions are summarized in **Table 1**.

Table 1. Summaries and suggestions of sport fishing way forward as component of NTFP.

Environment	Economy	Social
NTFP: Sport Fishing Management Plan for Puah and Tembat Reservoir - To develop comprehensive plan to manage fish resources sustainably (National Forestry Act, Enactment & Regulation) – Monitoring & Enforcement	To assess/determine economic potential from SF in generating income/benefit (tangible and intangible value) to national, state and community	CEPA 1: Awareness on law and regulation to educate public & anglers on Enactment & Regulation (eg. Refer to information board) - Section 47(1)(c)-entrance - Briefing prior to enter Puah and Tembat reservoirs
Guideline: To develop resource (fish) management guideline which addressed under APN Section 81(1)(f)	To suggest State Authorities to legalize sport fishing at Puah and Tembat reservoirs (Use Permits) – APN under Section 32,33&34	CEPA 2: IHG –to educate and train community (Training module)- involvement of community on monitoring and mitigation/prevention of illegal activities
To proceed to the next phase with aim to study the maximum carrying capacity of sport fishing programme at Puah and Tembat reservoirs to ensure sustainability of this programme	To enhance human resource capacity and competency of logistics and accommodation to increase source of income (e.g. homestay)	Active involvement of local communities to handle sport fishing at Puah and Tembat reservoirs
Application of NBOS initiative to enhance patrolling, security and enforcement (Department of Fisheries, PERHILITAN, Department of Environment, Marine Police) at Puah and Tembat reservoirs that is located in Forest Reserve to ensure sustainability of NTFP resources (fisheries)	To recommend the State Authorities to fix reasonable rate for Use Permits to generate new earning income for sport fishing programme at Puah Reservoir - to empower JPNT on implementing of sport fishing as NTFP [APN under Section 111(1),(2),(3)] This is an alternative	• JPNT to lead sport fishing initiatives at Puah and Tembat Reservoir support by other Govt/Non-Govt Agencies (eg. Dept. of Fisheries, PERHILITAN, TNB etc.) • To develop training module for In-House Guide for Community Based Eco-Tourism • To obtain recognition of

from illegal exploitation.	income for logging product.	sport fishing at Puah and Tembat Reservoir as NTFP that benefits to environment, economic and social at national/international level • JPNT to become role model for sport fishing as NTFP

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**PAPER 22: *BEGINNING OF A JOURNEY ...*
IMPLEMENTATION OF GAHARU AGRONOMY AT ULU SUNGAI
MENYANG CONSERVATION AREA**

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Abstract

Gaharu is a local vernacular name for the aromatic resinous wood produced by species of evergreen tropical trees from the genus *Aquilaria*. The tagline “*Beginning of A Journey ...*” is the brand ambassador and ground-breaking conservation business model implemented by Forest Department Sarawak to uplift the livelihood of the communities within Ulu Sungai Menyang Conservation Area at Batang Ai. It is part of the strategy to generate alternative income while conserving the pristine forests there under the Orang-utan Strategic Action Plan adopted by the state government. Therefore, conservation is the fundamental pillar of this program; striking a balance between conservation objectives while generating realistic alternative livelihood for the local communities. In this paper, threats and challenges to this area will be discussed and mitigation measures proposed. Unlike tradition concept of cultivating *Aquilaria* trees for the resinous wood, this model capitalising on a new market product — gaharu tea — as alternative cash crop. We propose to cultivate *Aquilaria* trees for their leaves. The advantages and environment friendliness of gaharu cultivation, such as zero deforestation, zero weedicide or pesticide policy will be deliberated. From a business perspective, this model is viable because of the involvement of a Sarawak-based company that has already marketed its own brand of premium gaharu tea. Forest Department is merely the bridging agent between the local communities and this business entity. The feasibility and economic viability of this model will be presented and compared with other cash crops such as pepper or oil palm. The potential income generated from gaharu leaves is estimated to be in the range of RM4,500 – 5,400/acre/year. As conclusion, gaharu agronomy may well be a game changer in balancing conservation aims while satisfying the aspirations of the local communities. Never in the history of conservation efforts in Sarawak that such a bold plan have ever been conceived. It is perhaps there is not a single NTPF, at least not until now, that is valuable enough to offset competition from other cash crop. Hence, the beginning of a journey ...

1.0 BACKGROUND INFORMATION

1.1. What is Gaharu?

Gaharu is the Malay word for agarwood, and can be considered one of the most valuable natural wood products. The sweet aromatic fragrance of smouldering agarwood is treasured by many cultures. The antiquity of agarwood usage is embedded in the custom and culture in Middle East (Antonopoulou et al., 2010), China (Anon., 2005), Tibet, and Japan (Compton & Ishihara, 2005) over the millennia. Agarwood is used in Ayurvedic, Tibaten and traditional East Asian medicine (Chakrabarty et al., 1994). Medicinally, agarwood is used to treat nervous

disorders, exhaustion, acroparalysis, relieve pain, asthma, enhance blood circulation as well as promotion of *qi* (Kim et al., 1997). It is also used in religious rituals, i.e. Hindus, Buddhists and Muslims, in the form of meditation incense or splinter chips to calm the mind, and to drive away evil spirits. Agarwood has also been sculptured into religious, usually Buddhist figurines, in China.

The highly prized section is the heartwood of the *Aquilaria* tree that is saturated with resin when subjected to certain pathological infections or physical wounds (Ng et al., 1997; Barden et al., 2000; Mohamed et al., 2010), and over times this had hardened and solidified into aromatic resin. The healthy wood is soft, even-grained texture and whitish in colour. The resinous infected heartwood emits an aromatic scent and appears blackish in colour. The best grade agarwood is hard solid black colour and sink in water. Inferior agarwood is paler in tone but still good for distillation of agarwood oil for perfumery — a luxury essential oil.

1.2. Ulu Sungai Menyang Conservation Area

Sungai Menyang in Sri Aman Division is one of the many tributaries of Batang Ai river that drains into the reservoir of Batang Ai Dam. Ulu Sungai Menyang Conservation Area, covering approximately 14,000 hectares, is a special area in Sarawak created for the protection of the orang-utan (*Pongo pygmaeus*) populations. This special area for orang-utan conservation was mandated by the then Honourable Chief Minister Pehin Sri Haji Taib Mahmud on 28 March 2013. For the first time in the history of conservation in Sarawak, the legal provision Section 28 of the Wild Life Protection Ordinance, 1998, is invoked to protect the landscape of Ulu Sungai Menyang for the benefits of the orang-utan populations found outside the existing totally protected areas (TPAs), namely Batang Ai National Park and Lanjak-Entimau Wildlife Sanctuary.

In 2015, Forest Department Sarawak and Wildlife Conservation Society (WCS)-Malaysia Program produced the Ulu Sungai Menyang Orang-utan Strategic Action Plan, which outlines several key time-bound interventions and implementation plans to protect the orang-utan habitat there. The paper entitled “*Beginning of A Journey ... : Implementation of Gaharu Agronomy at Ulu Sungai Menyang Conservation Area.*” presented here is the on-going pilot project implemented here since 2016.

1.3. Community Structure at Ulu Sungai Menyang

The community at Ulu Sungai Menyang, Batang Ai, Lubuk Antu is predominantly from the Iban ethnic group. There are eight longhouses in Ulu Sungai Menyang, with about 70 families altogether living in harmony with nature. The only accessibility to this area is by river transport across the Batang Ai Dam.

Because of the remoteness of this area without any road access, there is not much economy activity or opportunity. Subsistence farming, hunting and collecting of jungle produces is everyday life for these people. But these communities also aspired to be involved in mainstream economic activities and modern amenities, which is basic human right.

1.4. *Beginning of A Journey ...*

The tagline “*Beginning of A Journey ...*” is the brand ambassador of Forestry Department Sarawak’s ground-breaking community-based conservation initiatives for Ulu Sungai Menyang Conservation Area. The soul and fundamentals of this initiative is the protection of the pristine forests at Ulu Sungai Menyang and conservation of the orang-utan populations outside Batang Ai National Park and Lanjak-Entimau Wildlife Sanctuary. “*Beginning of A Journey ...*” is a metamorphic representation of such undertakings.

The heart of “*Beginning of A Journey ...*” is to plant *Aquilaria* trees for the production of gaharu leaves as an alternative livelihood for the inhabitants at Ulu Sungai Menyang. So far, this project has touched the heart and soul of many who have come into contact with it. It is a rather galvanizing and innovative idea. The Forest Department Sarawak, in collaboration with WWF-Malaysia (Sarawak Program), kicks start the journey and bridging the local communities with Aquilaria Plantation Sdn. Bhd. — a Sarawak-based private business entity who have produced and marketed their own brand of premium gaharu tea — to market the final product. Eventually, the former parties will take a back seat allowing the local communities to sell directly to the private company like any normal business transaction.

1.5. Gaharu Agronomy

The Iban communities at Ulu Sungai Menyang are very receptive to the orang-utan conservation initiatives because this animal is culturally significant and occupies a mythical spot deeply embedded in their folklores. In return to agreeing not to log or convert the pristine forests at Ulu Sungai Menyang (i.e. an important orang-utan habitat outside totally protected areas) into commercial plantation for short-term monetary gain, one must provide sustainable alternative livelihood that is environmentally friendly and economically attractive to them.

Many community-based initiatives had been carried for conservation purposes in the past, but almost all fell short of the intended desirable outcome. This is mainly because most of the non-timber forest product (NTFP) promoted could not compete with existing cash crops such as pepper or oil palm in terms of economic returns. Now, the department is adopting a totally different approach, a rather refreshing innovative idea — gaharu agronomy.

Nonetheless, this approach is totally different from traditional notion of planting gaharu tree for its valuable resinous wood after artificially inoculated these trees with chemical inoculant. There are not many successful examples because the effectiveness of these inoculants is extremely variable, and the time span is very long, taking no less than 7 years cycle.

So, in this new approach, instead of cutting down the cultivated gaharu trees for its aromatic resinous wood, this ground-breaking conservation business model capitalising on a new market product — gaharu tea — as alternative cash crop to uplift the livelihood of the local communities. In short, we are planting *Aquilaria* trees for their leaves.

Gaharu agronomy may well be a game changer in balancing conservation aims while generating realistic economic benefits to the local community. Never in the history of conservation efforts in Sarawak that such a bold plan have ever been conceived. It is perhaps there is not a single NTPF, at least not until now, that is valuable enough to offset competition from other cash crop.

1.6. Gaharu Tea

In a strict sense, the word “tea” is specifically referred to the infusion from the leaves of tea bush (*Camellia sinensis*). Any herbal infusions from other plant species should be called tisane. However, these terminologies are loosely applied because we often hear “herbal tea” rather than “herbal tisane” even if the product does not contain *C. sinensis* leaves. This is the same for gaharu tea. It is a product made from the leaves of gaharu trees (*Aquilaria microcarpa*); altogether a totally different plant family from the common tea bush.

Studies have shown that the chemical composition of gaharu leaves extracts contain mainly phenolics compounds such as flavonoid, phenolic acid, anthocyanidin, and tannins (Qi et al., 2009; Feng et al., 2011). In layman’s terms, these are antioxidants. However, one interesting group of compounds is the iriflophenone. Pranakhon et al. (2015) reported that iriflophenone 3-C- β -glucoside lowered the blood glucose levels in experimental mice by 40.3% as compared to insulin (41.5%).

There are other benefits of gaharu tea, which is beyond the scope of this paper. Suffice to say, the gaharu tea produced by Aquilaria Plantation Sdn. Bhd. is organically grown without using weedicide or pesticide. It is a refreshing beverage either taken hot or cold. Its wonderful golden coppery infusion is smooth to the palate without the harsh astringency of typical herbal health drink.

2.0 OBJECTIVES

The primary objective of this community based undertaking is to establish plots of gaharu farmstead at selected longhouse communities at Ulu Sungai Menyang. This ground breaking conservation initiative is to conserve the pristine forests there and protect the orang-utan habitat. In return, the gaharu farmstead is to become a source of viable alternative income *in lieu* for the local communities’ aspiration to open-up the land to plant other cash crop.

In short, the objectives of this initiative can be summarized as list below:-

- To conserve the pristine forests, biodiversity and its associated ecological integrity of Ulu Sungai Menyang Conservation Area, especially the protection of the orang-utan habitats;
- To uplift the economic livelihood of the communities at Ulu Sungai Menyang exploiting an innovative non-timber forest product, i.e. gaharu leaves, to generate an alternative livelihood that is economically appealing, viable and environment friendly;
- To guarantee sustainable land use and zero deforestation policy while generating realistic incomes via gaharu tea production and related tourism spin off;

- To implement a ground-breaking conservation businesses model incorporating the Forest Department Sarawak, the communities from Ulu Sungai Menyang, NGOs and an established private commercial entity that have already created a market demand for their premium gaharu tea; and
- To stimulate spin-off from gaharu-themed tourism product in collaboration with existing tourism players such as the Aiman Batang Ai Resort and Retreat next door.

3.0 THREATS AND CHALLENGES

The Iban communities had settled in Batang Ai over the millennia, and the forests around any human settlements had been cleared for shifting cultivation of hill paddy or for subsistence farming. Therefore, the landscape of Ulu Sungai Menyang comprises of mosaics of human settlements, farm lands, abandoned fallows, secondary forests and old re-growth along the hilly slopes of the valley and fringes of the reservoir. In contrast, the primary vegetation up-rivers, i.e. mixed dipterocarp forests, in the inaccessible undulating hills and mountain in the interior are relatively untouched and very pristine.

The biggest threat to the pristine forests is the aspirations and wishes of the local community. Cash economy has impacted on them, and somehow has shaped their desires. They wanted to cash-in on the land. They wanted to open up the area for rubber or oil palm plantation, because this is the only cash-crop they knew. This is reality.

What are the alternatives available to these people in exchange for not cutting down the forest, or further open-up the surrounding area. Promoting fruit tree cultivation or food crop is futile when there is no ready access to the consumer market. Oil palm is a good crop but hard to argue from a conservation perspective, and so is rubber.

Without a road access, the cost of production in whatever economic venture is definitely going to be extremely high. Transportation cost alone, i.e. time and fuel will be a logistic impediment. The only solution to satisfy the communities' aspirations and conservation goal concurrently is producing high value products. The question is which commodity fit into these criteria?

4.0 REMEDY AND MITIGATION MEASURES

As per the argument above, the precondition for the solution is this commodity must be something valuable, non-perishable like fresh fruits or vegetable, and so valuable that the logistic cost to transport it from Ulu Sungai Menyang to commercial centre like Kuching City is none issue. This solution also must be something easy to produce or cultivate. Its production must not require sophisticated technology or electricity as this is out of reach for the community. Another non-negotiable prerequisite is no forest shall be cut down in the process.

What option is economically attractive and socially or morally acceptable? Looking at the remoteness of the area, most profitable agriculture activities practiced in the coastal regions is not realistic options. Logging is extremely lucrative but not compatible with the project's conservation goals. Other non-timber forest product (NTFP) such as rattan and medicinal

herbs will not generate the desired quantum of profit or to cover the production and transportation cost from Ulu Sungai Menyang.

From the beginning, it can be easily ruled out rubber or oil palm from a conservation point of view. Without road access, there is nowhere the local communities can dispose of the freshly collected palm fruit. Rubber latex can be semi-processed for easy transportation but the price for rubber does not make it economical viable. Unfortunately as a matter of fact, these two crops will require large tracks of land to be cleared and converted into mono-culture plantation — something not compatible with the conservation objectives of sustainable land use.

Opportunity presented itself in 2013 — cultivated gaharu — a historically valuable NTFP yet no stranger to the local communities. Hence, gaharu agronomy may be the answer. For a start, gaharu tree (*A. microcarpa*) is native to Sarawak. So, we are not introducing exotic or alien species to the local flora composition. Gaharu is easy to grow. It does not have any major pests or diseases. Furthermore, gaharu cultivation does not need large tracks of land. In fact, it is an ideal tree species for enrichment planting in abandoned *temuda*, which is plentiful at Batang Ai.

Another unique feature of gaharu agronomy is that other cash crops cannot match the environmental friendliness of gaharu cultivation. The root-hairs of *Aquilaria* trees are vulnerable to chemicals and very sensitive to weedicide application. Therefore, weedicide use is strictly prohibited and this is good for the environment. Since the trees are now planted for the leaves to turn into gaharu tea, we can designate it as food crop, and when we adopt organic farming, no pesticide use is allowed. Zero weedicide and pesticide policy is imposed.

In summary, cultivating gaharu trees for their leaves to be made into gaharu tea offers many advantages and fit into the strict criteria for conservation initiatives at Ulu Sungai Menyang. These include:-

- (i) Gaharu tree from the genus *Aquilaria* is native to Sarawak. Historically, it is part of the local floristic diversity. In addition, the gaharu from Sarawak is revered for its quality;
- (ii) Given the correct cultivation techniques, *Aquilaria* tree is easy to grow;
- (iii) Unlike other cash crop like rubber or oil palm, gaharu cultivation does not need large tracks of land. A small plot of several thousand trees can have significant economic return;
- (iv) Secondary forests; and
- (v) No pesticide is needed in its cultivation. This is a conservation selling point.

It can be planted in any vacant land around the village. It can be inter-cropped with existing fruit trees. It is also good for enrichment planting in **Gaharu versus other cash crops**

Cultivated gaharu has many advantages, be it economic or conservation reasons, over other existing cash crops such as pepper, cocoa, rubber, oil palm, etc. Gaharu agronomy, i.e. planting *Aquilaria* trees for their leaves to be made into gaharu tea, is the only option simultaneously fulfilling the conservation goals and able to generate economically attractive alternative livelihood. This species can be cultivated in abandoned fallow or use for enrichment planting, hence preserving the pristine forests and conserve the biodiversity at Ulu Sungai Menyang. For example, 1,000 *Aquilaria* tree requires only slightly over one acre of land. Any space among the village dwellings or nearby secondary scrub can be rehabilitated for this purpose.

Secondly, gaharu trees are easy to maintain. They grow relatively fast if given the proper care. Furthermore, this tree species has multiple uses (e.g. gaharu tea, resinous heartwood, aromatic oil, etc.). Hence, it has a huge potential as a high value NTFP because the leaves can now be processed into premium gaharu tea.

Another clear advantage of cultivating gaharu tree over other commercial crops is NO chemical is used (e.g. weedicide, fungicide or pesticide). So, this can be considered organic farming. Gaharu trees are very hardy plants and there are no major diseases or pests that attack it. The only known serious pest (i.e. a type defoliate caterpillar) can be controlled easily without using chemical. Therefore, the economic benefit outweigh the risk, which is minimal or almost none existence. The table below shows the benefits of cultivating gaharu versus other cash crops.

Table 1: Comparison of gaharu cultivation versus other common cash crops.

	Gaharu	Oil Palm	Pepper	Cocoa	Rubber
Density	800/acre (1,980/ha)	48/acre (120/ha)	800/acre (1,980/ha)	450/acre (1,111/ha)	190/acre (470/ha)
Year to harvest	3 (for leaves)	4	3	4	4
Production	200 – 300 kg/acre	0.4 – 0.8 ¹ ton/acre/month	266 kg/acre/month	224 – 271 ² kg/acre/year	Latex ³ 607 – 1,214 kg/acre/year
Market Price	RM6/kg	RM0.7/kg ⁴	RM9 – 15/kg ⁵	RM8.7/kg ⁶	RM5/kg Latex.

Finally, within an established gaharu farmstead, 10% of the trees can be used for inoculation to produce the aromatic resinous gaharu heartwood in the long run, while the others are used for leaf production. Additionally, the rows and rows of neatly planted gaharu trees can be the selling point for potential tourism spin-off.

5.0 FEASIBILITY AND VIABILITY

The major hurdle of balancing conservation needs and agriculture land use is solved with gaharu agronomy simply because there is no need for large tracks of land to produce the desire economic output. For example the gaharu farmstead at Rumah Manggat occupied roughly 4 to 6 hectares ($\approx$ 12 – 15 acres) of abandoned fallow or *temuda* land. Comparing to the 14,000 hectares of Ulu Sungai Menyeng Conservation Area, this represents merely

¹Fully matured plantation of 6 – 7 years old. 1 – 2 ton/ha/month

²Taking the average for the reported range of 0.45 – 0.68kg/tree/year = 0.56kg/tree/year.

³Latex = 1,500 – 3,000kg/ha/year

⁴Oil palm highest price in 2012 at RM700/ton.

⁵Pepper price. This is the average price of black and white pepper from the year 1990 – 2016. Please note the huge price fluctuation.

⁶Cocoa price 2015, range RM8,500 – 9,050/ton. 2016 = RM7,300 – 7,650/ton.

0.0004% of land area! Secondly, there is plenty of idle land within Batang Ai area, especially surrounding the reservoir fringes.

As stated above, gaharu is a hardy and indigenous trees species. Planting them is a low risk undertaking as long as the local communities work hard for it. Aquilaria Plantation (Sarawak) Sdn. Bhd. is more than willing to transfer the knowledge of managing a gaharu farmstead and cultivation techniques to the local communities. The company adopts organic agriculture practices, and had already set the benchmark. No pesticide is used to control the defoliate caterpillars' infestation because they have studied the moth's breeding pattern and devised ways to fence off such massive attack. All needs to be done by the local communities is basically learning and duplicating what this company is doing.

This project has a high chance of success because this local company has already marketed its premium gaharu tea, with or without the current program at Ulu Sungai Menyang. Whenever the local communities can deliver quality gaharu leaves to them, they will buy it. At this point of time, this is a realistic and workable solution.

The next question to ask now is it feasible? Aquilaria Plantation (Sarawak) Sdn. Bhd., a partner in this project, has pledged to buy back the freshly harvested leaves at RM6/kg provided the leaf quality met the minimum standard and no weedicide or pesticide is used. An acre of land can be planted with roughly 800 plants, and an acre of 2 to 3 years old well-nurtured gaharu farmstead can yield roughly 200 – 300kg of fresh leaves per harvest. This translates to approximately RM1,200 – 1,800/harvest/acre. The same tree can be pruned every four months, meaning there can be 3 harvests per year.

6.0 IMPLEMENTATION — THE JOURNEY SLOWLY UNFOLDS

6.1 Creating 11,000-Tree Gaharu Farmstead in Six Months

The pioneer full-fledged gaharu agronomy project at Rh. Manggat called for the establishment of a gaharu farmstead with 11,000 *Aquilaria microcarpa* trees. And the window for planting during the rainy seasons is a mere six months from late October 2017 until early April 2018. It is impossible to expect the inhabitants of Rh. Manggat with 17 households, and mainly comprising of elderly and womenfolk to complete this colossal task of planting 11,000 gaharu seedlings within six months.

One ingenious solution came from the first author in the form of volunteer tree planting program mirrored the undertakings at Kuching Wetland National Park, the first RAMSAR site in Sarawak. These volunteers came from all walks of life and of all ages; from university students, polytechnic trainees, educators from teacher training college, nature-based social clubs, government agencies, etc. This volunteer tree planting program was repeated over and over again for seven times from late October 2017 to early April 2018 involving a total of 250 participants.

As stated above, the original purpose of the volunteer tree planting program is to mobilize significant numbers of people to Rh. Manggat to help plant the 11,000 gaharu seedlings targeted for this area. In return these volunteers enjoyed a so called “3D/2N paid holidays” to experience authentic Iban hospitality at Rh. Manggat. Surprisingly, this tree planting program received overwhelming responses beyond our

expectation, and we have received many requests from many groups of people wanting to participate.

Additionally, this program had turned out to be an excellence advocacy strategy, achieving many conservation education awareness objectives beyond original expectations. For a start, the volunteers thought that they are there just to plant gaharu seedlings, but at the end they realized their effort is ultimately saving the habitats of orang-utan at Ulu Sungai Menyang. They also gain some knowledge on gaharu cultivation, and were captivated by the gaharu tea — the corner stone of this innovative conservation model.

6.2 Potential Gaharu-Themed Tourism Spin-off

The conservation model presented thus far is tapping on gaharu agronomy to generate alternative livelihood while conserving the pristine forests at Ulu Sungai Menyang Conservation Area. The alternative income generator is basically the freshly collected gaharu leaves. However, unexpected opportunity presented itself along the way, resulting in new plausible additional revenue stream in the form of gaharu-themed eco-tourism spin-off. This is basically re-packaging the volunteer tree planting program into a hospitality product.

Plans are already in the pipe line to modify the volunteer tree planting program into viable tourism packages. In this 3D/2N package, guests will experience the rich cultural history of the Iban community and simple longhouse-style homestay with friendly hosts. The ambient setting is simply perfect, tucked away in the mist of tropical rainforests and serene jungle; away from crowded bustling cities. Visitors are expected to arrive at Rh. Manggat in the afternoon on the first day. The 20-minute long-boat trip from the main jetty to Rh. Manggat across the vast expanse of the reservoir is breath-taking. On the second day, paying guests are expected to keep themselves busy for a few hours in the cool morning helping the longhouse folk tending their gaharu farmstead or maybe help harvesting gaharu leaves, enjoying authentic local cuisine and BBQ picnic lunches by the lakeside. For those who love water-body, after a siesta, they can dip in the vast reservoir under hot afternoon sun to cool off. In the evening, after a sumptuous dinner, they can continue partying and marrying into the night singing and dancing away while drowning locally brew rice wine (*tuak* and *langkau*).

Incidentally located right next door to Rh. Manggat is the 100-room luxury Aiman Batang Ai Resort and Retreat (formerly Batang Ai Longhouse Resort managed by Hilton). The proposed gaharu-themed tour can be another value-for-money option for the resort guests. They can opt for a half-day excursion to see the gaharu farmstead and help to harvest the gaharu leaves at their leisure. Or they can do the highly recommended overnight package at Rh. Manggat to experience the longhouse lifestyle. All these are good tourism spin-off, and we strongly believe many will feel satisfied knowing that portions of their tourist money is channelled into conservation efforts to protect the orang-utan habitat at Ulu Sungai Menyang and assisted, in some forms or another, to uplift the wellbeing of the inhabitants of Rh. Manggat.

7.0 IMPACTS AND BENEFITS

Outcomes from the implementation of this project can be measured from two angles, i.e. the local community perspective and the project itself. From the community point of views, they would receive the ready-to-plant *Aquilaria* seedlings if they leave the pristine forests intake to conserve its biodiversity and protect the orang-utan habitat. Otherwise, the local community would not have the financial means to purchase these seedlings. Although they can source the seedlings from the forests, but that would defeat the purpose because when they chance upon any large matured mother tree, it will definitely be cut down by someone hoping to secure the much valuable resinous gaharu.

The young gaharu farmstead is the focal point and income generator. While waiting for the gaharu trees to grow to maturity, the tourism spin-off will kick in. Paying tourists will come to relax and enjoy the local hospitality as mentioned in section 6.2 above. This will represent an immediate direct income for the longhouse inhabitants derived from tourists' spendings.

When the gaharu trees are large enough for pruning, the gaharu leaves can be harvested for sale. An acre (or about 800 plants) of 3-year old *A. microcarpa* tree can easily produce between 200 – 300 kg of fresh leaves per pruning, and the same tree can be harvested every four months or three harvests per year. At RM6/kg of fresh leaves, this translate to roughly RM3,600 – 5,400/acre/year.

From the government stand point, the measurable benchmark is the conservation of the pristine forests and the protection of orang-utan habitat at Ulu Sungai Menyang. The local communities residing within this area wanted to open up the land for large-scale commercial oil palm plantation to uplift their social-economic livelihood. However, this is not compatible with the conservation goal. Therefore, as alternative, the Forest Department proposed gaharu agronomy to produce gaharu leaves for making gaharu tea. In addition, gaharu agronomy also has a good chance to stimulate others compatible eco-tourism spin off, hence creating another revenue stream. With proper implementation and commitment, Forest Department Sarawak can actually produce another sustainable land use model which the state can be proud off.

8.0 CONCLUSIONS

The project was conceptualised in 2016 and actual full-fledged planting started at the end of October 2017 until April 2018. This involved seven groups of volunteers totalling 250 able bodies to help the inhabitants of Rh. Manggat to plant 11,000 gaharu seedlings during the favourable rainy seasons. Now that the young gaharu farmstead has been planted and established, the project enters the next phase of nurturing these young trees into healthy mature gaharu plants.

The orang-utan habitats at Ulu Sungai Menyang are now protected, and the communities is benefiting from this ground-breaking conservation business model implemented by Forest Department. The idea of planting *Aquilaria* trees to produce gaharu leaves to be value-add into premium gaharu tea involving a Sarawak-based private business entity having years of experience in cultivating gaharu is very sensible collaboration. Gaharu agronomy may well be a game changer in balancing conservation goals while generating realistic economic benefits to the local community. This is because there is not a single NTFP, at least not until now, that is valuable enough to offset competition from other cash crop.

Another important fact is that out of the 14,000 hectare within Ulu Sungai Menyang Conservation Area, only 4 to 6 hectares at Rh. Manggat (or 0.0004% of the total area) is used to create the 11,000-tree gaharu farmstead. This small insignificant area compared to the overall landscape is basically abandoned fallow and no prime forests are cleared for this project. This is an amazing accomplishment. And this small patch of gaharu farmstead is expected to be able to generate between RM1,500 – 1,800/harvest/acre from the sales of freshly collected gaharu leaves. And each mature tree can be harvested three times every year.

Now in addition to gaharu leaves, it seems extra income from gaharu-themed tourism spin-off is very promising. This is basically re-packaging the volunteer tree planting program into hospitality tour package. This opportunity presented itself because almost all volunteers had a great time during their stay at Rh. Manggat; all were full of smiles and laughter.

Early indications pointed to positive development. This high impact conservation model has received admirers both internationally and locally. The WWF-Germany team that came in November 2017 was highly impressed how this model addresses a win-win situation between balancing orang-utan conservation and rural communities need for economic improvement. Finally, this program has also caught the eyes of other state and has been elevated as Key Focal Area under the State Rural Transformation Agenda.

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PAPER 23: BUILDING PARTNERSHIPS THROUGH COMMUNITY-BASED MONITORING IN REDD+: CASE STUDY OF THE EU PROGRAMME ENTITLED ‘TACKLING CLIMATE CHANGE THROUGH SUSTAINABLE FOREST MANAGEMENT AND COMMUNITY DEVELOPMENT’ IN SABAH.

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Abstract

It is increasingly recognized that community-based monitoring offers a positive model for greater participation and engagement of forest-dependent communities in the activities for monitoring, reporting and verification (MRV) to reduce emissions from deforestation and forest degradation and increase carbon removals (REDD+). This paper outlines the current community engagement initiatives through the European Union funded project entitled “Tackling Climate Change through Sustainable Forest Management and Community Development” to address reduction of carbon emissions from deforestation and forest degradation, conservation of forest carbon stocks and sustainable forest management initiatives. The project aims to demonstrate that the community-based monitoring approach can enable key REDD+ requirements in understanding local deforestation drivers and in measuring carbon stocks; and for providing information on safeguards through social and environmental assessments in the three project pilot areas, namely at Kg Gana, Kota Marudu; the riparian areas along Sg Kinabatangan in Kota Kinabatangan and within the Kinabalu Ecolinc area around Kinabalu Park, Ranau. This paper also highlights the practical challenges on the use of technology in producing reliable data on forest areas and carbon estimates through field measurements they may bring especially involving local communities.

Keywords: REDD+, MRV, Community-based Monitoring, Climate Change, Sustainable Forest Management;

1.0 INTRODUCTION

Forests have always been on the global agenda with significant adverse consequences of climate change over developing countries. It is a well-known fact that the world’s forests store more carbon than is actually contained in the atmosphere.

1.1 Why is Forest Important for Climate Change Mitigation?

Climate change and loss of forest resources are the two major threats to environmental problems. Actions that deal with these two threats are very much sort after in which deforestation is responsible for at least a quarter of all atmospheric carbon increase.

Likewise, loss of biomass i.e. forest degradation is also found to contribute considerably to carbon losses however it is hardly measured.

Afforestation and reforestation offer a quick and relatively cheap way of absorbing atmospheric carbon; however, these may also have negative implications to the local communities. Therefore, the management of natural forest is generally beneficial if local communities can also manage their natural forests and at the same time improve their livelihood.

Hence, community-based forest management is an effective means of reducing deforestation and forest degradation; and improving the health of existing forest areas whereby the communities can be part of the global effort against climate change and also get incentivized for their efforts. Although the amount of carbon that would be sequestered per hectare per year would be small, but the area that could potentially be brought under management is enormous and the management costs will be minimal. Therefore, community-based forest management presents a low intensity, cost effective strategy for carbon sequestration.

In addition, there are other non-carbon benefits (NCBs) from forest management such as water conservation and biodiversity protection, and these will impact not just the local community but more importantly society as a whole. A well-managed forest can support a variety of alternative livelihoods for communities when their main economic livelihood is threatened by climate change.

1.2 What is REDD+?

REDD-plus is a mechanism which provides an economic incentive to encourage developing countries to reduce carbon emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks. Deforestation and forest degradation are the second leading cause of global warming, responsible for about 15% of global greenhouse gas emissions, which makes the loss and depletion of forests a major issue for climate change.

The core elements of Reduced Emissions from Deforestation and Degradation (REDD+) are the reduction of greenhouse gas emissions from deforestation and forest degradation. For this to materialize, several predispositions are required. Among them are international rules, finance and investment, national accountability for future emissions levels compared to current levels; and incentive measures for changes in behaviour and policy that involve major external and local drivers of change in tropical forest management, conservation and protection. The most recent is the Paris Agreement (COP 21) on Climate Change which Malaysia ratified in December 2016. To date, the National and Sub-National Commitments and Pledges to Conservation are listed in Table 1.

Table 1: National and Sub-National Commitments and Pledges to Conservation.

International Ratifications & Agreements	• Ratified the Rio Declaration in 1992; • Ratified Convention on Climate Change (UNFCCC) in July 1994; • Ratified Convention of Biological Diversity (CBD) in June 1994; • Signed the Heart of Borneo (HoB) Declaration in February 2007; • Ratified the Paris Agreement in Dec 2016.
Sabah: Pledges and Commitments	• Ensure at least 50% of the total landmass is covered by forests; • Reduced Impact Logging (RIL) full implementation by SFMLA holders; • Credible forest certification attained by all Forest Reserves and SFMLA holders by year 2025; • Forest protection, preservation, conservation and sustainable management - the agenda to pursue under the HoB Declaration; • To advance Sabah towards receiving carbon and climate change related payments Sabah Forest Policy 2017; • Sabah Biodiversity Strategy 2012-2022; • To increase Totally Protected Area (TPA) to 30% or 2.2 million hectares by 2025.

Source: Sabah REDD+ Strategy (revised 2017)

1.3 Why REDD+?

Sabah, the second largest state in Malaysia has a landmass of approximately 7.36 million hectares, covering 22% of the total land area of Malaysia. Sabah as a state has recorded 0.75% per annum average deforestation rate over the period 1990 to 2010. As of 2016, Sabah's total forest cover is estimated to be at 4.4 million hectares or 60% of Sabah's total land area.

In the past, during the 1970's and 1980's the timber extraction volumes for Sabah remained relatively constant at around 10 to 12 million m³ per year. By the 1990's, much of Sabah's forests had been heavily and repeatedly logged which led to a decline in timber production. This decline is a result of over harvesting and combined with unsound sustained timber yields management.

In Sabah, conflict with local communities continues to simmer which the communities claimed is a result of historical and ongoing dispossession of their customary lands, whether for the gazettement of protected areas or granting of concessions for logging and plantations. It is with this challenging background that REDD+ programme in Sabah be developed, with adequate environmental and social safeguards in place, to ensure that the forests have a future for the economic wellbeing, social and environmental landscape in Sabah.

Hence, given the importance of forests for community livelihoods in Sabah, where a majority of inhabitants still live in rural areas and are predominantly dependent on subsistent agriculture and forests, more recognition of these contributions to livelihoods are needed. Important challenges to enhancing community livelihoods while at the same time maintaining forests include recognition of rights of indigenous communities; land tenure and access to forest resources through the establishment of Community Conserved Areas (CCAs).

2.0 STATUS OF REDD+ IN SABAH

Sabah had ventured into carbon related initiatives as early as in 1992, when a carbon offset projects through enrichment planting and rehabilitation of degraded logged over forests (Ulu Segama Malua Forest Reserve) project took place in collaboration between the Sabah Foundation and Face the Future (then known as the Face Foundation).

The Sabah Government has acknowledged the importance of involvement in the REDD+ mechanism, which goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. In 2012, Sabah has developed its REDD+ Roadmap to promote the elaboration and development of a sub-national REDD+ strategies towards the transformation of land use to sustainable development and sustainable forest management through equitable result-based payment. The roadmap's implementation framework includes a plan for the development of the State's Forest Reference Levels (FRLs), REDD+ Strategy; Measurement, Reporting and Verification System (MRV); Safeguards Information System (SIS); payment mechanism and benefit sharing and pilot demonstration project sites for implementation.

In October 2011, Sabah REDD+ Operational Taskforce, which also acts as the EU REDD+ Project Steering Committee, and Sabah REDD+ Technical Committee were established to oversee and guide the development of Sabah's REDD+ Strategy which is expected to be finalized by end of this year.

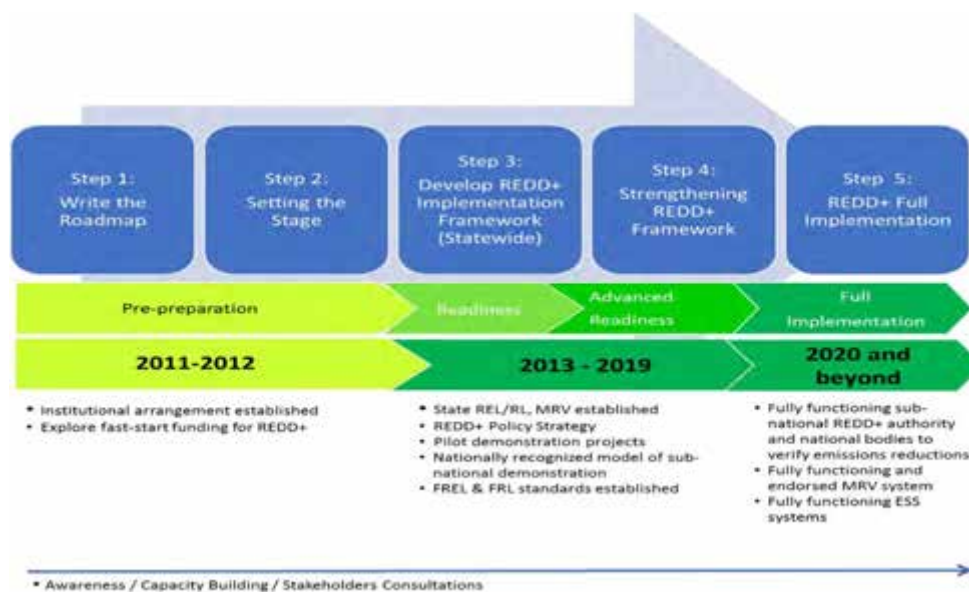


Fig. 1: Sabah REDD+ Roadmap (revised 2017)

In October 2011, Sabah REDD+ Operational Taskforce, which also acts as the EU REDD+ Project Steering Committee, and Sabah REDD+ Technical Committee were established to oversee and guide the development of Sabah's REDD+ Strategy. Sabah is currently in the process of finalizing its Sabah REDD+ Strategy.

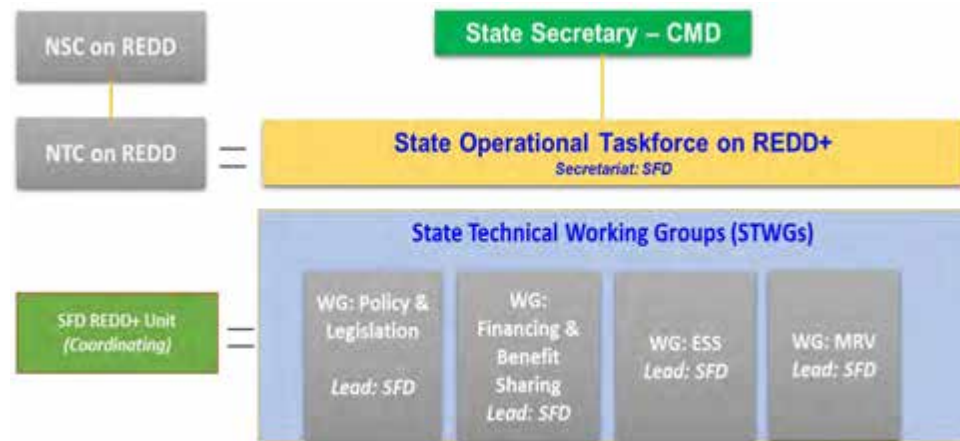


Fig. 2: Sabah Technical Working Groups (TWGs)

In 2012, Sabah further fine-tuned its institutional setup taking into account the National REDD+ institutional arrangement. At present, the Sabah REDD+ Operational Taskforce has four (4) Technical Working Groups (TWGs), which replaced the Sabah REDD+ Technical Committee. These TWGs are led by different state agencies and work in four (4) main domains of REDD+ i.e. (1) Policy and Legislation; (2) Financing and Benefit Sharing Mechanism; (3) Environmental and Social Safeguards; and (4) Monitoring, Reporting and Verification (MRV) System as listed in Table 2. The office of the Deputy Conservator of Forests (Forest Sector Planning) of the Sabah Forestry Department currently acts as the coordinating unit, however a dedicated REDD+ Unit will be established by 2019. In order to successfully carry out these tasks, capacity building for the Sabah Government is required and active involvement of the indigenous forest dependent communities in the process will be crucial.

Table 2: Sabah REDD+ Technical Working Groups (TWGs)

TWG Policy & Legislation	TWG Financing & Benefit Sharing	TWG Environmental & Social Safeguards (ESS)	TWG Measurement, Reporting & Verification (MRV)
- State Attorney General Office - Natural Resource Office (NRO) - Sabah Forestry Department - Land & Survey Department - Sabah Parks - Environmental Protection Department (EPD) - Sabah Wildlife Department	- Ministry of Finance (MoF) - Sabah State Economic Planning Unit (SEPU) - Natural Resource Office (NRO) - Sabah Forestry Department - Sabah Parks - Sabah Biodiversity Centre (SaBC)	- Sabah Forestry Department (SFD) - Environmental Protection Department (EPD) - Sabah Biodiversity Centre (SaBC) - Natural Resource Office - Lands and Surveys Department - Sabah Parks - Ministry of Rural Development - Department of Agriculture (DoA) - Pejabat Hal Ehwal	- Forestry Research Centre (FRC) - UMS - Environmental Protection Department (EPD) - Department of Agriculture (DoA) - Sabah Wildlife Department (SWD) - Land & Survey Department - Drainage & Irrigation Department

(SWD)		Anak Negeri Sabah • State Museum • Sabah Forest Industries (SFI) • Jabatan Kebajikan dan Kemasyarakatan • Sabah Law Association-PUSAKA • Kadazandusun Cultural Association (KDCA) • UMS • PACOS • Independent Social Experts • LEAP • SEPA	

Source: Sabah REDD+ Strategy (revised 2017)

As of 2017, Sabah's total forest reserves area is 3.54 million hectares and another 0.27 million hectares under other protected areas such as State Parks, Wildlife Sanctuary and Wildlife Conservation Area (Table 3). The percentage of forest reserves and other protected areas in relation to Sabah's total landmass of 7.36 million ha is about 52%. Out of the 3.81 million hectares, about 1.91 million hectares are within the Totally Protected Areas (TPAs) category, which is well above the 10% target set by IUCN on all countries, at about 25.9%. There is an increase in the TPAs from 1,874,061.544 ha (25.46%) in 2016 to 1,906,896.204 ha (25.9%) in 2017. The State is determined to further increase its TPAs to 2.2 million ha or 30% of the total Sabah's land mass by 2025.

Table 3: Forest land-use in Sabah 2017

No	Forest Land-use	Area (Ha)
	Forest Reserve	
1	Class I – Protection Forest Reserve	1,386,614.62
2	Class II – Commercial Forest Reserve	1,659,899.95
3	Class III– Domestic Forest Reserve	4,656.00
4	Class IV – Amenity Forest Reserve	11,386.45
5	Class V – Mangrove Forest Reserve	232,039.27
6	Class VI – Virgin Jungle Reserve	106,911.614
7	Class VII – Wildlife Reserve	139,240.97
	Total	3,540,748.87
	Other Forest Lands (Parks & Wildlife Sanctuary)	
1	Sabah Parks	245,172
2	Wildlife Sanctuary	26,103
3	Wildlife Conservation Area	2,854
	Total	274,129

Sabah Forestry Department 2017

Sabah's REDD+ goal is to contribute towards significant reduction of forest-based carbon emissions by implementing SFM; promoting conservation; rehabilitation of forest ecosystems; development of low carbon sustainable forest economy; and generating economic, social and environmental benefits in sustainable and equitable manner. Sabah's REDD+ objective is to develop a sub-national REDD+ Strategy towards the transformation of land use to sustainable development; and sustainable forest management through sustainable and equitable result-based payment.

2.1 EU-REDD+ Project

In 2010, at the International Conference on 'Forests and Climate Change – Decoding and Realizing REDD-plus in the Heart of Borneo (HoB), with Specific Focus on Sabah', EU representative pledged to support Sabah in the development and implementation of REDD+ strategy in Sabah. By 2012, several rounds of stakeholder consultations, including the government agencies, non-governmental agencies, private companies and SFMLA holders were conducted and there after the discussions with EU representative on the Grant Contract commenced. The three (3) EU REDD+ pilot sites were selected based on their high existing or potential carbon stock; significant threats from deforestation, degradation, fires etc., strong communities' interests and supports for conservation activities and pro-poor communities who could benefit from the project.

The project 'Tackling Climate Change through Sustainable Forest Management and Community Development' is co-funded by EU and had been designed to meet the needs of Sabah, in particular to enhance the capacity and understanding of options to effectively engage local communities in forest management and rehabilitation both on government (state lands) and community land. It is believed that this will generate experiences and enhance the capacity relevant to the further development and implementation of the planned Sabah REDD+ Strategy.

The Grant Contract (GC) for the Project was signed between Sabah Forestry Department and EU in December 2013. The duration of the project is 6 years starting in December 2013 and ending November 2019. The total cost of the project is EUR4,157,179.80 (~RM18,657,007.22) whereby EU Contribution of 77.23% is EUR3,210,589.96 (~RM14,408,806.68) and the co-funding by the Sabah State Government of 22.77% is EUR 946,589.84 (~RM 4,248,200.55).

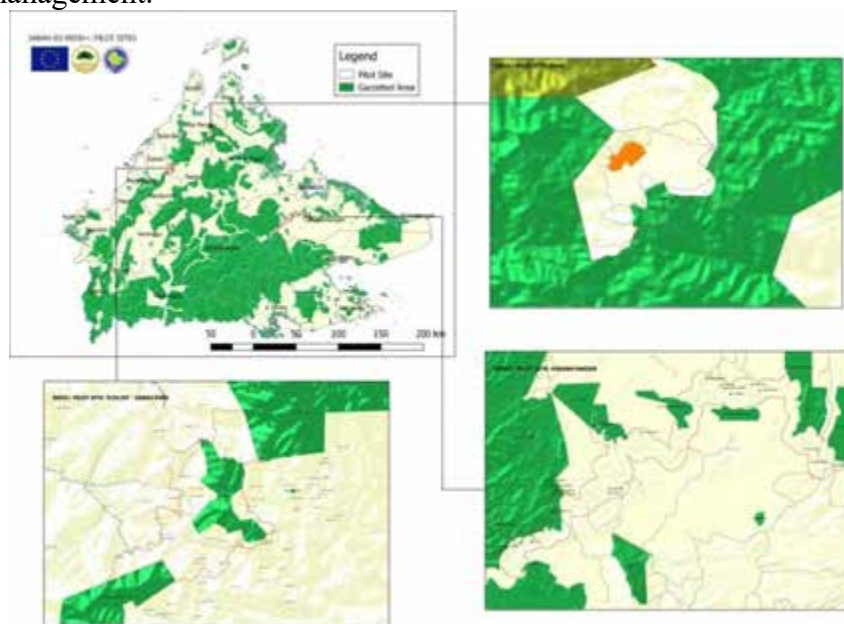
2.2. Project Components

The project has two (2) parallel components i.e. Component I and Component II. Component II consists of four sub-components i.e. Core sub-component and the three REDD+ Pilot sites (Map 1) i.e. Kg. Gana Pilot Site, Kinabatangan Pilot Site and Kinabalu-Ecolinc Pilot Site. Whereas Component I is the Technical Assistance which aims to complement and support the project as well as other aspects of the Sabah's REDD+ Roadmap. The Component II is implemented by the Sabah Forestry Department (SFD) in collaboration with other partners i.e. Sabah Parks, Sabah Wildlife Department, with financial support from the EU.

The overall objective of the project is to contribute to the sustainable and low carbon development of the State of Sabah with specific objective to enhance Sabah's REDD+

Readiness and implementation through REDD+ demonstration activities to strengthen communities' engagement in forest protection and pro-poor sustainable forest management. Overall, the project has identified TEN (10) main activities to be implemented as follows:

- i. Documentation and sharing of community forest protection, management and livelihood experience, in which results are fed into REDD+; and community development policies and plans;
- ii. Community-based protection and rehabilitation of water catchments in Gana Forest Reserve;
- iii. Community-based agroforestry in degraded lands in and adjacent to Lingkabau Forest Reserve;
- iv. Development of REDD+ strategy for forest conservation in the Kinabatangan Corridor;
- v. Enhancing forest protection and rehabilitation within the Batu Puteh-Deramakot-Malua-Segaliud Lokan forest landscape;
- vi. Promoting forest-related sustainable livelihoods and community support for conservation in target villages;
- vii. Establishment of Community-Conserved Forest Areas (CCAs) in selected communities;
- viii. Community-based restoration of degraded habitat in CCAs and adjacent areas.
- ix. Development of sustainable agriculture for livelihoods and enhanced land management; and
- x. Enhancing forest-related community tourism options to support forest management.



Map 1: Location of Sabah EU-REDD+ pilot sites

3.0 COMMUNITY-BASED MONITORING

The UNFCCC recognizes the importance of indigenous local communities have in REDD+ since the first decision on REDD+ was made by the COP at its 13th session in Bali, December 2007. The definition of “full and effective” with specific reference to monitoring and reporting is made in paragraph 3 of Decision 4/CP.15. In addition, in paragraph 72 of

Decision 1/CP.16 countries are requested “when developing and implementing their national strategies or action plans, to address, inter alia, the drivers of deforestation and forest degradation, land tenure issues, forest governance issues, gender considerations and the safeguards [...], ensuring the full and effective participation of relevant stakeholders, inter alia indigenous peoples and local communities”. Therefore, developing countries implementing REDD+ have to “promote and support” this participation and provide information on how this is “addressed and respected”.

3.1 Community-Based Monitoring Under the EU REDD+ Project

In the Sabah EU-REDD+ project, through its collaborative monitoring approach, engages with local communities on data collection, data interpretation, and local applications for the local communities’ purposes. There are significant degrees of the local community involvement in forest related monitoring whereby the information-acquisition processes are specifically designed and aimed towards local communities’ interests and participation.

Community-based monitoring under the EU-REDD+ Project is through the Carbon Stock Assessment (CSA) which include measuring the tree diameter (DBH) and identifying tree species. The methodology of the CSA is from the Component I of the project which looks into the technical aspect of REDD+ activities. To date, about 50 sampling plots have been established by the local communities in the three pilot sites. Through the participatory community mapping in Kinabatangan; and the participatory land-use planning in Gana and Ecolinc pilot sites, much more information was captured by the community members. The effectiveness, value added; and benefits to the community lies both in the specific products of the participatory activities and in the processes of participation such as 3D model of their village areas and thematic GIS maps generated by the communities themselves. This paper will highlight on the Community-based monitoring through the Participatory Community Mapping exercise by the local communities within Kinabatangan REDD+ pilot site.

3.2 What’s in it for the Community within Kinabatangan REDD+ Pilot Site

In Kinabatangan REDD+ pilot site, the Participatory Community Mapping is a process in which the local communities volunteered and took active role in gathering data and information of their existing resources which includes forest resources and then transforms it into GIS maps. Through the project, capacity building activities on mapping their resources using GIS capabilities (Q-GIS software) were conducted to the respective village Community Mapping Team, which were established in each of the five (5) participating villages.

3.2.1 Land ownership

Through the Participatory Community Mapping by the EU-REDD+ Project, the communities are recognizing the importance of carbon stocks information to establish their rights over carbon and their access to REDD+ incentives; as well as other related benefits such as PES. Community-based monitoring is an element of the community’s responsible management of their forest areas, thus helping to justify their tenure claims such as in Kg. Sungai Lokan (Map 2) with the ongoing feud over village land.

The concerns on their land ownership is a significant driver for the Project's community-based monitoring because it reinforced the communities' claims for customary rights and entitlements for their lands being lost or encroached.



Map 2: Settlement Map of Kampung Sungai Lokan, Kinabatangan prepared by the Sungai Lokan Village Community Mapping Team.



Map 3: Location Map of Kampung Balat Kinabatangan prepared by the Balat Village Community Mapping Team.

3.2.2 *Land Use Change*

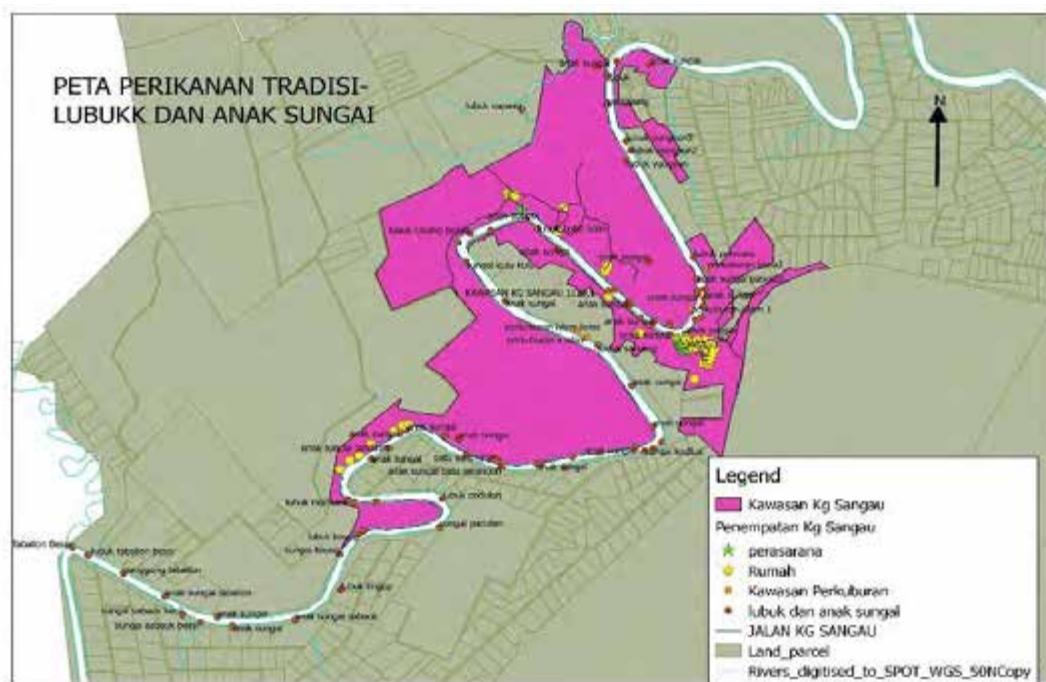
Through the participatory community mapping exercise conducted in the five villages, the communities were able to assist the project to identify and map the drivers of deforestation and forest degradation in their respective villages such as the type of forest degradation, their locations and causes, wood fuel extraction, deterioration of NTFP stock and land use change.

The assessments of their forest resources will map boundaries of forest areas, settlement areas, agriculture land, forest reserves and other land uses. These baseline maps will be used to guide the project interventions such proposed forest restoration areas by the Balat (Map 4) by the Balat Community Mapping Team.

In addition, the locations and impacts such as forest fires, source of water pollution, flooding, erosion are also monitored and mapped. In seeking new ecotourism opportunities such as the proposed 'Tagal Sungai' areas in Kampung Sangau, Kinabatangan as shown in Map 5, they are seeking ways to monitor threats to the ecological status and the aesthetic quality of the landscape.



Map 4: Proposed Forest Restoration areas in Kampung Balat, Kinabatangan



Map 5: Proposed 'Tagal Sungai' areas in Kampung Sangau, Kinabatangan

3.2.3 Input to State's REDD+ MRV Databases

Through the data gathered from the CSA, detailed information on carbon stock at the community scale can populate, densify and strengthen the State MRV database and provide higher levels of credibility. This community level data will then be linked with remote sensing data to develop the above ground biomass (AGB) model for the EU-REDD+ pilot sites to assess changes in carbon stock. Trainings on the usage of

QGIS software in processing algorithms and local allometric equation were provided by Component I of the project.

The participatory community mapping provides local specific knowledge of species, land ownership, forest qualities, drivers of deforestation and forest degradation; and socio-economic information. In Kinabatangan, the community is also doing *in-situ* surface water-quality monitoring especially streams adjacent to the oil palm estates.

3.2.4 Community-Based Sustainable Forest Management

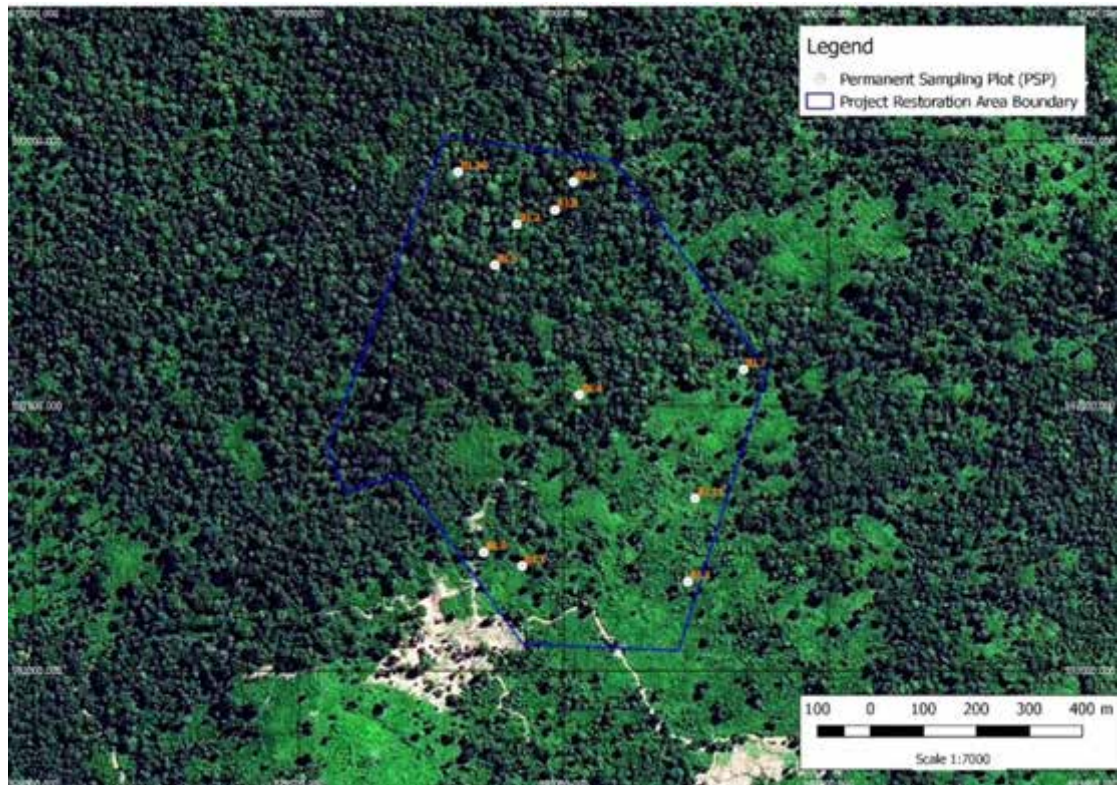
All of the project's activities related to forest management and rehabilitation involved direct local community engagement such as in propagating the seedlings through their own back-yard community nurseries; replanting or enrichment planting of degraded forests; monitoring and patrolling of forest areas e.g. forest fires and encroachments; and the development of alternative livelihoods. The main focus is on empowering the communities in the EU-REDD+ pilot sites to protect and manage the forests on their traditional village lands whereby priority is on community-to-community and peer-to-peer learning approaches. The project is based on Bundu Tuhan Native Reserve which was gazetted in 1983 as model for the Community Conserved Area (CCA) establishment.

"These forests are important for our community's livelihoods: it is where we hunt, collect forest products for our daily needs, such as for food, medicines, household goods and so on" (Statement by a Community Elder from Bundu Tuhan in 2009)

The Project also emphasised on women involvement in the community-based monitoring since in certain tasks, activities, skills, and knowledge are primarily the domain of the women in the community. Hence, the project has allocated activities specifically for the women group in the pilot sites. It is expected that the community-based monitoring will also involve in other forest-related resources management such as Payment for Ecosystem Services (PES) for hydrological services, erosion control, biodiversity, endangered species or landscape aesthetics values.

3.2.5 Carbon Stock Assessment

Based on the progress to date on the Carbon Stock Assessment (CSA), 61 carbon sampling plots in all the EU-REDD+ pilot sites have been established with the community themselves which includes 28 sampling plots in Gana Pilot Site, 11 in Kinabatangan pilot site (Map 6) and 22 sampling plots in Ecolinc pilot site. Trainings on CSA and Sustainable Forest Management (SFM) were conducted as preparatory steps for the community-based monitoring. It is anticipated to reduce operational and transaction costs of setting up REDD+ projects, and local employment generation. To date, about 50 local communities have been trained in CSA and mostly are the youth group.



Map 6: Carbon Stock Assessment (CSA) plot in Kinabatangan REDD+ Demonstration Area

3.2.6 Commitment and Ownership

It is the project's objective that through the community-based monitoring particularly the youth group, will empower the local communities to look after their forest and therefore improved their natural resource management. However, with the influx of youth often leave in search of better opportunities in urban areas, there is a need for incentive for young people to stay and assume a variety of leadership roles in their communities. By empowering the youth will build local capacities and builds self-confidence within the community in specific areas like the handling of technologies, processes and procedures. The participatory community involvement leads to more local acceptance, local understanding, and 'ownership' of a REDD+ project.

4.0 CHALLENGES

a) Negative Attitudes

The project experienced lack of interest by the community in doing the participatory community mapping. This group of villagers felt that the activity is a waste of their energy and time because they are unable to see the long-term benefits of it. The participatory community mapping is planned in such a way that all in the community groups in the village have to get involve irrespective of religion, age, social standing and race. The Project, however, received positive feedback from the younger generation whereby by supporting the Project activities is part of their way to learn new things particularly mapping with the use of GIS software (QGIS) and other

gadget such as GPS receiver. However, the absent of the elders group delayed the process since the access to certain village information such as forest boundary, village boundaries, streams tributaries, sacred and historical need the consent of the elders. In addition, access to the sacred areas in the village need custom ritual and approval by the elders. Lack of awareness and exposure of the importance of mapping, particularly in village resources within the elders group lead to the lower participation and support from these groups.

b) Time Constraint

The Project also encountered difficulties in gathering all the communities together to do the participatory community mapping. Since the villagers have their own jobs commitments and daily activities, it is very difficult to get all the villagers to attend the participatory community mapping. Hence, due to the communities' time constraints, the Project have to conduct the participatory community mapping during weekends or after office hours. To date, the Participatory Community Mapping have been conducted in four (4) out of the five (5) participating villages i.e. Balat, Buang Sayang, Tanjung Bulat and Sangau.

c) Logistic

All five (5) villages that were directly involved with the Kinabatangan EU-REDD+ Project are riverine communities and situated within floodplain area, therefore, weather and level of the Kinabatangan river affecting the Project's participatory community mapping schedule. Hence, coordination with the village's head and the REDD+ committee of the respective villages is very crucial for project activities implementation.

d) Lack of Resources and IT Literacy

The main issue with most of the villagers that participated in the participatory mapping is their low level of knowledge in Information Technology (IT). It was found this is limiting proper knowledge transfer, especially the GIS and mapping concept. Limited number of resources available such as GPS, cameras, computer notebooks and other mapping equipment lengthen the process of field data collection. Most of the equipment need to be shared between the 5 participating villages whereby in some cases, the project has to use the village boat for the project activities.

e) Conflict of Interest with Neighbouring Government Agencies and Stakeholder

During the participatory community mapping, there is resistance from the neighbouring stakeholders such as the oil palm plantation estate. This is due to overlapping land titles issues with multiple applicants or claimants. There were also cases of private land encroachment by the oil palm estate. This issue is currently not resolved at the village level, however, the project through its village mapping exercise will assist the villages to forward their claims to the relevant government agencies.

5.0 WAY FORWARD

Based on the Project's progress to date particularly in Kinabatangan Pilot Site, it is proven that the community-based mapping activities create a meaningful outcome to the local communities. The participatory approach by the project is built on trust and confidence, although it is a slow incremental process but with assistance from relevant stakeholders, it is envisioned that the participatory effort will strengthen communities' empowerment and devolved planning,

Since a major focus of the Project is on communities' involvement, therefore it is essential that appropriate techniques for participatory engagement be used at the different pilot sites. This will depend on the exact nature of the proposed project interventions at the respective sites. However, the project conducted several prior consultations with communities in the pilot areas in order to provide complete information and to obtain as appropriate Free Prior and Informed Consent (FPIC) for any activities which may restrict access to traditionally used resources or to indigenous lands.

In addition, although the project has put in place a community-friendly mechanism for the CSA, however, there still a need to estimates the typical rates of carbon sequestration resulting from community-based forest management, and its impact on REDD+.

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PAPER 24: LOCAL COMMUNITIES ENGAGEMENT TOWARDS FOREST MANAGEMENT CERTIFICATION IN SARAWAK: ISSUES AND PERCEPTIONS.

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Abstract

The State government of Sarawak is taking another bold step towards strengthening the implementation and practices of Sustainable Forest Management (SFM) by making it mandatory for all long term timber license to be certified by the year 2022. SFM offers a holistic approach to ensure forest activities do not compromise any of the SFM pillars by balancing the economic benefits, environment and social needs. Forest Management Certification (FMC) is the tool to prove this and to connect the consumer with the sustainable origins of their products. To achieve forest certification is not an easy task when it involves the local communities who reside within or adjacent to the Forest Management Unit (FMU). These are the people who would be directly affected by the forest operation either in a positive or negative impact. Their understanding and acceptance including the impacts of forest operation on their rights and livelihood are among the major indicators in Malaysian Criteria and Indicators (MC&I) standards. This paper is intended to share some of the findings on issues and perceptions with regards to FMC from the local communities residing within the FMUs in Sarawak and how it affects the certification process. The information gathered was based on 6 FMUs that are going for certification since 2016. It is hoped that this paper would provide a better understanding on community engagement in achieving certification and to prepare the rest of the FMUs who are going for FMC.

Keywords: Local communities, Sustainable Forest Management, Forest Management Certification

1.0 INTRODUCTION

The Sarawak Government is gearing up towards Sustainable Forest Management (SFM) by making its mandatory for all long term timber licenses to be certified by the year 2022. The State determinedly encouraging the timber concession holders to obtain forest management certification as one of their commitments towards SFM. SFM is the management of forests according to the sustainable forest development and it has to balance out the three (3) main pillars: environment, economic and socio-cultural. Among these three pillars, the social component is the most difficult to achieve because it involves humans as a living indicator whether the system and practices are acceptable or not. Any uncertainties would lead to all kind of issues and perceptions. Failure to address this issues would be a major hindrance to achieve forest certification. Forest Management Certification (FMC) is an important tool to promote SFM – a voluntary market-based instrument to promote trading of timber and timber-based products from sustainably managed forests. Malaysia Timber Certification Scheme (MTCS) signifies social aspects as an important consideration in the forest management standard i.e. Malaysian Criteria and Indicators for Forest Management

Certification (Natural Forest). The MC&I require the management of Forest Management Unit (FMU) to engage and consult people and local communities that are affected by the logging operations either directly or indirectly and to evaluate the social impacts of these operations. Those results of consultation from multi-stakeholders and evaluation shall be incorporated into the forest planning and management practices of the FMU.

To meet the requirement, six (6) FMUs who have committed to undertake the forest certification had engaged Sarawak Forestry Corporation Sdn. Bhd to carry out the assessment on HCVF and SIA for their FMUs. These FMUs are located in Lawas, Bintulu, Baram and Kapit. The main ethnic groups reside inside the FMUs covered are the Lun bawang, Punan, Penan, Berawan and Iban. As part of the assessment, issues and perception of the local communities were also recorded. The findings on issues and perceptions gathered from these six FMUs were highlighted in this paper.

2.0 METHODOLOGY

Formal letter regarding the assessment was delivered to the relevant authority (District Office) then to the headmen to notify the local communities. This is to fulfil the Free, Prior and Informed consent (FPIC). A participatory approach through field visit, dialogue and interview with local community was conducted. The purpose of the assessment was explained to the community prior to the questions and answer sessions to avoid any misunderstanding. Brief introduction and explanation on SFM and MC&I certification were explained during the dialogue session.

Structured questionnaires for the village profile and respondent's feedbacks were used during the SIA interview, which covers main components such as the identification of key social impacts, the adverse impacts, mitigation/enhancement measures and monitoring recommendations. HCVF questions are covering specific topics such as the area's most visited to collect jungle produces, hunting and fishing activities; the level of dependency on these elements; their main water resources and the presence of burial and sacred sites inside the license area. The questionnaires also included their awareness and perceptions on SFM and MC&I certification. Ground surveys are carried out to their water catchment areas and also to the important sites such as burial grounds, sacred sites and historical sites

3.0 FINDINGS

3.1 Issues

Based on the assessments that had been conducted in these FMUs, a number of issues had been raised up and identified.

3.1.1. Environmental and Forest Resources degradation

Environmental degradation is the most critical issue being raised by the local communities. Water and river pollution, erosion, siltation, sedimentation and decline in number of wild games and aquatic life are the major concerns.

River pollution is a direct adverse impact due to logging activities and the quality and quantity of water is greatly affected. In some areas, the locals claimed that water pollution happened due to logging operation of using heavy machineries along the

riverbanks. In some areas where Tagang system and paddy fields depend very much on the clean river water, river pollution is their major concern on the

In term of supply of forest resources and river produces, they are negatively affected by the previous unsustainably logging practices. Number of wild games, fish and Non-Timber Forest Products (NTFP) are getting scarce near the vicinities of villages due to timber harvesting. Thus, this indirectly changes the pattern of their livelihood. The depletion numbers of wild games due to changes in forest landscape have affected the traditional way to gain some earnings for some local people that depend very much on the jungle produces, fishing and hunting.

A change in lifestyles among the local communities is evident as they are slowly moving to towns and major cities to work and are becoming less dependent on forest produce. Although hunting is becoming less of a primary occupation, it is still being carried out mostly once to 4 times a month. It varies in some people as some of them do hunt everyday as their main source of incomes.

The resources for building materials nearby their villages is also limited as it is slowly depleting and almost gone. Thus, it affects the communities who are still depending on wood to build their home, furniture and other basic construction.

3.1.2. Land dispute & encroachment

Land disputes is the second critical issue being raised by the communities, especially related to Native Customary Right (NCR) land, Communal land (*Pemakai menoa*) and Communal Forest Reserve Area (*Pulau Galau*). Loss of land ownership, loss of land for farming, unpaid compensation, encroachment and soil erosion/siltation on farming area are among the concerns within the communities.

Issues on Pemakai Menoa and Pulau Galau had been a hot topic as according to the locals, these serve as important areas for them to hunt, fish and to collect jungle produces. They voiced out their concern as their Pemakai Menoa & Pulau Galau has been affected by operation activities without any pre-harvest consultation and consent from the locals. In some areas, some well, intact forested lands that are held as their Pemakai Menoa and Pulau Galau are being sternly guarded by the community to ensure that no encroachment by any logging operation activities. They also demanded compensation for their encroached temuda, Pulau Galau and Pemakai Menoa.

3.1.3. Unfulfilled promises by the previous management

A number of unfulfilled promises by the previous camp managements, such as compensation, commission, physical assistance (road maintenance, bridge, land clearing, paddy field, etc.) had stirred the unsatisfactory feelings among the communities. One case as example, the locals claimed that for a certain period (5 years), they didn't get any compensation on damaged paddy fields and encroachment as promised. In some FMUs, the locals voiced out their anger on unpaid commission as promised and this leads to tension between the two parties.

3.1.4. Lack of communication/dialogues/consultations

Lack of communication between the FMU management and the local communities contributed to prolong, unsettled conflicts. In some FMUs, the camp management never conduct any dialogues, consultations & visits to the villages. Majority of the local communities want the FMU management to consult them before any activities being conducted near the settlements and in their area.

3.1.5. Welfare of the local communities

A number of issues had been raised regarding the welfare of the local communities. Unfair job opportunity is the main issue under this topic. The local communities claimed that the camp management prefer to hire foreign workers instead of local people. In some FMUs, none of the local people are being hired as workers. This has created unsatisfactory feelings among the local, especially the elders as their younger generations are not given a fair treatment. Thus, this lead to ill feelings in the local communities.

3.2 Perceptions

The local communities are still being grounded by the past history (mismanagement by the previous management, unfulfilled promises, unsatisfactory feelings). These had led to a mixture of perceptions – both negative and positive.

The local communities said that it is so hard to deal with the company/camp management as they seem reluctant to deal with local communities (lack of communication). This creates unsatisfactory feelings among the local communities. They plan to opt for blockade as their last resort if no necessary actions are taken, especially issues relating to their land (NCR, Pemakai Menoa & Pulau Galau) and livelihood (water and forest resources).

They don't like logging as the activity bring more destruction rather than benefits, especially towards the environment and socio-cultural. Influx of outsiders, increase in social problems and uncontrolled hunting and fishing activities are among the adverse impacts that concerned the local communities.

They are still sceptical about the idea of SFM due to past history with the timber companies. Apart from that, most of them are still new to the concept of SFM and they only heard about it through the assessments. They are still new to both FMC & SFM concepts such as what is SFM & FMC, how does it works (flow of the processes and what are the benefits to the local in general.

4.0 DISCUSSION & RECOMMENDATIONS

Majority of the local communities are permanent settlers in the area and had been living in the areas before any logging operations established. Thus, their dependency on the surrounding forests is still very important. As their perceptions are grounded by bad, past history, this has contributed to prolong conflicts between the local communities and the FMUs. It requires (often lengthy) conflict resolution processes as their trust had to be earned again. To achieve certification, the FMUs and relevant agencies have to work together to address the main issues and carry out awareness and programs to convince the local

communities that SFM is a way forward for their benefits. The successful implementation of SFM and FMC require a long term support and participation from the local communities.

A number of recommendations are outlaid below:

- i) Community forestry is an important mechanism for addressing social equity while pursuing the sustainability of the forest resources. Thus, the formation of CRC and FMU Liaison Committee is required as a platform to discuss any conflicts arise in the future. It may be the only effective way of achieving SFM even though in some areas, it is very hard to implement;
- ii) There are some claims on Native Customary Rights (NCR) land, *Pemakai Menoa* and *Pulau Galau* by the local people within the FMUs. Even though the concern is mostly on their *Pemakai Menoa* and *Pulau Galau*, the Sarawak Land Code does not recognize both as part of the NCR land. Until such time when the government has found the solution to resolve the land dispute, the FMUs' management has to consider the need of local communities to use the claimed lands and forest for their livelihood activities;
- iii) Consultations and discussions should be conducted before any pre-harvesting activities, especially related to their nearby land to avoid any destruction and encroachment. Apart from that, promises should be fulfilled once the FMU management had agreed with the locals on all matters;
- iv) In a matter related to water catchment areas, they want the FMUs' management to protect the buffer zones surrounding their water catchment areas and to avoid any operation activities in the area as to maintain the quality and cleanliness of the water supply;
- v) The FMUs should prioritize employment, training and other services for the local people, especially the younger generation. This is to assist them in uplifting their economic status; and
- vi) Lack of awareness on SFM and FMC among the local communities hindered them from understanding the concept/policy and seeing the benefits. Thus, briefings and awareness programme on SFM and FMC is recommended to be conducted jointly with relevant authorities (SFC and FDS) for the local communities. The participation should involve both the younger and older generations.

5.0 CONCLUSION

The acceptance of local communities residing within and adjacent to the FMUs is one of the key element to achieve forest certification. Therefore, their involvement and active participation is vital for Sustainable Forest Management (SFM) to succeed. In many ways their participation could smoothen the management and operation of the FMUs. Thus, the practice of Free, Prior and Informed Consent (FPIC), rights and responsibilities of local communities should be fully embraced by the FMUs to establish good rapport and to gain support from the communities. Over time trust would be instilled between the two parties. Only then any issues and negative perception could be slowly navigating towards amicable solution. In achieving the principle of SFM, the operation of the FMUs must be economically viable, technically sustainable and environmentally and socially acceptable. In the social dimension, the core principle is hinged on the philosophy that the operation must serve the public good and that, in the design and implementation of the project, all efforts are exerted to help ensure that the project-affected households and communities are not worse off. Moreover, the FMU management should provide an opportunity for the local people to derive benefits from it.

It is the hope of the local communities that the FMUs to strictly adhered to the new policies related to SFM, FMC and requirements imposed in the MC&I standard to ensure the forests are sustainably managed and consequently the present of wild games, aquatic life and forest products are maintained. The discussion and conclusion written in this paper are based only on data obtained from 6 FMUs, it this to give a general view of issues and perception of the local communities living and adjacent to the FMUs. It is by no means a definite conclusion and therefore not to be used to generalize the issues and perceptions of local communities in Sarawak. More information and in depth study need to be conducted to provide a better perspective and insight knowledge of the local community's involvement and their understandings. There should be a comparison study conducted before and after the practice of SFM. It is also important to develop an indicator of sustainable livelihood specifically for Sarawak to evaluate the impacts of logging on the local communities socio-economic, cultural and their living standards.

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INFORMATION PAPER

**INFORMATION PAPER 1: *AQUILARIA* SPECIES OF ULU
MENTAWAI, MULU NATIONAL PARK**

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Abstract

Three species of *Aquilaria* namely *Aquilaria beccariana*, *Aquilaria malaccensis* and *Aquilaria microcarpa* were recorded during two years research in Ulu Mentawai, Mulu National Park. A total of 113 trees of *Aquilaria* species with diameter from less than 10 cm to more than 50 cm dbh were tagged, recorded and location marked by using Global Positioning System (GPS) device. Based on the preliminary results, Ulu Mentawai of Mulu National Park has set a new record for the distribution of *Aquilaria malaccensis*. Three species of *Aquilaria*; *Aquilaria beccariana*, *Aquilaria malaccensis* and *Aquilaria microcarpa* listed as protected plants in Wild life Protection Ordinance of Sarawak, 1998 because of the highly valuable resin known as agarwood or gaharu for incense, traditional medicines and in the perfumery industry. Thus, survey on population of gaharu in Ulu Mentawai, Mulu National Park had been conducted to check the population of the species in the area and as efforts in conservation of the protected species in Sarawak.

Keywords: *Aquilaria* sp., Sarawak, Mulu National Park, conservation and population

1.0 INTRODUCTION

The *Aquilaria* species is widely distributed in Malaysia except in Perlis (Faridah-Hanum et al., 2009). Five species are identified distributed in Malaysia *A. beccariana*, *A. malaccensis*, *A. microcarpa*, *A. hirta* and *A. rostrata* (Lee & Mohamed, 2016) but only three species found in Sarawak; *A. beccariana*, *A. malaccensis* and *A. microcarpa* (Tawan, 2004). *Aquilaria* belongs to Thymelaeaceae produced high valuable heartwood known as agarwood, aloeswood, eaglewood, *gaharu*, *karas* or *engkaras*. The resinous and fragrant agarwood becomes highly demanded because of their uses in perfumery industry, medicinal used and incense for various religious such as Buddhist, Jewish, Christian, Muslim and Hindu societies (Wyn & Anak, 2010). To ensure the survival of the species does not threaten by the international trade activity, *Aquilaria* species is listed under Appendix II of Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES). Apart from that, *Aquilaria* species was also recorded in International Union for Conservation of Nature (IUCN) Red List of Threatened Species for different category. Thus, this study aims to identify populations of *Aquilaria* species in Ulu Mentawai, Mulu National Park as conservation efforts of this Protected Plants which is listed under Wild life Protection Ordinance of Sarawak, 1998. Besides that, this study also helps in updating the status of *Aquilaria* species in Sarawak.

2.0 MATERIALS AND METHODS

2.1 Study Site

Population survey for the distribution of the *Aquilaria* species in Ulu Mentawai, Mulu National Park was held in 2014 and 2015 where several field trips were conducted within two years. The population assessment of the species was carried out along both side of the river of Sungai Mendalam and Sungai Mendamit, 10-meter from the river bank.

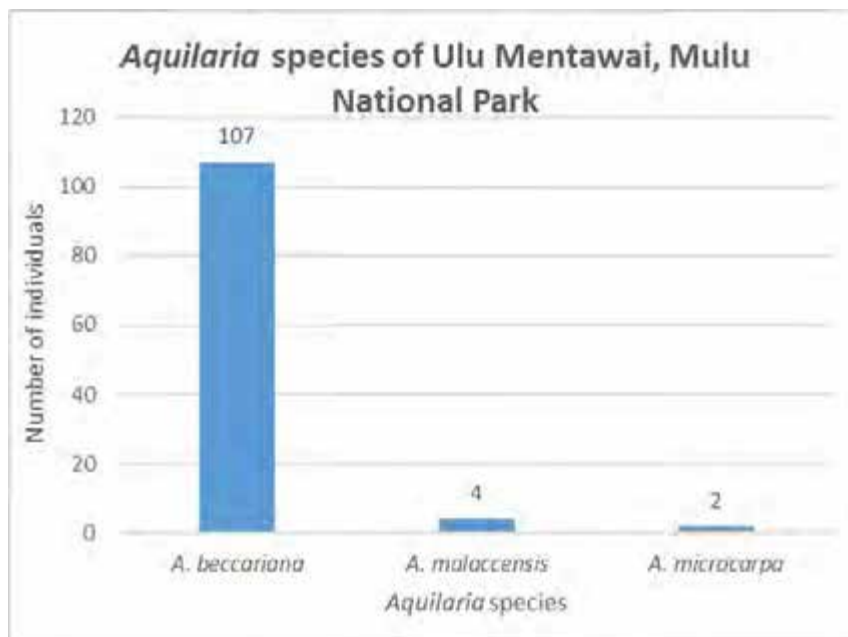
2.2 Data Collection

Each of individual were tagged with aluminium plate, data such as species, height and dbh recorded in data sheet and the location of the trees marked by using Global Positioning System (GPS) device. For identification of the *Aquilaria* species, leaves sample from each tree were collected and identified by referring to herbarium specimens and reference books.

3.0 RESULT AND DISCUSSION

A total of 113 *Aquilaria* trees from *A. beccariana*, *A. malaccensis* and *A. microcarpa* were tagged and recorded during two years survey at Ulu Mentawai, Mulu National Park. *Aquilaria beccariana* listed as the dominant species at the area with total of 107 individuals followed by *A. malaccensis* with 4 individuals and *A. microcarpa* with 2 individuals. Kanazawa (2017) recorded in his study of Sustainable Harvesting and Conservation of Agarwood in Upper Baram River that the *Aquilaria beccariana* known as *gaharu ba* which gives meaning “river agarwood” among the Penan. The reason for the *Aquilaria beccariana* population found most along the river of Ulu Mentawai might be because it is their habitat.

Table 1: Number of individuals of *Aquilaria* species in Ulu Mentawai, Mulu National Park

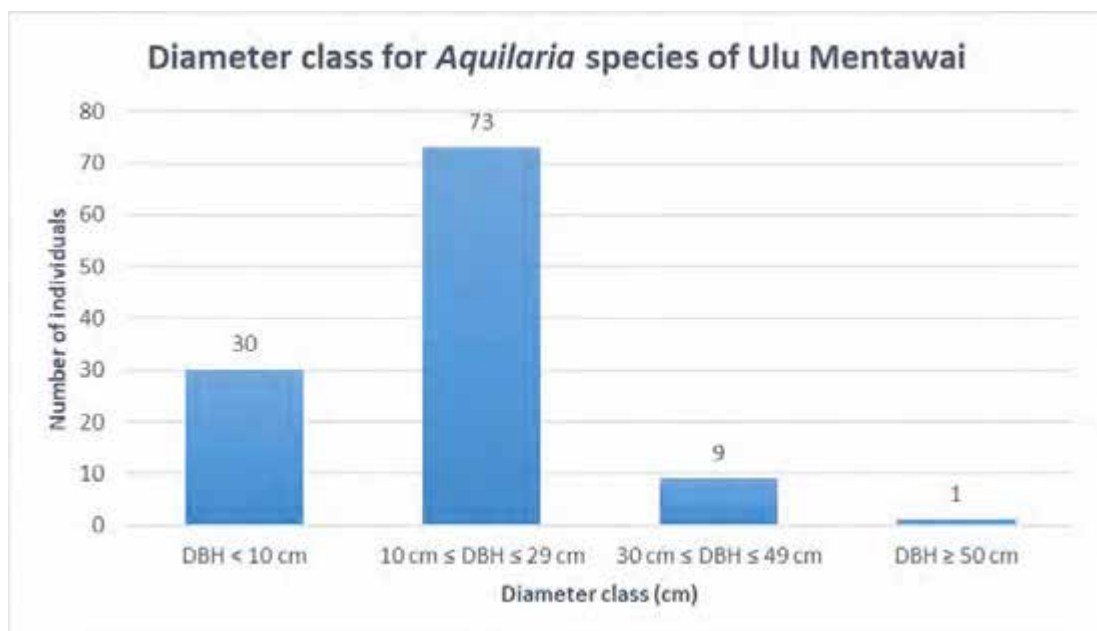


According to Mohd Fauzi et al. (2017), *A. beccariana* recorded to be found at high elevation of 850 m above sea level in Johor, Sabah and Sarawak where the species documented as common species in its natural habitat of the lowland forests. However, *A. beccariana* in Ulu Mentawai recorded at the elevation below 120 m above sea level. This is not only recorded for *A. beccariana*, but also for *A. malaccensis* and *A. microcarpa* since the distribution of the species were only found at a distance of 10-meter from the riverbank along both side of the river. *A. beccariana* status in IUCN Red List of Threatened Species is vulnerable. However, the species current population trend is decreasing. Kanazawa (2017) reported that the habitat for the agarwood has been threatened by the introduction of the commercial logging and hill rice cultivation in Upper Baram River.

Aquilaria malaccensis in Sarawak has been recorded in 52-hectare Forest Research plot in Lambir Hills National Park (Lee et al., 2002). Faridah-Hanum et al., (2009) also examined five herbarium specimens of *A. malaccensis* from various places in Sarawak such as Ulu Baram, Lanjak Entimau P.F and Kuching. However, Anderson (1980) stated that the distribution of *A. malaccensis* in Sarawak is rare. Four individuals of *A. malaccensis* found at Ulu Mentawai, Mulu National Park has set the area as new record for distribution of the species.

A total of 113 *Aquilaria* species in Ulu Mentawai has different diameter class. The diameter of the three species divided into four diameter classes; less than 10 cm dbh, 10 cm to 29 cm dbh, 30 cm to 49 cm dbh and dbh more than 50 cm (Table 2). The range of dbh is between 10 to 29 cm for most of the Ulu Mentawai except for one individual which has a dbh of more than 50 cm. The height of the three species ranged from 3 to 40 meter tall.

Table 2: Diameter class for *Aquilaria* species of Ulu Mentawai, Mulu National Park



The three species of *Aquilaria*; *A. beccariana*, *A. malaccensis* and *A. microcarpa* recorded different minimum and maximum diameter for each of the species. The dominant species of Ulu Mentawai, *A. beccariana* has the minimum dbh (2.6 cm) and maximum dbh (43 cm). The dbh of *A. beccariana* recorded in Ulu Mentawai was bigger compared to *A. beccariana* found by Kanazawa (2017) in Upper Baram River with 30 cm dbh.

A. malaccensis recorded the largest dbh among the three species at 82.7 cm. The species of *A. malaccensis* can be found at elevation up to 270 m above sea level in lowland mixed dipterocarp forest (Tawan, 2004). This species is classified as Critically Endangered in IUCN Red List of Threaten Species where the current population trend is reported decreasing.

The status of *A. microcarpa* reported to be Endangered in IUCN Red List of Threaten Species. Though only two individuals found at Ulu Mentawai, the dbh of the species is quite large (30.8 cm). The distribution of the species reported to be in Bintulu and Kuching districts (Tawan, 2004).

Table 3: Minimum and maximum diameter of *Aquilaria* species in Ulu Mentawai



Lim and Noorainie (2010) reported that there were poaching of gaharu by Malaysian or non-Malaysian in some areas in Sarawak such as Ulu Baram, Mulu National Park, Lanjak Entimau Wildlife Sanctuary and Lambir Hills National Park from 1991 to 2005. Jayachandran et al., (2014) reported that the price of the first grade for agarwood ranged from few dollars to USD 30,000 per kg depending on the quality of the natural raw materials. The poaching activities for gaharu materials are due to the high demands and their high price in market has raised the main concern for the *Aquilaria* population in their habitat.

4.0 CONCLUSION

The main threat for *Aquilaria* species in their habitat is the hunting for their agarwood. Therefore, conservation efforts by frequent monitoring at the area of the species and penalty or fine to the poachers are one of the actions needed in order to protect the species from extinct or threaten in their habitat. Apart from that, *ex situ* conservation of the species might also help to protect the population. Thus, the data on the *Aquilaria* population in Ulu Mentawai might be helpful in giving the status of the species in Sarawak.

5.0 ACKNOWLEDGEMENT

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**INFORMATION PAPER 2: DIVERSITY OF UNDERSTORY
HERBACEOUS PLANTS IN FALLOW SHIFTING CULTIVATION**

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Abstract

Shifting cultivation is frequently identified as one of the main causes of tropical forest disturbance and retrogression to secondary forest vegetation. Although forest ecosystem is typically defined by the over-story species, the study on herb layer is also important because the herb layer always showed the greatest diversity and the most responsive to harvest mediated disturbance. Thus this study aims to determine the diversity and floristic composition of understory herbaceous plants comparatively at five different aged of fallows shifting cultivation represented by 1, 3, 5, 10 and 20-years of fallow. Based on the survey conducted in Sabal Agroforestry Centre Sarawak, a total of 15,348 individuals were recorded comprising of 178 species in 145 genera and 70 families. Both 1 and 10-years of fallows showed the highest diversity index ($H' = 3.24$) while having the lowest similarity index (SI). Cluster analysis indicated 3 clusters, resulting 1-year of fallow to form one cluster itself, 3 and 5-years of fallows in another cluster, while 10 and 20-years of fallows fall in another cluster. The study indicates that the species composition of understory herbaceous vegetation is very responsive to the disturbance and may change considerably over time, thus reflected to the site condition.

Keywords: Herbaceous, fallow, diversity, similarity, cluster.

1.0 INTRODUCTION

Shifting cultivation is frequently identified as one of the main causes of tropical forest disturbance (Lawrence et al., 1998) and retrogression to secondary forest vegetation. In Sarawak, shifting cultivation is a predominant method of agriculture and has been widely practiced by groups of native people in order to produce various types of crops for their income.

Succession is a natural recovery process of vegetation and ecosystems that occur after disturbance (Mohizah, 2003). The common forest succession established after 1 year shifting cultivation is grassland which is mainly dominated by herbaceous plants. Herbaceous plants are characteristically as non-woody plants which the stem is soft and green, rooted on the forest floor and low height. Typically, herbaceous communities at recently disturbed site show high species richness which may persist during the first year of succession due to high rates of species turnover (Valázquez and Gómez-Sal, 2009). However, according to Ainie et al. (2007), as forest succession occurs continuously, the diversity of these sun-loving plants will decline rapidly as the impact of closed canopy and competition among dominant species for soil resources.

This study was intended to enable the comparative study at different ages of fallows on herbaceous diversity and was undertaken at the area of Sabal, Sarawak in the Samarahan Division where shifting cultivation has been actively practiced by local people for many years.

1.1 Objective

The objective of this study was as follows:

- To determine the floristic composition and diversity of the understory herbaceous vegetation comparatively in different-aged of fallows

2.0 METHODOLOGY

2.1 Study Area

The study was carried out at Sabal, Sarawak in Samarahan Division which is about 112 km southeast of Kuching City, accessible through Kuching-Sri Aman trunk road. There were five different study sites selected within the area (Fig. 1). All selected study sites were abandoned areas left after shifting cultivation with the fallow age of 1-year, 3-year, 5-year, 10-year and 20-year after the abandonment. Those sites were called as 1-year fallow, Temuda I, Temuda II, Belukar I and Belukar II respectively according to the local people.



Fig. 1: Map of study sites at Sabal, Sarawak

2.2 Data Collection and Analysis

Samplings were done based on the list or census count quadrature method (Kim and Moody, 1983). A total of 50 sample quadrates (1 m x 1 m) were randomly tossed at each study site (Frerichs, 2008). In this study, shrubs and tree seedlings with less than 1.3 m height (Klanderud et al., 2010) were included as understory herbaceous vegetation since they were also considered under herb (Bahera and Misra, 2006). All understory herbaceous vegetation found within the quadrates were identified, recorded and classified systematically.

The species composition for each study site was analyzed to assess their species diversity, richness and evenness, as well as the similarity composition of species among study sites.

3.0 RESULTS AND DISCUSSION

3.1 Species Composition

A total of 15, 348 individuals of understory herbaceous plants were recorded at five different study sites. They belonged to 178 species, 145 genera and 70 families (Table 1). From the total of 178 species, 78 species occurred at one year fallow, 40 species at Temuda I and 45 species at Temuda II. Belukar I and Belukar II were recorded to have 68 species and 49 species respectively.

Table 1: Floristic composition recorded within each study site at Sabal.

Floristic composition	Study sites				
	1 year fallow	Temuda I	Temuda II	Belukar I	Belukar II
Number of families	35	25	31	41	33
Number of genera	64	38	43	62	47
Number of species	78	40	45	68	49
Number of individual	10614	2137	1113	644	840

The early stage of fallow was strongly dominated by the grass and broad-leaved herbaceous species. The most species found at one year fallow was *Imperata cylindrica* followed by *Asystasia intrusa*. The sedge species, *Scleria sumatrensis* and the fern species, *Nephrolepis biserrata* were the two common species recorded at Temuda I, Temuda II and Belukar I. While at Belukar II, the most common species found were the fern species that were *Dicranopteris linearis* followed by *Blechnum orientale*.

As forest regenerated, the high proportion of herbaceous species (broad-leaved herbaceous, grasses, sedges and ferns) at one year fallow, Temuda I and Temuda II was gradually decreased with 75.7%, 70.0% and 53.3% respectively since the proportion of woody species (shrubs and tree seedlings) increased (Fig. 2). Therefore, the proportion of woody species at Belukar I and Belukar II were higher than herbaceous species with 67.6 % and 53.1% respectively.

In tropical rainforest, the trend of increasing woody species composition as secondary succession progresses is typical (Howorth and Pendry, 2006). Dong et al. (2007) supported that herbaceous species dominated the plant community in most area at the early stages of reforestation and woody species became more important with time after

reforestation. According to Chazdon (2008), rapid initial growth of pioneer tree seedlings would cause canopy closure in only five to ten years after abandonment.

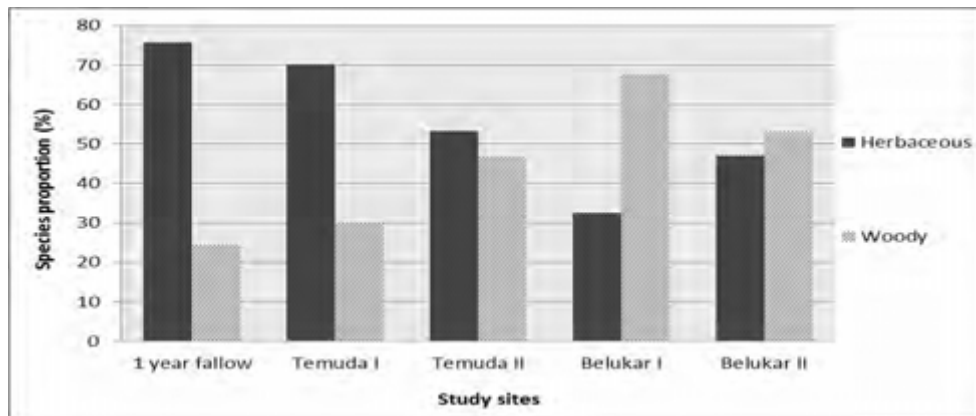


Fig. 2: Proportion of herbaceous and woody species within each study site.

3.2 Species Diversity

Both of the one year fallow and Belukar I had the highest species diversity index ($H' = 3.24$) that represent as the most diverse study sites (Table 2). The analysis of species distribution also showed that the Belukar I had the highest evenness index ($E = 0.77$) which indicated that the species at Belukar I were more evenly distributed than the others. Furthermore, with only 644 individual accounted for 68 species at Belukar I, the richness index showed that the site had the highest species richness index ($R = 10.36$).

The increased in diversity was partly due to an increased on species richness (Clinton and Vose, 2000) while the evenness was sensitive to the changes of both cover and richness in a community (del Moral, 2000). The profusion of woody species had contributed to the increased of species diversity at Belukar I since they increased in species richness and evenness. High evenness value reflects the less dominance of certain species occurred within a community where all species are relatively equal in cover and importance, thus species richness was also high since there were chances for species to cover and spread evenly (Thrasher-Haug et al., 1997).

Table 2: Diversity indices for each study site.

Diversity indices	Fallows				
	1 year fallow	Temuda I	Temuda II	Belukar I	Belukar II
Shannon-Wiener's species diversity index, H'	3.24	2.23	1.93	3.24	2.91

Pielou's

evenness	0.74	0.61	0.51	0.77	0.75

index, E

Margalef's

richness	8.31	5.09	6.27	10.36	7.13

index, R

3.3 Species Similarity

Based on Sorensen's similarity index (SI), the analysis showed that Temuda I and Temuda II had the highest degree of similarity (SI= 0.4471) which indicated that both of these study sites shared the most similar species composition (Table 3).

Table 3: Similarity index among the five study sites.

Fallows	Sorensen's similarity index, SI				
	1 year fallow	Temuda I	Temuda II	Belukar I	Belukar II
1 year fallow	0.0000				
Temuda I	0.3729	0.0000			
Temuda II	0.3252	0.4471	0.0000		
Belukar I	0.1507	0.3704	0.2832	0.0000	
Belukar II	0.1732	0.3146	0.3404	0.3419	0.0000

Hence, the hierarchical cluster analysis figured that all five study sites could be clustered into three communities which were distinguished by the species composition, and shared floristic similarity within clustered community (Fig 3). The first cluster consisted of only one year fallow site which was highly dominated by the non-woody herbaceous species mainly from the family of Poaceae that vigorously grow in open-disturbed areas under full sunlight condition. Werner (1999) had defined this vegetation class as a very young regrowth (1-2 years).

The second cluster formed by Temuda I and Temuda II which composed of herbaceous species as well as the recruitment of pioneer woody species like *Cephaelis* sp. This vegetation class was defined by Werner (1999) as a young secondary regrowth (3-7 years).

While Belukar I and Belukar II were clustered together into the third cluster since most of the species established at both sites were woody seedlings such as *Lithocarpus* sp. and *Goniothalamus* sp. The pattern of rapid change from herbaceous to shade-tolerant woody species as well as palm species upon canopy closure had characterize this vegetation class, as expected by Schoonmaker and McKee (1988) in their study of 20 years after clear-cutting. According to Werner (1999), this vegetation class was defined as medium-aged secondary forest (8-19 years).

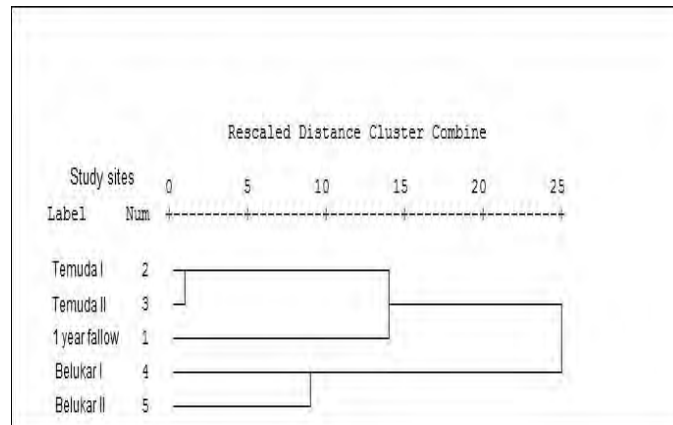


Fig 3: A dendrogram showing similarity relationship among five study sites.

4.0 CONCLUSION

Understanding on how floristic composition responds to disturbance is essential to predicting and managing the impacts of forest harvesting on plant communities. Therefore, species composition matters during forest restoration since it may significantly reflect the progression of vegetation succession. A predictable sequence of life forms was shown in this results which revealed the dominance pattern of non-woody herbaceous species at the early succession of secondary forest while the woody species took place gradually and became important in dominance with time. This indicated that discrete community assemblages may characterize various stages of fallows and forest succession thus very important for the work of vegetation restoration and improvement.

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**INFORMATION PAPER 3: A COMPARISON OF SITE SUITABILITY
FOR *Rhizophora mucronata* BETWEEN DISTURBED AND NATURAL
SITES WITHIN THE KUCHING WETLAND NATIONAL PARK**

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Abstract

The Sg. Lemidin site in Kuching Wetland National Park (KWNP) was being disturbed in a way the soil from the river nearby was being dug and dump at the site. Due to heavy machineries, such as excavator the soil being forcedly compact and affecting *Rhizophora mucronata* root not able to penetrate into the soil as normal. It also becomes a site for dumping of dredged soils and materials from the flood diversion within construction located on the western side of the KWNP channel. It was learnt that 3000 acres, all entirely in the southern sector of the park have been earmarked as the soil dumping site. This dredges soils and materials contains sulfidic materials (iron pyrite), as is the case with soils at Sungai Lemidin, would alter soil salinity, redox potential and sulfide concentration, which are important factors that influence mangrove seedling establishment and subsequent growth (McKee, 1993;1995).

Keywords: *Rhizophora mucronata*, aboveground biomass, belowground biomass, soil texture, soil compaction, bulk density, soil moisture, RAMSAR, Kuching Wetland National Park.

1.0 INTRODUCTION

Soils and the management is the main concern in this study. The soil serves as a sink and recycling factory for abundant waste products which might accumulate effecting the environment. Varying from hard, dense, large pieces of rock through gravel, sand, silt and clay to organic deposits of soft compressible peat may occur over a range of physical properties, such as moisture contents, texture, bulk density and strength of soils. Therefore, to deal properly with soils manage it requires knowledge and understanding of these physical properties.

2.0 OBJECTIVE

1. To study the soil physical properties on disturbed and natural site at Sg. Lemidin, Kuching Wetland National Park, Kuching Sarawak; and
2. To find the relationship of soil properties with the growth performance of planted trees.

3.0 STUDY SITE

The study was conducted at Ramsar site at Sungai Lemidin, Kuching Wetland National Park.



Figure 1: Soil sampling area (plot 1 and 2)



Figure 2: Biomass sampling points (plot 1)



Figure 3: Control site (plot 4)

4.0 MATERIALS AND METHODS

Biomass harvesting: Each of the harvested trees will be separated then weighed to get the fresh weight (g). The components oven dried at 85°C for 48 hours and later weigh to get the dry weight.

Soil sampling: The sample points were randomly selected. For each point, the sample was collected at low tide from a depth 0-50 cm and 50-100 cm using a soil auger. The samples then air dried for a few days and after that manually process to become flour like texture.

Soil texture: A simple field method used which was “texture by feel”. The procedure for the soil texture generally followed the method guided by USDA Natural

Resources Conservation Service (1997) with some modifications. **Bulk density:** The samples collected using 3-inch core and weighed. The samples then were oven dried at 105°C for 24 hours and weighed again.

Soil compaction: Cone penetrometer used in this method.

Soil moisture: The soil samples retrieved using soil auger. All the samples being air-dried first before being oven-dried at 105°C for 24 hours and determine the oven dry weight.

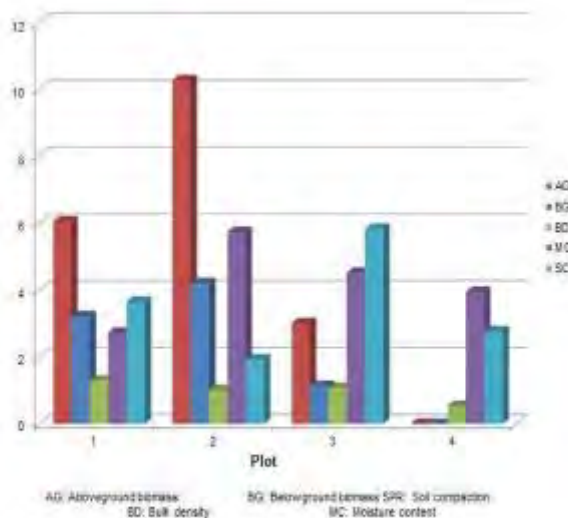


Table 1: Total biomass vs soil physical analysis

The reason we used a cone penetrometer suitable for this study, when the soil layer is no longer disturbed, age hardening may gradually increases its soil strength (Dexter et al., 1988). The moisture content of the soil is an important property that controls its behaviour. As quantitative measure of wetness of a soil mass, moisture content affects the level of compaction of soil, which is indicated by its bulk density. Soil bulk density is an indicator of the degree of compaction and in this study it was used as an indicator to problems such as root penetration, soil aeration and water infiltration.

5.0 CONCLUSION

The planted *Rhizophora mucronata* growth was stunted at the disturbed site. Therefore, the physical properties such as soil compaction and bulk density in that area should be higher than natural sites. Bulk density will relate with soil moisture content which shows the aeration and the porosity of the soil texture.

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INFORMATION PAPER 4: MAPPING THE DISTRIBUTION OF *Shorea kunstleri* King

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Abstract

Mapping species through classification of spectral data is an invasive approach to understand tree species distribution. Classification of tree species requires in-situ observation matched to the hyperspectral image. *Shorea kunstleri* is one of the species from Genus *Shorea* that listed in IUCN red list which fall into category critically endangered. Through this study the distribution of the selected *Shorea kunstleri* was done by mapping the selected tree species. All of the mapping process was done using the ENVI 5.0 software. The spectral reflectance extracted from hyperspectral image were analysed to map the tree; each of tree species was identified and that requires field observation. This study aims to map the distribution of red list species *Shorea kunstleri*. To analyse the differences in spectral response of *Shorea kunstleri* for within species and between species. The project site was conducted in mixed dipterocarp Lambir Hills National Park, Miri.

1.0 INTRODUCTION

Hyperspectral imaging combines the power of digital imaging and spectroscopy. It contributes in detailed information about a scene than a normal colour camera that acquires three different spectral channels corresponding to visual primary colours red, green and blue. Therefore, hyperspectral imaging improved the ability of hyperspectral image to classify objects in the scene based on their spectral properties. The application of hyperspectral remote sensing in solving problems regarding species identification has been used for many years such as vegetation classification and change monitoring (Gress, 1993; Roshier and Rumbachs, 2004; Rebelo et al. - in press). Low altitude airborne widely used by researchers than space borne remotely sensed data on wetland classification and species identification. This is because space borne data can be influenced because of the constraints of image calibration, such as atmospheric correction and geographic correction (Sanders et al. 2001; Secker et al. 2001). Spectral data that extracted from hyperspectral image displaying unique reflectance that allows the discrimination of tree species.

2.0 OBJECTIVES

Lambir Hills National Park is composed largely of mixed dipterocarp forest that located in Miri, Sarawak. Lambir Hills National Park is home to few endemic tree species in Borneo. The current practice of our inventory system can be improved with the use of hyperspectral data and appropriate techniques for mapping the tree species. *Shorea kunstleri* is listed as critically endangered by IUCN and this project is expected (i) to map the distribution of *Shorea kunstleri* at Lambir Hills National Park that will help to monitor the current population of this species. We were using in-situ method to validate data by going out in the field alongside with hyperspectral data (ii) to analyse the differences in spectral response of *Shorea kunstleri* for within species and between species.

3.0 MATERIALS AND METHODS

3.1 Study Area

The stands selected for this study are located at lowland mixed dipterocarp forest at Lambir Hills National Park.



Figure 1: Location of Lambir Hills National Park

(Source: Google Maps)

3.2 Spectral Data Collection

Airborne hyperspectral data was acquired using a KESTREL sensor 10 with 0.5 spatial resolutions. The sensor was flown at an altitude 2300 - 2500 meters. Multiple flights were flown according to the flight lines of the study area. Spectral data of selected tree species was extracted from the hyperspectral image.

3.3 Ground Data Collection

Tree descriptions of the selected stands were collected. The description from bark to leaf was collected. The geographical location of selected *Shorea kunstleri* tree were recorded using geographical position system (GPS) so that they could be located in the hyperspectral image. The reference point was made and georeference using known distances and directions. Leaf specimen also collected for species identification.

3.4 Plant Identification

To ensure that specimens collected are the right species, above ground observation was conducted. After that, the specimens were brought to herbarium to compare with the preserved reference collection.

3.5 Pre-Processing

Most pre- processing and post-processing data were completed using ENVI 5.0. The atmospheric corrections was applied to each flight line images which converting the image radiance to reflectance. The flight lines were mosaicked using the seamless mosaic tool. This approach allows producing better resolution of hyperspectral image.

3.6 Classification

The ground data collection was used for classification. Tree species classification were carried out using support vector machine (SVM). SVM is a non-parametric binary classifier that locates the optimal hyper plane between the two classes to separate them in a new highdimensional feature space by taking into account only the training samples that lie on the edge of the class distributions known as support vectors. Mantero et al.

(2005) stated that SVM could handle small training datasets with high classification accuracy.

4.0 RESULTS AND DISCUSSION

The hyperspectral image of Lambir Hills National Park is shown in Figure 2. It is shown that each tree species has different in crown shape and colour reflectance.



Figure 2 : Hyperspectral image of study site (before classification)

The image from training sample in Figure 2 is classified using SVM and is shown in Figure 3. The green region from the map in Figure 2 is the distribution of *Shorea kunstleri*.

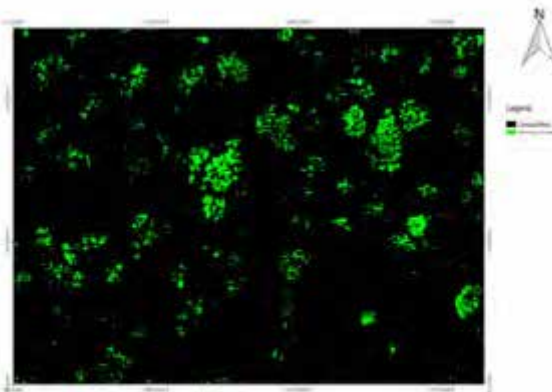


Figure 3: Distribution of *Shorea kunstleri* (after classification)

5.0 CONCLUSION

Based on the results shown, *Shorea kunstleri* can be discriminated. By using the new technology development, species distribution of selected tree species can be discriminated in effective way. This method could be implemented in the expert inventory system which can help to reassess the population of selected tree species.

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**INFORMATION PAPER 5: SPATIAL VARIATIONS OF TOTAL
PRODUCT BIOMASS OF PLANTED *Rhizophora mucronata* Poiret
BASED ON SITE CHARACTERISTICS OF THE SARAWAK
MANGROVE FOREST**

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Abstract

Mangroves are salt-tolerant forest ecosystems found mainly in tropical and subtropical intertidal regions of the world. *Rhizophora mucronata* Poiret is one of the most important species in mangrove forest. It is also one of the commercial mangrove timber species in Asia-Pacific Region which leads large areas of mangrove in this region. In order to estimate the total product biomass of *R. mucronata* Poiret, the development of site-specific allometric equation is needed based on their site characteristics. The objectives of this study are to develop the site-specific allometric equations to estimate the total product biomass of planted *Rhizophora mucronata* Poiret for three selected sites of the Sarawak Mangrove Forest and comparison of the accuracy of developed site-specific allometric equations with general allometric equations particular species across varying site conditions. Our study has showed that a better fit is found for site-specific model as compared to relying on a general model for that particular species across varying site characteristics.

Keywords: Total product biomass, allometric equation, site characteristics, *Rhizophora mucronata* Poiret

1.0 INTRODUCTION

Around the world, mangroves are estimated to cover an area of between 180, 000 and 200, 000 km² (Spalding et al., 1997; Kairo et al., 2008). Mangroves are salt-tolerant forest ecosystems found mainly in tropical and subtropical intertidal regions of the world where annual rainfall is fairly high (Chandra et al., 2011). Mangrove forest is the main coastal vegetation community in tropical Asia, with the Malay-Indonesian region as its center of distribution. Malaysia has 645 852 ha or 2% of its total land area that rank third after Indonesia and Australia.

Biomass studies on mangroves are very significant to know the facts of successional changes, production and competition in vegetal communities, site-productivity, nutrient cycling, nutrient budget, amount of carbon sequestration, predicting future change due to climate change and overall to manage the forest in sustainable way. It is also important for Reducing Emissions from Deforestation and Degradation (REDD) program since deforestation and forest degradation in the forests considered as a major cause of climate change. The most frequently used method for estimating biomass of forest is through allometric equations. The allometric equations are developed and applied to forest inventory data in order to estimate biomass at larger spatial scales.

According to the study made by Vashum and Jayakumar, the allometric equations for biomass estimation are developed by establishing a relationship between the several physical parameters of the trees such as the diameter at breast height (DBH), height of the tree trunk, total height of the tree, crown diameter and others. In addition, allometric equations are

commonly considered to be both species and site-specific. On the other hand, the inability of constructing a new allometric equation for every species encountered at every site has led to increasing interest in the development of general equations for biomass estimation

The objectives of this study are to develop the site-specific allometric equations to estimate the total product biomass of *R. mucronata* Poiré for three selected sites of the Sarawak Mangrove Forest and comparison of the accuracy of developed site-specific allometric equations with general allometric equations particular species across varying site conditions.

2.0 METHODOLOGY

2.1 Study Site

The study was conducted at three selected sites in Sarawak Mangrove Forest which are Kuala Bako (Sarawak Mangrove Forest Reserve), Kampung Selabat dan Pasir Putih (Sarawak Mangrove Forest Reserve) and Sungai Lemidin (Kuching Wetland National Park).

2.2 Tree Selection and Harvesting

Planted tree species *R. mucronata* Poiré were randomly selected at the study sites. The crown diameters, diameter of the stems, DBH (measured at 30 cm above the highest prop root in *Rhizophora*) and the heights of all the selected trees were measured. To calculate the crown area, crown diameters were used and the crown area is considered an ellipse.

2.3 Fresh weights of Above-Ground Biomass

The trees were then cut at its stem just above the ground by using handsaw to obtain above-ground parts. The above-ground parts were separated into stem, branches, leaves and prop roots. The total harvested fresh weight of each component was weighed using digital scale weighing and recorded at the site. The fresh weight was recorded in kg.

2.4 Fresh weights of Below-Ground Biomass

High-pressure water pumps and hoses were used to remove tree roots systems for below-ground biomass.

2.5 Dry Weight

A representative sub-sample which is about 1000g of each harvested component was put in the ovens with temperature of 85°C for 48 hours. After 48 hours, the dried components were weighed using digital weighing scale. The dry weights of the components were recorded in kg.

2.6 Allometric Equations

General allometric equations were developed with the data collected across the three sites ($n = 46$), while site-specific equations were developed with the 15 sampled trees at Kuala Bako, 15 sampled trees at Kampung Selabat dan Pasir Putih and 16 sampled trees at Sungai Lemidin. General and site-specific equations were fitted using non-linear

regression method. From the non-linear regression method, crown area (CA) was used as the independent variable and the total product biomass (TPB) as the dependent variable. The total product biomass of the selected trees were estimated by power functions, using crown area as the independent variable $Y=AX^B$, where Y=total product biomass, x=crown area and, a and b are the regression constants.

3.0 RESULTS AND DISCUSSION

The developed of general allometric equation within the three sites is $y = 3.5586CA^{1.165}$, $r^2 = 0.7717$, $p < 0.05$. The site-specific allometric equations used for predicting the total product biomass for *R. mucronata* Poiret at Kuala Bako is $y = 1.123CA^{1.4897}$, $r^2 = 0.6125$, $p < 0.05$, for Kampung Selabat dan Pasir Putih is $y = 4.4016CA^{1.2184}$, $r^2 = 0.7877$, $p < 0.05$ and for Sungai Lemidin is $y = 4.031CA^{1.4441}$, $r^2 = 0.8318$, $p < 0.05$.

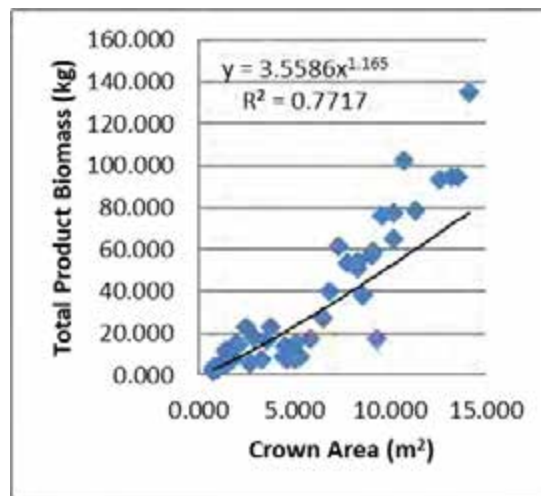


Fig. 1: General model within the three sites

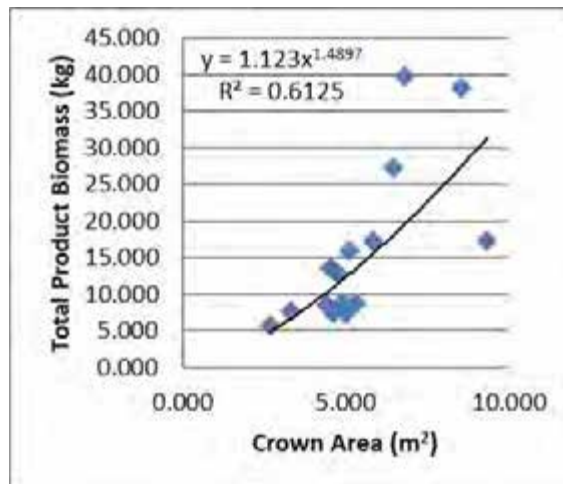


Fig. 2: Site-specific model for Kuala Bako

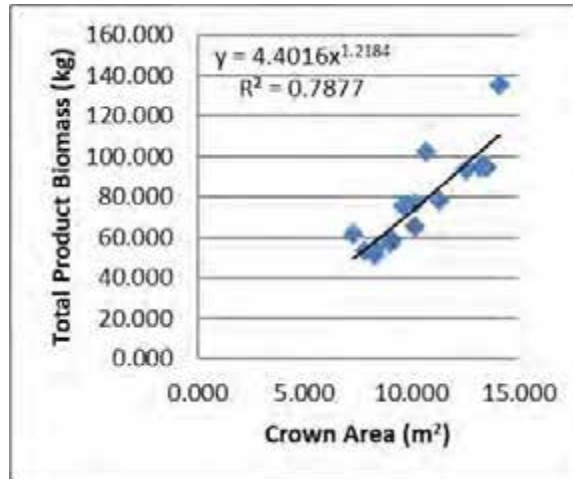


Fig. 3: Site-specific model for Kampung Selabat dan Pasir Putih

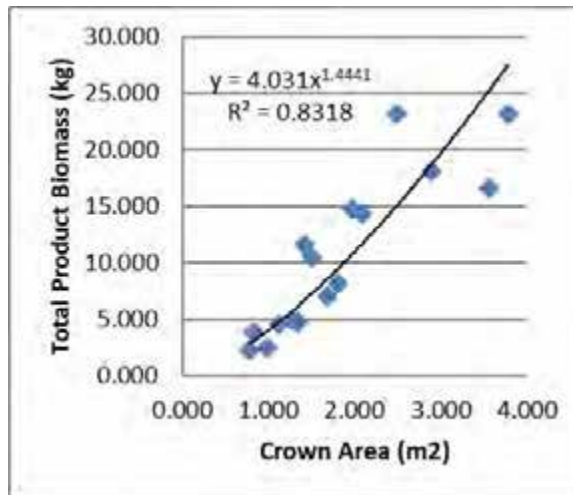


Fig. 4: Site-specific model for Sungai Lemidin

Based on these results, the use of site-specific model was more accurate compare to general model for particular species across varying site characteristics. This was due to the changes of environmental conditions (e.g. climate, geomorphology, edaphic factors and inundation regimes among others), age and the history of forest. Moreover, the estimation of nutrients and carbon stock of each tree components may provide more accurate.

4.0 CONCLUSIONS

This study has shown that a better fit is found for site-specific model as compared to relying on a general model for that particular species across varying site characteristics. Other than that, it is hoped that the equations or models developed for the species will aid in estimating the standing biomass of mangrove forests in Sarawak and therefore enhance mangrove management.

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INFORMATION PAPER 6: STRENGTHENING FOREST FIRE PREVENTION AND SUPPRESSION THROUGH BLUE OCEAN STRATEGY (BOS) AND COMMUNITY ENGAGEMENT: SABAH'S EXPERIENCES.

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Abstract

Forest fire is one of the main causes of forest area losses in Sabah. It was recorded that during extreme El Niño in the years 1982 to 1983 and 1997 to 1998, about 1 million ha and 190,000 ha of forest areas were destroyed by fire respectively. However, during the El Niño in 2016, the total forest areas affected by forest fire were drastically reduced to only about 20,000 ha. This was largely due to the implementation of Blue Ocean Strategy (BOS) in conducting forest fire prevention and suppression operations through collaboration with other government agencies and also engagement with communities. Sabah Forestry Department (SFD) has initiated the establishment of Peat Fire Action Team (PFAT) comprising of SFD, BOMBA, Department of Environment (DOE), Environmental Protection Department (EPD), District Land Office and other relevant government agencies based on BOS. One of the main objectives of the team is to address issues of open burning particularly involving alienated land located surrounding forest areas. Besides, SFD has conducted more awareness campaign, installation of signage and distribution of flyers in strengthening its forest fire prevention through community engagement.

Keywords: BOS, PFAT, El-Nino, Forest Fire

1.0 INTRODUCTION

The worst forest fire ever recorded in Sabah was during extreme El-Nino in 1982-1983 where about 1 million hectares of forest areas were burnt. In the 1997 to 1998 extreme El-Nino events, it was estimated that the total forest area burnt was about 190,000 ha. During the recent El-Nino phenomenon in 2016, Sabah again faced forest fire occurrences throughout the state, particularly in the forestry districts of Beaufort, Keningau, Sook and Tongod. However, the total forest areas affected were drastically reduced to about 20,000 ha. The forest losses due to these forest fire incidents were huge in terms of its biodiversity and economic values, as for instance, it was estimated that the economic losses due to the 2016 El-Nino's forest incidents were estimated at about RM118 million. These losses would be even higher if other economic values of payment of ecosystem services such as biodiversity, water and carbon were taken into account in the valuation. In this regard, effective forest fire prevention and suppression is crucial.

2.0 FOREST FIRE PREVENTION AND SUPPRESSION

Based on the experiences in combating forest fires, it was found that the main causes of fire were due to open burning in the alienated and state land, and to some extent due to poaching. Beside shortage of forest fire equipment (Fig. 1), this frequent open burning during long dry period was the big challenges for the SFD's Forest Fire Crew in conducting forest fire suppression. Based on these experiences, the SFD has strengthened its collaboration with relevant government (Fig. 2) and local communities living surrounding the forest areas.



Fig. 1: Fire Break and Thick Smoke – Proper Protective Equipment Needed during Forest Fire Suppression Operation



Fig. 2: Joint Forest Fire Suppression with BOMBA.

2.1 Fighting Forest Fire through Blue Ocean Strategy (BOS) Approach

Taking into consideration the experiences in combating forest fires during 2016 El-Nino phenomenon, the SFD has initiated the formation of a Peat Fire Action Team (PFAT) based on BOS approach, involving relevant government agencies in Beaufort and Kuala Penyu districts. Members of the PFAT comprise of SFD, BOMBA, Department of Environment (DOE), Environmental Protection Department (EPD), Department of Agriculture (DOA), District Office, District Land Office and Sabah Metrological Department (Fig. 3 and 4). The main objectives of the team are to address issues related to open burning particularly involving alienated land, and also formulating strategies and action plan in preventing and fighting forest fire.



Fig. 3: PFAT Meeting – Discussion on Strategy for Combating Forest Fire



Fig. 4: Awareness Program Conducted by PFAT

2.2 Forest Fire Prevention and Suppression Training

As part and parcel in strengthening its forest fire prevention and suppression, the SFD has continuously conducted the training involving its forest fire crews and workers of long-term licensees. The main objective of the training is to refresh and enhance their knowledge and skills in handling forest fire equipment and conducting fire prevention and suppression. In 2016 and 2017, the department has conducted 13 series of training involving 123 SFD's forest fire crews [consisting of 50 Initial Attack Crew (IAC) and 73 general Forest Fire Crew (FFC)], 116 staff and workers of long-term licensees (Fig. 5) and also 51 staff and workers of oil palm estates.

Most of the forest fire training was conducted by SFD's Forest Fire Training officers. However, the SFD with collaboration with BOMBA has also conducted special training involving SFD's IAC (Fig. 6). Modules of the training include theory and practical and covered the following core subjects:

- Terminology of forest fire;
- Forest fire types and inflammation rank;
- Fire behaviour and the influencing factors;
- Fire Danger Rating System (FDRS);
- Forest fire prevention, suppression strategy and fire fighting precautions;
- Handling forest fire equipment; and
- Water delivery system.



Fig. 5: Fire Training involving workers of the SFMLA holders



Fig. 6: SFD's Initial Attack Crew (IAC) attended training at BOMBA academy, Kota Kinabalu

2.3 Public Awareness Campaign

The awareness campaigns conducted include awareness programs involving local communities residing nearby forest areas (Fig. 7), installation of signage (Fig. 8) and distribution of flyers (Fig. 9). Based on BOS approach, the SFD has collaborated with BOMBA, DOE, DOA and EPD in implementing the awareness program, to enhance its effectiveness. There were 642 local communities attended the awareness programs which were conducted in 2016 and 2017.



Fig. 7: Fire Training Involving Local Communities



Fig. 8: Forest Fire Awareness Signage



Fig. 9: Forest Fire Flyers for Public Awareness and Prevention of Open Burning

**INFORMATION PAPER 7: SABAH TIMBER LEGALITY
ASSURANCE SYSTEM (TLAS): ARE WE DONE YET AND NEARLY
THERE?**

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Abstract

Sabah TLAS has been developed in line with the requirements for Forest Law Enforcement, Governance and Trade - Voluntary Partnership Agreement (FLEGT-VPA). Since the establishment of audit system based on the Sabah TLAS standard in 2009, so much have been achieved. The key achievement of Sabah TLAS was the certification by Bureau Veritas in 2016 in accordance with the requirements of management system standards of ISO 9001:2008. The ISO-certified work procedures of Sabah TLAS audit process will serve as a Standard to further uplift the TLAS standard and to address Correction Action Requests (CAR) throughout the process of auditing monitored by the Sabah Forestry Department (FDS), with more clarity. TLAS has become the legality Standard for Forestry and Chain of Custody (CoC) to ensure trees are legally harvested and that the timber is traceable through final products that can be licensed for export. On the other hand, another significant achievement for Sabah TLAS in 2016 was the mandatory implementation of the CoC. This was part of the FDS's efforts to further strengthen the Sabah Legality Standard. The decision of CoC mandatory implementation had been agreed in 2016 and it is now incorporated in the Sabah TLAS under Principles 5 & 6. The question now is, are we done yet and nearly there? So this paper will report on the findings on whether we are done and achieved the Sabah TLAS objectives.

Keywords: Certification, legality, Chain of Custody

1.0 INTRODUCTION

FLEGT is an initiative by the European Union (EU) with the main objective to combat illegal logging by strengthening sustainable forest management, improving forest governance and ensuring legal trade of timbers and timber products (EU FLEGT Facility, 2018). VPAs are part of the main instruments in the EU FLEGT Action Plan. A VPA is a bilateral trade agreement between the EU and timber-exporting/ producing country outside the EU. Under this agreement, the EU countries will only accept timbers that are coming from legal sources. Besides, the timber exporting/ producing countries will need to develop systems to verify the legality of the timbers or timber products. TLAS verifies that wood products conform to national laws. Once the VPA comes into force, there will be a licensing scheme to ensure that only timber products that have been produced in accordance with the legality standards and regulations of the partner country are imported into the EU.

Six partner countries have signed VPAs with the EU, namely Indonesia, Ghana, Cameroon, Liberia, The Congo Republic and Central African Republic. Indonesia was the first country to start the FLEGT licensing for exports to the EU market in November 2016 (European Commission, 2016). Meanwhile, the other five countries are still in the stage of implementation and developing the system to control, verify and license legal timber or

timber products. Malaysia, on the other hand, began to negotiate a VPA with the EU, in 2007. There were series of developments in Malaysia-EUVPA negotiations in 2014 such as the Malaysia-EU Technical Discussion on the control of the timber supply chain and data management, the finalization of TLAS and its related issues during the Malaysia-EU Sixth Joint Experts Meeting (JEM-6), Meeting on the Malaysia-EU Eleventh Technical Working Group, and Public Information Session organized by the EU (WWF Malaysia, 2015). However, the Malaysia-EU VPA negotiations have been on hold since 2015 and until to date, negotiations have yet to come to a conclusion. In preparation of signing the VPA, Malaysia has taken steps to work towards developing a TLAS and field monitoring and auditing activities are ongoing in accordance to the rules and requirements of the TLAS. The TLAS has mostly been developed for Peninsular Malaysia and Sabah.

2.0 SABAH TIMBER LEGALITY ASSURANCE SYSTEM

The implementation of the Sabah TLAS commenced in 2009 with the support from Germany and The Netherlands. The commitment to comply with the proposed international EU agreements regarding to the initiation and development of FLEGT was reflected through the proactive application of TLAS auditing in Sustainable Forest Management License Agreement (SFMLA) and Long Term License Agreement (LTL) areas throughout Sabah.

At the national level, the FDS has been actively involved in the Joint Expert Meetings on FLEGT- VPA, headed by the Ministry of Plantation and Commodities Malaysia. The meeting serves as a platform where comments and responses of Malaysia and the EU regarding to the TLAS are systematically examined and discussed. Sabah has vigorously participated in the FLEGT-VPA negotiation and the progress thus far has been the formulation of an auditing system that is based on the evaluation and revision of the Sabah TLAS standard and Audit Checklist conducted by NepCon in 2013.

Sabah recognizes the importance to address international concerns in tropical timber trade which is deemed as high risk by European countries and other countries with legal timber procurement regulations. The Sabah TLAS was developed in part through the EU negotiation process and is now considered as the main timber legality standard and system to determine timber legality compliance for Sabah. The legality standard which incorporates CoC, ensures that trees are legally harvested and that the timber is traceable to the final products and point of export. The Sabah TLAS also amongst others, emphasizes company's system sourcing procedures, implementation and records.

The Sabah TLAS has since been improved with several revisions and is currently being used to facilitate in the due diligence process and verification of timber legality produced and exported from Sabah. To further strengthen the legality claims of Sabah's timber, the Sabah TLAS Principles 5-6 Checklist have incorporated additional elements on Risk Assessment and CoC. The CoC implementation has been made mandatory to all wood processing mills in Sabah in September 2016, while the Removal Passes of all timber harvested from areas that have been awarded with Sabah TLAS Compliance Certificate are stamped with "Sabah TLAS Compliant" effective 1 January 2017, to facilitate CoC implementation and monitoring. In August 2016, the Sabah TLAS has been certified under ISO 9001:2018 by Bureau Veritas.

Timber products that comply with the Sabah TLAS standard are generally accepted in the markets as having complied with the due diligence requirements for legal timber. Compliance Certificates for Principles 1 to 4 are awarded to logging companies who have complied with

the Sabah TLAS standard while Compliance Certificates for Principles 5 to 6 are awarded to manufacturers and exporters who have complied with the Sabah TLAS standard, upon recommendation by the third party auditor, Global Forestry Services (M) Sdn.Bhd (GFS) which was appointed by the FDS. The appointment of a third party auditor to conduct transparent audits of Sabah TLAS implementation is part of the FDS's efforts to ensure transparency and credibility in the system. In addition to the third party audit, the implementation of the Sabah TLAS is also assessed and monitored through internal monitoring conducted by other government implementing agencies which form the Implementing Agency Coordination Committee (IACC).

2.1 The Important Outcomes of FLEGT-TLAS in Sabah

The implementation of FLEGT-TLAS in Sabah since then has resulted in several changes concerning the environmental, economic and social aspects surrounding the forest sector. From the context of economic, the industry is heading in a new direction, whereby Sabah timber producers have improved awareness in moving towards the "Green Lane". From the social perspective, the participation from the various stakeholders in the FLEGT-TLAS initiative has become a fundamental component of this system. Specifically, involving stakeholders such as the environment and social NGOs, government departments, SFMLAs' license holders, manufacturers and others in the FLEGT-TLAS decisions has increased the understanding and awareness regarding to FLEGT-TLAS matters and compliance with the standard and regulations. In addition, the stakeholders' involvement has reduced or resolved conflict between the parties involved and at the same time, garnered the supports to FDS in improving the TLAS system from time to time.

Other than that, the FLEGT-TLAS has also increased/ improved transparency (good governance) in the management of forest and timber trade in Sabah as FDS has engaged a third-party auditor, GFS to conduct monitoring audit in SFMLA, Form I and FIIB licensed areas and also for the timber-based manufacturers and exporters in Sabah based on the Sabah TLAS standard Principles 1-6. This, in turn, has further increased the image and credibility of FDS. On the other hand, importers especially from the EU countries begin to request for Sabah TLAS Compliance Certificate as a document required for due diligence and recognition of a feasible process.

For the benefit of Sabah, the TLAS efforts have granted the State the capacity to consolidate the various requirements of existing laws imposed by the numerous Departments and Agencies under one guideline, The Sabah TLAS, which is in lieu with the concept and principle of timber legality.

3.0 SABAH TLAS PROGRESS AND ACHIEVEMENTS

3.1 Revision of Sabah TLAS Checklist for Principles 1-4 and Principles 5 & 6

The proposed revisions of Sabah TLAS P1 – P4 & P5 – P6 were delivered in two (2) Stakeholders Meetings held in 2016, whereby decisions were successfully derived from the discussions to include CoC elements and risk assessments for imported materials (including from Sarawak) within the Standard of Principles 5 & 6. In addition, other than simplify of standard for Principle 1 - 4, the stamping of "Sabah TLAS Compliant" on the removal passes of the timber suppliers (from the forest to the mill) that have

complied with the audit under Principles 1 - 4, has also been included in the checklist and applied commencing on 1st January 2017 (Sabah Forestry Department, 2016).

3.2 Sabah TLAS Audit Findings for 2017

The audit findings of Sabah TLAS Principles 1 – 6 audit assessment for 2017, carried out by the third party auditor, GFS, to all the Timber Industry Players in Sabah, have been technically analyzed and summarized accordingly based on the monthly summary reports submitted by GFS to the FDS.

The audit results of 2017 for Principles 1- 4 shows that out of 73 licensees audited, 53 had complied with the Sabah TLAS Standard. 20 licensees had failed to comply and were imposed with Major Gaps which denote their non-compliance to the Sabah Timber Legality System (**Table 1**). Although the licensees operating under Principles 1- 4 were now quite well accustomed with the enforced laws and regulations of the State's timber industry, there is still the need for these licensees to improve on the environmental issues such as the implementation of relevant mitigation measures related to the environment and submission of the Environmental Compliance Report. These issues which fall under Criterion 2.1.3 made up the most number of Major Gap reported in 2017 as in **Fig.1**.

As for Principles 5 & 6, there were 123 mill licensees audited throughout Sabah in 2017 and the findings in Table 1 show that a total of 102 complied with the Sabah TLAS while 21 licensees were considered to have failed in the audit (**Table 1**). **Fig.2** shows that a number of the millers and exporters audited under Principles 5 & 6 have failed to comply with Criteria 5.2.4, 5.2.5, 5.2.7, which focused on the establishment of CoC and its implementation in the mill or for pure exporters with a total of 12 Major gaps issued, respectively. This shows that these licensees are still quite weak in complying with the criteria. The CoC requirement has been made mandatory for the Sabah TLAS requirement since September 2016. It is anticipated that there will be improvements in 2018, given that training on CoC has been conducted to the mill operators and exporters in 2017.

Overall evaluation based on the Principles 1-6 in 2017 (**Table 2**) demonstrates that the licensees assessed under Principles 1-4 have the most significant difficulties in complying with Principle 2 - Forest Operation as 23 Major Gaps, 52 Minor Gaps and 113 Observations were issued during that year. Meanwhile, no issues were raised for Principle 4 - Other Users' Right in the same year. On the contrary, the evaluation also shows that the performance of the mill operators and exporters in complying with Principle 5 - Mill Operation is less encouraging as a total of 57 Major Gaps, 353 Minor Gaps and 256 Observations were imposed (**Table 2**).

Table 1: Summary of TLAS Audit from January to December 2017

MONTH	AUDITED		PASSED		FAILED	
	P1-P4	P5&P6	P1-P4	P5&P6	P1-P4	P5&P6
January	4	11	4	9	0	2
February	4	12	1	12	3	0
March	4	10	3	10	1	0
April	4	9	1	8	3	1

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May	4	10	2	10	2	0
June	4	9	3	6	1	3
July	8	12	7	12	1	0
August	10	9	7	8	3	1
September	9	9	8	5	1	4
October	5	11	4	6	1	5
November	9	10	6	8	3	2
December	8	11	7	8	1	3
TOTAL	73	123	53	102	20	21

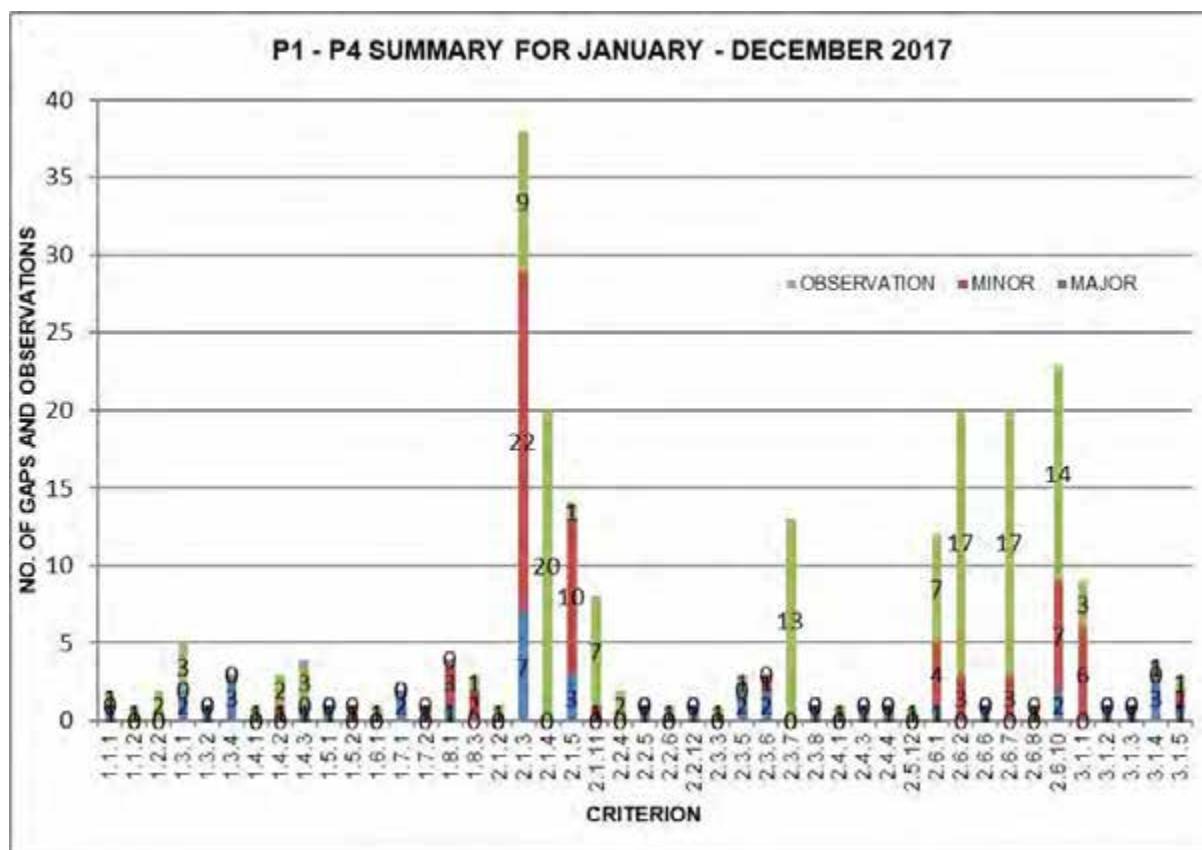


Fig. 1: Sabah TLAS P1 – P4 analysis for January to December 2017

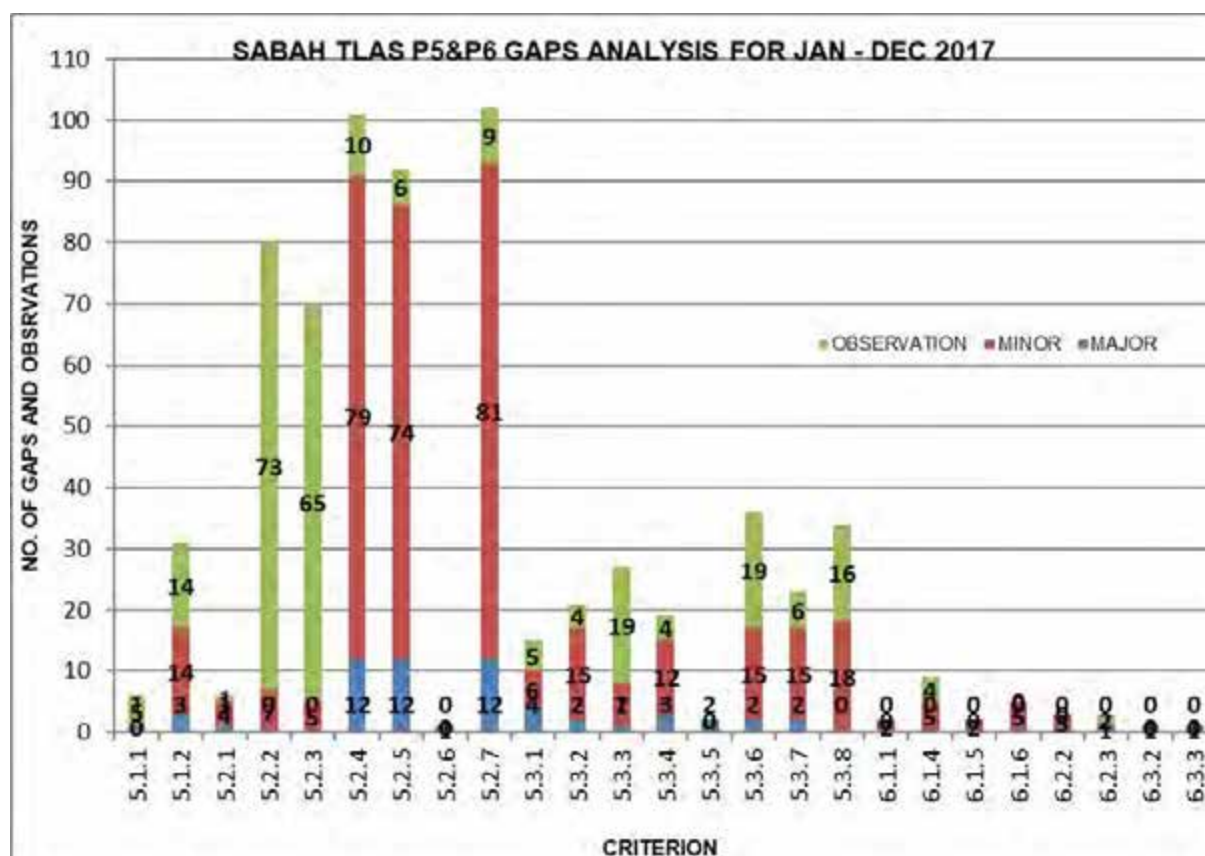


Fig. 2: Sabah TLAS P5 – P6 analysis for January to December 2017

Table 2: Summary of Gaps and Observations for P1-P6 2017

PRINCIPLE	MAJOR	MINOR	OBSERVATION
1	12	8	15
2	23	52	113
3	6	7	5
4	0	0	0
5	57	353	256
6	0	20	6
TOTAL	98	440	395

3.3 The issuance of Sabah Timber Legality Assurance System Compliance Certificate (Sabah TLAS - CC) in 2017

In 2017, the FLEGT Unit has issued a total of 66 Sabah TLAS Compliance Certificates to the recipients under Principles 1 – 4 and another 114 certificates to the recipients under Principles 5 and 6. In the long term, FDS through GFS will continue with the ongoing Sabah TLAS compliance auditing exercise on an annual basis based on the schedule provided by FDS. The STCC will be continuously issued to those licensees that have complied with the Sabah TLAS.

3.4 Achievements from the Year 2009 to 2017

Fig. 3 illustrates the trends in FLEGT-TLAS Audit Compliance, with a classification of compliance and non-compliance, from 2009 to 2017. Over the period it can be observed that the number of licensees that complied with the FLEGT-TLAS standard gradually

increased since 2009. There was also a dramatic climb, of approximately 90% of the total number of licensees that complied with the audit from 2014 to 2015. This is due to the start of TLAS Principles 5 and 6 audit for mill operators and exporters, which in turn, further increase the number of licensees audited in 2015.

In the year 2016, the number of licensees complied with the TLAS standards was 159, but this figure dropped in 2017 to 155. This is mostly because of the new revision of the Sabah TLAS Checklist Principles 5-6 that put the CoC implementation as a mandatory requirement set by the FDS and to be adhered to by the mill operators and exporters, commenced on September 2016. Not only that, the environmental issues such as the failure to provide EIA and ECR report, especially by the FIIB license holders which were audited under TLAS Principles 1-4 also contributed to the decrease in number of licensees that complied with the rules. This also explains the increase in the number of licensees that failed to comply with the audit, from 10 to 41 in 2016 and 2017, respectively (**Fig.3**).



Fig. 3: FLEGT-TLAS Compliance 2009-2017

4.0 CONCLUSION

Since the implementation of Sabah TLAS audit covering Principles 1 – 6 is mandatory to all downstream and upstream timber players in Sabah, various setbacks and obstacles have been identified and appropriate solutions and good practices have also been outlined in the stakeholders and IACC meetings. It is anticipated that with the full commitment given by all stakeholders, proper solutions can be achieved to assure credibility and efficiency of the system. Therefore, it cannot be denied that the good efforts implemented by FDS will further enhance the Sabah TLAS system. This is in line with the FDS's commitments in combating illegal logging, enhancing transparency, improving forest governance and definitely elevating the level of traceability and to ensure that only legal timbers are being traded on the market.

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**INFORMATION PAPER 8: MERBAU'S LAST STAND IN SABAH
& THE WAY FORWARD**

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Abstract

Merbau is regarded as the most valuable timber not only in Malaysia but throughout Southeast Asia. Taxonomically known from the genus *Intsia*, both *I. bijuga* and *I. palembanica* are facing the risk of endangerment to local species extinction. There is a significant reduction on timber production of these particular species over the years due to continuous harvesting and illegal trade. Alarmed by these critical event, *Intsia* has been listed in CITES of Index II, and some countries, including Malaysia, have restricted the export of *Intsia* wood to support the national mitigation effort that was set for these species. In order to manage the resources of what are left for *Intsia*, there have been few a systematic approach to cultivate the species. However, the prospect of integrating Merbau into plantation programme is incongruous due to their slow growing characteristic. In this study, the current distribution of *Intsia* in Sabah via Ecological Niche Modeling is estimated to be about 30% of the total predicted area that remained within the TPA network. Further potential research and management recommendation are discussed.

Keywords: *Intsia*, Merbau, timber trade, CITES, Ecological Niche Modeling and conservation

1.0 INTRODUCTION

Vernacularly known as Merbau in Malaysia, it is regarded as high-end luxury wood. It is recorded as widespread, ranging from India, Thailand, Sumatra, Malaysia, Singapore, and Borneo. However, the pressure on Merbau has increased over the last years as demand for Merbau decking and other markets had driven them to local extinction. According to Greenpeace International, 2007, the volume of Merbau for commercial quantities only reported in Papua Land, Indonesia (Papua Land) and in Papua New Guinea. Even in these two countries, the range of Merbau has already been heavily impacted by habitat destruction and illegal logging. Over 60 per cent of the original Merbau range has been affected by various land-use activities and most of the natural stands are locally depleted. The World Bank projected that about 70 to 80 percent of Merbau timber productions are illegal in Papua province. It is estimated that around 300 000 cubic metres of Merbau logs are being smuggled out of Papua every month. This massive theft is being organised by powerful syndicates of brokers and fixers, spanning from Indonesia, Malaysia, Singapore, India and China (EIA Telapak, 2005). As reported recently, massive land is being cleared for oil palm plantation development and for that reason unscrupulous investors exploit out the forest resources legally especially sourcing for Merbau timber (West Papua Daily, 2017). This example is

associated with the Merbau's trade that were driven previously by international demand for cheap tropical timber, principally the markets of China, Japan, the US and the European Union. Mitigation effort to resolve these problems have gained international intentions to promote responsible management by listing Merbau into CITES. The Sabah Forestry Department (SFD) has declared that all Merbau species, including Merbau lalat (*Sympetalandra borneensis*) are prohibited species in natural forest management area. In case of special circumstances e.g unavoidable road construction, damaged trees and etc. royalty that issued are varies according to irrespective size of the log and type of land use of where it is present (SFD, 2017). Nevertheless, the prospect of integrating *Intsia palembanica* into plantation programme could be hindered by its slow growing rate as reported by Appanah and Weinland (1993), as the annual diameter increment of ~0.6cm only. Merbau has been used in planting trials due to its seed dormancy characteristic. The seed can be stored at room temperature for more than three years due to its ability to reduce the moisture content less than 10% without losing the viability (Sasaki & Ng, 1981). Alternatively, collecting Merbau's seeds for planting material for *ex-situ* programme is the way forward to preserve its genetic population from depleted. In this study, Ecological Niche Modeling was used to predict the potential remaining population of Merbau in Sabah for species phenology monitoring programme, in the hope to utilize the stock plant production of Merbau seeds for *in-situ* restoration.

2.0 METHODOLOGY

2.1 Species Distribution Model of *Intsia* Using Ecological Niche Modeling.

Ecological niche modeling is an approach for generating maps of a species potential distribution on the basis of a mathematical representation of its distribution in environmental space (Phillips et al., 2006), and allows for the reconstruction of a species historic distribution (Maycock et al., 2012). Preliminary ecological niche models were generated using MAXENT v. 3.3.1 (www.cs.princeton.edu/~schapire/maxent/, Phillips et al., 2006) based on locality data obtained from herbarium specimens. However, error of over prediction by the program are likely to occur if the herbarium data collection are biased or may not represent the whole habitat range of a species. Many of these herbarium collections were made prior to the advent of GPS technology and need to be geo-referenced post-collection (Beaman and Conn 2003). Hence, specimens collected without geographical coordinates in the 1960's, or earlier were assigned with probable coordinates using the geographical information contained on the specimen label in consultation with 1:250,000 soil maps and 1:50,000 forest stratum maps. To proof-checked herbarium data collection, all *Intsia* specimens were filtered and re-positioned based on informative maps, e.g. land use map of Sabah, Soil map of Sabah, altitudinal map of Sabah, research plots and previous logging compartments by Sabah Forestry, current GPS data that obtained through scientific expeditions. The digitizing of these coordinates were conducted by using DIVA GIS programme. In this study, the background land-use map of Sabah was based on 2012. Therefore, all predicted population within the Totally Protected Area (TPA) network are based on land use of Sabah in 2012.

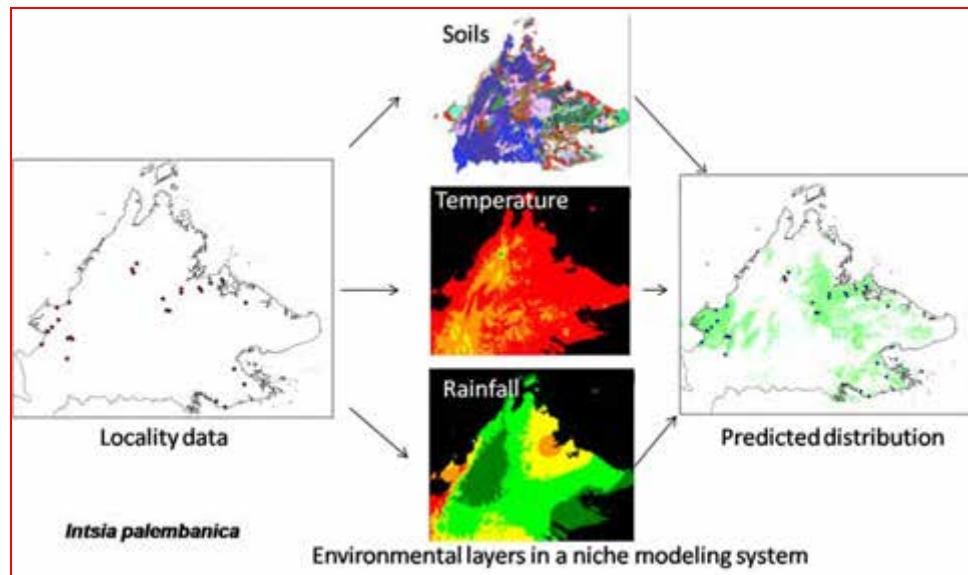


Fig. 1: The work flow of ENM.

In total, 35 out of 39 localities of the two *Intsia* species were geo-referenced. Four localities were omitted due to unreliable or insufficient geographical information recorded in the specimen collection. The oldest herbarium specimen of Merbau was recorded back in 1960. Its belong to *Intsia palembanica* which can be accessed through SAN 57252 in Sg. Tingkayu Camp. While the oldest herbarium specimen of *Intsia bijuga* was recorded back in 1961, accessed through SAN 25757 in Banggi Island, Kudat.

Based on the geo-referenced herbarium specimens, both species coincide partially on their natural habitats. Both species are recorded on Klias and Tinagat soil associations. Soil association of Klias derived from deposits of peat, which overlie alluvium and forming peat swamps. The peat swamps are associated with river floodplains with extremely sluggish external drainage. Meanwhile, Tinagat soil association occurs on mountains and hills of basic and intermediate igneous rocks (CAIMS, 2002). Nevertheless, *Intsia palembanica* harboring more to inland of lowland kerangas and up to upland dipterocarp forest, in contrast with *Intsia bijuga* which prefers coastal and bordering swampy forest.



Fig. 2: Herbarium specimen of *Intsia bijuga* recorded in Pulau Bangi, Kudat (1961)



Fig. 3: Herbarium specimen of *Intsia palembanica* recorded in Sg. Tingkayu Camp (1960)

Table 1: Geo-referenced herbarium specimens of Merbau's in Sabah.

Species & number of locality geo-referenced	Species distribution	Soil Association
<i>Intsia palembanica</i> (24 localities)	Weston, Klias, Merintaman, Kabili Sepilok to father inland of Telupid, Tangkulap and up to Ranau and Crocker Range, from 4m up to 900 masl.	Rumidi, Silabukan, Klias, Lokan, Kepayan, Kinabatangan, Kretam, Gumpal, Brantian, Dalit, Bidu-Bidu, Bang, Sinarun, Tinagat, Crocker & Labau
<i>Intsia bijuga</i> (11 localities)	Islands of Gaya, Banggi, Berhala, Sipadan to coastal areas of Weston, Membakut and Beluran, ranging from 8m to 78 masl.	Weston, Klias, Tinagat, Binalik & Maliau.

3.0 RESULTS AND DISCUSSION

Fig. 4 shows that the predicted distribution of *Intsia bijuga* based on 11 localities were mostly distributed at the coastal areas bordering mangrove swamps, rivers or floodplains. The further inland areas at the east coast of Sabah consist of district Beluran, Bongaya, Sugut and Paitan (mangrove associates) and Kinabatangan (floodplain area). It is estimated about 51.53% of the population were lost due to the adverse impact of land use alteration. About 44.08% are inside the TPA network and are considered to be in low risk of losing their population, unless it being jeopardized by the occurrence of natural disaster, such as forest fire. While 4.39% is predicted inside the Class II of production forest, indicated higher risk of population's lost due

to habitat disturbance by logging practices that may lead to soil degradation and erosion. Finally, it summarises that the predicted distribution of *Intsia bijuga* has depleted more than 50% from its past population.

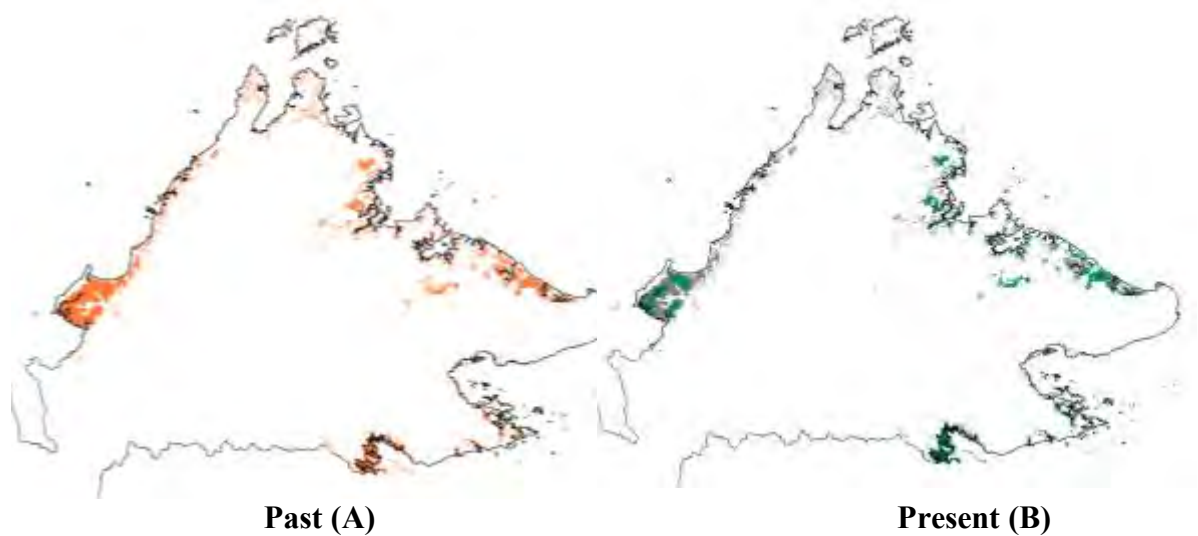


Fig. 4: The past and present of predicted distribution for *Intsia bijuga* in Sabah: **A)** Predicted distribution of *Intsia bijuga* using 11 localities from the FRC herbarium collection (1961-2000); **B)** *Intsia bijuga* by land use (as at 2012) predicted 51.53% habitat lost, 44.08% in protected forests and 4.39% inside production forests.

Fig. 5 shows that the predicted distribution of *Intsia palembanica* based on 24 localities were mostly distributed in the lowland of Bonggaya FR to the hills of Timimbang FR., Ulu Tungud FR. and Tawai FR., followed by the upland vegetation of Trusmadi FR. and the Crocker Range FR. It also covered minor land of mangrove associates and river flats. Those are, namely, in the east coast of Sandakan (Sg. Gum-gum FR., Sg. Loboh FR., Labuk VJR & Kabili FR.), Beluran, Semporna (Timbun Mata FR. & Segarong FR.), Tawau (Tinagat FR. & Membalua FR.) and Kalabakan (Sg Serudung FR.). While in the west coast consists of only Beaufort district, Menumbok FR., Padas Damit FR., Klias FR. and Binsuluk FR. It is estimated about 72.53% of the population were lost due to the adverse impact of land use alteration, and about 17.29% are inside the TPA network that are considered to be in low risk of losing their population, unless it being jeopardized by the occurrence of forest fire. While, 10.17% indicated higher risk of population's lost due to habitat disturbance by logging practices that may cause soil degradation and erosion. This summarises that the predicted distribution of *Intsia palembanica* has depleted more than 70% from its past population.

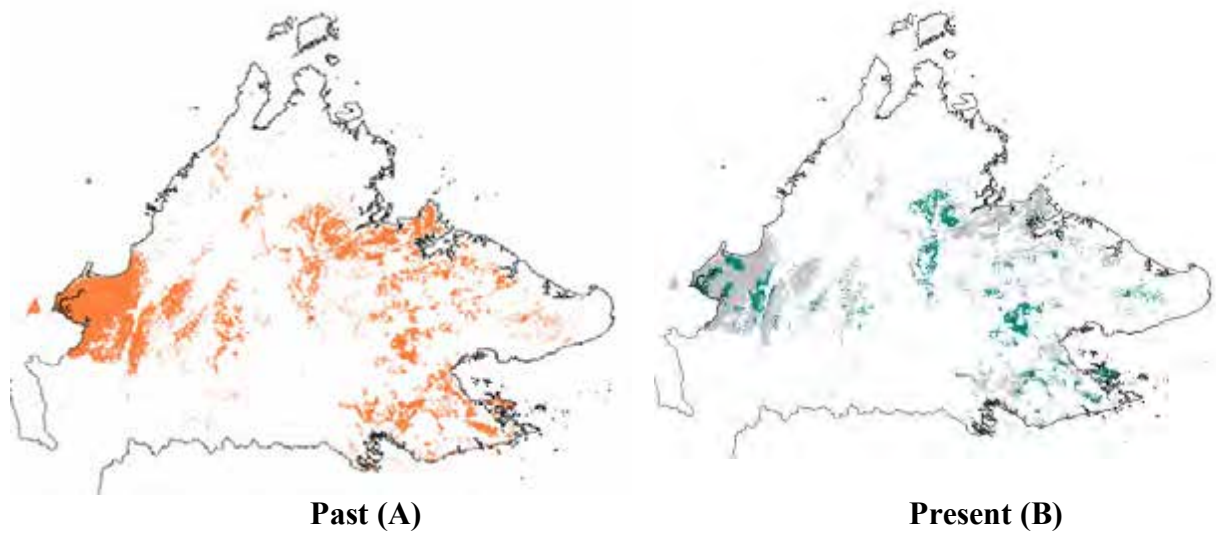


Fig. 5: The past and present of predicted distribution for *Intsia palembanica* in Sabah:
A) Predicted distribution of *Intsia palembanica* using 24 localities from the FRC herbarium collection (1961-2000);
B) *Intsia palembanica* by landuse (as at 2012) predicted with 72.53% habitat lost, 17.29% in protected forests and 10.17% inside production forests.

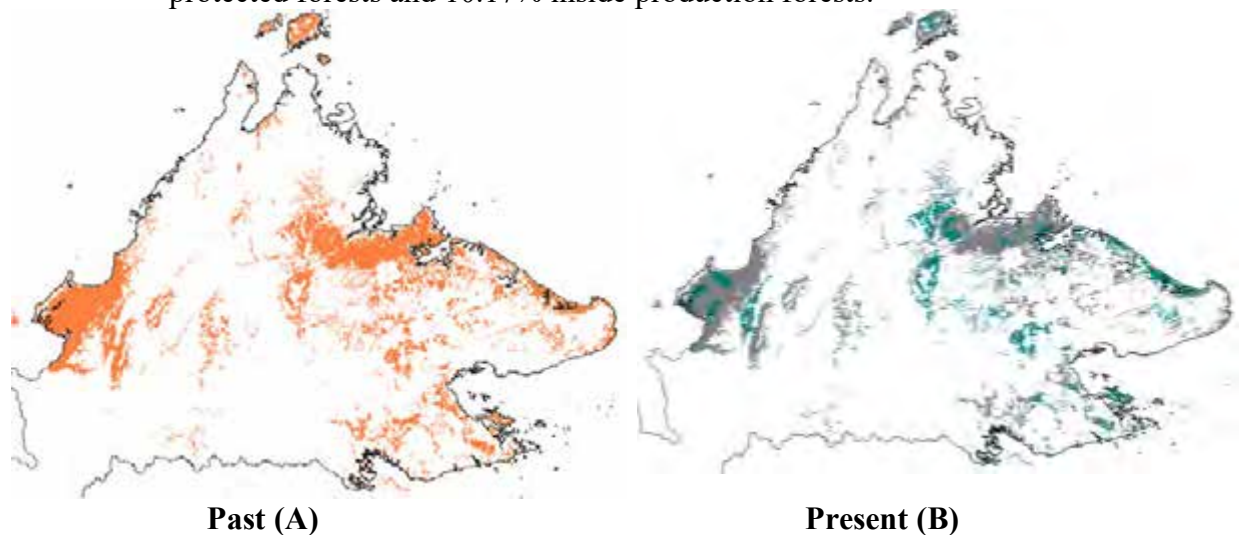


Fig. 6: The past and present of predicted distribution for Merbau (*Intsia bijuga* & *Intsia palembanica*) in Sabah:
A) Predicted distribution of Merbau of both *Intsia bijuga* & *Intsia palembanica* using 35 localities from the FRC herbarium collection (1961-2009);
B) Merbau by land use (as at 2012) predicted 69.95% habitat lost, 19.81% in protected forests and 10.24% inside production forests.

Fig. 6 shows the predicted distribution of both species combined *Intsia bijuga* and *Intsia palembanica*, based on 35 localities that were recorded from herbarium specimens (1960 - 2009). It represented the past distribution model for Merbau's in Sabah **(A)** before underwent a process of overlay filtering by land use information map. Thus, it will produced an optimistic prediction inside the TPA network regardless of adverse impact on disturbed and developed areas. The present model in **(B)** explained Merbau's distribution covered from coastal areas to the lowland and up to the Crocker Range. It is estimated that about 69.95% of the population were lost due to the adverse impact of land use alteration, about 19.81%

remained in the TPA network and are considered to be in low risk of losing their population, unless it being jeopardized by the occurrence of natural disaster such as forest fire. While, 10.24% were inside the production of Class II forest reserve indicated higher risk of population lost. This summarises that the predicted distribution of both *Intsia bijuga* and *Intsia palembanica* in Sabah have depleted nearly 70% from its past population. The predicted population inside the TPA network are the Lower Kinabatangan-Segama Wetlands RAMSAR SITE, Tabin Wildlife Reserve, Timbun Mata FR., Mt. Pock FR., Kalumpang VJR, DAMAI, Lingkabau FR., Timimbang FR., Ulu Tungud FR., Bonggaya FR., Serudung FR., Banggi FR., Trusmadi FR. and Crocker Range. However, ground truthing should be conducted to validate these areas to locate Merbau's tree.

Risk assessment and the way forward to manage Merbau resources

Based on the recorded locality number of Merbau in Sabah from 1961, it is predicted that nearly 70% of its population are depleted and could be in endangered state. This led to only 30% of the Merbau population remained intact within the TPA network (*refer to fig.6*). Despite the scenario, it is yet to be confirmed until further research and ground truthing has been conducted. Furthermore, there are uncertainties of forest intactness in the TPA network, especially peat swamp areas like in Klias FR. and Binsuluk FR.; which both were previously affected by forest fire. Furthermore, threatened and endangered assessment based on IUCN protocol should be conducted to determine the conservation status on local context.

Promoting *ex-situ* and *in-situ* conservation programme

In order to preserve the Merbau resources from further depletion, effort in *ex-situ* and *in-situ* management should be in place. Continuous research on procurement of planting material, such as seeds and wildings are essential. Therefore, ground survey is required to identify and mark down the location of mature adult trees within the predicted area of TPA network. This effort is to be followed by initiating species monitoring programme to monitor flowering and fruiting event that eventually collection of planting materials such as seeds could be carried out. Subsequently, research on nursery techniques that include study of seed germination and seedling development can be conducted in order to produce high quality planting materials for reforestation or restoration. With the establishment of Merbau's stock plant, it will be an initial effort to support the FMU's restoration programme. Furthermore, creating public awareness in regard of the importance of conservation, is essential in the attempt to curb illegal harvesting of Merbau from the brink of local extinction.

4.0 CONCLUSION

The study indicates that *Intsia* species could be categorised as endangered species in Sabah due to the adverse impact of land use alteration. Further research is require in order to formulate species conservation programme that focus on the protection of viable population of these high value conservation species.

5.0 ACKNOWLEDGEMENTS

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**INFORMATION PAPER 9: BOTANICAL ASSESSMENT: CASE STUDY
IN ULU SEGAMA MALUA FOREST MANAGEMENT UNIT, SABAH**

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Abstract

A compilation of flora records from various botanical assessments and herbarium plant database in the Sandakan Herbarium for Ulu Segama-Malua Forest Management Unit (USM) was conducted. The assessment aimed to list out plant diversity and to identify interesting, endemic, rare and threatened plant species, which are considered high conservation value species. These high conservation value species are key conservation targets for any forested area such as USM. With the proper knowledge of plant diversity, their conservation status and key conservation targets of the area, they can be used as the basis of recommendation which is vital in enhancing biological resource information and provide conservation target species for the management and monitoring activities in the next management plan of USM.

Keywords: Plant diversity, conservation status, endemic, rare, threatened plant, forest management plan.

1.0 INTRODUCTION

The Ulu Segama Malua Forest Management Unit (USM) is a Class I Protection Forest Reserve with an area of 241,098 ha, under the jurisdiction of Ulu Segama Malua District Forestry Office. The area has experienced timber extraction and other forestry activities in the past, resulting in the insufficient timber stock, and hence, logging activities have been ceased. Hence, the last 10-year forest management plan (FMP) (2008–2017) for Ulu Segama-Malua Sustainable Forest Management Project Area dealt mainly with restoration and management of forest resources. In terms of botanical collection, there has been many botanical collections made around USM. These secondary data were used in the botanical assessment for the preparation of High Conservation Value Forest (HCVF) report and the next FMP (2018-2028) for USM.

2.0 STUDY SITE

2.1 Location

The USM is located within the Ulu Segama Malua Forestry District in the south eastern part of Sabah (Figure 1) and is accessible by road from Lahad Datu. Lahad Datu is the nearest town where the key government administrative offices are located. USM is surrounded by forest reserves in the southern and western parts while statelands in the northern and eastern parts.



Fig. 1: The map of USM and its location in Sabah.

2.2 Soils

The USM area encompasses several soil associations of which about 87% of the total areas are covered by 6 soil associations, namely the Mentapok, Gumpal, Bang, Kretam, Bidu-Bidu and Malubok Associations. The Mentapok association is the most extensive association, which covers about 111,443 ha, particularly in the eastern and southern portion of the area.

2.3 Topography

The USM is located on land with a large altitudinal range of 30–1,290 m above sea level (a.s.l). About 60% of the USM landforms consist of undulating terrain with slopes varying from 6° to 24° and altitudinal range from 200–600 m a.s.l. The higher elevations which cover an area of 10% of the USM area is mostly located on the eastern and southern parts of USM, which can be classified as mountainous terrain with slopes >25°. The other remaining areas in northern part of Ulu Segama, Malua and Merisuli forest reserves can be classified as lowland, found below 200 m a.s.l. with <5° slope, including a fraction of low-lying flood plain areas. The highest mountain in USM is Mt Tribulation with a height of 1290 m a.s.l.

2.4 Vegetation

The natural vegetation of USM consists of Lowland and Upland Mixed Dipterocarp Forests and Lowland and Upland Ultramafic Forests. However, the area has experienced timber extraction and other forestry activities in the past and due to that, forests in the reserve can be generally categorized into three broad vegetation classes, i.e., old growth forest, secondary vegetation and planted vegetation. The old growth forest consists of various climax forest formations including mixed dipterocarp forest, ultramafic forest, montane forest and seasonal freshwater swamp forest. The secondary vegetation type can be differentiated into two classes, i.e. the late secondary forest and low stature secondary vegetation (SFD, 2012).

3.0 METHODS

All flora data were compiled from the recent (Sg. Bole) and past records (SFD, 2012; Sugau et al., 2016; SAN Herbarium Plant database). Relevant literature materials were consulted to determine the conservation status of the plants listed.

4.0 RESULTS AND DISCUSSION

4.1 Plant Diversity

Based on the herbarium and voucher specimens, including recent and past records, a total of 1621 plant taxa from 156 families were recorded from the reserve. These are represented by the following families (in brackets) of various plant groups, lycophyte (1), ferns (17), Gymnosperms (3), Angiosperms (Monocotyledon) (16) and Angiosperm (Dicotyledon) (119) (Table 2).

Table 2: Number of taxa by plant groups from Ulu Segama-Malua (USM), Sabah, Malaysia.

Plant group	No. of families	No. of taxa
Lycophytes	1	12
Ferns	17	67
Gymnosperm	3	8
Angiosperm:	16	167
Monocotyledon		
Dicotyledon	119	1367
Total	156	1621

The ten most speciose families are the Dipterocarpaceae (83), Rubiaceae (76), Annonaceae (73), Myrtaceae (65), Phyllanthaceae (64), Euphorbiaceae (63), Fabaceae (59), Lauraceae (52), Malvaceae (51) and Meliaceae (43) (Figure 2). The largest family, Dipterocarpaceae was represented by seven genera (*Cotylelobium* and *Upuna* were not encountered during the survey) with 83 species. The most interesting finding was the discovery of *Dipterocarpus ochraceus*, one of the Sabah endemic dipterocarp species, near Sg. Juak during the recent survey. This is a new distribution record for the species as it was previously only known from the Ranau district.

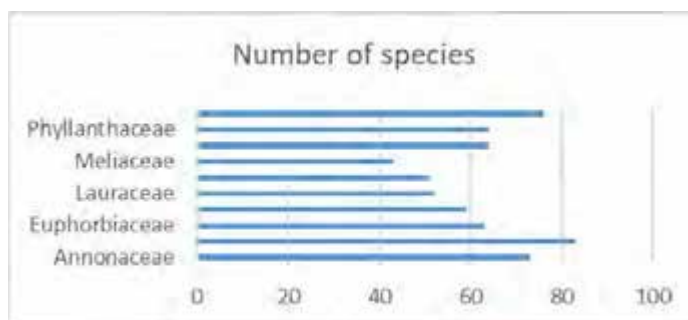


Fig.2: The ten most speciose families in USM.

Ferns and lycophytes are green plants that lack flowers. They reproduce by microscopic spores, rather than by seeds as in flowering plants. Ferns can be distinguished from

lycophytes by having highly divided fronds with branching veins and spore-bearing structures on the margins or undersides. While in lycophytes, their sporangia are on the upper surfaces of the small leaves with unbranched veins. There were 12 species of lycophytes and 67 fern species encountered. None of the ferns identified within the management unit was found to be endemic to either Borneo or Sabah. For the lycophytes, two species (*Selaginella boschai* and *S. conferta*) are endemic to Borneo.

Gymnosperms are vascular, seed bearing and non-flowering plants with seeds that are not protected by an ovule. This includes the conifers (*Agathis* and podocarps) and gnetophyte. There were 8 species of gymnosperms recorded from USM.

In terms of plant group, the flowering plants, also known as Angiospermae was the most diverse group in USM, with 1534 number of species. The flowering plants are divided into two groups, i.e., monocotyledon and dicotyledon. The monocotyledons are a class of flowering plants, whose embryo (seed) store only one cotyledon. This includes all aroids, grasses, sedges, gingers, palms, orchids, etc. There were 167 species of monocotyledons recorded from USM. The dicotyledons are those plants with a pair of leaves, or cotyledons, in the embryo of the seed. This includes mostly all the trees, some herbs and shrubs. There were 1367 species of dicotyledon recorded from USM.

4.2 Plant Conservation

4.2.1 Endemism

Endemism is the ecological state of being unique to a defined geographic location, such as an island, nation or other defined zone, or habitat type. Organisms that are indigenous to a place are not endemic to it if they are also found elsewhere. The extreme opposite of endemism is cosmopolitan distribution. Endemics can easily become endangered or extinct if their restricted habitat changes, particularly but not only due to human actions, including the introduction of new organisms.

Of the 1621 taxa that have been recorded, 415 taxa are endemic to Borneo, including 77 taxa endemic to Sabah. These Sabah and Borneo endemics are distributed all over USM and they are found in all past and recent survey areas/plots. In terms of legal protection, 14 endemic plants are protected by the Sabah Forest Enactment 1968, 19 by Sabah Wildlife Conservation Enactment 1997 and 11 by the CITES. Two species, *Begonia ruthiae* and *Syzygium silamense* are considered narrow endemics as these two species are so far known from Danum area and Gunung Silam respectively.

4.2.1.1 The IUCN Red List

The IUCN Red List of Threatened Species is designed for evaluating the conservation status of plant species. There are 23 plant species that are listed as Vulnerable (VU), 5 Endangered (EN) and 12 are Critically Endangered (CR) from the reserve. In terms of legal protection, only three threatened species (*Aquilaria beccariana*, *Eusideroxylon zwageri* and *Durio acutifolius* are protected under state law (Sabah Forest Enactment 1968 and Sabah Wildlife Conservation Enactment 1997) and international law (CITES, of which Sabah-Malaysia is a signatory).

4.2.1.2 Wildlife Conservation Enactment 1997, CITES and Sabah Forest Enactment

Sabah Wildlife Conservation Enactment 1997 (SWD, 1997), under part VI (Protection of Plants) listed plants that may not be harvested without a license. There are five taxa, namely *Tetrastigma dichotomum*, *T. diepenhorstii*, *T. megacarpum*, *T. papillosum* and *T. pedunculare* that fall under Schedule 1, part II, Totally Protected Plant Species. There are 65 plant taxa, comprised of 15 species of gingers, 1 *Rhododendron*, 5 *Nepenthes*, 3 Podocarp, 1 Ramin, 1 Gaharu and 39 orchids that fall under Schedule 2, part II, Protected Plant Species.

There are 46 species that are listed under Appendix II CITES, 1 from the Gaharu, 1 ramin, 39 orchids and 5 from the pitcher plant family. There are 73 plant species that are prohibited under Sabah Forest Enactment 1997, mostly of fruits trees and threatened tree species.

5.0 ISSUES AND RECOMMENDATION

During the recent survey, there were no pressing issues or threats to the forest and to the high conservation value plants observed in USM. Since the forests in USM have already been legally gazetted as a Protection Forest (Class I), hence, the next essential step is to formulate a forest management plan for the reserve. Forest management plan is essential as a guideline to manage any forested area or forest reserve, such as USM, in order to maintain the integrity of the reserve, including protection or conservation of plant species of high conservation value.

Plant species of high conservation value may include species that are, e.g. endemic to a locality, threatened and also important as food source for wildlife. These high conservation value plants or plant conservation targets must be identified and monitored, including conducting population studies. However, most of the Sabah endemic plant species (except for some *Begonia* species) as well as the threatened plant species that are found in USM are widely distributed in Sabah, hence, there are no urgent measures required. Nevertheless, we propose two species, namely *Dipterocarpus ochraceus* (Sabah endemic and critically endangered) and *Begonia ruthiae* (Sabah endemic and only found around Danum area) as the plant species conservation targets to be monitored. The justification for the selection of these species is that they are easily recognisable in the field, Bornean endemic and threatened (Critically Endangered) species. *D. ochraceus* was recorded from permanent sample plots number 4, 5 and 6 while *B. ruthiae* was recorded from around Kawag Reception Centre. Protection of the forest reserve as a whole, including from forest fire, poaching and illegal encroachment must also be emphasized in the forest management plan.

6.0 CONCLUSION

The study recorded 1621 plant taxa from the reserve, of which 415 taxa are endemic to Borneo, including 77 endemics to Sabah. The forests in USM contain high conservation value plant species.

7.0 ACKNOWLEDGMENTS

The survey was conducted to obtain botanical information for the HoB scientific expedition and for the preparation of the Forest Management Plan of the reserve. We thank the Deputy Director (Forest Sector Planning) for his support. We also thank the USM DFO for his permission to stay in the DFO rest house and the Deputy Chief Conservator (R&D), Dr. Lee

Ying Fah for his continuous support. En. Jumri Abd. Hamid provided maps and the staff of the Systematic Botany section are gratefully acknowledged for their hard work in the field.

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**INFORMATION PAPER 10: DOCUMENTATION OF INSECTS AS A
TOOL TO ENHANCE BIODIVERSITY CONSERVATION WITHIN
THE HEART OF BORNEO AREA IN SABAH**

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Abstract

Insects are very diverse and are ecologically significant in the tropical rainforest ecosystems. Under the Heart of Borneo Initiative in Sabah, biodiversity documentation within selected forest reserves, including insects, has been one of the department's key priorities since the HoB Declaration in 2007. Insect diversity data and species documentation (endemic, rare and interesting species) procured from scientific expeditions will serve as baseline information to promote, support and enhance conservation efforts and sustainable forest management. The data procured are incorporated in formulation of forest management plans and high conservation value reports for forest certification. To date, more than 30 forest reserves in Sabah have been surveyed and insect fauna was documented. Besides insect diversity documentation, other conservation aspects and issues related to insects and forests were also studied, such as forest fragmentation, connectivity and corridor, forest fire, encroachment and land-use changes.

Keywords: Insect diversity, biodiversity conservation, Heart of Borneo.

1.0 INTRODUCTION

Sabah is a beacon of biodiversity and is situated within one of the twelfth mega-biodiversity hotspots in the world. The natural ecosystems of Sabah, especially the tropical rainforests, support a diversity of wildlife, including insects. Sabah is home to the iconic orang-utan, proboscis monkey, tembadau, rhinoceros and pygmy elephant. The latter two species are distributed mainly in Sabah, Borneo. The tropical rainforests in Sabah are recognized to be of inestimable value and extraordinary beauty (Mannan 2014). Some 49% of the land area in Sabah is under Permanent Forest Reserves (PFRs), governed by the Forest Enactment 1968, and the Sabah Forestry Department is the custodian to these forests. They are an important asset to the state, not only for their significant contribution to the socio-economic development but also for their essential role in the maintenance of the quality of the environment (e.g. protection of water quality and supply, prevention of soil erosion and nutrient depletion, and moderation of climate), biodiversity, ecotourism and biotechnology. Hence, sustainable use of natural resources from the forests and biodiversity conservation are significant in ensuring a better tomorrow for our future generation (Mannan et al. 2013).

1.1 Insect Fauna of Sabah

Insects are a very important group of animals because of their immense diversity and abundance. About 75% of the animal species on earth are insects, and many are found

in the tropical rainforests. Due to their dominance in species and individuals, they are ecologically significant in the functioning of the rainforest ecosystem, as decomposers, pollinators, defoliators, nutrient recyclers and also in plant and other animal relationships (Chung 2013). Many in Borneo are interesting, rare and endemic, especially those from the montane habitat, which lies within the Heart of Borneo landscapes in Sabah.

1.2 The Heart of Borneo Initiative

The Heart of Borneo (HoB) programme is a 'three countries – one vision' responsibility, which is to protect and conserve the rich biodiversity within this area. The initiative is a voluntary transboundary cooperation aiming at conserving and managing the ecologically inter-connected highlands of Borneo and parts of the adjacent foothills and lowland rainforests, which straddle the borders of three ASEAN countries, covering an area of approximately 200,000 km². The state government of Sabah, through the Sabah Forestry Department, has always been committed to this initiative and has in fact designated about 39,000 km² of the state's landmass, mainly comprising of the important inland and highland forest ecosystems, as part of this programme (Anon. 2009 & 2013).

1.3 HoB Research Undertaken by the Sabah Forestry Department

Biodiversity research and documentation is one of the important aspects in strengthening the protected areas for conservation and sustainable forest management within the HoB in Sabah. With funding from the Federal Ministry of Natural Resources and Environment under the 9th-11th Malaysian Plan, the Department has embarked on a number of scientific expeditions or surveys to document the flora and fauna in selected forest reserves in Sabah, including insect diversity. Such baseline information will serve as the foundation, as well as to enhance the effort in conservation of biodiversity, for example in formulation for Forest Management Plan (FMP), drafting of High Conservation Value (HCV) report and preparation of Environmental Impact Assessment (EIA) report for forest reserves. In addition to the baseline information, the threats in the surveyed forest reserves were also identified and recommendations were suggested to prevent or reduce the adverse impacts which threaten the biodiversity of the forest reserves. Some of these results were published or presented in various conferences, e.g. Chung et al. (2013, 2014 & 2016), Nilus et al. (2014a & 2014b) and Sabran et al. (2014).

2.0 MATERIALS AND METHODS

Insect diversity surveys were conducted concurrently with the Botany and Ecology surveys with researchers from the Forest Research Centre, Sepilok and cooperation from the District Forestry Officers (DFOs). In some of the surveys, there were participants from various other agencies, such as the Sabah Parks, University Malaysia Sabah and individual researchers. Such cooperation signifies a smart partnership in a concerted effort in biodiversity conservation.

2.1 Study sites under the HoB (Sabah) Initiative

The study sites were chosen after thorough discussion among forestry officers and researchers, based on the priority and importance to procure data to enhance biodiversity conservation of the forest reserves. All selected study sites are under the Class I (Protection) and Class VI (Virgin Jungle Reserve) forest reserves. From 2009 to 2018, more than 30 forest reserves were surveyed, as shown in Table 1.

Table 1: Location of insect surveys in various forest reserves throughout Sabah under the Heart of Borneo Initiative from 2009 to 2018.

Year	Forest Reserve	Forestry District
2009	Tawai FR	Telupid
	Ulu Telupid FR	Telupid
	Lipaso FR	Telupid
	Bukit Kuamas FR	Telupid
	Bidu-Bidu FR	Telupid
	Taviu FR	Ranau
2010	Bukit Hampuan FR	Ranau
	Gn. Lumaku FR (southern part)	Tenom
	Milian Labau FR	Sook
2011	Gunong Lumaku FR (northern part)	Sipitang
	Ganui FR	Sipitang
	Crocker Range FR	Tambunan-Kota
	Rafflesia FR	Kinabalu Tambunan
2012	Nurod Urod FR	Kalabakan
	Sg Siliawan FR	Sook / Nabawan
	Sg. Sansiang FR	Tibow
	Batu Punggul FR	Tibow
2013	Gg. Tinkar FR	Tongod
	Sg. Imbak (2a & 2b) FR	Tongod
2014	Sg. Imbak (2c & 2d) FR	Tongod
	Timimbang-Botitian FR	Beluran
2016	Kungkular FR	Tenom
	Agathis FR	Tenom
	Kawag FR	Lahad Datu
	Pensiangan FR	Nabawan
	Tenompok FR	Ranau
2017	Sg. Bole, USM	USM
	Nuluhon Trusmadi FR	Ranau
	Tambulanan FR	Kalabakan
	Batu Timbang FR (Imbak Canyon)	Tongod
2018	Ulu Kalang FR	Tenom
	Sg Rayoh FR	Tenom

2.2 Insect Groups

As all the studies covered a wide area, it was a daunting task to sample all the insects during the surveyed periods. Thus, focus was given to certain insect groups, e.g.

butterflies, moths, beetles and dragonflies. Moreover, identification materials and expertise on the selected insect groups were available. Only the interesting and potential indicator insect species were sampled, as to minimize the workload at the laboratory in preparing the specimens for identification. Common insects were not sampled but photographs were taken for record purposes.

2.3 Sampling Methods

Light trap was used to sample nocturnal insects while sweep nets and manual collecting (with forceps) were used to sample diurnal insects.

The light trap consisted of a vertical white sheet (2 X 2 m) illuminated by a 250W mercury-lithium bulb, powered by a portable generator. Since 2014, a 12V 100 AH battery set was used to power the bulb, which is more environmentally friendly as it does not produce any noise or smoke compared to the portable generator. The trap was set up in an open area facing the forest reserve, from 7:00 to 9:00 p.m. A GPS (Model: Garmin etrex Vista) was used to determine the coordinates of each sampling site. To evaluate diversity of the sampling area, insect species and individuals (≥ 5 mm) within the 1 X 1 m square of the white cloth were enumerated from 8:30 to 9:00 pm. This was a rapid biodiversity assessment method because by the end of the sampling time, species and individual numbers were obtained, and the data was used to calculate diversity indices, i.e. Shannon Wiener, Simpson and Fisher Alpha, using a diversity analysis software by SDR (2006). Comparison with other sites was carried out. This method is simple, fast and can be carried out by non-insect specialist. To avoid compounding human error, the same staff was assigned to count the species and individual numbers throughout the sampling period, and also for other sampling sites.

Sweep nets were used to collect flying insects, such as butterflies and dragonflies while other insects were sampled using fine forceps. Butterflies and dragonflies were put in triangle papers while other specimens were put in vials with 75% ethanol solution. Sampling was conducted along the trails established by the Botany and Ecology Sections of the Forest Research Centre. Most of the trails were going up the slope heading towards the ridge or peak within the area.

2.4 Specimen Sorting and Identification

All specimens were dry-mounted and sorted to family and some to the genus and species level. Unidentified specimens were morphotyped. The specimens sampled from this study are deposited at the Forest Research Centre, Sepilok, Sabah. Dry-mounted specimens were identified based on the FRC Entomology Collection and various reference materials. Photographs of some unidentified species were sent to various insect experts for identification.

3.0 RESULTS & DISCUSSION

3.1 Comparison of Insect Diversity Among Forest Reserves

Data procured from light-trapping in various forest reserves within HoB, Sabah were compared and the status of nocturnal insect diversity was evaluated. Species richness, abundance, Shannon Index, Simpson Index and Fisher Alpha Index are among the

assessment on insect diversity. The species-rank abundance curves were also plotted to investigate the distribution of insect species in the sampling sites.

From the insect diversity surveys in various forest reserves within HoB areas, the montane habitat, such as Crocker Range F.R. and Bukit Hampuan F.R. recorded very high species number, with 148 and 113 species respectively within a one-square-metre (Figure 1). The lowland forests, such as Tambulanan F.R. and Pensiangan F.R. showed lower species richness. These forests are normally disturbed and have been logged previously.

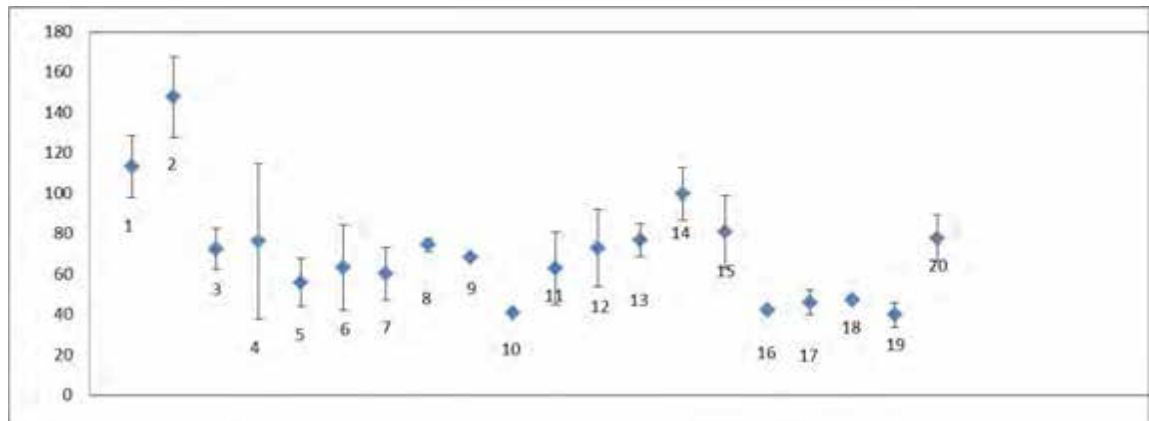


Fig. 1: Comparison of species number (with standard deviation) within one-square-metre as assessed through light-trapping in various forest reserves in Sabah. Diversity index was not calculated for some of the forests when light-trapping was not conducted.

(1 = Bkt Hampuan, 2 = Crocker Range, 3 = Rafflesia, 4 = Gn. Lumaku, 5 = Gunong Lumaku, 6 = Milian Labau, 7 = Kawag, USM Office, 8 = Sg. Siliawan, 9 = Nurod Urod, 10 = Punggol & Sansiang, 11 = Gg Tinkar, 12 = Sg Imbak 2a&2b, 13 = Tim-Bot, 14 = Sg Imbak 2c&2d, 15 = Kungkular, 16 = Pensiangan, 17 = Nuluhon Trusmadi, 18 = Batu Timbang, 19 = Tambulanan, 20 = Ulu Kalang).

In the results as indicated by the Shannon Index, the montane habitat also showed similar results of very high insect diversity (Figure 2). The lowland forests, in terms of insect diversity generally show similar trend with species richness in Figure 1.

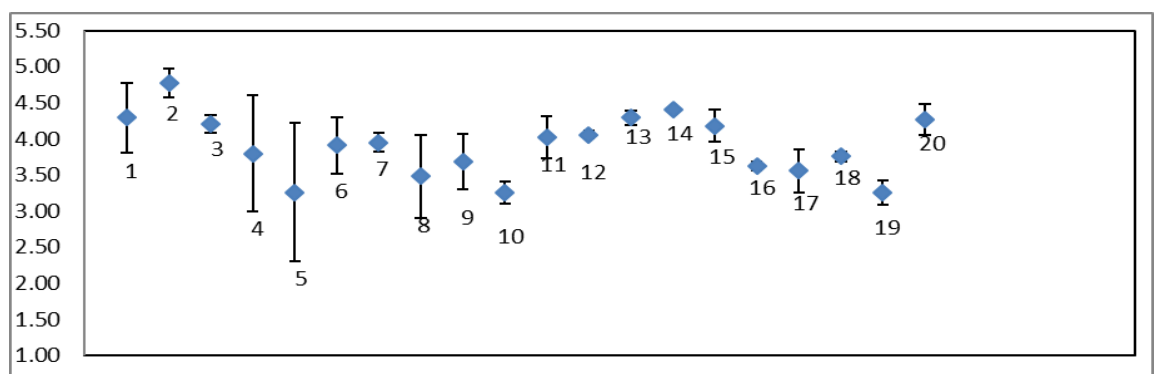


Fig. 2: Comparison of Shannon Index (with standard deviation) within one-square-metre as assessed through light-trapping in various forest reserves in Sabah. For the numbering, please refer to Figure 1.

It is not surprising that both Crocker Range and Bukit Hampuan recorded such high diversity because of their elevation between 670 to 1,700 m which is very conducive for

insects. As such, this promising result will further enhance biodiversity conservation of the montane habitat for insects (Chung et al., 2013 & 2016).

Comparison of nocturnal insect diversity among study sites provides an overview environmental status of the area from the insect perspective. Such data obtained from the rapid assessment using light trap can support the need for biodiversity conservation of an area.

3.2 Using Endemic Insect Species as an Indicator to Enhance Biodiversity Conservation

Endemic insect species can be used as an indicator in the effort to promote biodiversity conservation. They are species confined to an area and are not found elsewhere. Documentation of endemic species is also among the criteria to be incorporated in High Conservation Value (HCV) reports. Moths, butterflies, some beetles and dragonflies are well-studied groups and the endemic species can be determined quite easily from reference materials. For example, numerous endemic insect species were recorded from Crocker Range F.R. and Bukit Hampuan F.R., but only a few were recorded from other surveyed forest reserves. This indirectly alleviates the status of these two forest reserves in biodiversity conservation, especially on insects.

3.3 Using Iconic and Rare Insect Species to Promote Biodiversity Conservation

Flagship or iconic species often attracts attention, and this is obvious in mammals, such as the proboscis monkey, orang-utan and the Sumatran rhinoceros. Some insects are gaining the iconic status as well, because of their beautiful and interesting appearance which fascinates many people. The Rajah Brooke's Birdwing (*Trogonoptera brookiana*) and the Common Birdwings (*Troides* spp.) are among the iconic butterflies of Malaysia. Some large beetles from the family Lucanidae and Cerambycidae, and the Giant Bush Cricket (*Macrolyrstes imperator*) are equally intriguing. Thus, the presence of such iconic species can be used to promote biodiversity conservation. Similarly, rare insect species can be used to enhance biodiversity conservation.

3.4 Threats and Recommendations for Insect Diversity and Conservation Within the Heart of Borneo in Sabah

The insect surveys conducted in the various forest reserves had enabled the researchers to gain up-to-date and first-hand information on the status of the forests, and thus identifying the risks or threats not only on insect diversity but also on other wildlife and plants. The issues or threats, and recommendations were discussed in depth by Nilus et al. (2014b).

Forest fire is perhaps the most serious indirect threat to insect diversity (and other wildlife) in all the forest reserves in Sabah. Any prolonged drought (normally in March until May) would adversely affect the wildlife. The intense heat and also the haze caused by forest fires in other areas would worsen the situation. The cause of fires is obviously by irresponsible people, either intentionally for cultivation, or unintentionally, e.g. cigarette butts. Due to the dry weather condition and the dried leaves on the forest floor, the fire would spread very fast and destroy a large part of the area within a short period.

Under the Sustainable Forest Management Division of the Forestry Department, forest fire occurrence has always been given due attention (SFD 2016). Effective measures are taken, as follows:

- Monitoring & Fire Danger Rating System by DFOs;
- Pro-active and prompt action by Forestry Department's staff;
- Data from weather stations;
- Adequate fire fighting equipment;
- Fire observation towers;
- Air surveillance;
- Training on handling forest fire; and
- Dissemination of information and public awareness on the detrimental effects of forest fire.

Forest fragmentation is also a factor that affects insect diversity. Fragmentation is an ever-increasing threat to biodiversity and forest connectivity and corridors are a possible solution. Some forest reserves are in isolation, separated by oil palm plantations, human settlements, roads and natural barriers, such as rivers. Wildlife corridors are now often used as a major buzzword in conservation biology and landscape ecology. They are the prime means of physically linking wildlife habitat and allow some species to move between otherwise isolated areas. This can help to replenish isolated populations. Ideally, the corridor itself also meets some or all of the need for shelter, protection, food and breeding sites.

A wildlife corridor is often regarded as a continuous strip of land that aids in the movement of species between disconnected areas of their natural habitat. Corridors can be non-continuous too, and this is known as the 'stepping stones' approach. Examples of this approach are clumps of habitat not too far apart, such as small forest pockets, ponds and riverine areas. Stepping stones can create a more wildlife-friendly environment between patches of richer habitat. Some species may not need a direct link but suffice to patches of suitable habitats that help the species to move, feed and breed, and therefore ultimately survive.

Land-use changes and development are also posing a threat to insect diversity. Any major land-use changes will change the types of habitats and species, irrespective of any changes in diversity. Ongoing land-use changes and development can reduce the diversity of life forms by causing the extinction of organisms and the loss of genetic diversity in the remaining ones. Conversion of some of the areas for agriculture purposes would reduce insect diversity. The increase in human activities and development would eventually affect the insect diversity.

With the present national and state policies in place, the state government has been proactive in monitoring to ensure sustainable development for the state. It is important to create a balance in development that brings economic benefits to the people but at the same time, it does not significantly affect the environment. Monitoring and enforcement through various government agencies and the NGOs are crucial so that there wouldn't over-exploitation of the natural resources and the environment.

Illegal timber harvesting and encroachment for wild animals and plants are among the threats indirectly affecting insect diversity in the forests. Many timber trees and

plants in the forest are hosts to a myriad of forest insects. The Forestry Department through the Enforcement, Investigation & Prosecution Division in cooperation with the District Forestry Officers (DFOs), and MCEE (Monitoring, Control, Evaluation & Enforcement) Officers have carried out significant efforts to tackle these illegal activities (SFD 2016). Upgrading of infrastructures and facilities also assisted in monitoring and enforcement under the HoB programme. These included procurement of patrolling vehicles, construction of field outposts, purchase of mobile radio for communication in remote areas, as well as capacity building through training and courses in monitoring and enforcement. Lack of awareness on the importance of forest resources also leads to such illegal activities. The Sabah Forestry Department, through various environmental education programmes promotes the importance of forest conservation and the significance of forest services to mankind, among the local communities and the younger generation. The establishment of the honorary forest rangers among the local communities and the public would assist the Forestry Department to curb illegal activities in the forest reserves.

Lack of awareness on the importance of forests and taxonomic research is also an issue in insect diversity and conservation. As pointed out by Nilus et al. (2014b), the long-term vision in Sabah should be sustainable uses of biological diversity. This should be firmly anchored in the public's awareness and that people should align their way of living accordingly, which will drastically reduce the depletion of biodiversity. Basic taxonomic research is not given much attention lately. There is a need to continue to support and promote taxonomic work as this is the foundation for biodiversity studies and conservation.

4.0 CONCLUSION

The tropical rainforests in Sabah are teeming with a myriad of insects, and thus, should be given due attention in biodiversity conservation, especially those within the HoB highland areas. Under the HoB Initiative, research on insect diversity in various forest reserves has provided a better understanding on the environmental status of the forests, from the perspective of insects. The insect diversity data and species documentation, especially endemic, rare and interesting species procured from the scientific expeditions serve as baseline information to promote, support and enhance conservation efforts and sustainable forest management. Participation in the expeditions also enabled the researchers to gain first-hand information on the forest status, and to identify the threats affecting the insect diversity and to suggest recommendations in tackling the threats.

5.0 ACKNOWLEDGEMENTS

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INFORMATION PAPER 11: FOREST ECOSYSTEM ASSESSMENT OF NULUHON TRUSMADI (EXTENSION) FOREST RESERVE, SABAH

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Abstract

An ecological survey was conducted from the 8 – 13 May 2017 in Nuluhon Trusmadi (Extension) Forest Reserve, Sabah. The chief objective of this survey was to assess the forest ecosystems present in Nuluhon Trusmadi (Extension) Forest Reserve. Two 0.125 ha permanent sample plots (PSPs) were established respectively in both upland mixed dipterocarp forest and lower montane forest. A total of 377 individual of trees with diameter at breast height (DBH) ≥ 10 cm were enumerated from the four PSPs. This figure comprises of 145 taxa and 79 genera from 43 different tree families. The most speciose tree family was Lauraceae with 15 taxa, followed by Myrtaceae (12 taxa), Fagaceae (10 taxa) and Burseraceae (8 taxa). Statistics analysis from pooled data of all four PSPs showed that the tree family Myrtaceae has the highest Relative Dominance value that is 13.56%. It is closely followed by other tree families including Dipterocarpaceae (12.73%) and Fagaceae (11.69%). This study shows the importance of the gazettement of Nuluhon Trusmadi (Extension) Forest Reserve and that it was the right decision made at the right time. The establishment of long-term ecological research plot or PSPs is one of the reliable tools to monitor forest dynamics.

Keywords: Borneo, forest ecology, permanent sample plots

1.0 INTRODUCTION

On 8 December 2016, 12,241 ha of forested area was gazetted as Class I Protection Forest Reserve and incorporated into Forest Management Unit 10 (FMU 10). This area, known as Nuluhon Trusmadi (Extension) Forest Reserve lies between longitude 116° 30' – 116° 45'E and latitude 05° 30' – 05° 45'N. Under the auspices of Sabah Heart of Borneo (HoB) initiative, the research and development division of Sabah Forestry Department conducted a scientific expedition in the area from 8th – 13th May 2017.

1.1 Research Objectives

This study aimed to assess the forest ecosystems present, and to establish long-term permanent sample plots (PSPs) in Nuluhon Trusmadi (Extension) Forest Reserve.

2.0 METHODOLOGY

2.1 Study Site

The scientific expedition focused on the southeastern part of Nuluhon Trusmadi (Extension) Forest Reserve (Fig. 1). The study site is next to Trusmadi Forest Reserve, a Class II Commercial Forest Reserve and accessible from Tongod in the District of Telupid or from Sinua in the District of Keningau.

The topography of Nuluhon Trusmadi (Extension) Forest Reserve is mountainous. The altitude ranges from 600 – 2500 m. The whole forest reserve consists of three soil

associations namely, Lokan, Crocker and Trusmadi. Initially, the whole area comprised of pristine upland mixed dipterocarp forest and lower montane forest. However, since the area was subjected to anthropogenic disturbances, disturbed forests and secondary vegetations with various regenerative stages are now common.

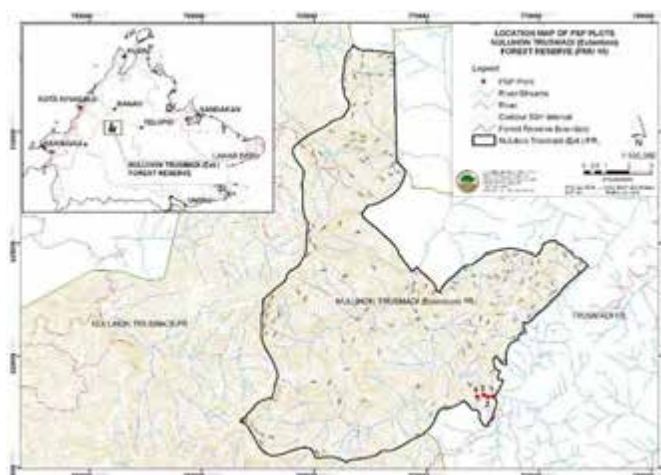


Fig. 1: Location map of four PSPs in the southeastern part of Nuluhon Trusmadi (Extension) Forest Reserve. Inset is a map of Sabah showing the location of the forest reserve.

2.2 Sampling and Tree Enumeration Description

A total of four 0.125 ha circular PSPs were established during the scientific expedition (Table 1). All trees with diameter at breast height (DBH) ≥ 10 cm were enumerated and identified to species level. This field work utilized a number of field equipments including recording sheets, diameter tapes, a Hagl f Vertex IV hypsometer, transponder, handheld Global Positioning System (GPS) units, maps and paint.

Table 1: PSPs numbers and their corresponding GPS coordinates for forest assessment and rapid plant diversity inventory of Nuluhon Trusmadi (Extension) Forest Reserve.

PSP No.	Latitude	Longitude	Altitude (m)	Soil Association	Forest Ecosystem	Remarks
1	05°34'40.2"	116°39'18.5"	858	Lokan	Upland mixed dipterocarp forest	Logged-over forest
2	05°34'39.0"	116°39'11.3"	950	Trusmadi	Lower montane forest	Logged-over forest
3	05°34'42.1"	116°39'05.4"	1034	Trusmadi	Lower montane forest	Logged-over forest
4	05°34'40.0"	116°38'55.6"	1100	Trusmadi	Upland mixed dipterocarp forest	Logged-over forest

2.3 Plant Identification

Majority of the tree species were identified to species level on site by means of their distinctive field characteristics (e.g. leaf, fruit, flower, tree bark and resin). For those that could not be readily determined, voucher specimens were collected for further identification purposes at the Sandakan Herbarium (SAN). The voucher specimens

collected were subjected to a standard process of being oven-dried at 45 – 50 °C before their identity can be determined. All specimens were sorted according to morphospecies and then identified to species-level by cross-referencing with existing authentic herbarium specimens.

2.4 Data Analysis

The Importance Value is the relative dominance of each species or family of trees enumerated in the PSPs that was calculated as the average of relative tree density and relative basal area (Brower & Zar, 1977):

$$\text{Relative tree density} = \left[\frac{\sum \text{tree density of species or family}}{\sum \text{tree density of all species or family}} \right] \times 100$$

$$\text{Relative basal area} = \left[\frac{\sum \text{basal area of species or family}}{\sum \text{basal area of all species or families}} \right] \times 100$$

$$\text{Relative dominance} = \frac{[\text{Relative tree density} + \text{Relative basal area}]}{2}$$

3.0 RESULTS AND DISCUSSION

A total of 377 individuals of trees comprised of 145 taxa, 79 genera and 43 families were enumerated from four PSPs. The most speciose tree family was Lauraceae with 15 taxa, followed by Myrtaceae (12 taxa), Fagaceae (10 taxa), Phyllanthaceae (9 taxa) and Burseraceae (8 taxa) (Figure 2). Lithocarpus (8 taxa), Syzygium (8 taxa), Elaeocarpus (5 taxa), Litsea (5 taxa), and Baccaurea (4 taxa) were the top five most speciose genera. With 22 individuals, *Lithocarpus encleisocarpus* was the most abundant taxa. It is then followed by *Hopea beccariana* (18 individuals), *Syzygium* sp. (17 individuals), *Elaeocarpus* sp. 1 (11 individuals), *Hydnocarpus* sp. (11 individuals), *Pternandra* sp. (11 individuals), *Shorea ovata* (11 individuals), *Litsea lucida* (10 individuals), *Nauclea* sp. (9 individuals), and *Rhodamnia* sp. (9 individuals).

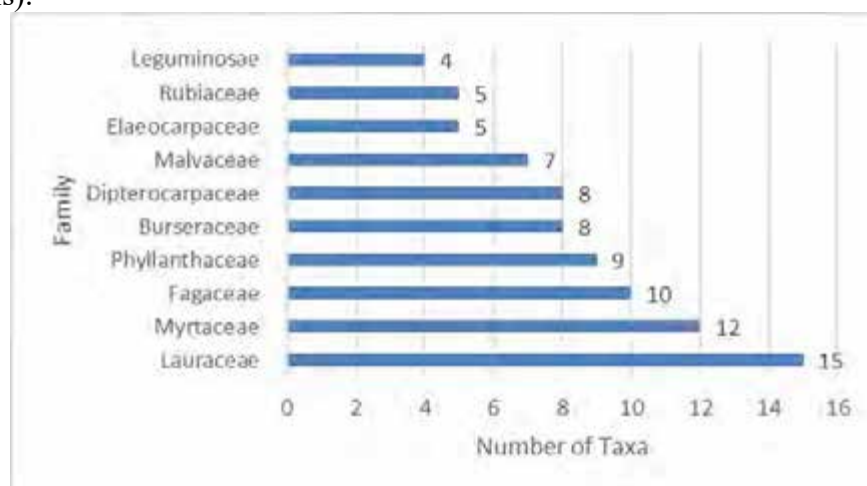


Fig. 2: The 10 most speciose tree families derived from pooled data of all four PSPs for trees (DBH ≥10 cm) in Nuluhon Trusmadi (Extension) Forest Reserve, Sabah.

Statistics analysis from pooled data of all four PSPs showed that the tree family Myrtaceae has the highest Relative Dominance value that is 13.56% (Fig. 3). It is closely followed by other tree families including Dipterocarpaceae (12.73%), Fagaceae (11.69%) and Lauraceae (9.33%). The dominance of tree family Myrtaceae in Trus Madi Range has been highlighted by forest ecologists (Kitayama et al., 1993; Adam, 2001). Ecological features of each PSP along the altitudinal gradient are shown in Table 2.

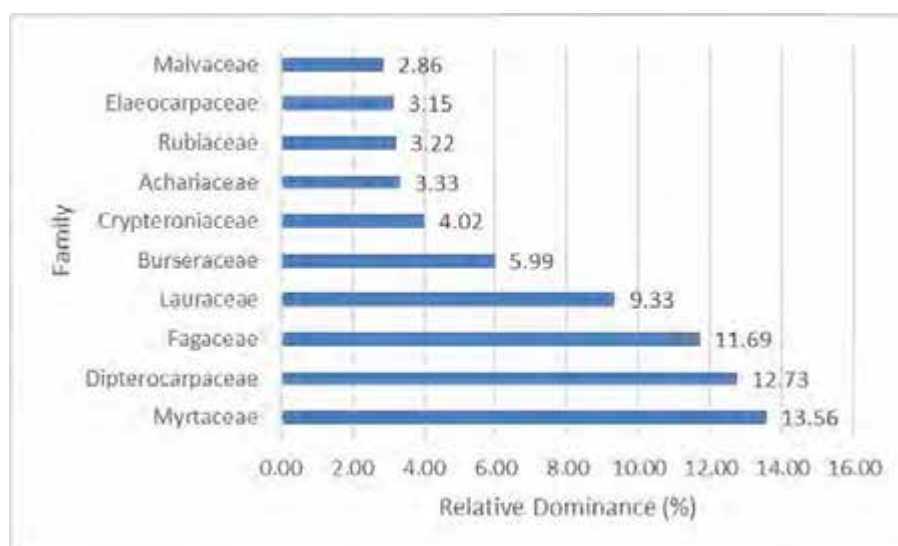


Fig. 3: The 10 most dominant tree families derived from pooled data of all four PSPs for trees (DBH ≥ 10 cm) in Nuluhon Trusmadi (Extension) Forest Reserve, Sabah.

Table 2: Ecological features of each PSP along the altitudinal gradient in Nuluhon Trusmadi (Extension) Forest Reserve.

Ecological Feature	PSP 1	PSP 2	PSP 3	PSP 4
Altitude (m)	858	950	1034	1100
Plot area (ha)	0.125	0.125	0.125	0.125
Number of taxa (<i>S</i>)	47	57	50	44
Density (<i>N</i>)	81	94	93	109
Estimated density per hectare (<i>N ha</i> ⁻¹)	648	752	744	872
Total basal area (Σ BA) (m ²)	4.965	4.963	5.015	5.664
Estimated basal area per hectare (BA ha ⁻¹) (m ²)	39.73	39.71	40.12	45.31
Dominant species	<i>Lithocarpus</i> <i>enclisocarpus</i>	<i>Crypteronia</i> <i>paniculata</i>	<i>Lithocarpus</i> <i>enclisocarpus</i>	<i>Hopea</i> <i>beccariana</i>
Co-dominant species	<i>Syzygium</i> sp.	<i>Litsea</i> <i>lucida</i>	<i>Tristania</i> <i>opsis</i> sp.	<i>Shorea</i> <i>ovata</i>
Dominant family	Fagaceae	Lauraceae	Myrtaceae	Dipterocarpaceae
Co-dominant family	Dipterocarpaceae Myrtaceae	Crypteroniaceae	Burseraceae Fagaceae	Fagaceae

In disturbed upland mixed dipterocarp forest ecosystems, the main canopy layer comprised of mature trees with DBH ≥ 50 cm and could attain up to 40 – 50 m in height. Only eight species contributed to the main canopy layer: *Semecarpus* sp., *Crypteronia paniculata*, *Hopea beccariana*, *Hopea nervosa*, *Engelhardia apoensis*, *Cinnamomum porectum*, *Scaphium parvifolium* and *Artocarpus odoratissimus*.

Middle storey layer of disturbed upland mixed dipterocarp forest ecosystem consisted of trees with DBH ranging between 20 – 49.9 cm but they rarely exceed 40 m in height. It is partly represented by trees from the canopy layer, as well as other medium-sized mature trees (Table 3). Meanwhile, the understorey layer of disturbed upland mixed dipterocarp forest ecosystem comprised of tree species found in both main canopy and middle storey layers, alongside understorey treelets with DBH less than 20 cm. Hence, this forest layer is richer in tree species (Fig. 4). Only three species managed to reach the main canopy layer in disturbed lower montane forest: *Crypteronia paniculata*, *Castanopsis costata* and *Tristaniopsis* sp. (Table 4). Trees found in montane forests are often small in stature due to extreme environmental conditions (Fig. 5).



Fig. 4: Vegetation stands at upland mixed dipterocarp forest ecosystem in Nuluhon Trusmadi (Extension) Forest Reserve.



Fig. 5: Vegetation stands at lower montane forest ecosystem in NuluhonTrusmadi (Extension) Forest Reserve.

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Table 3: Common tree species that forms various forest canopy layers in disturbed upland mixed dipterocarp forest ecosystem in Nuluhon Trusmadi (Extension) Forest Reserve. (Notes: main canopy layer (MC); middle storey canopy layer (MS); and understorey canopy layer (US)).

Family	Species	MC	MS	US
Dipterocarpaceae	<i>Hopea beccariana</i>	/	/	/
Dipterocarpaceae	<i>Hopea nervosa</i>	/	/	/
Dipterocarpaceae	<i>Shorea ovata</i>		/	/
Dipterocarpaceae	<i>Shorea parvistipulata</i>		/	/
Fagaceae	<i>Lithocarpus cf. blumeanus</i>		/	/
Fagaceae	<i>Lithocarpus conocarpus</i>		/	/
Fagaceae	<i>Lithocarpus elegans</i>		/	/
Fagaceae	<i>Lithocarpus encleisocarpus</i>		/	/
Fagaceae	<i>Lithocarpus gracilis</i>		/	/
Myrtaceae	<i>Syzygium elopuræ</i>		/	/
Myrtaceae	<i>Syzygium</i> sp.		/	/
Achariaceae	<i>Hydnocarpus</i> sp.		/	/
Achariaceae	<i>Hydnocarpus subfalcata</i>		/	/
Lauraceae	<i>Cinnamomum porectum</i>	/		
Lauraceae	<i>Notaphoebe</i> sp.			/

Table 4. Common tree species that forms various forest canopy layers in disturbed lower montane forest ecosystem in Nuluhon Trusmadi (Extension) Forest Reserve. (Notes: main canopy layer (MC); middle storey canopy layer (MS); and understorey canopy layer (US)).

Family	Species	MC	MS	US
			/	/
Myrtaceae	<i>Rhodamnia</i> sp.		/	/
Myrtaceae	<i>Syzygium</i> cf. <i>chloranthum</i>		/	/
Myrtaceae	<i>Syzygium</i> cf. <i>fastigiatum</i>		/	/
Myrtaceae	<i>Syzygiu melopuræ</i>		/	/
Myrtaceae	<i>Syzygium rosulentum</i>		/	/
Myrtaceae	<i>Syzygium</i> sp.		/	/
Myrtaceae	<i>Tristaniopsis</i> sp.	/	/	
Myrtaceae	<i>Tristaniopsis whiteana</i>		/	
Lauraceae	<i>Litsea fulva</i>		/	
Lauraceae	<i>Litsea lucida</i>		/	/
Lauraceae	<i>Litsea lucidus</i>		/	/

Fagaceae	<i>Castanopsis costata</i>	/	/	/
Fagaceae	<i>Lithocarpus encleisocarpus</i>		/	/
Burseraceae	<i>Canarium littorale</i>		/	/
Burseraceae	<i>Dacryodes</i> sp. 1		/	
Burseraceae	<i>Dacryodes</i> sp. 2		/	
Crypteroniaceae	<i>Crypteronia paniculata</i>	/	/	/

4.0 CONSERVATION SIGNIFICANCE

A total of 500 taxa of plants were recorded during the scientific expedition in Nuluhon Trusmadi (Extension) Forest Reserve. This figure represents plants collected within and outside of the PSPs by research teams from the Ecology Section and the Systematic Botany Section of Forest Research Centre, Sepilok. Only two taxa were treated as threatened species under the IUCN Red List of Threatened Species. In the context of endemism, 115 taxa are confined to the island of Borneo. A total of eight taxa are endemic to the state of Sabah.

In the concurrent study conducted by the wildlife research team, a total of 20 taxa of terrestrial mammals were recorded in Nuluhon Trusmadi (Extension) Forest Reserve (Suis et al., 2018). The wildlife research team also recorded 105 birds from the study site, of which 10 of them are Bornean endemic. Chung (2017) reported that Nuluhon Trusmadi (Extension) Forest Reserve is home to 121 taxa of insects, and at least 15 of them are endemic to Borneo. These findings imply that the Nuluhon Trusmadi (Extension) Forest Reserve harbours significant assemblages of threatened and endemic species.

5.0 THREATS AND RECOMMENDATIONS

5.1 Forest Fire

The Southeast Asian tropical rainforests are not prone to naturally occurring wildfires. Since the vegetation is not adapted to fire, forest fires in Borneo are often caused by humans intending to clear forests for agricultural and other land uses. El Niño-Southern Oscillation (ENSO) often exacerbates the drought season of this rainforest type (Walsh, 1996). ENSO climatic phenomenon occurs when warm water currents from west Pacific moves to east Pacific, and when there are long drought events in Southeast Asia, it increases the susceptibility of tropical rainforest vegetation to wildfire. It is widely accepted that logged-over forest and secondary vegetation are more susceptible to fire in comparison to pristine forest (Woods, 1989). Since both are common in the studied area, hence, forest fire is considered a major threat to the natural forest conservation and management of Nuluhon Trusmadi (Extension) Forest Reserve.

Therefore, efficient forest fire prevention programmes are crucial to protect Nuluhon Trusmadi (Extension) Forest Reserve ecosystem's functionality from wildfire. The formulation of this programme should maintain multi-faceted activities including fire prevention, detection, control and suppression activities, in order to provide effective

protection from fire to other forest values, such as water and watersheds, fisheries, wildlife, recreation, aesthetics, soil productivity and soil stability.

5.2 Poaching

Poaching activities in Sabah has reached concerning levels. Traditionally, people will harvest wildlife and plants for self-consumption or to secure a sufficient food supply. Nowadays, poaching activities are mainly fueled by commercial demands. Many wildlife species are sought after for their parts such as ivory tusks, skins, feathers and meats to be used as valuable products.

Signs of poaching were observed in the Nuluhon Trusmadi (Extension) Forest Reserve and also in adjacent reserves (Fig. 6). The threat is still rampant due to the existence of old-logging road networks in these forest reserves. Research shows that uncontrolled hunting activities inflict more negative impacts on wildlife abundance and richness when compared to conventional logging activities (Brodie et al., 2014). If left uncontrolled, poaching could speed up the local extinction process of many plants and wildlife species in Sabah. Hence, improvements on patrolling strategies is highly advisable to protect both the forests and wildlife.



Fig. 6: Deserted shelter built by poachers in Nuluhon Trusmadi (Extension) Forest Reserve.

6.0 CONCLUSION

This study shows the importance of the gazettement of Nuluhon Trusmadi (Extension) Forest Reserve and that was the right decision made at the right time. Nuluhon Trusmadi (Extension) Forest Reserve is blessed with high conservation significance at local and landscape level. The establishment of PSPs is a scientific approach in monitoring and documenting forest dynamics.

7.0 ACKNOWLEDGEMENT

We would like to thank the Chief Conservator of Forests, Datuk Sam Mannan, Deputy Chief Conservator of Forests (Forest Sector Planning), Mr. Frederick Kugan and Deputy Chief Conservator of Forests (Research & Development), Dr. Lee Ying Fah for their overwhelming support. We thank Ranau District Forestry Officer, Mr. Harry Ikok and his staff for logistics

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INFORMATION PAPER 12: AN ASSESSMENT OF SOIL CARBON DENSITY AT TANGKULAP AND SUNGAI TALIBU FOREST RESERVES, SABAH

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Abstract

The capacity of forest soils in providing ecosystem services of carbon sequestration through soil organic matter management have received considerable attention in recent years not only to maintain forest productivity but also in relation to climate change mitigation. Ample evidence is available about the effects of management on the amount of carbon in the organic layers of the forest floor but much less information about measurable effects of management on carbon pools in the mineral soil. A study was conducted at Tangkulap and Sungai Talibu Forest Reserves with the aims to assess the soil carbon stock at this forest reserve. By employing a systematic random sampling, a total of 38 circular plots were established with 3 points of soil sampling were sampled within 30cm depth in each plots. Soil analysis was conducted at Forest Research Centre, Sandakan. Result shows that the total soil carbon density was in range 27.3 - 31.6 Mg/ha with the average value for this forest reserve is about 30.0 Mg/ha. Soil organic carbon is concentrated in the upper 30cm of the soil thus it is readily depleted by anthropogenic (human-induced) disturbances through mechanical removal of this layer or due to accelerated erosion process. Soil carbon contents decreased gradually from top to lower horizon.

1.0 INTRODUCTION

Forest and forest soils play a broad and complex role. They are intrinsically linked, with huge impacts on each other and to the environment. Forest soils provide essential needs for trees and the entire forest to grow over million years. Soils help in regulate important ecosystem processes, such as decomposition, nutrient uptake and water availability. In addition, forest soils acting as one of the highest carbon pools on the earth, which can impact carbon storage and emission through soil organic matter (SOM) management. Globally, it has been estimated the forest ecosystem contain about 1240 Pg C (Dixon et. at., 1994). Out of this amount, the plants (vegetation) contain about 536 Pg C, and the soil contains up to 704 Pg of C. Soils in the tropical forest regions form a vital component of the global carbon store, yet increasingly threatened by land use change (LUC) and forest disturbance over these past decades.

Soil carbon becomes the most important component in soils as it affects the soil properties. Carbon as soil organic matter (SOM) alters the physical, chemical, and biological properties of the soils. Soil organic matter helps retain water, increases soil capacity holding on the important nutrients such as nitrogen and phosphorous and serves as a source of energy for below ground organisms. SOM is essential for improving soil quality and hence sustains forest productivity. The improvements in SOM create a more favorable environment, leading to an increases in the forest stands growth. Physically, soil organic matter improves aggregation of soil particles which lead to better soil structure, allowing for movement of air and water through the soil as well as better root development. More stable soil structure results in less susceptible to soil erosion, retains nutrients on the land and also protects water

quality (Rice, C.W., 2005). According to Gruneberg et al., 2014, the amount soil C is determined by the net balance between the rate of organic C input and output. The soil carbon input is from forest debris and the output by heterotroph and tissue respiration. The ability of soil to stabilize soil carbon and the relationship between soil structures are key elements in soil C dynamic. The understanding of the mechanisms and factors of organic carbon dynamic in forest soils is important to identifying and enhancing natural sinks for carbon sequestration to mitigate the climate change (Lal, 2005).

This study, was conducted with the objective to assess the soil carbon stock at Tangkulap and Sungai Talibu Forest Reserves, Sandakan, Sabah.

2.0 STUDY SITE

This study was conducted at Tangkulap and Sungai Talibu Forest Reserves that geographically located between 5°18' - 5°31'N and 117°12' - 117°21'E. The reserve covers an area of approximately 50,020 ha and constituted mainly of lowland dipterocarp forests. The general landform condition ranging from gentle terrain to a considerably rugged slope with its elevation varies from 80 to 1200 meters above sea levels. The geology is formed from two different rocks types namely sedimentary rocks of mid to late tertiary period and ultrabasic igneous rocks of cretaceous to early tertiary period. The reserve has been subjected to a series of logging activities in the past until year 2001.

Vegetation cover in the area had been stratified and mapped based on the visual interpretation of the timber stand density (≥ 60 cm diameter) as well as the density of canopy trees based on crown diameter in the satellite image (Spot image taken on July 2003). There are 4 different categories of forest stratum that have been recognized namely Stratum 1 (high density), Stratum 2 (mid-high density), Stratum 3 (mid-low density), Stratum 4 (low density) and small crown forest (Fig. 1).

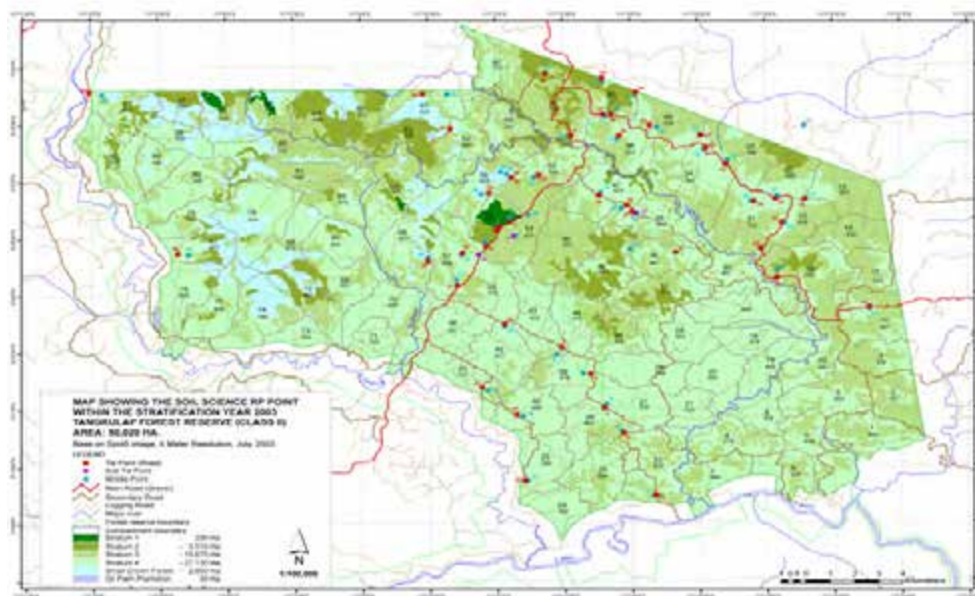


Fig. 1: The distribution of 38 circular plots over various stratum classes in Tangkulap and Sungai Talibu Forest Reserves.

3.0 SAMPLING METHOD

Based on the stratification map, 38 circular plots of 20m radius (0.126ha) were established randomly within each of the 4 different stratum classes. Three (3) predetermined soil sampling points within plot were selected. Soil samples were collected at three (3) depths: 0-10cm, 10cm-20cm and 20-30cm using a hand core sampler. A total of 684 soil samples were collected from the field. Total of 342 soil samples were air-dried, grounded and sieved through 2mm mesh for soil organic carbon analysis. Another 324 soil samples for soil bulk density analysis, of which soil samples were oven dried at 105°C for 24 hours. Soil bulk density was determined by dividing the soil dry mass with its volume. The soil organic carbon content was analyzed by using Walkley-Black method (Nelson & Sommers, 1982). All analysis were conducted in Chemistry Laboratory at Forest Research Centre, Sandakan.

4.0 SOIL ANALYSIS AND CALCULATION

To calculate soil carbon in the soil, three (3) variables namely the percentage of organic carbon, soil bulk density and soil depth were used. The soil carbon density was calculated as follow:

$$C = \text{SOC (\%)} \times \text{BD} \times D \times 100$$

Where;

C : Carbon density (Mg/ha)

SOC : Soil organic carbon (%)

BD : Soil bulk density (g/m³)

D : Soil depth (cm)

5.0 RESULTS

Table 1 shows the soil bulk density value varies from 0.77g cm³ to 1.45g cm³. The trend is that soil at the top layer has lower density as compared to the soil at depth. The soil organic C ranges from 0.41 % to 1.75% with a higher value particularly in the upper first 10cm layer and decreased with depth. Total soil C density ranges from 27.3-31.6 Mg C/ha with the average value for this forest reserve is about 30.0 Mg C/ha (table 1).

Table 1: Soil bulk density and carbon density

Forest stratum	Soil Depth (cm)	S. organic Carbon (%)	S. bulk density (g/cm ³)	C density by depth (Mg/ha)	Total C density (Mg/ha)
1	0-10	1.31	0.90	11.8	28.9
	10-20	0.73	1.32	9.6	
	20-30	0.52	1.45	7.5	

2	0-10	1.52	0.96	14.6	29.7
	10-20	0.70	1.31	9.2	
	20-30	0.41	1.44	5.9	
3	0-10	1.75	0.77	13.5	27.3
	10-20	0.80	0.97	7.8	
	20-30	0.43	1.40	6.0	
4	0-10	1.64	0.89	14.6	31.6
	10-20	0.89	1.15	10.2	
	20-30	0.48	1.41	6.8	
Average soil carbon density					30.0

6.0 DISCUSSION

Several factors influencing the variability of soil carbon density value in this study, such as organic sources, soil properties and forest disturbance. In this study, the result showed that soil C decreased with increasing of soil depth (from top to lower horizon) and significant decrease occurred from the depth 10cm to 30cm. Organic inputs into the soil occur mainly in the surface horizons and decrease sharply with depth. According to Han et al. (2010), the process of decomposition in the soil weaken with increasing soil depth, and it made up higher soil C stored in top horizon of the soil. Fu et. al. (2010) reported soil C density has significant correlation with soil texture, bulk density and nitrogen in the mineral horizon. According to Zhou et al. (2013), carbon characteristic and stability mechanisms may be different between top and deep soil, and due to different in terms of their carbon dynamic process and the response of the external environment change. Soil disturbances by human activity such as mechanical removal of top horizon or due to accelerated erosion process will directly lower the soil carbon the area. Harvesting operation also caused drastic soil disturbance. This activity interrupt the C and N inputs in the soil, resulting in an imbalance between input and output of C and N, and releasing these elements to atmosphere as GHG emissions (Durigan, M.R et al. 2017).

The soil C density of 30.0 Mg/ha found from this study is lower as compared to other research studies. Ngo et al. (2013) reported soil carbon stock at Bukit Timah Nature Reserve, Singapore estimated at 77.5 Mg/ha. Estaban& Robert (1999) study reported soil C density at tropical evergreen forest is estimated at 474 Mg/ha. The differences of soil C density value reported through these studies influenced by different in soil sampling depth and microclimate. Microclimate affects soil organic carbon content as it is a major determinant of the rate of decomposition and therefore the turnover time of C in soils.

More accurate soil carbon estimates could be improved by increase the number of soil samples, adding some soil analysis test (soil texture, pH and C/N ratio) to assess the

correlation of soil C density between soil texture, pH and as well as accounting for variations in soil type, soil depth soil horizon and their corresponding soil carbon content.

Carbon sequestration in forest soils has a potential to mitigate climate change. Increase in C stock of forest soils can be achieved through good practices of soil and forest management including site preparation, fire management, afforestation, tree species management, fertilizer application and soil amendment (Lal, 2005).

7.0 CONCLUSIONS

Total soil carbon density at Tangkulap and Sungai Talibu Forest Reserves varies from 27.3 - 31.6 Mg C/ha with the average value for this forest reserve is about 30.0 Mg C/ha. Carbon value decreased with increasing soil depth. Several factors influencing the variability of soil C density reported in this study such as soil bulk density and forest condition. A good practices of soil management is important to enhance soil quality and increase soil C stock for mitigating climate change.

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INFORMATION PAPER 13: BIODIVERSITY CONSERVATION IN MULTIPLE-USE FOREST LANDSCAPES MANAGEMENT IN SABAH

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Abstract

The Government of Malaysia and UNDP-GEF initiated a project within the 261,264 ha contiguous forest landscape located in the eastern part of Sabah. The project was designed to institutionalize a multiple-use forest landscape planning and management model that brings the management of critical protected areas and the connecting landscapes under a common and integrated management umbrella in order to mainstream biodiversity, ecosystem functions and resilience, while enabling ongoing sustainable uses. Three interconnected and complementary components with fifteen (15) outputs were identified to achieve the project's overall objective. Connectivity corridors of approximately 156,586 ha protected areas for the three globally significant conservation areas namely, Maliau Basin, Danum Valley and Imbak Canyon were established. The landscape-level biodiversity and forest quality assessment works are being carried out whereby a large number of digital images of the biodiversity of the project area were collected and made available to the Sabah Forestry Department and others for future use. The development of policies aimed at achieving no net loss/net gain in biodiversity through science-policy interface and capacity building were completed. Inputs from the payment for ecosystem services add value to the State Government's efforts to diversify income opportunities for conservation.

Keywords: Sabah, Biodiversity, Conservation, Payment of Ecosystem Services, Connectivity, Protected Areas.

1.0 BRIEF PROJECT DESCRIPTION

Sabah's biodiversity is exceptionally high, helping to earn Malaysia its status as one of 17 mega-diversity countries in the world. Most of Sabah's biodiversity is found in its forest reserves, which occupy about half of the state's total landmass of 7.34 million ha. Sabah's forest reserves are an integral part of the 20 million ha of equatorial rainforests demarcated under the 'Heart of Borneo' tri-government (Malaysia, Indonesia and Brunei Darussalam) initiative, which is aimed at conservation and sustainable use of the region's tropical forest biodiversity. However, over the last 30 years, Sabah has experienced rapid economic growth and has relied heavily on its forest resources to finance its socio-economic development programmes. As a consequence, there has been an acceleration of forest conversion, particularly outside the forest reserves, as well as, forest degradation within the forest reserves, associated with over-harvesting of resources and destructive harvesting methods. These trends have resulted in the progressive loss and degradation of much of the biodiversity within the forest landscape. Protected areas are becoming increasingly isolated and thus, decreasing prospects for viability of species.

In order to mainstream biodiversity, ecosystem functions and resilience, while enabling sustainable uses, the Government of Malaysia and UNDP-GEF (GoM-UNDP-GEF) have initiated a project on “Biodiversity Conservation in Multiple-use Forest Landscapes in Sabah, Malaysia” hereafter called the project.

The 261,264 ha project, hereafter called the project landscape, is located in Yayasan Sabah’s Sustainable Forest Management Licence Agreement (SFMLA) Area in Kalabakan-Gunung Rara Forest Reserves – see Figure 1. The project, which was signed in June, 2012 is a 6-year project. It is now in its fifth year of implementation; and was scheduled to end on 31 December 2018.

The GEF-financed project would strengthen the conservation of largest area of mostly contiguous forest in Sabah, that is, the project landscape, which is one of the remaining forest landscapes in the Heart of Borneo (HoB). The project also forms important connectivity of the three (3) sizeable and renowned protected areas in Sabah - Maliau Basin, Danum Valley and Imbak Canyon Conservation Areas respectively. The GEF’s intervention amounts to USD 4.4 million with co-financing (USD 19.5 million) from implementing partners, that is, the Sabah Forestry Department, Sabah Foundation and WWF Malaysia.

2.0 DEVELOPMENT CONTEXT IN BRIEF

The project is consistent with Malaysia’s National Policy on Biological Diversity (1998), particularly Strategy 15: Establish Funding Mechanisms; Strategy 4: Strengthen the Institutional Framework for Biological Diversity Management; and Strategy 6: Integrate Biological Diversity Considerations into Sectoral Planning Strategies.

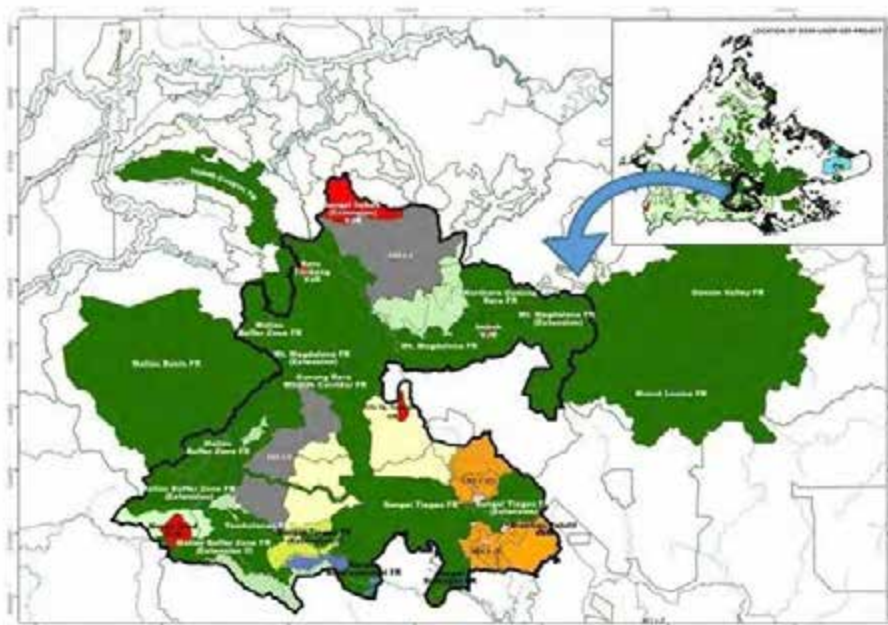


Fig. 1 Project location

The project is also anchored on Sabah’s Outline Perspective Plan (OPPS), covering the period 1995-2010, which aims to create a socially and politically stable environment through efficient management of the State’s economy. Item 4.6 of this Plan highlights the State’s intention to ensure reliable and sustainable raw material supply, indicating the formulation of

sensible and effective conservation strategies for natural resources such as forests, land and marine life.

Another salient consideration is that Sabah is one of the key areas for the trilateral Heart of Borneo (HoB) initiative. This project supports the State's strategy for this initiative and will, over time, contribute significantly to the HOB strategy. The project is also an important component of this initiative (HOB) as this focuses on three priorities that have direct synergy with the project: (i) maintenance of forest connectivity through the strengthening of the Protected Area Network; (ii) establishment of sustainably managed forested corridors connecting these areas; and (iii) the opportunity for enhanced transboundary co-operation.

Therefore, the project concept, as articulated in the Inception Report, was in both conceptual and general terms, consistent with national, state and sector development priorities.

3.0 PROBLEMS THE PROJECT SOUGHT TO ADDRESS: THREATS AND BARRIERS TARGETED

The problems the project has been developed to address through its objective and implementation strategies are directly pertinent to the objective of the CBD Programme of Work on Protected Areas (POWPA), as well as, the biodiversity goals of the Global Environment Facility (GEF). At a national level, the project's objective and outcomes are aligned with the National Biodiversity Strategy and Action Plan (2011 – 2020). Of direct relevance to the project, is the reality that healthy and well managed biodiversity interventions have the potential to generate economic value through the provision of ecosystem services such as food, water and materials, and services such as climate regulation, pollination, disaster protection, nutrient cycling and tourism.

The relevance of the project strategy to the UNDP CPAP 2016 – 2020 is focused on "Improved capacity of stakeholders in environmental management". It is anticipated that the project can provide/make significant contributions to capacity-building objectives.

The State Government of Sabah has a wide array of policies and plans related to biodiversity conservation. These include (a) Outline Perspective Plan for Sabah (1995-2010); (b) Sabah Physical Land-use Plan; (c) Sabah Conservation Strategy (1990); (d) Sabah Water Resources Master Plan (1998); (e) Sabah Agricultural Policy (1999-2010), and (f) Sabah Forestry Policy (2005). The general intentions of these State policies and plans are in congruence with the project's fundamental objective and plans.

Therefore, the project is an exceptionally complex intervention and an innovative landscape management model. If found successful, it will serve as a model to catalyze innovation in processes and increase management know-how in achieving an optimal balance across potentially competing uses, one which maximizes economic, social and environmental benefits to society. In addition, lessons learnt from the project will be used to transform management of vast forest landscapes in Sabah, which housing some of the most important remaining biodiversity in Borneo.

4.0 PROJECT OBJECTIVE AND COMPONENTS

The project was designed to institutionalize a multiple-use forest landscape planning and management model that brings the management of critical protected areas and the connecting

landscapes under a common and integrated management umbrella in order to mainstream biodiversity, ecosystem functions and resilience, while enabling ongoing sustainable uses. In order to achieve this project objective, it would require a well-developed biodiversity, socio-economic, connectivity conservation, and responses. These need to be inherent parts of the multiple-use forest landscape planning and management model. Therefore, the project aims to achieve this objective through delivery of three (3) interconnected components and fifteen (15) outputs. The 3 interconnected components are:

- i. An enabling environment for optimized, multiple-use planning, financing, management and protection of forest landscapes;
- ii. Demonstration of multiple-use forest landscape planning and management system; and
- iii. Sustainable financing of protected areas and associated forest landscape areas demonstrated at the pilot site.

5.0 LAND-USES AS OUTLINE IN THE PROJECT DOCUMENT

The baseline land-uses within the project landscape as stated in the 2012 Project Document are as follows:

- 69% Natural Forest Management (NFM);
- 17% Industrial Tree Plantation (ITP);
- 7% conservation and research; and
- 7% enrichment planting.

However, during an inception workshop in July 2013 and a follow up strategic framework workshop in October 2013, it was revealed that there had been significant changes to land-use allocations against the baseline above. As a consequence, the stakeholders expressed concern that the proposed land-use changes within the project landscape (particularly the introduction of oil palm and mosaic planting) would have some major impacts on biodiversity and on the viability of key conservation areas and financing mechanisms that the project had been planning to support.

6.0 DESIGN AND STRATEGY – ADAPTIVE MANAGEMENT

Because of pre-emptive land-use decisions revealed during the Inception Workshop, the original design and strategy of the project became obsolete; and this compromised primary the project's overall objective. In order to determine a preferred option and formulate a viable future direction, a Technical Working Group (TWG) was officially formed in December 2013 to advise the Project Board on issues relating to biodiversity, with specific reference to proposed changes to land-use within the project landscape, possible impacts of these changes and how these might be mitigated. Following this, the TWG has generated recommendations for modifications to the July 2013 Plan and for future management of the project landscape. According to the TWG report (2014), despite the land-use allocations, the TWG determined that with significant modifications, a restructured project could achieve the project's overall objective. Subsequently, a Memorandum of Understanding (MoU) was signed between UNDP and the Sabah Forestry Department (SFD) on 12 November 2014. It is believed that the adaptations in project design and implementation strategy described in the Inception Report along with the consensus implied by the TWG Report and MoU, is an important milestone in preparing for the development phase of the project, as well as, reaffirming commitment of the SFD and UNDP to implement and to achieve the project's overall objective.

7.0 PROGRESS SUMMARY TOWARDS PROJECT OBJECTIVE AND RESULTS/OUTCOMES

There are numerous factors that influenced the smooth progress of the project. Amongst them include:

- a)* significant delays following the project inception phase;
- b)* as a consequence of (a) above, there was a limited period of effective project implementation; and
- c)* the project is being implemented through some 16 separate consultancies, contracts and subcontracts.

In Relation to (c) above, of these, 10 have been completed, 3 are in progress and 3 have been cancelled because they were overtaken by several fundamental land-use allocations decisions.

The project experienced a 2-year delay following the project inception phase and slow start-up phase due to significant difficulties related to land-use allocations/changes, mobilising of qualified and competent project management staff, and a number of other often generic and reasonably common project mobilisation delays. In spite of the delay, the SFD decision to gazette 95,486 ha of a former NFM area within the project landscape as Class 1 - Protection Forest Reserve in 2012 was significant. This policy decision has increased the Class 1–Protection Forest Reserve and conservation areas within the project landscape from 18,517 ha to 115,673 ha in 2013. This exceeded the original project’s target of 50,000 ha. Following this success, a new project target has been set at 145,000 ha by the end of the project, that is, 2018. This new target was achieved in 2015 - well ahead of schedule where 156,586 ha were successfully established and gazetted as Class I-Protection Forest Reserves. They are subsequently managed and maintained as viable connectivity corridors for the three globally significant conservation areas namely, Maliau Basin, Danum Valley and Imbak Canyon. Approximately 61,330 ha of the 156,586 ha gazetted have been certified as a well-managed forest under the FSC certification scheme in 2015. This FSC certificate will expire in 2020.

A ground-based biodiversity assessments in the project landscape (using a range of key taxa), mapping and monitoring programmes by a consortium of scientists led by University of Aberdeen are work-in-progress. According to their preliminary report (Report # 6), as of January 2018, a large number of digital images (deriving from camera traps, etc.) were collected from the project landscape. Terrestrial mammals have been sampled using camera traps at 162 locations across five land-use classes (forest reserve, virgin jungle reserve, agroforestry, integrated mosaic planting, and active logging compartments). Twenty eight mammal species have been observed in a total of 1803 detection records. In addition, twenty three 1.5 km ground transects have been completed for orangutan nest counts, strangler figs and hornbills across land-use classes, and these are matched to much larger areas surveyed using Unmanned Aerial Vehicles (UAVs). Preliminary analyses suggest that the density of orangutan nests recorded in both UAV surveys and ground transects was positively correlated with the density of strangler figs, and negatively correlated with elevation.

A total of 25 plots for estimating local tree diversity and above-ground carbon density (ACD) has been established across land-use classes. Tree identification work on the specimens collected from these plots is on-going. The analyses will be used to determine whether tree diversity and ACD vary consistently among land-use classes, and will be matched to other

data-sets to determine the inter-relationships among different biodiversity indicators. All these information will be collated in some form to generate ‘field guides’, or even a single field guide to the biodiversity of the project area in hard copy format. These guides would be valuable for future long-term monitoring, both within the project landscape and more generally across Sabah.

Meanwhile, training events were delivered to enhance the capacity of research assistants from Yayasan Sabah to conduct Gibbon point count surveys and from the Sabah Forestry Department to conduct drone surveys for Orangutan nests and install carbon plots. Discussions were also held with the Kalabakan Forestry Office staff on carrying out SMART Patrols and entering data into SMART software.

In terms of qualitative achievements, there has been less accomplishment in this area. However, some efforts were being directed towards “institutionalising a multiple-use forest landscape planning and management model”, which can be realised after the project ends. Similarly, “management of critical protected areas and connecting landscapes under a common management umbrella” demands priority consideration. The project acknowledged that these are relatively long-term undertakings that will most likely require a comprehensive evaluation of the structure within the SFD.

An international consultant (Forest Trends) has been hired by the project in 2014 to undertake an assessment on policy & regulations for implementing No Net Loss/Net Gain of biodiversity in sustainable multiple-use forest Landscape in Sabah. One of the results or recommendations from this consultancy service is that the SFD is required to draft a “roadmap” of steps that would be needed over a periods of approximately 5 years to develop and put in place a regulatory NG programme. In order to support this, a Net Gain Policy of Biodiversity is required for Sabah. Consequently, the same consultant was hired by the project in 2016 to draft a Net Gain Policy and Guidelines for Sabah. Following this, they have completed their Briefing Report on “Forest Loss-Gain Analysis for Sabah”, which they have presented to the SFD and other stakeholders.

According to the report by Amrei & Erin (2017), achieving Biodiversity Net Gain may not be feasible for Sabah in the first few years. In this case, Sabah would build towards a policy of “managed retention” of biodiversity approach, which can achieve a specific conservation target that considerably exceeds the CBD’s Aichi targets. This will build capacity in government and developers, and in a few years, Sabah will likely be in a better position to implement a Net Gain policy, which then ready to facilitate expansion / replication of the model to other forest landscapes in Sabah. Consequently, they came with their final products, namely, a Draft Policy on “Managed Retention of Sabah’s Forests: Moving towards Biodiversity Net Gain” and “Outline of Guidelines to Accompany the Draft Policy on Managed Retention”.

Meanwhile, inputs from the payment for ecosystem services (PES) add value to the State Government’s efforts to diversify income opportunities for conservation. This contract was formulated to address Output 1.2: “*New state-level policies and regulations for generating and disbursing revenues at landscape level from innovative financing mechanisms*”. In a detailed report, the consultant (Green Spider) explored and reviewed in depth PES schemes from a range of global locations - Palau, Ecuador, Costa Rica, Mexico, Belize, Brazil, and the United Kingdom. This helped to evaluate schemes or aspects of schemes that could be applied in Sabah. An analysis of their suitability for replication in Sabah was explored, both in their aptness for replication in socio-economic and socio-political terms, as well as, the revenue

they were likely to create. The report extracted seven (7) key elements that had made these schemes successful PES scheme and possible models. According to the report, all the 7 of these key points are present in the Sabah context and that there is significant levels of support for the establishment of a PES scheme that would feed into an autonomous, State-Level, conservation fund. However, based on the rationale and outcomes from this consultancy, there are two income-generating ideas that are most likely to produce substantial income flows to finance PES projects in Sabah. These include the tourism related Green Fee and a monthly or quarterly Water Levy charged to downstream water users.

Following this, a conservation finance strategy was finalized. Reports on “*Favourable Conditions for Implementing State-level PES Programme*”; a cash flow analysis on “*Collection of Proposed Ecosystem Conservation Fee at Airports*”; and a PES Policy and guidelines were developed while, a PES cabinet paper to explore options for introducing instruments such as, fees and grants to raise revenues for the protection, conservation and management of natural resource and the environment of Sabah, i.e., for the purpose of sustainable financing for conservation was prepared and submitted to the Cabinet in early 2018 for approval. Meanwhile, a draft report on “*Study on Willingness of Visitors to Sabah to Pay Ecosystem Conservation Fee*” was prepared and presented to the Ministry of Finance and Ministry of Tourism, Culture and Environment respectively. According to Shahwahid (2018), the revenue collections from the tourism related green fee based on three scenarios¹, the revenue collections per year could range from RM 22.78 million (low range case), RM28.43 million (medium range and RM 34.07 million (high range case). This would multiply current available funds for conservation in Sabah by a factor of 2.

With regards to the Proposed Ecosystem Conservation Fee, an independently managed conservation trust fund and guidelines have been developed; while a new "Ecosystem Conservation Fee Enactment" for Sabah is yet to be developed. This new enactment provides legal basis for imposition of such a fee on foreign and non-Sabahan Malaysian tourists departing Sabah or staying in Sabah.

8.0 CONCLUSION

The project made progress following the formulation of the Project Inception Document and the appointment and mobilisation of the Project Manager and Technical Working Group. To achieve the overall project objective would require a well-developed biodiversity, socio-economic, connectivity conservation, and responses. These need to be inherent parts of the multiple-use forest landscape planning and management model. The project's progress in the development and advancement of this critical part of the project particularly the socio-economic issue is still in-progress. Nevertheless, based on present trends and achievements coupled with an 18 months no-cost extension in order to complete the on-going activities and other priority interventions, the project has a reasonable probability that it will achieve its overall project objective and positively contributes to GEF biodiversity conservation objectives.

¹ Fee ranged from RM 10 (low), RM 15 (medium) and RM 20 (high) for international visitors while, Non-Sabahan Malaysians assumed to be RM 5 for each scenario.

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**INFORMATION PAPER 14: EXPLORING THE INSECT FAUNA OF
PENSIANGAN FOREST RESERVE IN SABAH**

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Abstract

Pensiangan Forest Reserve is a Class I Protection Forest Reserve and is situated in the Nabawan district in south central Sabah. An insect diversity survey was carried out from 18th to 22nd of July, 2016. The nocturnal insect diversity was moderate, compared to other forest reserves surveyed earlier. The mean Shannon Index was 3.62 while Simpson Index was 68.59 and Fisher Alpha Index was 99.97. The mean species richness, however, was low, with an average of 42.5 species from 53 individuals recorded from a one-square-metre of the light-trapping cloth. Some Bornean endemic species were recorded during the survey, namely *Amata prepuncta*, *Auriculoceryx pterodactyliformis* and *Lyclene nr acutiseriata* (all moths), *Dinophasma guttigerum*, *Haaniella echinata* and *Parorthormeria alexis* (all stick insects) and *Coelliccia nigrohamata* (damselfly). These pioneer data serve as baseline information for other research work in future. The endemic and interesting insect species recorded during the survey provide salient information to enhance the conservation of this forest which was recently being gazetted as a Class I Forest Reserve.

Keywords: Insect fauna, diversity, Pensiangan Forest Reserve.

1.0 INTRODUCTION

Located in the Nabawan District in Sabah, Pensiangan Forest Reserve is a Class I Protection Forest Reserve, covering an area of 67,964 ha. This reserve experienced timber extraction activity in the early 1990s and is dominated by disturbed mixed hill dipterocarp forest. Gunung Antulai (1,604 m a.s.l.) is the highest peak of the reserve. The soil associations in this reserve are mainly Crocker and Maliau, with a small portion of Labau (19 ha).

The scientific survey was carried out from 18 to 22 of July, 2016, with the base camp located at the southern part of the reserve beside Sg. Karilin. The journey by road from Sandakan to the base camp was about eight hours. The objectives of this study were to document the insect fauna of Pensiangan F.R. under the HoB programme, and to investigate the threats affecting insect diversity, as well as to provide recommendations that would contribute towards biodiversity conservation of the study area. Research findings from this study will be incorporated in the formulation of the Forest Management Plan (FMP) of this reserve, which has been recently gazetted as a Protection Forest Reserve from a Commercial Forest Reserve status.

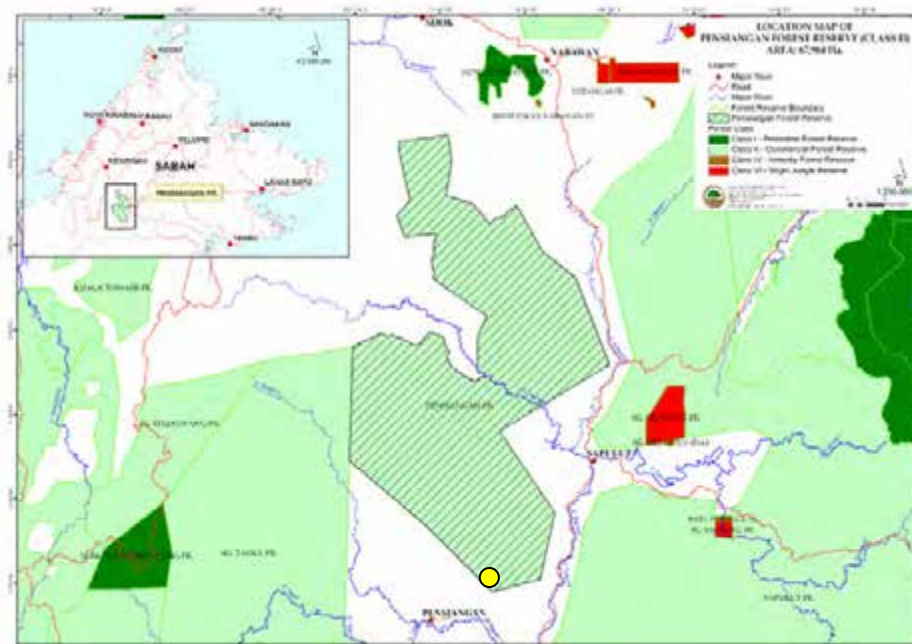


Fig. 1: Location of Pensiangan Forest Reserve in Sabah (inset) and the reserve in close-up (light green with lines), and the location of the base camp (yellow dot).

2.0 MATERIALS & METHODS

2.1 Insect Sampling Methods

Light trap was used to sample nocturnal insects while sweep nets and forceps were used to sample diurnal insects.

The trap consists of a vertical white sheet (2 X 2 m) illuminated by a 250W mercury-lithium bulb. It was powered by a portable Yamaha generator.

The trap was set up in an open area facing the forest reserve, from 7:00 to 9:00 p.m. A GPS (Model: Garmin GPSMAP 60CSx) was used to determine the coordinates of each sampling site. Temperature and humidity were taken with a digital hygrometer from Extech Instruments (model no. 445702).

To evaluate diversity of the sampling area, insect species and individuals (≥ 5 mm) within the 1 X 1 m square of the white cloth were enumerated from 8:30 to 9:00 pm. This is a rapid biodiversity assessment method because by the end of the sampling time, species and individual numbers can be obtained, and the data can be used to calculate diversity indices, i.e. Shannon Wiener, Simpson and Fisher Alpha, using the Species Diversity & Richness version IV (SDR 2006). This method is simple, fast and can be carried out by non-insect specialist. To avoid compounding human error, the same staff was assigned to count the species and individual numbers throughout the sampling period, and also for other sampling sites. Light-trapping was conducted at the same spot under the shed at the base camp. It was raining every night, hence, light-trapping could not be carried out at other sites in the forest.

Table 1: Light-trapping site at the base camp of Pensiangan F.R.

Sampling site	Coordinates	Elevation (m)	Temp. (°C)	Humidity (%)	Sampling date	Remarks
A1	N 04°39'25.9" E 116°22'14.7"	674	22.9	83	20 July	Drizzling and later, raining
A2	N 04°39'25.9" E 116°22'14.7"	674	21.4	86	21 July	Raining

Sweep nets were used to collect flying insects while other insects were sampled using fine forceps. Butterflies were put in triangle papers while other specimens were put in vials with 75% ethanol solution. Sampling was conducted along the trails established previously and also old skid trails. Details of the daytime sampling sites are listed in Table 2.

Table 2: Daytime sampling sites in Pensiangan F.R.

Sampling site	Starting point coordinates	Elevation (m)
1 (Along the road out to Sapulut)	N 04°40'58.3" E 116°23'58.8"	864-1049
2 (Base camp area – Sg Karilin)	N 04°39'25.9" E 116°22'14.7"	674-694
3 (Along the road to Pensiangan)	N 04°36'48.3" E 116°20'33.2"	836-574

2.2 Insect Specimens and Identification

In this survey, focus was given to certain insect groups, i.e., butterflies, moths, beetles, dragonflies and damselflies. Only interesting and potential indicator insect species were sampled, as to minimize the workload at the laboratory in preparing the specimens for identification. Photographs were taken with DSLR Nikon D800E and Nikon Coolpix cameras to facilitate identification. Common insects were not sampled but photographs were taken for record purposes.

Selected specimens were dry-mounted and sorted to family and some to the genus and species level. Many of the identifications are still tentative while some will be identified later. The specimens sampled from this study are deposited at the Forest Research Centre, Sepilok, Sabah. Dry-mounted specimens were identified based on the FRC Entomology Collection and various reference materials, e.g. Otsuka (1988 & 2001) for butterflies; Holloway (1983, 1985, 1986, 1988, 1989, 1993, 1996a, 1997, 1998a & b, 1999, 2001, 2003, 2005, 2008, 2009 & 2011) and Robinson et al. (1994) for moths; Fujita (2010), Makihara (1999) and Tung (1983) for beetles; Seow-Choen (2016) for stick insects; Orr (2003) and Tang et al. (2010) for dragonflies and damselflies. Some other insects were identified based on Hill and Abang (2005). Insect expert, i.e. Dr Francis Seow-Choen, assisted in identification of stick insects.

3.0 RESULTS & DISCUSSION

3.1 Overall Insect Diversity

The nocturnal insect diversity was moderately high, as shown in Table 3. The mean Shannon Index was 3.62 while Simpson Index was 68.6 and Fisher Alpha Index was 99.97. There was a proliferation of a species of micromoth (*Arthroschista hilaralis*) which were attracted to the lights at the base camp. However, not that many were attracted to the mercury lithium bulb of the light trap. Hence, the proliferation did not adversely affect the insect diversity calculation. On the other hand, the continuous rain throughout the sampling nights affected the reading. *Arthroschista hilaralis* is a serious pest of the local pioneer tree, *Neolamarckia cadamba*, locally known as Laran. It is abundant in the logged-over forest of Pensiangan.

During light-trapping, the temperature was between 21⁰C and 23⁰C with humidity relatively high, between 83% and 86% (Table 2). Although the diversity was moderately high, the species number was low, with an average of 42.5 nocturnal species recorded. The distribution of insect species from the light-trapping sites is reflected in the species-rank abundance curves in Figure 2.

Table 3: Insect diversity within a one-square-metre, as sampled through light-trapping in Pensiangan F.R.

No.	Sampling site	Species	Ind.	Shannon	Simpson	Fisher Alpha
1.	A1	42	53	3.57	51.04	93.64
2.	A2	43	53	3.66	86.13	106.30
	Mean	42.5±0.7	53±0	3.62±0.06	68.59±24.81	99.97±8.95

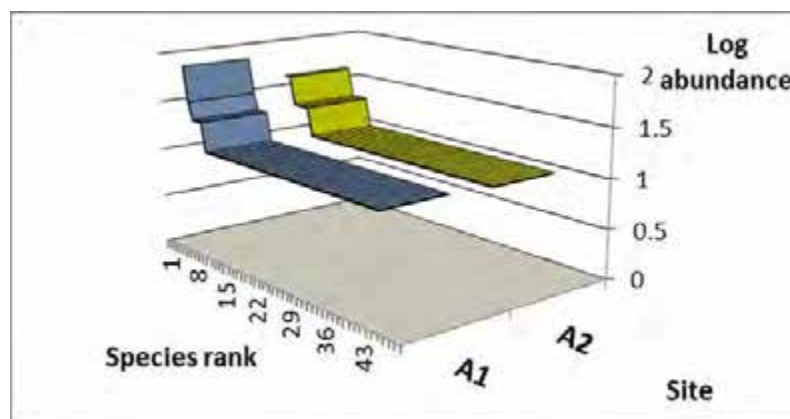


Fig. 2: Species-rank abundance curves of the light-trapping in Pensiangan F.R.

As expected, when the nocturnal insect richness is compared with other forest reserves, Pensiangan F.R. (in red) appeared to be low as shown in Figure 3a. In terms of nocturnal insect diversity, it is moderately high and almost comparable to many other forest reserves sampled previously (Figure 3b).

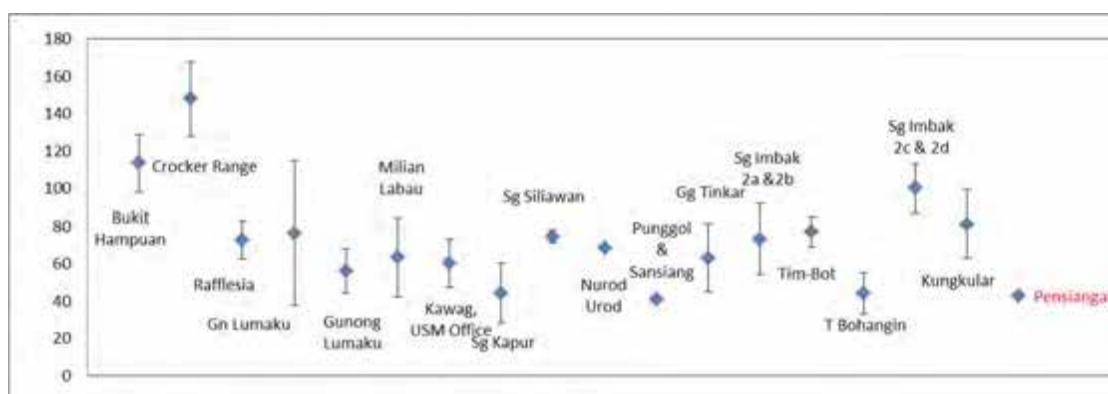


Fig. 3a: Species number ($\pm$ standard deviation) within one square metre as assessed through light-trapping in various forest reserves in Sabah.



Fig. 3b:

Shannon Index ($\pm$ standard deviation) within one square metre as assessed through light-trapping in various forest reserves in Sabah.

Some Bornean endemic species were recorded from Pensiangan F.R. during the brief survey, as listed in Table 4. The endemics included three moth species, one damselfly species and three stick insect species. This information provides input towards recommendations on High Conservation Value Forest (HCVF) of the area, namely HCV 1.3 (WWF-Malaysia 2009).

Table 4: Bornean endemic insect species from Pensiangan F.R. during the survey.

No.	Species	Author	Order	Family
1	<i>Amata prepuncta</i>	Holloway	Lepidoptera	Arctiidae
	<i>Auriculoceryx</i>			
2	<i>pterodactyliformis</i>	Holloway	Lepidoptera	Arctiidae
3	<i>Lyclene</i> nr <i>acutiseriata</i>	Holloway	Lepidoptera	Arctiidae
4	<i>Coelicia nigrohamata</i>	Laidlaw	Odonata	Platycnemidae
5	<i>Dinophasma guttigerum</i>	Westwood	Phasmida	Aschiphasmataidae
6	<i>Haaniella echinata</i>	Redtenbacher	Phasmida	Heteropterygidae
7	<i>Parorthormeria alexis</i>	Westwood	Phasmida	Aschiphasmataidae

3.1.1 Butterfly (*Lepidoptera*)

At least 20 butterfly species were sampled during the survey. During the same period, many butterflies were spotted elsewhere, e.g. Sapulut Forest Development, but surprisingly not that many were sighted within the Pensiangan F.R. All species sighted during the survey were common and can be seen elsewhere in Sabah.

3.1.2 Moth (*Lepidoptera*)

Some 39 moth species were selectively recorded during this study and three are endemic to Borneo. All are from the family Arctiidae. There could have been more moth species recorded if not because of the rain every night. The most spectacular moth species sampled was a male Moon Moth, *Actias maenas*. Some hairy caterpillars of the family Lymantriidae were found feeding on the foliage of Morugis (*Ilex cissoidea*). Unfortunately, the caterpillars died while in captivity. Hence, the species could not be determined.

3.1.3 Beetle (*Coleoptera*)

At least eight species of macro-beetles were recorded. All are known to be common species. The largest species from the survey was the Rhinoceros Beetle, *Xylotrupes gideon*. A Leaf Beetle, likely to be from the genus *Aulacophora* was spotted feeding on the flower of the wild bamboo orchid, *Arundina graminifolia*.

3.1.4 Dragonfly and damselfly (*Odonata*)

Some 17 species of dragonflies and damselflies were documented. One of the damselflies is endemic to Borneo, namely *Coelicia nigrohamata*. At least two *Vestalis* species were recorded, and some species from this genus could be endemic to Borneo. The largest dragonfly sampled was the Pond Cruiser, *Epophthalmia vittigera*, with a body length of about 80 mm and a hindwing length of 51 mm. This species is widespread in South-east Asia.

3.1.5 Stick insect (*Phasmida*)

A few stick insect species were sighted during the survey and three of them are endemic to Borneo, as shown in the figure below. *Haaniella echinata* was sampled by Sabah Parks staff while trekking along Sg. Karilin near the base camp at night.

3.2 Threats and Issues Affecting Insect Diversity

Like other forest reserves, forest conservation should be viewed in a holistic approach. Conserving the forest would mean protecting its flora and fauna as well. Hence, any threats or issues that are affecting the ecosystem would indirectly have an impact on insect fauna as well. Among the common issues are listed as follows:

- **Unsustainable harvesting of natural resources**—natural resources, whether plant or animal-based, can only bear limited levels of harvesting. If the resources are harvested too much, then supplies inevitably decline, and eventually lead to rarity or even extinction;
- **Forest fire**—drought-induced fire on forest may lead to change in biomass stocks, impact plant and animal species' functioning and alter the hydrological cycle;
- **Poaching**—illegal harvesting of natural resources;
- **Fragmentation**—the loss, degradation or fragmentation of ecosystems through land conversion for agriculture, forest clearing and other form of development; and
- **Encroachment**—illegal clearing within the reserves.

Of all the issues above, the main concern in Pensiangan F.R. is poaching. During the survey, various signs of poaching could be sighted. Poaching has been an activity in this forest reserve as well as adjacent forests for quite a while. It is quite a daunting task for the relevant authorities, especially Wildlife Department, to tackle this issue as such activity has been on-going for generations and some claim that it is their native and customary practices. In the long term, public awareness and environmental education are important in educating the villagers and younger generation on the significance of conservation and protection of wildlife.

4.0 CONCLUSION

From this study, the nocturnal insect diversity in Pensiangan F.R. was moderately high when compared to other forest reserves surveyed earlier. The species richness, however, was low, which could be due to the rain during sampling. A few endemic species were recorded.

These pioneer data will serve as baseline information for other research work in future. The endemic and interesting insect species recorded during the survey provide salient information to enhance the conservation of this forest as a Class I Forest Reserve.

The threats, especially poaching, have indirectly affected the insect fauna. Relevant agencies would have to work hand-in-hand to tackle the issues. Public awareness and environmental education would have to be enhanced among the villagers and their children who are living adjacent to the reserve.

5.0 ACKNOWLEDGEMENTS

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**INFORMATION PAPER 15: FLORA SURVEY IN TAMBULANAN
FOREST RESERVE, KALABAKAN, SABAH MALAYSIA—A HEART OF
BORNEO (HOB) INITIATIVE**

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Abstract

Under the Heart of Borneo (HoB) Initiative, the Sabah Forestry Department conducted scientific expedition which includes flora survey in Tambulanan Forest Reserve (FR), Kalabakan, Sabah from 2 to 7 October 2017. The primary objective of the expedition is to identify the key conservation targets within the forest reserve. This paper will present the findings which include plant richness, endemism and their conservation status. Such findings are vital for HoB's initiative to support the formulation of forest management plan of this protected area.

Keywords: Flora survey, plant richness, endemism, plant conservation status.

1.0 INTRODUCTION

Tambulanan FR is a Class I Protection Forest Reserve, located at the south of Maliau Basin, in the western part of Sabah (Fig. 1). With an area of 3,625 ha, the forest reserve is under the jurisdiction of Kalabakan District Forestry Office. The area has experienced timber extraction activity in the past and currently dominated by upland mixed dipterocarp and kerangas forest and partly lowland mixed dipterocarp forest with the elevation from 300 to 900 m above sea level. Prior to this flora survey, no collection was recorded from Tambulanan FR. These data are used in the botanical assessment for the preparation of High Conservation Value Forest (HCVF) and Forest Management Plan (FMP) reports for Tambulanan FR.

1.1 Study Site

1.1.1 Location and Access

The Tambulanan FR is located within the Kalabakan Forestry District and can be accessed from Keningau-Kalabakan road. Kalabakan is the nearest town where the key government administrative offices are located. Tambulanan FR is surrounded by forest reserves such as Maliau Buffer Zone FR in the north and south and Kalabakan FR in the east and south. Adjacent to the reserve, most land area have been developed into agroforestry landscape, such as fruit orchards and oil palm estates.

1.1.2 Soils Description

The soils in the reserve are represented by one main soil associations, i.e., Maliau and small patches of Kalabakan, Labau and Lokan soil associations (Acres & Folland, 1975). In Maliau association, the dominant soil units of Orthic and Gleyic, Acrisol, Dystric, Cambisol, Podzolic and Lithosol. Acrisols becomes the most widespread soil

with pozol soil sometimes occurs in the cuestas of long gentle dip slopes. In steep slopes, Dystric, Cambisol and Lithosol are dominant soil. The soils texture ranging from sandy to sandy clay loam and its soil colour ranges from brown to yellowish-brown.

1.1.3 Topography

The topography of Tambulanan FR is mostly hilly with steep slopes. The highest point is about 950 m above sea level in the east, north east and west.

1.1.4 Vegetation

The natural vegetation of Tambulanan FR is made up of Lowland Mixed Dipterocarp Forest and Upland Mixed Dipterocarp and Kerangas Forests.

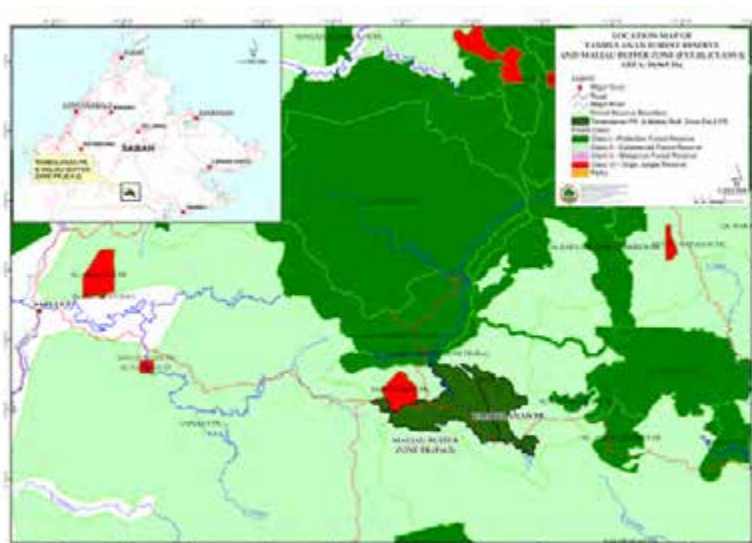


Fig. 1. Location map of Tambulanan FR, in the southeastern of Sabah, Malaysia.

2.0 MATERIALS AND METHODS

2.1 Sampling and Plant Identification

Prior to field survey, various maps, including soil map, satellite image (world map), and natural vegetation map were obtained for field survey planning. From the maps, areas of interest were identified and located. The field surveys were conducted from 2 until 7 October, 2017. All plant species and trees ≥ 10 cm diameter at breast height (dbh) were recorded from six of 0.13-ha circle plots which were established in various forest conditions (Table 1). This field activity utilized several items, i.e., recording sheet, diameter and linear tapes, altimeter, compass, handheld Geographical Positioning System unit, maps and flags.

Plant specimens with reproductive parts were collected (including voucher specimens) and deposited at the Sandakan Herbarium (SAN). The protocols of collecting and preserving plant specimens is based on Bridson et al. (1992). The common plant species were identified directly to species level in the field by means of their distinctive field

characteristics. For those that could not be readily identified, voucher specimens were collected for subsequent determination at SAN. The voucher specimen collections were oven-dried at a temperature range of 45–50° C for several days before determining their identities. All specimens were sorted according to morphospecies and identified to species level by cross-referencing with the existing specimens in the herbarium and related flora references (e.g., Airy Shaw, 1975; Dransfield, 1984, 1992; Kern, 1974; Soepadmo et al., 1995, 1996, 2000, 2002, 2004, 2007, 2011; Wood & Cribb, 1994; Wood, 1997). Other plant data were obtained from the dipterocarp survey. Plant classification of the Angiosperm group is based on Stevens, P.F. (2001 onwards). These flora data were compiled. Relevant literature materials and online reference, especially the IUCN Red List of Threatened Species (http://www.iucnredlist.org/static/categories_criteria_3_1) were also consulted to determine the conservation status of the plants listed.

Table 1. Plot numbers and their corresponding geographical position points for the flora survey in Tambulanan FR.

Plot No.	Vegetation Formation	Geographical Position	Elevation (m)
P1	Lowland Mixed	04°59'50.0" N	515
	Dipterocarp Forest	117°04'38.8" E	
P2	Upland Mixed Dipterocarp	04°59'57.9" N	624
	Forest	117°04'29.1" E	
P3	Upland Mixed Dipterocarp	05°00'03.8" N	777
	Forest	117°04'04.8"E	
P4		05°00'1.2" N	1099
	Montane Forest	117°03'43.5" E	
P5	Lowland Mixed	05°00'06.4" N	366
	Dipterocarp Forest	117°04'41.5" E	
P6	Lowland Mixed	05°00'03.6" N	413
	Dipterocarp Forest	117°04'40.2" E	

3.0 RESULT AND DISCUSSION

3.1 Botanical Findings

From the flora survey collections (herbarium and voucher specimens), a total of 599 taxa were recorded from the reserve. These number are represented by five lycophyte family, 15 ferns, one Gymnosperms, 13 Angiosperms (Monocotyledon) and 69 Angiosperm (Dicotyledon) (Table 1). The botanical collection was made in a short period of time, and therefore, the findings may represent only a small fraction of plants that occur in the undisturbed lowland and upland dipterocarp forests. It is anticipated that a greater number of plant species can be found if the length of survey is prolonged and the sampling size is increased.

Table 1. Number of plant groups collected during the botanical survey at Tambulanan FR, Sabah, Malaysia

Plant group	No. of families	No. of taxa
Lycophytes	5	5
Ferns	15	33
Gymnosperm	1	1
Angiosperm:		
Monocotyledon	13	36
Dicotyledon	69	524
Total	103	599

The ten most speciose families were Annonaceae and Rubiaceae (37), Lauraceae and Dipterocarpaceae (36), Myrtaceae (23), Leguminosae and Fagaceae (20), Burseraceae (17), Meliaceae (15) and Euphorbiaceae (14) as summaries in Fig. 2.

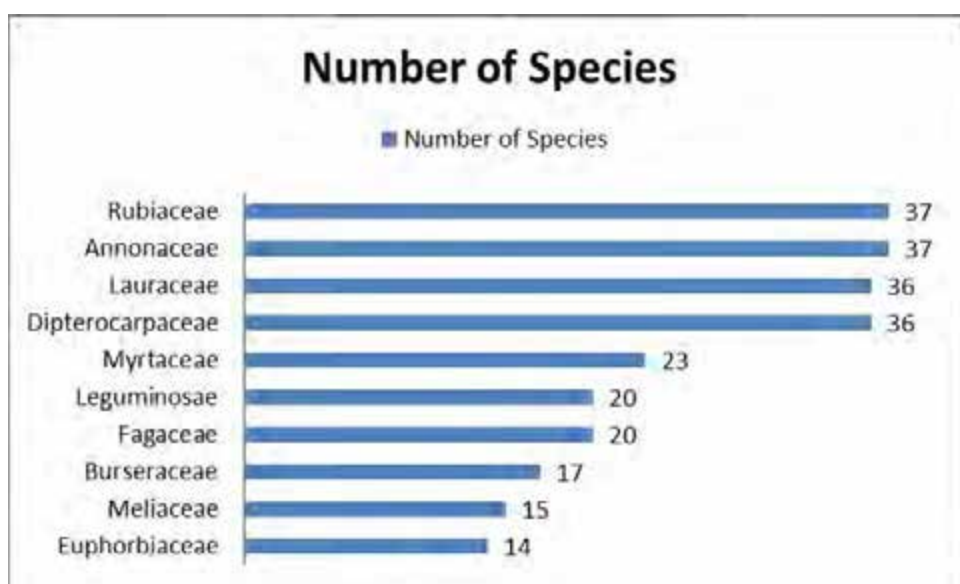


Fig. 2. The ten most speciose families in Tambulanan, FR.

3.2 Plant Conservation

3.2.1 Endemism

Endemism is the ecological state of being unique to a defined geographic location, such as an island, nation or other defined zone, or habitat type; organisms that are indigenous to a place are not endemic to it if they are also found elsewhere. The extreme opposite of endemism is cosmopolitan distribution. Endemics can easily become endangered or extinct if their restricted habitat changes, particularly but not only due to human actions, including the introduction of new organisms.

Of the 599 plant species that been recorded, 128 species are known to be endemic to Borneo, including 7 endemic to Sabah. However, most of the endemics are found to be relatively widespread or common in other places with similar forest formation and are not restricted to the reserve and even to Sabah.

3.2.2 The IUCN Red List

The IUCN Red List of Threatened Species is designed for evaluating the conservation status of plant species. There are six plant species that are listed as Vulnerable (VU), seven Endangered (EN) and nine are Critically Endangered (CR) from the reserve (Table 2).

Table 2. List of threatened plant species in Tambulanan FR based on the IUCN Red list.

No.	Species	Family	IUCN Status
1	<i>Shorea superba</i>	Dipterocarpaceae	CR
2	<i>Vatica sarawakensis</i>	Dipterocarpaceae	CR
3	<i>Shorea flaviflora</i>	Dipterocarpaceae	CR
4	<i>Hopea montana</i>	Dipterocarpaceae	CR
5	<i>Hopea nervosa</i>	Dipterocarpaceae	CR
6	<i>Parashorea malaanonan</i>	Dipterocarpaceae	CR
7	<i>Shorea hopeifolia</i>	Dipterocarpaceae	CR
8	<i>Shorea johorensis</i>	Dipterocarpaceae	CR
9	<i>Shorea symingtonii</i>	Dipterocarpaceae	CR
10	<i>Dryobalanops lanceolata</i>	Dipterocarpaceae	EN
11	<i>Shorea argentifolia</i>	Dipterocarpaceae	EN
12	<i>Shorea obscura</i>	Dipterocarpaceae	EN
13	<i>Shorea faguetiana</i>	Dipterocarpaceae	EN
14	<i>Shorea pauciflora</i>	Dipterocarpaceae	EN
15	<i>Shorea platyclados</i>	Dipterocarpaceae	EN
16	<i>Shorea ovata</i>	Dipterocarpaceae	EN
17	<i>Shorea macrophylla</i>	Dipterocarpaceae	VU
18	<i>Durio grandiflorus</i>	Malvaceae	VU
19	<i>Gonystylus keithii</i>	Thymelaeaceae	VU
20	<i>Dillenia philippinensis</i>	Dilleniaceae	VU
21	<i>Hopea beccariana</i>	Dipterocarpaceae	VU
22	<i>Aquilaria malaccensis</i>	Thymelaeaceae	VU

3.2.3 Wildlife Conservation Enactment 1997, CITES and Sabah Forest Enactment

Sabah Wildlife Conservation Enactment 1997 (SWD, 1997), under part VI (Protection of Plants) listed plants that may not be harvested without a license. There was only one (1) species, namely *Tetrastigma diepenhostii* that fall under Schedule 1, part II, Totally Protected Plant Species. There were eight plant taxa, comprised of four species of gingers, one species of palm and three orchids that fall under Schedule 2, part II, Protected Plant Species.

There were ten species were listed under Appendix II CITES, one from the Agarwood, two ramin, three orchids and four from the ginger family. There are 77 plant species that

are prohibited under Sabah Forest Enactment, mostly from the Dipterocarpaceae (30 species).

3.3 Issues and Recommendation

Since the forests in Tambulanan have already been legally gazetted as a Protection Forest (class I), the next essential step is to formulate a forest management plan for the reserve. Forest management plan is essential as a guideline to manage any forested area or forest reserve, such as Tambulanan in order to maintain the integrity of the reserve, including protection or conservation of plant species of high conservation value. Plant species of high conservation value may include species that are, e.g. endemic to a locality, threatened and also important as food source for wildlife. This high conservation value plants or plant conservation targets must be identified and monitored, including conducting population studies. However, most of the Sabah endemic plant species that found in Tambulanan FR as well as the threatened plant species are widely distributed in Sabah, hence there is no urgent measure required. Nevertheless, we propose one species, namely *Dryobalanops lanceolata* as the plant species conservation target to be monitored. The justification for the selection of this species is that it is easily recognizable in the field, Borneo endemic and threatened (Endangered) species.

Protection of the forest reserve as a whole, including from forest fire, poaching and illegal encroachment or felling must also be emphasized in the forest management plan.

2.0 CONCLUSION

The survey recorded 599 taxa from the reserve, of which 128 taxa were endemic to Borneo, including seven endemic to Sabah. The forests in Tambulanan FR contain high conservation value plant species.

3.0 ACKNOWLEDGMENTS

The survey was conducted to obtain botanical information for the HoB scientific expedition and for the preparation of the Forest Management Plan of the reserve. We thank the Deputy Chief Conservator of Forests (Forest Sector Planning) for his support. We also thank the Kalabakan District Forest Officer for his help in the accommodation arrangement at Asiatic and the Deputy Chief Conservator (Research & Development), Dr. Lee Ying Fah for his continuous support. En. Jumri Abd. Hamid provided maps and the staff of the Systematic Botany Section and Ecology Section, Forest Research Centre for their hard work in the field and in the herbarium.

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INFORMATION PAPER 16: *NEPENTHES* SPECIES OF MOUNT TRUS MADI IN SABAH BORNEO

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Abstract

Nepenthes is the genus of the carnivorous tropical pitcher plants that are mostly distributed within the Malesian region. Many endemic *Nepenthes* have a highly restricted distribution and known from a single locality or small area, such as a mountain peak, which makes them vulnerable to threats. Mount Trus Madi is the second highest mountain in Malaysia with an elevation of 2,642 m above sea level, located within the totally protected area of Nuluwon Trusmadi Forest Reserve under the management of the Sabah Forestry Department. This paper highlights the *Nepenthes* species that can be found on Mount Trus Madi. Ten plots were established along the five kilometres Kaingaran summit trail and four species and one natural hybrid of *Nepenthes* were enumerated from all plots, namely the *Nepenthes macrophylla*, *N. lowii*, *N. tentaculata*, *N. fusca* and a natural hybrid, *N. x trusmadiensis*. Their presence and abundance vary widely based on site elevation and vegetation. The most abundant species is the ubiquitous *N. tentaculata* with more than 75% of total individual counts in the sampling plots. The *N. lowii*, *N. macrophylla*, and their natural hybrid, *N. x trusmadiensis* have a narrow altitudinal distribution range and are confined to the upper montane forests and summit scrub zone of the mountain. The latter two are endemic to Mount Trus Madi.

Keywords: Borneo, Mount TrusMadi, *Nepenthes*, pitcher plant.

1.0 INTRODUCTION

Tropical pitchers plants, scientifically known as the *Nepenthes*, are one of the most prominent plant groups in the Malesia region. They are widely known for their carnivorous and unusual jug-shaped leaf extension to trap and digest fauna for nutritional benefit. Currently, there are approximately 170 species of *Nepenthes* distributed worldwide, 40 of which can be found in Malaysia. Out of the 40 species, 12 species (five endemic) are found in Peninsular Malaysia, 23 (six endemic) in Sabah and 28 (six endemic) in Sarawak. However these figures are constantly changing due to newly discovered species, as well as new localities information.

Many endemic *Nepenthes* species have a highly restricted distribution and very localised on a single locality such as on a mountain peak and ridges. The highest mountain in Malaysia (4,101 m), Mount Kinabalu, has a total of nine *Nepenthes* species recorded and of these; four are endemic to the mountain (Clarke 1997). Approximately 50 km to the south of Mount Kinabalu is the second highest mountain in Malaysia, known as Mount Trus Madi (2,642 m). The overall vegetation on Mount Trus Madi is akin to Mount Kinabalu with similar species composition and appearance of their montane forests, but has less floristic richness due to

lower summit height and less diverse geological substrates (Kitayama et al., 1993). Nevertheless, Mount Trus Madi has its own endemic *Nepenthes* which are *Nepenthes macrophylla* and its hybrid, the *N. x trusmadiensis*. Mount Trus Madi, located within the Nuluhon Trusmadi Forest Reserve with a total protected area of 74,736 hectares, is under the management of the Sabah Forestry Department (Figure 1).

The aims of this study were to identify the species composition, abundance and density of *Nepenthes* species that can be found on Mount Trus Madi. The findings of this study will provide information on the current population and distribution of the *Nepenthes* species on the mountain, as well as identifying the correlated environmental factors and any threat.

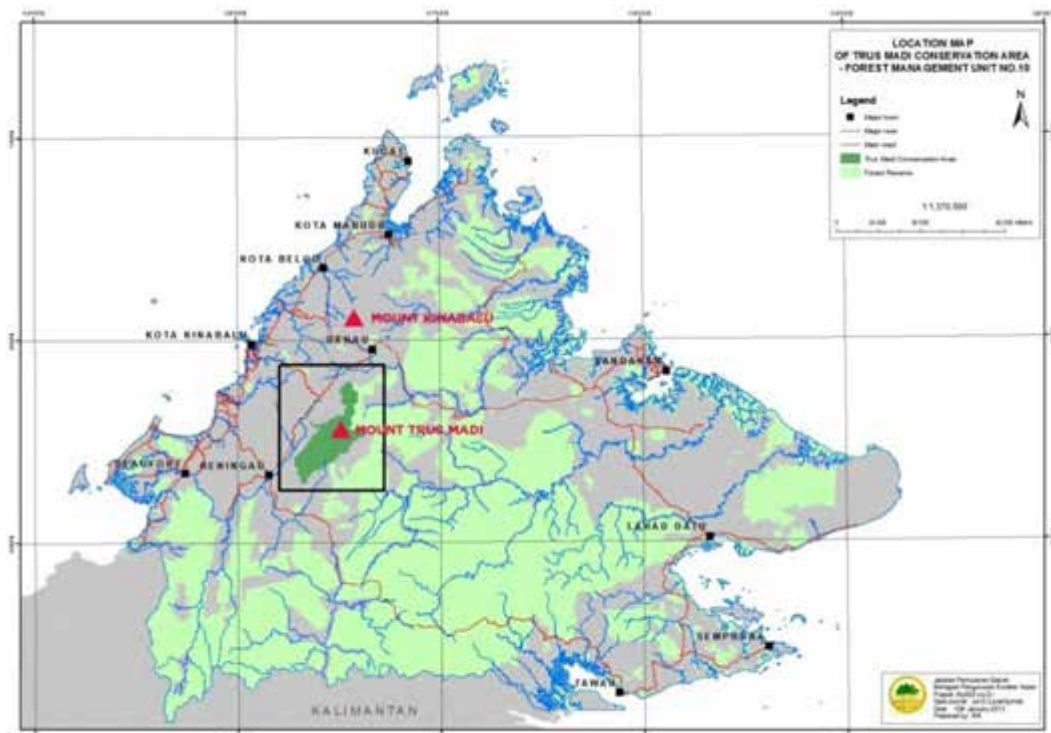


Fig. 1 The location of Mount TrusMadi within the Nuluhon Trusmadi Forest Reserve (also known as Trus Madi Conservation Area) in Sabah.

2.0 MATERIALS & METHODS

Nepenthes are known to have aggregated but patchy distribution, especially on forest gaps or low canopy forest (Damit et al., 2017). Thus, ten *Nepenthes* plots were established subjectively on their natural habitat along the Kaingaran Trail of Mount Trus Madi in August 2016. The plot design was adapted from the demographic study of *Nepenthes* at Mount Kinabalu by Adam (2002). Each plot measured 10 m × 10 m (0.01-ha) and was divided into 25 subplots measuring 2 m × 2 m. All individual plants of *Nepenthes* species in each plot were identified, tagged and recorded in the field. A second assessment was made a year following plot establishment, in September 2017, to compare and determine any changes in the abundance and density of the *Nepenthes* community. The density of each *Nepenthes* species enumerated from all ten plots was calculated per 100 m² for both years, and then compared and tested using paired-samples T-test in the statistics package SPSS Version 25 with p values above 0.05 indicating significant difference. A non-parametric Wilcoxon Signed Rank test will be used on the non-normal distributed data (Pallant, 2011).

3.0 RESULTS & DISCUSSION

Four *Nepenthes* species and one natural hybrid were enumerated from all plots, namely the *N. macrophylla*, *N. lowii*, *N. tentaculata*, *N. fusca* and hybrid *N. x trusmadiensis*. A total of 631 pitcher plants were recorded in 2016 during the first assessment (Damit et al., 2017). During the second survey, a total of 611 pitcher plants were recorded with 295 new individuals, 86 deaths, and 229 of tagged individuals were not found (Table 1).

Table 1: *Nepenthes* abundance in 2016 and 2017

Species	2016	2017	New	Dead	Not found
<i>N. tentaculata</i>	479	484	254	68	181
<i>N. lowii</i>	76	63	20	12	21
<i>N. macrophylla</i>	68	54	16	3	27
<i>N. x trusmadiensis</i>	8	9	4	3	0
<i>N. fusca</i>	0	1	1	0	0
TOTAL	631	611	295	86	229

The occurrence and abundance of each of the *Nepenthes* species varied widely based on the site elevation and vegetation (Figure 2). The most abundant species was *N. tentaculata* with more than 75% from the total individuals in both years. This species was present in all of the plots, except the highest elevation site near the peak (Plot 10). *Nepenthes tentaculata* is known to be the most ubiquitous montane pitcher plant and is commonly found in the damp mossy forests throughout Borneo (Cheek & Jebb, 2001).

Nepenthes macrophylla, *N. lowii* and their hybrid, the *N. x trusmadiensis*, only occurred in the five highest elevation plots, which were above 2,300 m elevation. This suggested that these three pitcher plant species were restricted to this narrow altitudinal distribution range in Mount Trus Madi. *Nepenthes fusca* was seen during the first survey (at about 2,077 m elevation) but was not subsequently recorded as it was found outside of the studied plots (Damit et al., 2017). However, a single epiphytic plant of *N. fusca* was discovered later in 2017 at Plot 3 (1,932 m elevation). Three more species, *N. stenophylla*, *N. chaniana* and *N. veitchii*, were also recorded on this mountain (Damit 2014, Lamb et al., 2007 & Sugau et al., 2013) but were not found in any of the plots examined.

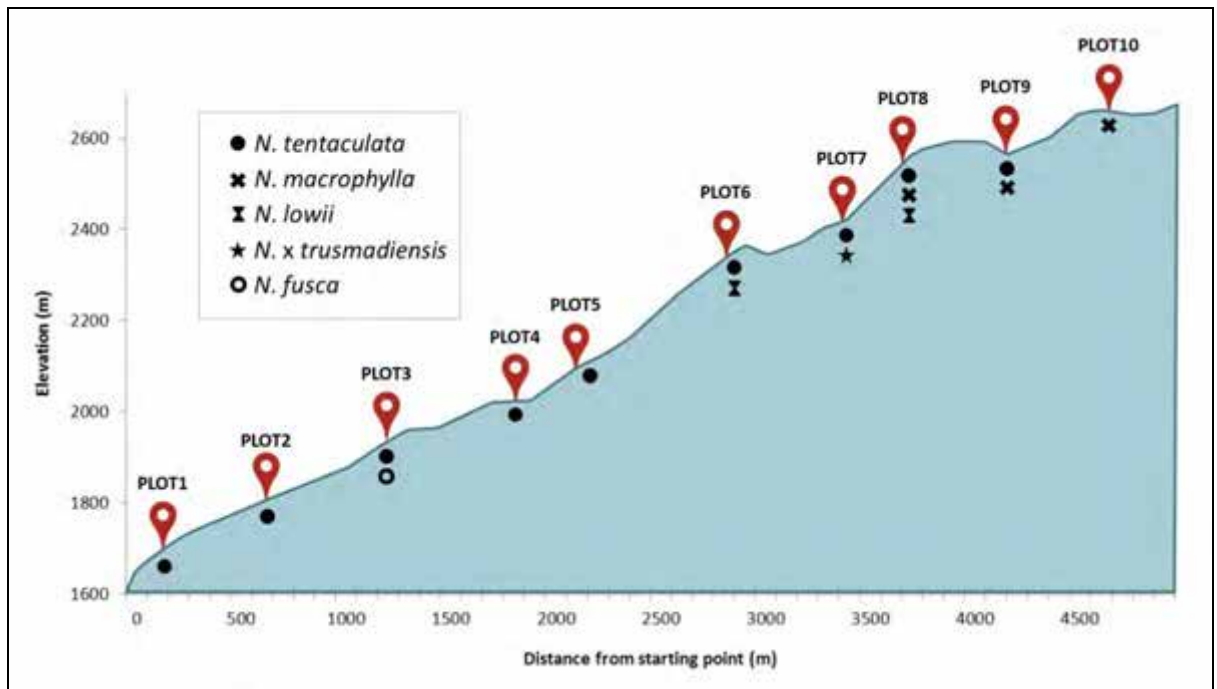


Fig. 2 Elevation profile of Mount Trus Madi and the locations of all plots along the Kaingaran trail.

The density data of *N. tentaculata* and *N. macrophylla* were log10 transformed to reach normality and then were tested using paired-samples T-tests. The non-normal density data resulting from the sample sizes for *N. lowii*, *N. x trusmadiensis* and *N. fusca* were tested using the non-parametric Wilcoxon Signed Rank test. There were some mean density increases for *N. tentaculata*, *N. x trusmadiensis* and *N. fusca*, but some reductions for *N. lowii* and *N. Macrophylla* (Table 2). However, these differences were not significant when tested. This indicates that there was no significant change in the density of the *Nepenthes* community along the Kaingaran Trail between 2016 and 2017. Despite this, the stability of this community could not be affirmed as the duration of this study was too short, and therefore any long term impact might be not detected.

Table 2: Mean density ($\pm$ standard error) of each *Nepenthes* species across all plots for both surveys in 2016 and 2017.

Species	Mean density ($\pm$ SE)		P value
	2016	2017	
<i>N. tentaculata</i>	0.479 $\pm$ 0.194	0.484 $\pm$ 0.211	0.496
<i>N. lowii</i>	0.076 $\pm$ 0.068	0.063 $\pm$ 0.053	0.655
<i>N. macrophylla</i>	0.068 $\pm$ 0.043	0.054 $\pm$ 0.035	0.111
<i>N. xtrusmadiensis</i>	0.008 $\pm$	0.009 $\pm$	0.317

	0.008	0.009	
<i>N. fusca</i>	0	0.001 ± 0.001	0.317

The major potential threats to the population of *Nepenthes* in Mount Trus Madi are the anthropogenic disturbance and climate change. The popular natural hybrid to this mountain, *N. x trusmadiensis*, used to be quite common on the mountain but its abundance may have declined due to tourist activities that may had caused detrimental impact on their natural establishment, such as physical damage due to pitcher plucking and ground vegetation clearance due to trampling impact (Clarke 2001). In a study of the potential impact of climate change on the Trus Madi Forest Reserve, *N. macrophylla* was predicted to be the most severely affected species, with its preferred climate envelope predicted to disappear from Trus Madi by 2050 (Maycock et al., 2011). Hence, it is important that their remaining populations and distributions are monitored closely.

4.0 CONCLUSION

Our study found four *Nepenthes* species and one natural hybrid along the Kaingaran Trail of Mount Trus Madi with *N. tentaculata* being the most abundant species, followed by *N. lowii*, *N. macrophylla*, *N. x trusmadiensis* and *N. fusca*. The IUCN Red List of Threatened Species categorized *N. macrophylla* as a critically endangered species, whereas *N. lowii* and *N. fusca* are vulnerable species due to their fragmented or small number of localities and restricted area of occupancy. Under these categories, these species may face higher risk of extinction in their wild habitats in the future.

Although this study shows that there was no significant difference in mean densities of the *Nepenthes* community between 2016 and 2017, however this is most likely due to the short interval of surveys. In order to implement effective monitoring of *Nepenthes* on Mount Trus Madi, further consistent observations on these established plots are recommended to systematically evaluate any changes on the *Nepenthes* community and to determine the factors that may influence such changes.

5.0 ACKNOWLEDGEMENTS

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**INFORMATION PAPER 17: THE PRIVATE SECTOR AND
SUSTAINABLE FOREST MANAGEMENT: FROM THE
PERSPECTIVES OF PRIVATE FMUs IN SABAH**

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Abstract

Sustainable Forest Management (SFM) requires substantial financial resources. Most of developing countries are struggling to raise adequate public funds to sustainably manage their forests, and reinvestment of revenues in forest management has been minimal. While funding continues to be sought from traditional sources, such as government budgets, the private sector is among the new and innovative a key source of forest financing, if tapped properly, could result in benefits for the environment along with profit for business. SFM has been adopted in Sabah since 1997 as an important guiding principle in managing the State's forest resources in the long term for overall socio-economic-environment benefits of the state. It started with the ten (10) private companies that willingly subscribed to this forest management concept. The private sector is expected to play a lead role in economic and production activities, while the public sector provides supportive policy as well as the legal and other institutional environment in SFM implementations. Today, after nearly a two-decades of operations, the number of company advocates on the SFMLA concept in implementing SFM has increased substantially to 34, covering about 1.56 million ha or 93% of the State's Commercial Forest Reserve. Since embarking on this endeavour, so much have been achieved ever since, for example, good forest governance, protection, forest restoration, enrichment planting, certification, etc. The progress is achieved due to strong collaboration between private and public partnerships. This paper presents the results of the questionnaire survey for the private sector views and perceptions regarding the extent of their involvement in the sustainable forest management and in which direction it is moving, and other issues and constraints, and suggestions to facilitate its greater progress.

Keywords: SFM, FMU, private concessionaire, implementation progress.

1.0 INTRODUCTION

The word "sustainable" is not new to forestry operation, but the dynamics of societal values, specifically those related to forest resources and environment, have added new dimensions to thinking about sustainability of forest resources and forest management. The recent concerns about sustainability, signaled by the publication of the 'Limits to Growth' by Meadows et al. (1972, 2004) and 'Our Common Future' by WECD (1987), are not limited to a specific product or resource but include all natural systems and human life. The roots of the concept of sustainable forest management (SFM) can be found in these two publications, but it derived impetus from several global events, including the 1992 United Nation Conferences on Environment and Development (UNCED) held in Rio de Janeiro, Brazil - also known as 'Earth Summit'.

Sustainable Forest Management (SFM) requires substantial financial resources. Most of developing countries are struggling to raise adequate public funds to sustainably manage their forests, and reinvestment of revenues in forest management has been minimal. While funding continues to be sought from traditional sources such as government budgets, the private sector is among the new and innovative a key source of forest financing, if tapped properly, could result in benefits for the environment along with profit for business.

2.0 SUSTAINABLE FOREST MANAGEMENT IN SABAH

Sabah is the second largest state in Malaysia with the total area is about 73,620 km² / 7.362 million ha. The forest cover is 59% of Sabah's total land area. These forests are fairly heterogeneous but dipterocarp forest account for more than 75% of Sabah's natural forest. Commercially they are the most important assets in terms of revenue and economic activity for the state. Forest resources in Sabah have been seriously depleted through uncontrolled timber harvesting repeated logging of the past. The timber that survived in forest areas was considered to be poor quality and not good for export or local markets. According to Sam and Yahya (1997), some of the key factors that have caused "massive depletion of forests", amongst other are, harvesting beyond the forest's ability to regenerate, premature "re-entry", political change and instability, an unstable forestry policy environment, etc.

To address the situation and protect future timber resources, Sabah adopted SFM policy in 1997 as an important guiding principle in managing the State's forest resources in the long term for overall socio-economic-environment benefits of the state. The key to the realisation of this policy is the replication of the model devised in the Deramakot Sustainable Forest Management Project. This was initiated in 1989 in partnership with the German Agency for Technical Cooperation. This project involved using 55,000 hectares of Deramakot Forest Reserve as a pilot project for developing SFM system in Sabah. In 1997, this project achieved the distinction of becoming the first area of forest in developing tropics to be certified by the FSC and became a learning model for SFM in Sabah and Malaysia.

Following from the Deramakot pilot project, SFD decided to apply this model to the whole of the Commercial Forest Reserve (Class II). This involved dividing the Permanent Forest Reserve into forest management units which were then contracted out to private companies under Sustainable Forest Management Licence Agreements (SFMLAs). Each SFMLA valid for 100 years, as opposed to the previous short-term concession. This is to provide security of management tenure and encourage long term planning and more sustainable practices. Licensees were required to comply with the management practices and commit to achieving accreditation under a recognised certification. They were also required to deposit a RM5 million performance bond, which would be forfeited if the licence was rescinded for non-compliance.

Privatization of the state's forest resources is aimed at reducing the state's budget deficits. The private sector is expected to play a lead role in economic and production activities, while the public sector provides supportive policy as well as the legal, higher level capacity building and strategic planning and other institutional environment in SFM implementations (Mannan and Awang 1997). This is a unique example of government and private sector partnership working towards a common goal, sustainable forestry. Such as partnership is also seen as a vehicle for expediting further SFM and implementation.

Under SFMLA system, each licensees (FMU holders) is required to have a ten-year Forest Management Plan (FMP), and the forest is zoned into different land use functions, namely, production, conservation or protection, community forestry, and research. Area delineated for protection are normally based on topography and aim to protect steep slopes if more than 25 degrees and permanent streams, and are off-limits to timber harvesting or any development. The licensees are also required to conduct environmental and social impact assessments, and HCVs assessments as part of the forest management planning system. They must also submit Annual Work Plan (AWP) and Compliance Report (CR). A Comprehensive Harvest Plan (CHP) has to be prepared for each logging block prior to harvesting, based on Reduced-Impact Logging (RIL) systems. These major planning elements form the basis for forest management, which was lacking under the previous short-term licensing system. SFD responsible for approving all management and operational plans, as well as monitoring the activities of licence holders. For transparency, the forest operations are subject to 3rd party auditing.

Sustainable Forest Management was started with the issuance of ten (10) SFMLAs to the private companies in 1997. Today, after about two-decade of operations, the number of company advocates on the SFMLA concept in implementing SFM has increased substantially to 38, covering about 1.65 million ha or 93% of the State's Commercial Forest Reserve. Since embarking on this endeavour, so much have been achieved ever since, for example, good forest governance, protection, forest restoration, enrichment planting, certification, etc. The progress is achieved due to strong collaboration between private-public partnerships.

3.0 THE PERCEPTION OF PRIVATE SECTOR

People's perception and preference has the potential to effectively support decision-makers in the management and preservation of forest resources, and being aware of it is important for effective designing and implementing management policies (Paletto et al., 2013). In July 2018, the SFD undertake survey to investigate and understand private sector's perception towards sustainable forest management implementation in Sabah.

4.0 METHOD AND SAMPLE

The survey through questionnaire form was conducted in July 2018. The initial process of questionnaire preparation began in March 2018 with a meeting and discussion on the work plan and focus group between the respective officers. When the draft was completed, it was circulated to 44 SFMLA/LTL holders including their joint venture companies. The response rate was 38%, with 16 SFMLA/LTL holders responding to the questionnaire.

The questionnaire scripts with 25 questions and were structured into six sections. Section 1 intended to gather information on the background of the licence. Section 2 included questions about their general understanding and interest towards SFM, while Section 3 was dedicated to get the information on the extent of their involvement in forest management practices. Section 4 was designed to measure their level of acceptance towards environmental and social aspects of SFM, including human capacity. Section 5 assesses their acceptance and attitude towards a variety of topics related to the forest management practices that are being implemented. Section 6 includes open ended and guided questions to get their views on various issues related to sustainable forest management, including on the newly introduced policy of logs export.

All respondents were male (100%) with 81% of them within the age group ranging from a minimum age of 30 to a maximum of 64. Most of the respondents were Manager or Senior Manager (75%) and 25% were Assistant Manager. Most respondents managed forest area between 10,000 ha – 50,000 ha (62%), 25% of the respondent managed area less than 10,000 ha, and 0.12% of the respondents managed the area of more than 50,000 ha. Over half of the respondents (63%) have started their forestry operation for more than 10 years, while only 37% has just commence their operation of less than 10 years.

Most of the respondents are local companies (88%). The paid-up capital are mostly above RM500,000.00 (75%). The average budget allocated by 88% of the respondents to run the licence operation is more than RM 1 Million per year, and 63% of the financial sources was through self-financing. Financial sources were also obtain through bank loan (12.5%) and government incentive (12.5%).

5.0 THE RESULTS

Due to time constraints and small number of responses of the survey, the following are the **interim results** of the study.

6.0 BASIC UNDERSTANDING ON SFM

When asked about the three pillars of SFM, almost all of the respondents (94%) knew about the three aspects of SFM, i.e. economy, environmental and social. High proportions (88%) of respondents were interested or very interested in issue concerning sustainable forest management, and 6% felt that they were at least somewhat interested. In relation to objective or purpose in venturing into SFM business, 81% of the respondents expressed that economic benefit, social acceptance and environmental safeguard are their objectives, while 13% of the respondents seek the economic benefit only.

7.0 FOREST MANAGEMENT PRACTICES

The questions were also dealt with forest management practices they had undertaken within the preceding three-year period, or planned to undertake in the next three years. As shown in **Figure 1.0**, setting aside areas of off-limit harvesting is the most activities undertaken in the past three years (87%) which includes establishment of riparian buffer zones, steep areas of more than 25 degree slopes, wildlife corridor, etc. Similarly, salvage logging and site preparation were also ranked higher as the most undertaken activities in the past three years, i.e. 75% respectively, and these activities will continue to be carried out in the next three years. Tree planting activity will increase in the next three years as more respondents will take part in this activity while maintenance of planted trees is an ongoing activity. Harvesting of NFM areas was also an ongoing activity since the last three years. This indicated most of the areas are still in the developing stages.

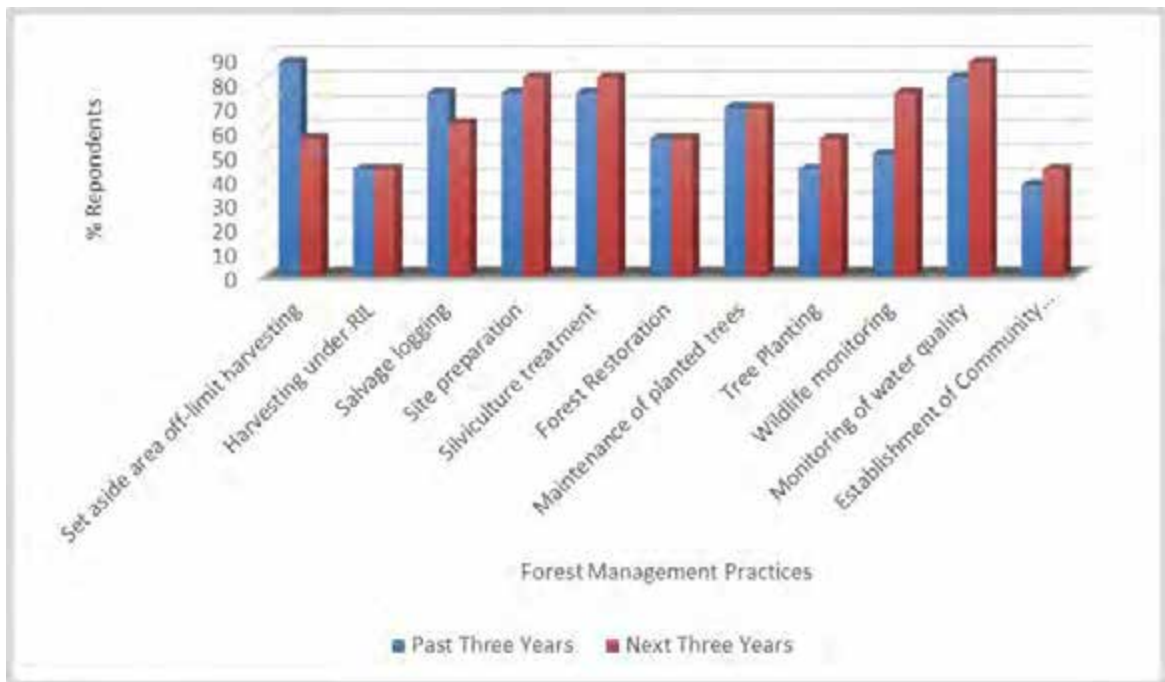


Fig 1.0: Forest Management Practices in past three years and in the next three years

Respondents were also undertaken timber stand improvement, wildlife monitoring and water quality monitoring and establishment of community compartments and these activities will continue to be carried out or increase in the next three years. These indicated evident of private sector cooperation towards sustainable forest management.

8.0 ACCEPTANCE TOWARDS ENVIRONMENTAL AND SOCIAL ASPECTS OF SFM AND HUMAN CAPACITY

The primary focus of this section of the survey was to assess how the SFMLA/LTL holders perceive the importance of environmental and social aspects, and enhancing capacity towards achieving sustainable forest management. They were requested to rate on the scale 1 to 5 on how important they think about the protection of environment and forest ecosystem, wildlife, water quality, enhancing knowledge and skills of forest managers and workers and application of environmentally technologies, and including the importance of improving the forest dwelling communities. The result is appears in Figure 2.0.

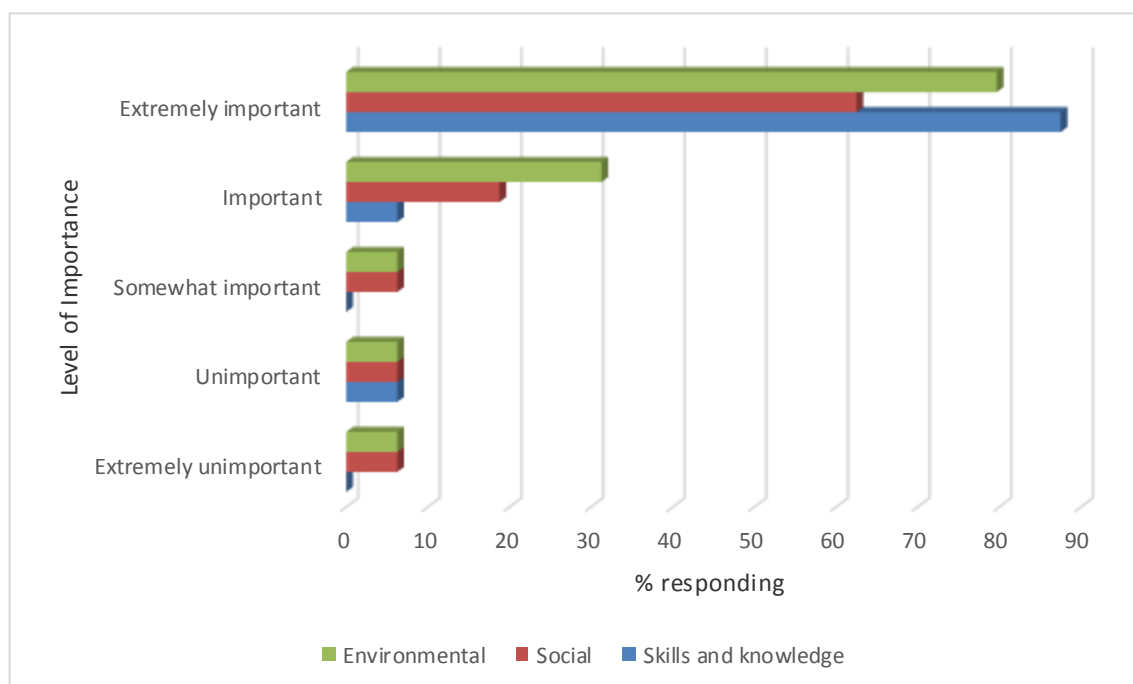


Fig. 2.0.: Level of importance of environmental and social aspects of SFM and human capacity

A vast majority (87.5%) of respondents felt that enhancing knowledge and skills of forest managers and workers are the utmost priority in implementing SFM. They also consider that environmental (79.7%) and social (69.5%) are important aspects to be addressed to achieve sustainable forest management.

9.0 ATTITUDE AND PERCEPTION TOWARDS VARIOUS TOPICS OF SUSTAINABLE FOREST MANAGEMENT PRACTICES

The questions also focused on attitude and perceptions towards topics related to sustainable forest management practices that were being implemented by asking respondents to indicate their level of agreement or disagreement. As shown in **Figure 3.0**, statements with which received the highest level of agreement included: “Certified timber should be eligible for a higher price (93.75%), Forest certification ensure continuous best-practices of forest management (87.5%), forest restoration can meet the objective of biodiversity conservation and ecosystem function (75%) and SFM addresses the needs of forest dwelling communities while also providing wood for economic growth (62.5%)”. Majority of respondents (87.5%) agree to strongly agree that TLAS improve operational management on the ground, Reduced Impact Logging technique reduced cost of post-harvest treatment of logged over forest (85.7%) and that forestry industry players are taking long-term interest in maintaining a healthy forest (93%). When asked about restriction in timber harvesting, more than half of respondents (60%) express their willingness to accept the restriction. Level of disagreement is notably low across all statements except for “Forest ecosystem services is less important than the benefit of timber harvesting” (26.7%), which indicated that most respondents agreed on the importance of forest ecosystem services. With regard to post-harvest treatment of logged over forest, more than half of respondents (56.3%) agreed that forest should be allowed to regenerate naturally without human intervention. A possible reasons may be the cost incurred in forest rehabilitation. In practice, silviculture treatment is one of the management prescription of logged over forest.

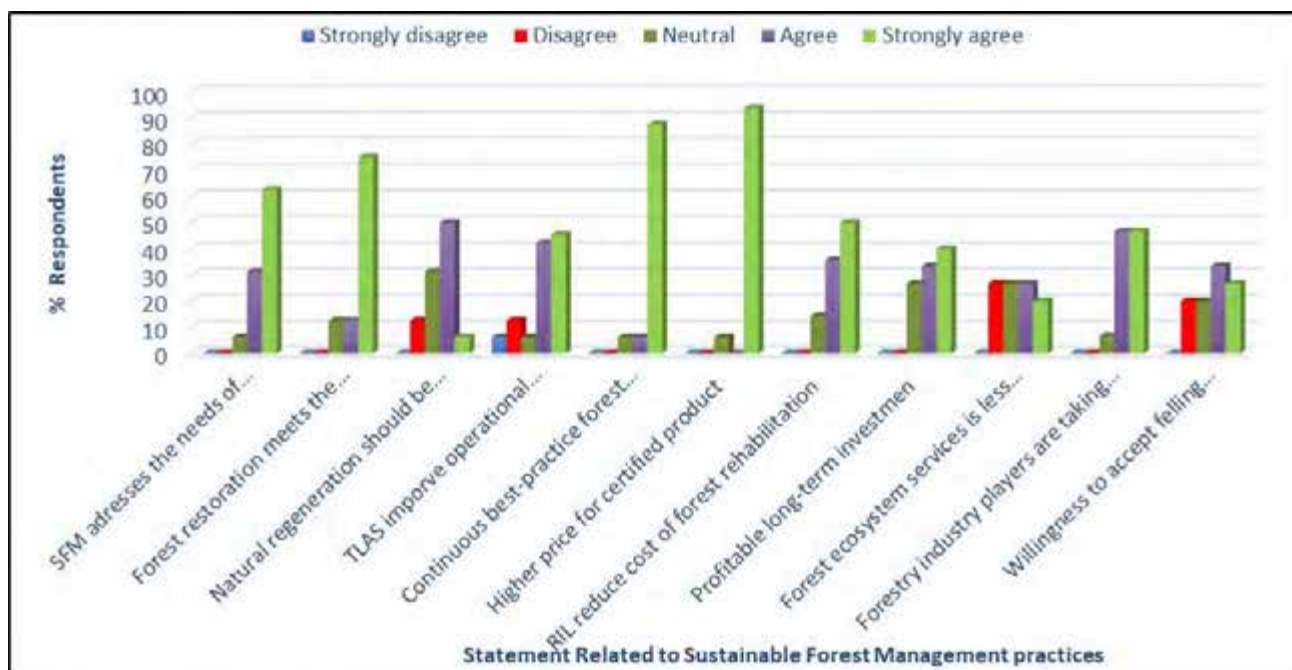


Fig. 3.0 Attitude and perception towards various topics of sustainable forest management practices

10.0 SFMLAS' VIEWS TOWARDS ISSUES RELATED TO SUSTAINABLE FOREST MANAGEMENT

Only 75% of respondents express their opinions towards matters related to sustainable forest management such as forest certification, forest restoration, challenges in venturing SFM and on the newly introduced policy i.e. the ban of export logs.

With regard to forest certification, majority of respondents expressed that economic benefit such as wider market and anticipated higher price for certified products are amongst the things that motivates them to participate in forest certification. They also indicated that other reasons are their concern on safeguarding the environment for future generation and sustainability of resources. Only few respondents stated that they undertake forest certification because it is required by law.

Most respondents expressed the lack of capacity and capability in term of financial and expertise are amongst the main obstacles in forest certification. This included lack of expertise on wildlife, social, etc. to carry out specific tasks to fulfil the certification requirements such as HCVF and social impact assessments. In addition, inadequate competent staff and high turnover of workers were also the hindrance in forest certification. Other obstacles included problem in maintaining proper documentation and too many requirements to comply with.

When asked if it is important for their areas to be certified, most respondents viewed that forest certification is important to ensure sustainability of resources, safeguarding environment as well as to get higher or better price for certified products. Only 25% respondents viewed that forest certification is not important as there is no direct benefit from that exercise and it incurred high cost especially for smaller areas.

In relation to challenges in implementing SFM, respondents had identified various issues, amongst other, include long gestation period of investment, financial, lack of expertise, policy continuation, difficulties to comply with principle and criteria of forest plantation certification, forest fire occurrences, illegal felling and hunting, conflicts with local communities, and issuance of licence that is not in tandem with the regeneration of the forests.

On log export banned, a vast majority of respondents (90%) believed that the banned of log export will result in the flooding of timber supply in local market and thus will result in unattractive timber price in the long run, while certain group of species may not be sellable due to selective demand of timber species for local processing. In the long run, this will affect their profitability and SFMLAs would have to revise their operational cost. However, few respondents believed that the banned of log export will ensure sufficient supply of timber for local processing, and ensure continuous job opportunities.

11.0 DISCUSSION

1. The response rate is quite low (38%) most probably due to the short period of time given for completion of the questionnaires, i.e. only one week. There is no statistical analysis carried out on the results due insufficient number of samples obtained. Nevertheless, this survey can provide basic understanding and overview on how private sector perceive sustainable forest management implementation in Sabah. Further research are needed to have a bigger sample in order to provide a fairly accurate reflection and a truly representative of the private sectors views and perceptions.
2. The survey showed that private sectors have different interest, capabilities and constraints in venturing into SFM. Private sector pursues profit in investment, but investing in SFM is not as profitable as unsustainable forest management or other opportunities, and it requires substantial financing. Besides, it is a long gestation period of investment. In addition, SFM means more regulations and standards to meet (Chipeta, et al., 2001), which means additional cost of operations. In moving forward, it is important that policy effort should be to make SFM more financially rewarding.
3. This survey also indicated that not only adequate finance is required for sustainable forest management, but equally important is human capacity – expertise, knowledge and skill of forest managers and frontline staff.
4. Forest certification is a tool to promote sustainable forest management, and private sectors have shown their concern for sustainability by participating in forest certification to meet high standard of forest management. However, forest certification adds to operational and production costs (Chipeta, et al., 2001), and these costs are not reflected in selling price yet. For small advocates, forest certification is already a burden and the standard requirements can lead to forgone opportunities for them. Without tangible benefits deriving from forest certification, they will have little incentive to improve their forest management with higher cost and even less motivation to participate further in forest certification.
5. Private sector also perceived that certified timber or wood products should be eligible for higher price. However, based on current situation, there is no differences in the price of certified and non-certified timber.
6. For successful SFM implementation, enabling environment is crucial, e.g. policy continuation.

12.0 CONCLUSION

This survey suggests that in spite of difficulties, private sectors are willing to implement sustainable forest management not only for economic gain but also for sustainability of resources. However, financial and lack of capacity and capabilities are the main challenges to achieve sustainable forest management. Further researches are needed in order to provide a fairly accurate reflection and a truly representative of the private sectors understanding and perception on sustainable forest management implementation in Sabah.

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**INFORMATION PAPER 18: ASSESSMENT ON GROWTH
PERFORMANCE OF A 2-YEAR-OLD PROGENY TRIAL OF *Eucalyptus
pellita* IN LUNGMANIS FOREST RESERVE, SABAH**

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Abstract

Eucalyptus pellita has become an important plantation species in Sabah as an alternative to *Acacia mangium* which is currently being adversely affected by *Ceratocystis*. Characteristics that made this species suitable for plantation establishment are its fast growth, good tree form with straight stem, high adaptability to various environmental conditions, resistance to pest and disease, and the wood is suitable for a wide variety of products. It plays a significant role in reforestation activities of several tropical countries such as Brazil, Indonesia, Cuba, and the Philippines. An *E. pellita* Progeny Trial was established at Babakang, Lungmanis Forest Reserve in 2015, with seed materials derived from a 21-year-old *E. pellita* Provenance Trial at Kolapis B, also in Lungmanis Forest Reserve. This progeny plot consists of 28 different provenances planted in a randomized complete block design with 5 replications, with a spacing of 4m x 3m. The objective of the study was to backward-select among the 21-year-old *E. pellita* and to evaluate and rank the breeding values through assessment of the growth performance of the families or offspring. Data for diameter at breast height (dbh), height of tree and survival were recorded and analyzed.

Keywords: *Eucalyptus pellita*, dbh, height, survival, progeny, provenance

1.0 INTRODUCTION

Eucalyptus pellita belongs to the family Myrtaceae, and is commonly known as red mahogany, large-fruited red mahogany, Daintree stringy bark and red stringy bark. It is a plant of the subtropics to the tropics, medium-sized to tall tree from the wetter forests of the east coast of North Queensland through the well forested areas of the region to Papua New Guinea. *Eucalyptus pellita* is often planted in tropical lowland regions at elevations up to 800 metres. It is frost resistant and grows best in areas where mean annual rainfall is within the range 900 to 4,000 mm and where there is all year round rainfall and mean annual temperature ranges from a cool month of 4° to 19° to a hot month of 24° to 34° (Clarke et al., 2009). It is recommended for planting on soils that are well-drained and sandy ranging from shallow sands on sandstone ridges to shallow sandy podzols and deep forest loams. The tree can grow up to 40 metres tall and at its best, it can achieve a straight bole up to half the total height of the tree and up to 100 cm in diameter (Dombro 2010).

Eucalyptus pellita is one of the favourites among popular plantation tropical tree species and fits all the requirements for a commercially successful timber tree. It is resistant to common pest and diseases, tolerant to a variety of soils and locations conditions, rapid growth under plantation conditions, straight stem with limited branching, tolerant of poor, infertile but well-drained soils and have a decent wood quality (Clarke et al., 2009).

Eucalyptus pellita tree has a wide range of uses. Its flowers provide large quantities of pollen for bee colonies, the large, heavily branched crown is suitable for shade and windbreaks and the tree can be used for afforestation purposes at coastal lands (Harwood, 1998). It produces attractive lumber and also known as a good source tree for the pulp and paper industry (Dombro, 2010). The wood is strong and durable and can be use for heavy construction and heavy ornamental works and a good source of fuel and charcoal (Orwa et al., 2009).

This study presents an assessment on growth performance of 2 year old progeny trial derived from a 21-year-old *Eucalyptus pellita* provenance trial established in eastern Sabah, Malaysia. The purpose of this study was to backward-select among the 21-year-old *E. pellita* and to evaluate and rank the breeding values through assessment of the growth performance of the progeny or offspring.

2.0 MATERIALS & METHODS

2.1 Study Area Description

The study area is a progeny trial established at Babakang Plot, Block 45A, Lungmanis Forest Reserve established in September 2015. It is located on moderate hills with altitudes reaching 75 m and slopes are between 10 and 20 degrees and the types of soils are mainly Kretam and Lungmanis Associations, with small areas of Rumidi, Kalabakan and Lokan Associations. The plot is located near oil palm estates and is easily accessible by road within 1 to 1.5 hours from Sandakan, Sabah.

2.2 Experimental Design and Data Collection

The site was established in September 2015 and is approximately 2 years old when assessed. The trial was planted at a 4m x 3m spacing with a total of 5 replicates in which each replicate consists of two blocks over an area of approximately 0.27 hectares. The total number of trees planted at the site is 1,120 trees from selected mother trees representing 28 families. The parameters measured were total height, diameter at breast height (DBH), and survival rate.

3.0 RESULTS AND DISCUSSION

3.1 Results

3.1.1 Survival Rate

Figure 1 shows the survival rate for 28 families of *E. pellita* progenies at Lungmanis Forest Reserve. The highest survival rate was portrayed by progenies from Serisa Village, Papua New Guinea (Sep No. 4210) and North of Kuranda, Queensland (Sep No. 4187), both with 90% survival rate. The lowest survival rate was portrayed by progeny from Tozers Gap, Queensland (Sep No. 4197) with 55% survival rate. The other families had a survival rate ranging from 60% to 85%.

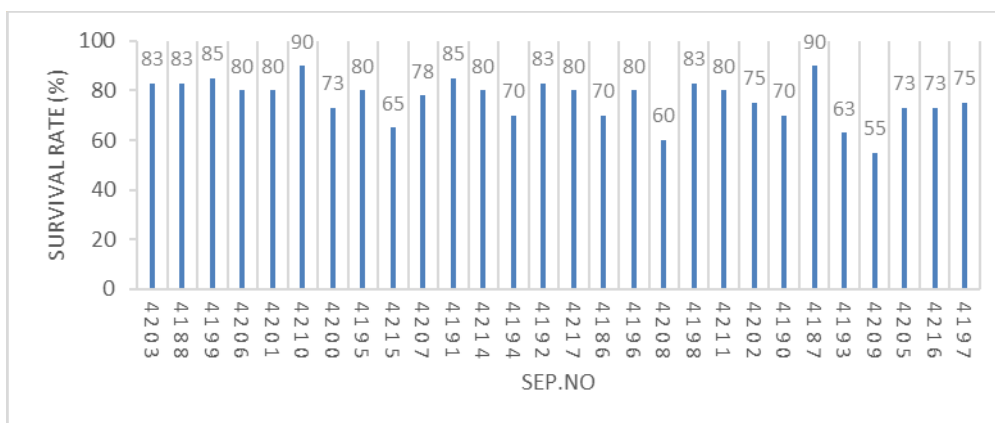


Fig 1. Survival rate for 28 *E. pellita* families at Lungmanis Forest Reserve

3.1.2 Mean Height and Mean Diameter at Breast Height

Table 2 shows the mean height and mean diameter at breast height for the 28 families of *E. pellita* at Babakang, Lungmanis Forest Reserve. The progeny from Jullaten, Queensland (Sep No. 4211) had the largest mean diameter at breast height at 4.7 cm and followed by the progeny from Serisa Village, Papua New Guinea (Sep No. 4210) at 4.6 cm. The progeny from Serisa Village, Papua New Guinea (Sep No. 4210) also had the highest mean height at 5.1 m, followed by the progeny from Jullaten, Queensland (Sep No. 4211) at 4.8 m.

Table 2. Mean height and mean diameter at breast height (DBH) for *E. pellita*

No.	SEP Number	Families		Mean Height (m)	Mean DBH (cm)
1	4203	South East Cardwell	Queensland	5.45	5.10
2	4188	Lankelly Creek	Queensland	5.83	5.33
3	4199	North West Ingham	Queensland	5.84	5.10
4	4206	Tozers Gap	Queensland	5.09	4.74
5	4201	North of Kuranda	Queensland	6.16	5.26
6	4210	Serisa Village	Papua New Guinea	6.03	5.53
7	4200	North West Ingham	Queensland	4.99	4.54
8	4195	South Bloomfield	Queensland	5.83	5.11
9	4215	South East Cardwell	Queensland	5.62	4.55
10	4207	North West Ingham	Queensland	5.07	4.73

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11	4191	North of Kuranda	Queensland	6.04	5.54
12	4214	Tozers Gap	Queensland	6.10	5.69
13	4194	South Bloomfield	Queensland	5.54	4.72
14	4192	North of Kuranda	Queensland	5.56	5.34
15	4217	North West of Kuranda	Queensland	5.52	5.30
16	4186	North West of Ingham	Queensland	5.08	4.13
17	4196	South Bloomfield	Queensland	5.98	5.56
18	4208	North West of Ingham	Queensland	4.98	4.42
19	4198	Tozers Gap	Queensland	4.94	4.39
20	4211	Jullaten	Queensland	6.10	5.88
21	4202	North of Kuranda	Queensland	4.61	4.44
22	4190	Tozers Gap	Queensland	6.17	6.08
23	4187	North of Kuranda	Queensland	5.63	4.86
24	4193	North of Kuranda	Queensland	5.54	5.43
25	4209	Tozers Gap	Queensland	5.97	5.39
26	4205	Serisa Village	Papua New Guinea	6.54	6.38
27	4216	Bloomfield/Daintree	Queensland	4.84	4.46
28	4197	Tozers Gap	Queensland	5.14	4.20

3.2 Analysis of Variance among Progenies

Table 3 below shows a one way ANOVA of the DBH for 28 families of *E. pellita* at Babakang, Lungmanis Forest Reserve.

Table 3. One-way ANOVA of the DBH for 28 provenances

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>
Between Groups	12.62399	27	0.47	1.42	0.0758
Within Groups	238.5371	727	0.33		
Total	251.1611	754			

The result from the one-way ANOVA showed that there was no significant difference in DBH for all the 28 families ($F=1.42$, $P=0.0758$; Table 3).

Table 4. One-way ANOVA of the height for 28 families

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>
Between Groups	6.975402	27	0.26	1.81	0.0073
Within Groups	103.5098	727	0.14		
Total	110.4852	754			

On the other hand, the result from the one-way ANOVA showed that there was a significant difference in height for all the 28 families ($F=1.81$, $P=0.0073$; Table 4).

3.2 Discussion

The progeny originating from Serisa Village, Papua New Guinea showed the best growth performance by having the highest mean height at 6.54 m, the second largest mean diameter at breast height at 6.38 cm and the highest survival rate with 90% survival rate at the age of 2 years old.

The second best performing progeny that shows good growth was from Jullaten, Queensland (Sep no. 4211) by having the largest mean diameter at breast height at 5.88 cm and the second highest mean height at 6.1 m at the age of 2 years old. Figure 2 shows the progeny trial at the Lungmanis Forest Reserve.



Fig. 2 (A and B) shows the progeny trial at Lungmanis Forest Reserve during data collection

Some of the other families also displayed good performance in terms of survival rate, particularly the progenies from North Kuranda, Queensland (Sep No. 4191) and North West Ingham, Queensland (Sep No. 4199) both with 85% survival rate.

4.0 CONCLUSION

Growth data of these families will continue to be recorded and assessed to determine their performance over time for better assessment and future selection. The best performing families were successfully selected based on the performance of the offspring or progeny. Through this study, the best seed sources, best adapted and most productive trees can be determined and the trial plot can be converted into a seed stand, and also perhaps for a gene bank of *E. pellita*.

5.0 ACKNOWLEDGEMENTS

The authors would like to express their deepest gratitude and to acknowledge the contribution of the staff from Agroforestry Section, Plantation Section, Seed Section, Tree Breeding Section, Nursery Section, and Non-Timber Plantation Section of the Forest Research Centre especially Mr. Ajis Ampawih, Mr. Japirin Hasman, Mr. Abdul Ajik Oyong and Mr. Ahmad Mustapha for their contribution, for without their support and assistance in data collection, the study would not have been possible. The authors would also like to acknowledge the assistance rendered by Nur Sykilla Amran, Sharifah Nur Ezzati binti SH Bokrata, Marwann bin Mamor and Mohammad Shahfudin bin Nurudin of University Malaysia Sabah.

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**INFORMATION PAPER 19: SEED SIZE AND GERMINATION
CHARACTERISTIC OF *Eucalyptus pellita***

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Abstract

The seed traits that exist in the *Eucalyptus pellita* were not well known by planters as this species was newly introduced to Sabah plantation as an alternative to *Acacia mangium* due to the problem of *Ceratocystis*. One of the challenges to exploit the seed traits of *E. pellita* is the small seed size ranging from 200 µm and above as reported in Indonesia (Yunarti, 2015) and 1000 – 1500 (2000 µm) reported in Australia (Slee *et. al.*, 2015). *E. pellita* seeds collected from Kolapis B, Sandakan, Sabah were sieved and sorted into three groups, namely large seeds (≥1000µm), medium seeds (≥850 –(<1000) µm) and small seeds (≥710 –(<850) µm) in order to obtain a promising trait and then efficiently assessed the trait for high quality planting materials. The parameters measured were mean root emergence, normal germination, root length and hypocotyl length. The results showed that higher mean root emergence (85-87%), mean of normal germination (88-89%) and longer root length (12-13mm) were obtained in large and medium seeds compared to small seeds (mean of rooting 54%, germination 71% and root length of 9mm) and the differences were significant. There were also significant differences of the hypocotyl length among the different seed sizes groups. As the seed size grouping plays an important role in seed market necessitates in depth study for its rooting and germination performance.

Keywords: *Eucalyptus pellita*, seed traits, seed sizes, root emergence, normal germination, root length and hypocotyl length.

1.0 INTRODUCTION

Eucalyptus pellita is a plantation tree species planted for its wood that has a wide range of uses, *i.e.* for heavy constructions, pulp and paper and even for resin production. The resin of this species can be used as essential oil and has termite resistance properties (Orwa *et al.*, 2009; Dombro, 2010). The species is originated from Australia and Papua New Guinea, and has now become popular as a tropical plantation species and is being widely introduced to Brazil, Congo, Fiji, Indonesia, Kenya, South Africa and Uruguay. Lately, Sabah and Sarawak have also started to plant the species. A second generation seedling seed orchard of *E. pellita* has been established in Indonesia and it has been revealed that this species has significant genetic gains in height, diameter and stem form (Leksono, 2009).

One of the challenges to exploit the traits of *E. pellita* is the small seed size ranging from 200 µm and above as reported in Indonesia (Yunarti, 2015) and 1000 – 1500 (2000 µm) reported in Australia (Slee *et.al.*, 2015). Naidu & Jones (2007) have reported that seed size of *E.grandis* is positively related to the field survival, which further indicated that large seed (seed size ≥1000 µm) is able to produce faster germination while small seed (seed size, ≥710

-(<850) μm) will have poor germination, possibly resulting in short seedlings. Thus, the objective of this study is to investigate the seed trait of *E. pellita* seeds, especially the seed size that influence the root emergence, root length, normal germination and hypocotyl length.

2.0 MATERIALS & METHODS

The *E. pellita* fruit pods were collected from Kolapis B, Sandakan, Sabah in February, 2018. The seed extraction and the germination experiment were carried out at the seed laboratory, Forest Research Centre Sepilok. *E. pellita* seeds were bulked and sieved using a laboratory wire mesh according to mesh sizes (Naidu & Jones, 2007) and grouping was done (Table 1) as the following:

Table 1: Seed grading based on the range of seed size.

Group	Size (μm)
Large seed	≥ 1000
Medium seed	≥ 850 - (<1000)
Small seed	≥ 710 - (<850)

Sixteen seeds with 5 replications (N=80) were sown in germination pouches, placed on a rack, and observation was made for a duration of 15 days. Emergence of rooted seeds, about ≥ 2 mm (Tigabu & Oden, 2001) and germinated seeds with 5mm hypocotyls (normal germination) were recorded (Plate 1). The root emergence, normal germination, root length and hypocotyl length also determined. ANOVA and post hoc Fisher's least significant difference (LSD) where significant value set at $P \leq 0.05$ are used to determine differences between groups.



Plate 1: Rooted and germinated seedlings of *E. pellita*.

3.0 RESULTS & DISCUSSION

The medium and large seeds of *E. pellita* had higher rooting emergence and germination compared to small seeds and the result were statistically significant (Table 2). The significant differences in the rooting and germination percentage in the different group showed that bigger seeds have the ability to take nutrient from the cotyledon and germinate better than the small seeds.

Table 2: One-way ANOVA of the root emergence and normal germination, for the three seed size group of *E. pellita*.

<i>Variable</i>	<i>Source of variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-Value</i>
Root emergence	Between Groups	13462.240	2	6731.120	46.783	.000
	Within Groups	8201.172	57	143.880		
	Total	21663.411	59			
Normal germination	Between Groups	4019.531	2	2009.766	17.487	.000
	Within Groups	6550.781	57	114.926		
	Total	10570.312	59			

E. pellita seed varied in the rooting emergence percentage, ranging from 54% to 80% and germination percentage, ranging from 71% to 89% (Fig. 2). Medium and large seed ($\geq 850 - (\geq 1000)$ μm) had larger amount of nutrient stored in the seeds that eventually increased the root emergence and germination performance. This led to the understanding that seed development is related to the nutrient in various seed size and mass, and it also has positive correlation with seed vigor (Copeland & McDonald, 1995). Larger seeds are also able to access the nutritive material from its parent faster than smaller seed. Similar findings by Hojjat et al. (2011) which also showed that bigger Lentil seed interacted positively on germination and early seedling growth.

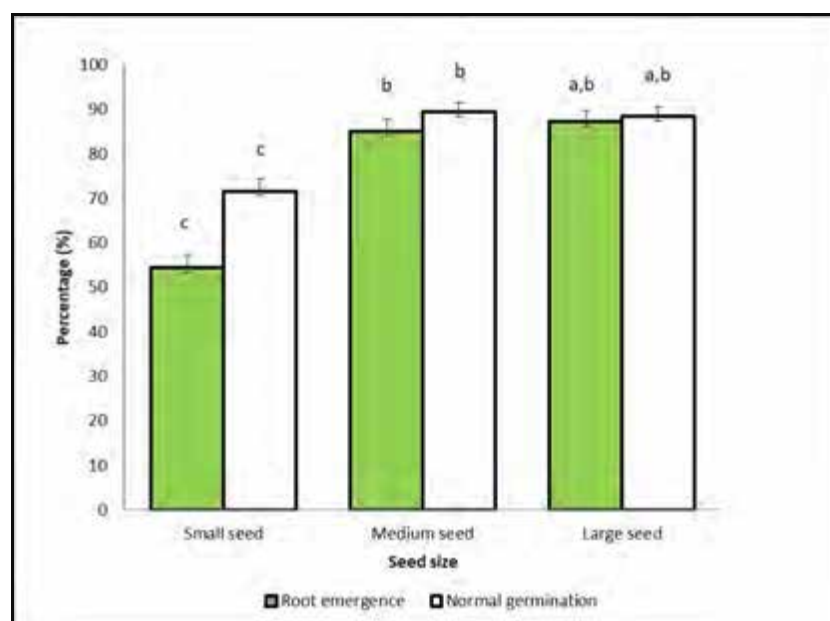


Fig. 2: Mean of root emergence and normal germination (with standard error) of *E. pellita* seeds. Significant difference between groups is indicated by different alphabet. $P \leq 0.05$.

There was significant difference in the root and hypocotyl length among the three seed size groups with medium and large seeds having longer root and hypocotyl compared to the small seeds (Table 3) and depicted in Fig.3. This is supported by previous studies indicating a positive effect of large seed on seed germination and early plant growth (Gan & Stobbe, 1992 & Erskine, 1996). The quality of seed may be also related to other factors such as seed nutrient content (Abideen et al., 1993) and time of seed collection (Bellari & Tani, 1993).

Table 3: One-way ANOVA of the root length and hypocotyl length for the three seed size groups of *E. pellita*.

Variable	Source of variation	SS	df	MS	F	P-Value
Root length	Between Groups	206.100	2	103.050	14.956	.000
	Within Groups	392.750	57	6.890		
	Total	598.850	59			
Hypocotyl length	Between Groups	333.033	2	166.517	27.822	.000
	Within Groups	341.150	57	5.985		
	Total	674.183	59			

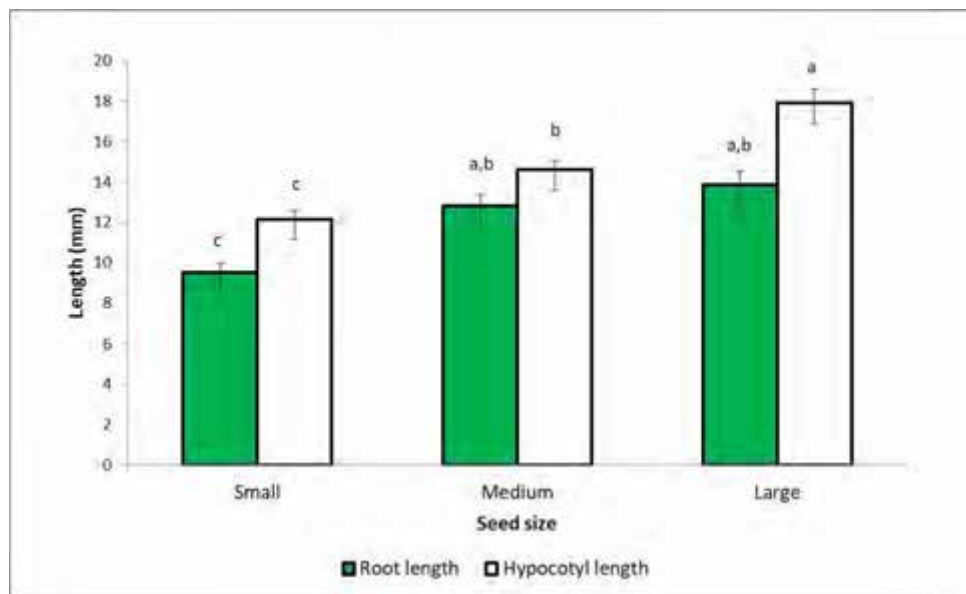


Fig. 3: Mean of root and hypocotyl length (with standard error) of *E. pellita* seeds. Significant difference between groups is indicated by different alphabet. $P \leq 0.05$.

4.0 CONCLUSIONS

The seed size of *E. pellita* plays an important role in influencing the rooting emergence, normal germination and the root and hypocotyl length. Larger seedlings can be obtained from large and medium seed size as bigger seeds are able to store food or nutritive materials from the parent and effectively use the available nutrients from the sowing media respectively. It is recommended that small seeds, with $<850\mu\text{m}$ long, should be removed during the seed processing to ensure the quality of planting materials is maintained.

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**INFORMATION PAPER 20: PRELIMINARY RESULTS OF ROOTING
Gymnostoma nobile CUTTINGS USING THE SIMPLE WATER
METHOD**

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Abstract

The simple water method is a simple and low-cost method of vegetatively propagating trees using stem cuttings. This study reports the preliminary results on an experiment to optimize the conditions for inducing rooting in stem cuttings of *Gymnostoma nobile* propagated using the simple water technique. Stem cuttings ($n = 5$) were treated with indole-3-acetic acid (IAA) of varying concentrations (100, 200, 500, 1000 and 2000 mg/L) for 30 minutes and for 24 hours. They were then cultured using distilled water under a mini greenhouse with high humidity. The result showed that calluses were prominent in all cuttings regardless of the IAA concentrations and treatment time. Despite having low success of rooting, *G. nobile* cuttings treated with 1000 ppm and 200 ppm of IAA for 24 hours formed roots after 33 days and 35 days, respectively. Both gave 7% root initiation. The study was continued until no further rooting was observed.

Keywords: Water culture, propagation, *Gymnostoma nobile*, rooting

1.0 INTRODUCTION

Gymnostoma nobile locally referred to as *Sempilau Laut* is one of seventeen species under the genus *Gymnostoma* in the family *Casuarinaceae*. Casuarina trees are regarded as valuable resources for agroforestry. Species under this family are naturally distributed across Southeast Asia, Australia as well as in the Melanesian and Polynesian regions of the Pacific (Wilson and Johnson, 1989). The trees and shrubs of *Casuarinaceae* are widely cultivated in towns and settlements for timber resources, landscaping, fuel-wood production, afforestation, dune stabilization, and establishment of shelter belts (Hamdan et al., 2016; Ipor et al., 1999; Midgley et al., 1983; National Research Council, 1984). The ubiquity of *Casuarinaceae* in agroforestry is attributed to its capacity for growing on nutrient-deficient soil. This ability is conferred by the trees' symbioses with nitrogen-fixing actinomycetes of the genus *Frankia* residing in the root nodules (Baker and Mullin, 1992; Lamont, 2003). Given its value in agroforestry, there is mounting interest in establishing methods to propagate of *Casuarinaceae* trees vegetatively for large-scale deployment (Goh et al., 1995).

One of the most popular methods to propagate stem cuttings is through the simple water method using stem cuttings. The attractiveness of this vegetative propagation technique is due to its cost-effectiveness: it does not require media preparations or highly trained personnel as in the conventional tissue-culture approach, and can be done within a relatively small area with minimal maintenance that, in turn, reduces labor force. The usual set-up involves soaking the stem cuttings upright in a water-based rooting medium that sufficiently provides the required oxygen and humidity (Hamilton and Midcap, 2003). Moreover, the use of water

as a growth medium would prevent the examining part of the cuttings from injuries or damages (Ventakaramanan et al., 2015). The stem cuttings are usually treated with auxins such as indole-3-acetic acid (IAA), indole-3-butyric acid (IBA) and naphthaleneacetic acid (NAA) that help in increasing rooting percentages, expedite root initiation, increase the number and quality of roots, and encourage uniformity of rooting (Hartmann et al., 2002; Macdonald, 1987).

In this study, we report the results from an experiment aimed at establishing a method for vegetatively propagating *Gymnostoma nobile* by using stem cuttings. A vegetative propagation technique for *G. nobile* using stem cuttings has not yet been established, perhaps due to it being the least specialized genus and the most primitive in the family (Wilson and Johnson, 1989). Therefore, the findings in this paper may provide preliminary insights pertaining to the conditions required for root formations in the target species.

2.0 MATERIALS AND METHODS

The objective of this study was to determine the effects of different concentrations of auxin (IAA) and the treatment time on stem cuttings of *G. nobile* cultured using the simple water method.

2.1. Collection of Plant Material and Preparation of Cuttings

Stem cuttings were collected from five individual trees planted around the Forest Research Centre, Sandakan. It was done in the early morning as the plants are still fully turgid at this hour. *Gymnostoma nobile* branchlets were snipped using a gardening pruner and placed in a cooler box filled with water to reduce the loss of moisture pending further treatment. The pruners were cleaned before and after each use to avoid cross contamination. The upper shoots were then trimmed and leaves at the lower half of the cuttings were removed. Cuttings from the five individuals were prepared in triplicates for each treatment.

2.2 Auxin Treatment and Propagation of Stem Cuttings

The cuttings were then treated with different concentrations of IAA: 50, 100, 200, 500, 1000, and 2000 ppm. Two sets of cuttings were separately dipped in each IAA solution for 30 min and for 24 h, respectively. Subsequently, the cuttings were transferred into plastic cups filled with distilled water (200 mL) and then placed in a mini greenhouse constructed using a semi-circle metal frame wrapped with thick polyethylene sheet (Figure 1). The purpose of the mini-greenhouse is to maintain humidity conditions (Goh et. al., 1995). Non-treated controls were concurrently prepared. Water in each cup was renewed daily and the surrounding humidity was maintained under average 90% throughout study.



Fig.1 Mini greenhouse of approximately 90 cm in width, 30 cm in length, and 38 cm in maximum height.

3.0 RESULTS

Table 1 shows the survival rate of the stem cuttings with respect to different IAA concentrations and treatment time. The survival rates of stem cuttings treated with different concentrations of IAA exhibited no discernible trend with increasing concentrations of IAA. Conversely, there was a huge difference (mean $\pm$ S.D.: 47.8 ± 32.4) observed in the survival rates of the stem cuttings that were soaked in IAA for 30 min and for 24 h. The overall mean ($\pm$ S.D.) percentage survival rates of stem cuttings soaked in IAA for 30 min and for 24 h were $95.5 \pm 5.4\%$ and $47.7 \pm 28.9\%$, respectively. High concentrations and longer treatment time appeared to have a compounding effect on the survival rates; stem cuttings treated with 1000 and 2000 ppm IAA and soaked for 24 h had extremely low (7 to 20%) survival rates while treatment time of 30 min had no effects on the stem cuttings (100% survival rates).

Table 1 Percentage of survival of *Gymnostoma nobile* cuttings treated with indole-3-acetic acid after 35 days

IAA Concentrations (mg/L)	Survival rate (%)		
	30 min	24 h	Difference
50	87	53	34
100	93	80	13
200	100	53	47
500	93	73	20
1000	100	20	80
2000	100	7	93

Table 2 shows the percentage rates of callus formation in the stem cuttings of *G. nobile* after 35 days following treatment with IAA. Although a majority of the cuttings that were treated for 24 h had low rate of survival, they were the first to initiate rooting. Cuttings treated with

200 ppm and 1000 ppm for 24 h rooted at the 35th and 33rd day, respectively. Interestingly, the roots appeared on the stem walls instead of on the base of the cuttings. Meanwhile, no rooting was observed in stem cuttings that were treated for 30 minutes. When treated for 30 min, there was a general trend of increased callus formation with increasing IAA concentrations, except for cuttings treated in 500 ppm, which showed a decline. Despite the lack of IAA treatment, stem cuttings in the control group were seen to have callused although no rootings were observed. There was no sign of further rooting after 35 days of study.

Table 2 Percentage of callused and rooted *Gymnostoma nobile* cuttings treated with indole-3-acetic acid after 35 days

IAA concentrations (mg/L)	30 minutes		24 hours	
	Callused (%)	Rooted (%)	Callused (%)	Rooted (%)
Control	40	0	13	0
50	33	0	20	0
100	53	0	27	0
200	60	0	33	7
500	27	0	20	0
1000	80	0	0	7
2000	87	0	7	0

4.0 DISCUSSION

Gymnostoma nobile, like many other hardwood tree species, are considered difficult to root although successful vegetative propagation among congeneric species under the genus *Gymnostoma* had been documented in *G. papuanum* (Lundquist and Torrey, 1984). The present study showed that there was a distinct survival and rooting rates among *G. nobile* cuttings in response to different IAA concentrations and treatment time.

The results herein indicated that *G. nobile* cuttings had low chances of survival when dipped in relatively high concentrations of IAA; i.e., more than 1000 ppm for 24 hours. The survival rate decreased as concentrations of IAA increased from 1000 ppm to 2000 ppm. Higher concentrations of auxin were reported to stimulate the production of abscisic acid (ABA) that causes the closure of the stomata, which may lead to death of the plant (Grossmann, 2000).

4.1. Callus Formation

Callus tissue has been associated with the formation of adventitious root in difficult-to-root species (Davies et al., 1982; Hiller, 1951). The pathways leading to the formation of calluses and roots are mutually independent although they would often coincide as both rely upon similar internal and environmental stimuli (Hartmann et al., 1990). The

prediction of callus growth in *G. nobile* cuttings is indeed correct.

4.2. Response towards IAA Treatment

Successful root initiation was observed in stem cuttings treated with 200 and 1000 ppm IAA for 24 h (Table 2), which were observed to have grown on the stem walls. This was despite the extremely low incidence of rooting ability among the *G. nobile* cuttings in this study. The lack of root formation at the bases of the cuttings was most likely due to blackening of these parts. This might have happened as a result of the combination of relatively long soaking period and high concentrations of IAA. Moreover, the condition of the bases turning black would not only diminish the chances of rooting, but may also promote fungal growth (CREC, 2018).

There are several challenges that contribute to the low rooting ability of *G. nobile* cuttings in this study. Firstly, the rate of IAA uptake from basal cuttings might be lower due to the use of mature cuttings. Previous studies on woody plants showed that juvenile cuttings are more responsive to plant growth-regulator treatments than mature cuttings (Lundquist and Torrey, 1984; Torrey, 1983; Puri, 1990). In comparison to mature shoots, juvenile tissues are comprised of younger, less-differentiated, and actively dividing cells that tend to contain negligible, if any, rooting inhibitors (Hartmann et al., 1990; Paton et al., 1970). In addition, limiting the length of the stem cutting to between 7 to 8 cm and with the basal end re-cut at steeper angle may better promote the uptake of auxin (CREC, 2018). Secondly, IAA might be less effective in regulating rooting of *G. nobile* cuttings. Many studies have suggested that indole-3-butyric acid (IBA) and naphthaleneacetic acid (NAA) may possess better root-forming properties than IAA (Lundquist and Torrey, 1984; Puri, 1990; Zimmerman and Wilcoxon, 1935). This is due to IAA being sensitive to light and is readily inactivated compared to IBA and NAA, which are more light-stable (Hartmann et al., 1990). Future studies may test these hypotheses.

4.3 Efficiency of Simple Water Method

The advantage of simple water method in propagating *G. nobile* cuttings is that it requires only a few basic materials with a simple set-up in order to be operational. Since studies reporting vegetative propagation of this species are nonexistent, employing cost-effective experiments to optimize growing conditions for the species would be more practical. As humidity plays an important role in initiating root, the thick polyethylene wrap was used as the cover to help in maintaining a conducive ambience within the mini greenhouse.

Based on the experience in using the simple water method, several measures and pre-treatments of cuttings can be taken to improve root quality and survival rate. Fungal attack is common during the propagation period in water method. Thus, treating the cuttings using fungicides can minimize fungal infestation. Next, adding a quarter strength Hoagland's solution without nitrogen at pH 7 to the cuttings at regular intervals may ensure that the plants receive sufficient nutrients for normal growth. Additionally, the containers used to place the cuttings can be wrapped using aluminium foil to prevent photodegradation of the auxin.

5.0 CONCLUSION

In conclusion, various internal and external factors affected the ability of *G. nobile* to root. The simple water method using metal cover of thick polyethylene maintains a highly humid surrounding that is vital in plant propagation system. Apart from being categorized as a hard-to-root plant, this study showed that initiating root of *G. nobile* is possible with suitable vegetative material, type of auxin and treatment time. In future study, juvenile cuttings of *G. nobile* with appropriate auxin (IBA or NAA) treatment and favorable rooting condition (light intensity, nutrient, humidity and temperature) may depict a better rooting result.

6.0 ACKNOWLEDGEMENT

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INFORMATION PAPER 21: PROPAGATING *Litsea* X BY STEM CUTTINGS

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Abstract

Not much information exists on *Litsea* X except of the provided notes in the pdf presentation pax with the purchased seeds. *Litsea* X belongs to the Lauraceae family where there are over 100 species that grow naturally in the Indo-Malayan region, Indonesia and the Philippines. *Litsea* X was discovered in Java as having the highest potential for high yielding and good quality timber useful for making indoor paneling, window frames, plywood and veneer, furniture and ornaments. The study investigated the rooting ability of *Litsea* X, in attempt to mass produce planting materials of the species. First rooting was observed after the sixth week with only 21 rooted cuttings. A total of 221 cuttings had rooted with 79 cuttings recorded dead after four months of this study, displaying a rooting success of 73.7%. There were no significant differences ($P \geq 0.05$) in the number of roots and the length of the longest root produced in the different rooting media. Likewise, no significant differences were detected in the number of roots and the length of the longest root produced with or without the application of rooting hormone. However, there were high significances ($P \leq 0.05$) in the number of roots and the length of the longest root produced in the position of cuttings used, with the tip (top position) appeared to be the most responsive explant that produced more and healthier roots. *Litsea* X rooted well in both rooting media without any application of hormone.

Keywords: *Litsea* X, vegetative propagation, stem cuttings.

1.0 INTRODUCTION

Litsea X belongs to the Lauraceae family where there are over 100 species that grow naturally in the Indo-Malayan region, Indonesia and the Philippines. It was discovered by an Indonesian botanist in the forest of Java as having the highest potential for high yielding and good quality timber useful for making indoor paneling, window frames, plywood and veneer, furniture and ornaments. The closest relative in Malaysia is probably the Medang tree, however Medang has also many varieties that makes it difficult to properly identify *Litsea* X (Anonymous, 2017).

In the pdf document provided with the seeds purchased, *Litsea* X is described as a fast-growing tropical tree comparable with that of the *Acacia mangium* and *Neolamarckia cadamba* (Laran). It is a promising plantation species that based on the economic evaluation (Anonymous 2017); it has the ability to generate huge revenues for large-scale plantation and also to smallholders. As it is seen as an economically viable plantation species to be introduced in future forest plantation programmes, we decided to look at its propagation

aspect other than seed i.e. vegetative propagation using stem cuttings. The main purpose of this study was to investigate the rooting ability of the species.

2.0 MATERIALS & METHODS

The study was conducted at the FRC nursery propagation unit from December 2017 to April 2018. The source of cuttings was derived from 100 seedlings (Plate 1) at about one year old and measuring roughly around 40 to 84 cm in height. From each seedling, 3 segments of cutting measuring about 10 cm were taken that we labelled as Position 1 (or Tip), Position 2 and Position 3 (Plate 2).



Plate 1: Seedlings of *Litsea X* at the age of about 1 year old.

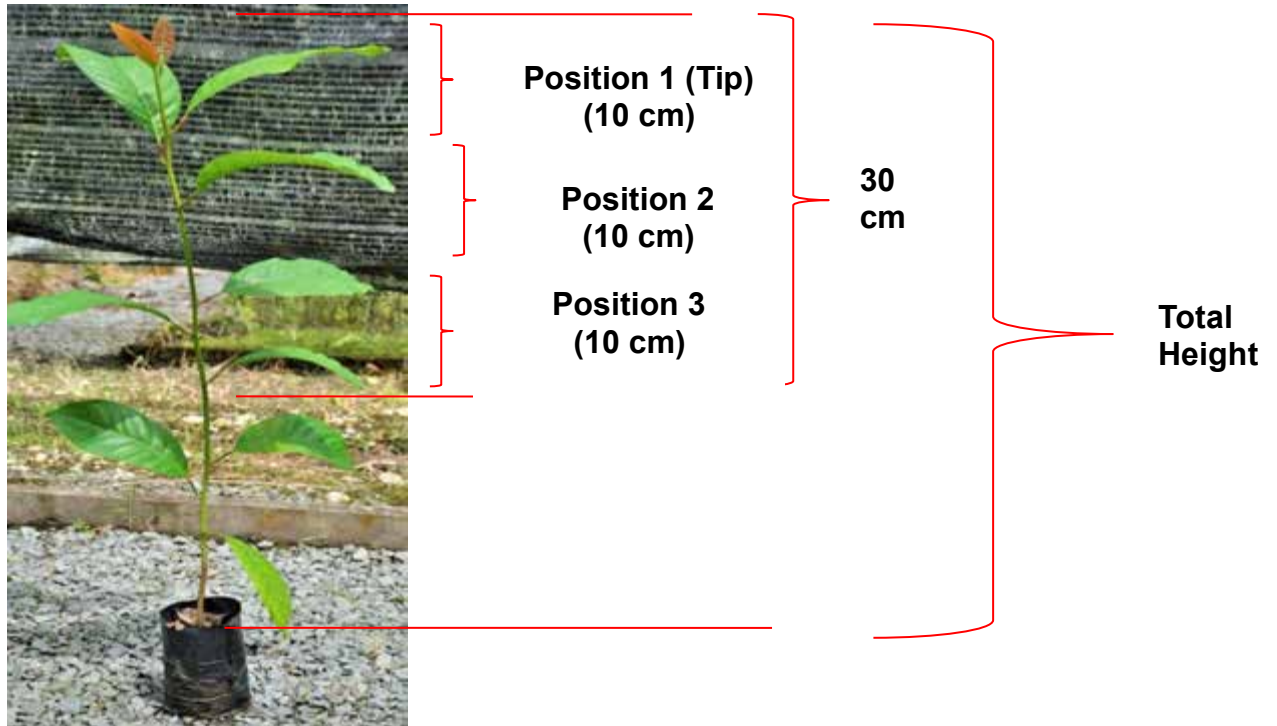


Plate 2: Cutting position derived from the seedling.

Preparation of cuttings followed the methodology established by Schdmit (1993), where cuttings were cut slanted at the base with the remaining leaf attached, trimmed to half of its size to minimise water loss through transpiration. Half of the cuttings were applied with Spectra, a commercial rooting hormone commonly used in woody plants while the other half of the batch was left untreated and labelled as control. These cuttings were then set onto the rooting media i.e. sieved river sand and peat moss (Plate 3).



Plate 3: Cuttings set onto the rooting media of peat moss and sieved river sand.

The relative humidity and temperature in the propagation unit fluctuated at a range from 62% to 92%, and 25°C to 32°C, respectively, providing a favourable environment for rooting development. The misting interval was set at 30 seconds of burst every 10 minutes. Data recorded were occurrence of rooting and the number and length of roots produced. Data analysis was carried out using SPSS ver. 24.

3.0 RESULTS & DISCUSSION

Rooting was first observed at the sixth week with only 21 rooted cuttings produced, whereby 15 were those without application of rooting hormone. This is a clear indication that rooting hormone did not help in root initiation. At four months on the completion of this study, a total of 221 cuttings had rooted with 79 cuttings recorded dead, indicating a rooting success of 73.7%.

A t-test analysis showed that there was no significant difference in the number of roots in sieved river sand ($M = 1.17$, $SD = 1.02$) and peat moss ($M = 1.30$, $SD = 1.18$); $t(298) = -1.05$, $P = 0.296$. Similarly, there was also no significant difference in the length of roots produced in sieved river sand ($M = 1.30$, $SD = 1.32$, $SD = 1.43$) and peat moss ($M = 1.53$, $SD = 1.79$); $t(298) = -1.12$, $P = 0.263$. The results showed that *Litsea X* could root in both rooting media.

There was also no significant difference in the number of roots produced with the application of rooting hormone ($M = 1.22$, $SD = 1.07$) and control ($M = 1.25$, $SD = 1.14$); $t(298) = -0.21$, $P = 0.835$. Likewise, no significant difference in the length of roots produced with the application of rooting hormone ($M = 1.28$, $SD = 1.54$) and control ($M = 1.56$, $SD = 1.69$); $t(298) = -1.46$, $P = 0.146$. While the rooting hormone (Spectra) clearly did not help in root initiation, it also did not give any effect to root development.

There were high significances ($P \leq 0.05$) in the number of roots and the length of the root produced in the position of cuttings used (Table 1). Figure 1 depicts the effect of cutting position to the number of roots and length of roots produced in *Litsea X*. Apparently, the tip/position 1 produced more and healthiest roots (Plate 4).



Position 1/Tip

Position 2

Position 3

Plate 4: Rooted cuttings of *Litsea X* on different positions from the stem.

Table 1: Analysis of variance for the number of roots and length of roots produced in different cutting positions.

Source of Variation		Sum of Squares	df	Mean Square	F	Sig.
Root number	Between Groups	22.527	2	11.263	9.806	.000
	Within Groups	341.140	297	1.149		
	Total	363.667	299			
Root length	Between Groups	33.402	2	16.701	6.613	.002
	Within Groups	750.129	297	2.526		
	Total	783.532	299			

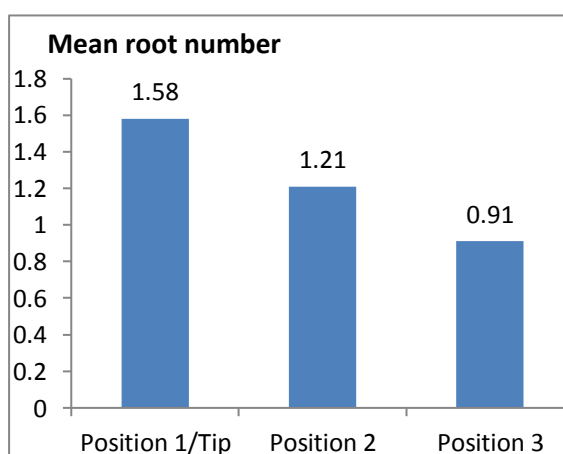
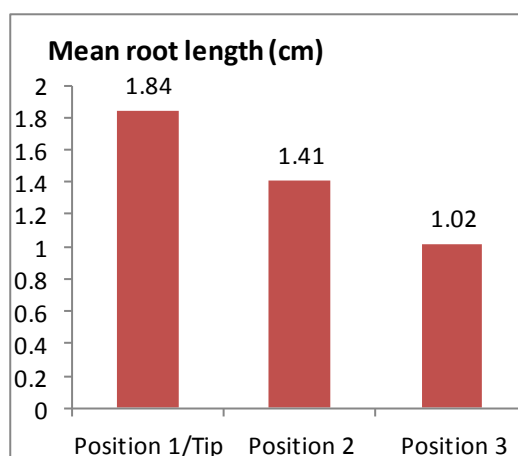


Fig. 1 Effect of cutting position on the mean root length and mean root number produced.

4.0 CONCLUSIONS

Based on the findings of this study, it shows that the rooting hormone (Spectra) does not help in the root initiation and developments; hence we conclude that no rooting hormone to be used in future vegetative propagation of this species. Both rooting media; sieved river sand and peat moss, provide excellent environment for *Litsea X* cuttings to root. We recommend the use of the tip (Position 1) as it is the most responsive explant that produces more and healthier roots.

It is so unfortunate that we do not know the true identity of *Litsea X* to actually find out whether similar study has been done on the species elsewhere or not. Nonetheless, with what little information provided with the seeds purchased, we are certain that the species has a huge potential to be introduced in forest plantation activities in Sabah.

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**INFORMATION PAPER 22: TREE VOLUME TABLE FOR
Eucalyptus pellita PLANTED AT KOLAPIS B RESEARCH STATION,
SABAH FORESTRY DEPARTMENT**

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Abstract

The sampled trees were taken from a provenance trial plot of *Eucalyptus pellita* in Kolapis B Research Station. All the trees were approximately 19-years-old and planted at 4 m x 3 m spacing. Several commonly used tree volume equations were fitted by the method of least squares to the total volume data. Furnival's index was used as the criterion for selecting the best fit regression. The most suitable tree volume equation is:

$$V = 6.324 D^{2.873} H^{0.382}$$

Where V is the underbark volume (m³), D is the diameter at breast height (m) and H is the total height (m).

This paper presents the volume and form factor tables derived from the best fit equation.

Keywords: form factor, furnival index, *Eucalyptus pellita*, volume equation.

1.0 INTRODUCTION

Eucalyptus pellita (family: Myrtaceae) also known as large-fruited red mahogany, is a medium-sized to large tree, up to 40 meters tall in height and 1 m in diameter at breast height. At its best, it has a straight trunk to about a half of the tree height. It is native to Australia and Papua New Guinea, and is been planted as an exotic species in many countries such as Brazil, Congo, Fiji, India, Indonesia, Kenya, South Africa and Uruguay. It can grow on gentle to moderate slopes, and can also be found on steep, well-drained slopes of large ridges. It is best grown in tropical lowland regions with uniform rainfall (Orwa et al., 2009).

Presently, *E. pellita* is becoming an important plantation tree species in Sabah due to its special attributes, such as fast growth, good coppicing ability, adaptability to a wider range of environment, good resistance to pests and diseases and suitability for a variety of timber products.

Sabah Forestry Department established the earliest plantation trial of *E. pellita* at Kolapis B Research Station, Lungmanis Forest Reserve, in May 1996. The site is located on moderate hills with an altitude reaching 75 m and slopes are between 10 to 20 degrees. The type of soils is mainly Kretam and Lungmanis Association, with small areas of Rumidi, Kalabakan and Lokan Association.

Volume table is a chart in the estimation of standing timber volume. These tables are based on mathematical equation chosen through regression analysis, providing information on wood contents of standing trees of various sizes. In this study, attempts are made to construct a local volume table and form factor table of *E. pellita* based on available data from the *E. pellita* plantation in Lungmanis Forest Reserve.

2.0 MATERIALS AND METHODS

2.1 Measurement of Sample Tree

The measurement of *E. pellita* plantation trial plot at Kolapis B Research Station was conducted in 2015, where the trees were at the age of 19 years old. Nine trees were selected randomly. Before felling, the diameter at breast height (DBH) at 1.3 m above the ground was measured. After felling, the diameter under bark (ub) of the felled trees were measured every one meter intervals starting from the based of the felled trees until top diameter of 7 cm. Height of stump and total height were also recorded.

2.2 Volume Calculation

The volume of each tree section is calculated by Smalian's formula:

$$V = [(A_1 + A_2)/2]L$$

where V = Volume underbark (ub),

A₁ = Cross-sectional area (ub) at the bigger end,

A₂ = Cross-sectional area (ub) at the smaller end,

L = Length of the log section.

The total volume of each tree is the sum of volume of the log section i.e., from the stump height up to the 7 cm diameter.

2.3 Fitting of the Volume Regression

Although many models of volume table construction are available (Chapman & Meyer 1949, Hummel 1955), the method of least squares is generally an accepted procedure. The popularity of the method is primarily due to its objectivity, the provision for the test of significance and the defining of confidence limits.

However, Wright (1964) and Cunia (1964) have discussed the need to weight volume equations in most circumstances in order to equalise or to induce homogeneity of variance in volume along the regression line, this being the pre-requisite before valid test of significance can be applied to the regression equation.

In this study, thirteen of the most commonly used regression models were tested. They are:

Non-transformation equations:

(1) $V = a + bD$

- (2) $V = a + b_1D + b_2H$
 (3) $V = a + bD^2H$
 (4) $V = a + b_1D^2 + b_2D^2H$
 (5) $V = a + b_1D^2 + b_2H + b_3D^2H$
 (6) $V = a + b_1D^2H + b_2(D^2H)^2$

Transformation equations:

- (7) $\text{Log}_{10}V = a + b_1 \log_{10}D + b_2 \log_{10}H$
 (8) $V/D^2 = a + b/D^2$
 (9) $V/D^2 = a + b_1/D^2 + b_2/D$
 (10) $V/D^2 = a + b_1/D^2 + b_2H/D + b_3H$
 (11) $V/D^2H = a + b/D^2H$
 (12) $V/D^2H = a + b_1/D^2H + b_2/H + b_3/D$
 (13) $V/(D^2H)^2 = a + b_1/D^2H + b_2/(D^2H)^2$

where V = volume (m^3);

D = diameter at breast height (m);

H = total height (m); and

a, b, b_1 and b_2 are constant.

The regression may be biased by a transformation of dependent variable (Alder 1980). Thus, Furnival Index (F.I.) is used for comparison of regressions for goodness of fit when several transformations of the dependent variable are involved (Furnival 1961).

The expression of Furnival's index is given as follows:

$$\text{F.I.} = S \cdot \text{anti log} [(\sum \log f'(y)^{-1}) / n]$$

where S = residual standard deviation from the fitted regression;

n = number of data;

$f'(y)^{-1}$ = reciprocal of the derivative of the transformation applied to the dependent variable.

More appropriate forms for the most common transformations are given below:

<u>Transformation</u>	<u>$f'(y)^{-1}$</u>
None	1
$\log_{10}y$	$2.3026 y$
y/w	w

In the above, y is the original dependent variable, w is any weight used in fitting the y to normalise residuals.

3.0 RESULTS AND DISCUSSION

3.1 Volume Equations

Thirteen volume equations were derived using statistical package on computer, as shown in Table 1.

Table 1: Non-transformation and transformation volume equations for *Eucalyptus pellita*.

Non- Transformation equations:			Furnival Index
(1)	$V = -1.541 + 7.623D$		0.10314
(2)	$V = 1.367 + 4.814D + 0.023H$		0.09346
(3)	$V = -0.011 + 0.2284D^2H$		0.08033
(4)	$V = -0.012 + 0.023D^2 + 0.283D^2H$		0.08677
(5)	$V = 1.728 - 18.372D^2 - 0.068H + 0.986D^2H$		0.08528
(6)	$V = 0.283 + 0.029D^2H + 0.050(D^2H)^2$		0.08207
Transformation equations:			
(7)	$\text{Log}_{10}V = 0.801 + 2.873\text{Log}_{10}D + 0.382\text{Log}_{10}H$		0.07992
(8)	$V/D^2 = 12.933 - 0.429/D^2$		0.08054
(9)	$V/D^2 = 31.165 + 1.056/D^2 - 10.451/D$		0.09094
(10)	$V/D^2 = -5.739 + 0.844/D^2 - 0.285H/D + 1.095H$		0.08407
(11)	$V/D^2H = 0.268 + 0.022/D^2H$		0.08806
(12)	$V/D^2H = 1.242 + 1/D^2H - 5.166/H - 0.354/D$		0.08336
(13)	$V/(D^2H)^2 = 0.062 - 0.029/D^2H + 0.346/(D^2H)^2$		0.11603

where V = volume (m^3);

D = diameter at breast height (m); and

H = total height (m).

The effect of data transformations upon the basic assumptions of linear regression involves three important points (Alder 1980):

- Regressions in which the same dependent variable has been subject to different transformations cannot be compared directly for goodness of fit using the

correlation coefficient R (R^2);

- ii. The distribution of the residuals will be influenced by any transformation of the dependent variable; and
- iii. The regression may be biased by a transformation of the dependent variable.

For comparison of regressions for goodness of fit when several transformations of the dependent variable are involved, the Furnival Indexes (F.I.) must be used (Furnival 1961). The calculated value of F.I. for all the thirteen equations are also presented in Table 1. The equation with the smallest Furnival Index indicates the best regression.

In this study, the most suitable model was found to be equation (7):

$$\text{Log}_{10}V = 0.801 + 2.873 \text{Log}_{10}D + 0.382 \text{log}_{10}H \quad (\text{with F.I.} = 0.07992).$$

Simplifying the equation by using antilogarithm produces the final volume equation:

$$V = 6.324 D^{2.873} H^{0.382}$$

3.2 Volume Table

A volume table based on the best regression model is presented in Table 2. It shows the volume underbark in cubic meter (m^3) for corresponding the total height in meter (m) and diameter at breast height in meter (m). Stump volume and the cone volume with basal diameter equal to 7 cm were excluded from the calculation of tree volume.

Table 2: Volume table of *Eucalyptus pellita* (figures enclosed within lines indicates the range of data collected).

DBH (m)	Height (m)							
	21	22	23	24	25	26	27	28
0.24	0.3353	0.3413	0.3472	0.3528	0.3584	0.3638	0.3691	0.3742
0.25	0.3770	0.3838	0.3903	0.3967	0.4030	0.4091	0.4150	0.4208
0.26	0.4220	0.4296	0.4369	0.4441	0.4510	0.4579	0.4645	0.4710
0.27	0.4703	0.4787	0.4869	0.4949	0.5027	0.5103	0.5177	0.5249
0.28	0.5221	0.5315	0.5406	0.5494	0.5581	0.5665	0.5747	0.5828
0.29	0.5775	0.5879	0.5979	0.6077	0.6173	0.6266	0.6357	0.6446
0.30	0.6366	0.6480	0.6591	0.6699	0.6804	0.6907	0.7007	0.7105
0.31	0.6995	0.7120	0.7242	0.7361	0.7476	0.7589	0.7699	0.7807
0.32	0.7663	0.7800	0.7934	0.8064	0.8190	0.8314	0.8435	0.8553
0.33	0.8371	0.8521	0.8667	0.8809	0.8947	0.9082	0.9214	0.9343
0.34	0.9120	0.9284	0.9443	0.9598	0.9749	0.9896	1.0039	1.0180

Table 2: (continued)

DBH (m)	Height (m)							
	29	30	31	32	33	34	35	36
0.24	0.3793	0.3842	0.3891	0.3938	0.3985	0.4031	0.4075	0.4120
0.25	0.4265	0.4320	0.4375	0.4428	0.4481	0.4532	0.4583	0.4632
0.26	0.4774	0.4836	0.4897	0.4957	0.5015	0.5073	0.5129	0.5185
0.27	0.5320	0.5390	0.5458	0.5524	0.5589	0.5654	0.5717	0.5778
0.28	0.5906	0.5983	0.6059	0.6133	0.6205	0.6276	0.6346	0.6415
0.29	0.6533	0.6618	0.6701	0.6783	0.6863	0.6942	0.7019	0.7095
0.30	0.7201	0.7295	0.7387	0.7477	0.7565	0.7652	0.7737	0.7821
0.31	0.7912	0.8016	0.8117	0.8216	0.8313	0.8408	0.8502	0.8594
0.32	0.8668	0.8781	0.8892	0.9000	0.9107	0.9211	0.9314	0.9414
0.33	0.9469	0.9593	0.9714	0.9832	0.9948	1.0063	1.0175	1.0285
0.34	1.0317	1.0452	1.0584	1.0713	1.0839	1.0964	1.1086	1.1206

3.3 Form Factor

Every volume defined in a tree has a corresponding form factor. The volume is presented with a form factor as follows:

$$V = f.g.h$$

where V = volume;

f = form factor;

g = cross-sectional area; and

h = height.

The form factor varies according to the point chosen for the measurement of cross-sectional area. For practical purposes, the basal area at DBH is normally used. From the volume table given with this basal area, the corresponding form factor table was constructed. The estimated form factor table is shown in Table 3, for corresponding diameters and heights.

Table 3: Form factor of *Eucalyptus pellita* (figures enclosed within lines indicates the range of data collected)

DBH (m)	Height (m)							
	21	22	23	24	25	26	27	28
0.24	0.3531	0.3431	0.3338	0.3251	0.3170	0.3095	0.3023	0.2956
0.25	0.3659	0.3556	0.3459	0.3369	0.3285	0.3207	0.3133	0.3063
0.26	0.3787	0.3679	0.3580	0.3487	0.3400	0.3318	0.3242	0.3170
0.27	0.3914	0.3803	0.3700	0.3604	0.3514	0.3430	0.3351	0.3276
0.28	0.4040	0.3925	0.3819	0.3720	0.3627	0.3540	0.3459	0.3382
0.29	0.4165	0.4047	0.3938	0.3836	0.3740	0.3650	0.3566	0.3487

0.30	0.4291	0.4169	0.4056	0.3951	0.3852	0.3760	0.3673	0.3592
0.31	0.4415	0.4290	0.4174	0.4065	0.3964	0.3869	0.3780	0.3696
0.32	0.4539	0.4411	0.4291	0.4180	0.4076	0.3978	0.3886	0.3800
0.33	0.4663	0.4531	0.4408	0.4294	0.4187	0.4086	0.3992	0.3903
0.34	0.4786	0.4650	0.4524	0.4407	0.4297	0.4194	0.4098	0.4006

Table 3: (continued)

DBH (m)	Height (m)							
	29	30	31	32	33	34	35	36
0.24	0.2893	0.2833	0.2776	0.2722	0.2671	0.2622	0.2575	0.2531
0.25	0.2998	0.2935	0.2876	0.2821	0.2767	0.2717	0.2669	0.2623
0.26	0.3102	0.3038	0.2977	0.2919	0.2864	0.2812	0.2762	0.2714
0.27	0.3206	0.3139	0.3076	0.3017	0.2960	0.2906	0.2854	0.2805
0.28	0.3309	0.3241	0.3176	0.3114	0.3055	0.2999	0.2946	0.2895
0.29	0.3412	0.3341	0.3274	0.3211	0.3150	0.3093	0.3038	0.2985
0.30	0.3515	0.3442	0.3373	0.3307	0.3245	0.3186	0.3129	0.3075
0.31	0.3617	0.3542	0.3471	0.3403	0.3339	0.3278	0.3220	0.3164
0.32	0.3718	0.3641	0.3568	0.3499	0.3433	0.3370	0.3310	0.3253
0.33	0.3820	0.3740	0.3665	0.3594	0.3526	0.3462	0.3401	0.3342
0.34	0.3920	0.3839	0.3762	0.3689	0.3620	0.3553	0.3490	0.3430

The volume and form factor tables are applicable generally to areas under site conditions and age classes similar to those of the sample plot for the estimation of volume of standing timber and the determination of volume increment.

4.0 CONCLUSIONS

The most suitable model is equation (7) with F.I. = 0.07992. Simplifying the equation by using antilogarithm produces the final volume equation:

$$V = 6.324 D^{2.873} H^{0.382}$$

Form factor varies between 0.3310 and 0.3531, depending on the diameter (DBH) and height of individual tree. Although there is no guarantee that the same form-relation exist in other plots in Sabah, these volume and form factor tables will probably be useful tool for estimating standing volume of individual tree of *E. pellita*, even outside the area where the basic data were collected.

Improvement of the tables will require a lot of time and effort in the future, but it is necessary. Selection and measurement of sample trees should cover various localities and a wider range of diameter, height and age classes. Data should be collected, whenever possible, stored and documented properly from time to time, for revising the volume tables.

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**INFORMATION PAPER 23: HOW MUCH WE GET IN TERMS OF
CARBON STOCK? CASE STUDY OF REDUCED IMPACT LOGGING
IN DERAMAKOT FOREST RESERVE, SABAH**

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Abstract

A study on the impact of reduced impact logging (RIL) on biomass and carbon stocks was conducted in Deramakot Forest Reserve (FR), Sabah. The biomass and carbon stocks were further compared with conventional logging (CL) that was conducted in Tangkulap FR. Sixteen circular plots of 20 m radius (0.1256 ha plot⁻¹) were established in each forest reserve. A total combined 2,012 trees with ≥ 10 cm diameter at breast height (DBH) have been enumerated in all sampling plots. Results of this study show that, total tree biomass in Deramakot FR was estimated at 574.65 t ha⁻¹ and in Tangkulap FR at 465.68 t ha⁻¹ with total carbon of 287.32 and 232.84 t ha⁻¹ respectively. The total biomasses, as well as the carbon stocks were greater in Deramakot FR by almost 23% as compared to Tangkulap FR. It shows an import contribution of RIL in climate change mitigation. Extrapolating for the entire area of Deramakot FR, RIL brought a net addition of about 3.0 million tonnes of carbon with estimated values hypothetically at USD63.31 million whereas the value of carbon loss due to CL for the whole area of Tangkulap FR would be about USD22 million. As a conclusion, it is established that RIL is needed as an essential tool in forest management not only to achieve optimum biodiversity and conservation values, but also for climate change mitigation via stocking of higher biomass and carbon stocks in the forest. The strategy and policy instruments to address certain drivers (or threats) of deforestation and forest degradation, as well as, to capitalize of carbon as payment for ecosystem services (PES) benefits through innovative financing are being strengthened and explored to maximize their full range of economic and non-market contributions to support conservation programs in the state.

Keywords: SFM, harvesting method, biomass, climate change mitigation, RIL

1.0 INTRODUCTION

This study attempts to describe the status of biomass and carbon stocks of tree communities of the lowland dipterocarp forests in two production forests of Deramakot FR and Tangkulap FR in Sabah. The forest reserves representing two different harvesting methods; RIL in the Deramakot FR and conventional logging (CL) in Tangkulap FR. Findings of this study will be used to determine impact of the harvesting technique on biomass and carbon stock to be further related on role of forests on climate change mitigation.

2.0 MATERIALS AND METHODS

The Deramakot FR and Tangkulap FR forest reserves form a contiguous stretch covering areas of 55 083 ha and 27 550 ha respectively as shown in **Figure 1** (SFD 2005). Both

reserves have been established since the 1960s and were re-gazetted as production forest reserves in 1984. These areas were arbitrarily chosen to reflect two harvesting methods being used for extraction of timbers, i.e. RIL in Deramakot FR and CL in Tangkulap FR. Deramakot and Tangkulap FRs.

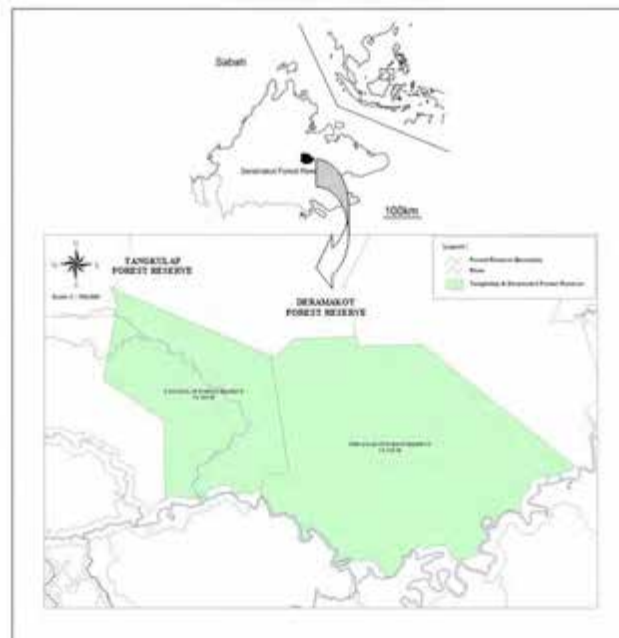


Fig. 1 Locations of Deramakot and TangkulapFRs in Sabah

In this study, four circular plots measuring 20 m radius each (0.1256 ha per plot) were established systematically which consist of 16 plots for every forest reserve. All trees in the study plots with diameter at breast height (dbh) of ≥ 10 cm were tagged with plastic labels, measured and identified. Estimations of above-ground biomass were carried out using all the data sets, by means of the regression equation of Kato et al. (1978). The estimation of below-ground biomass or roots biomass (kg) is calculated using dbh (cm) measurement by means of the regression equation of Niiyama et al. (2009). The total biomass for trees is the total sum of the total above-ground biomass and below-ground biomass. Meanwhile, carbon content in biomass is derived using a conversion factor. As the conversion factor may vary according to plant part, species and site, the global default conversion factor of 50% as recommended by the IPCC is adopted for this study (Brown 1997).

3.0 RESULTS AND DISCUSSION

In this paper, the authors are focusing results on parameters of tree volume biomass and carbon in both forest reserves as follows:

3.1 Tree Biomass

The biomass values of trees with ≥ 10 cm dbh in all plots at Deramakot FR and Tangkulap FR are shown in **Table 1**. The results indicated that Deramakot FR had higher tree biomass by almost 23% or 108.97 t ha^{-1} than Tangkulap FR.

Table 1. Tree biomass and estimated carbon content values (t ha⁻¹) in Deramakot FR and Tangkulap FR (figures in brackets are the percentages of the total)

Diameter Class (cm)	Deramakot Forest Reserve				Tangkulap Forest Reserve			
	AGB (t ha ⁻¹)	BGB (t ha ⁻¹)	Total Biomass (t ha ⁻¹)	Carbon (t ha ⁻¹)	AGB (t ha ⁻¹)	BGB (t ha ⁻¹)	Total Biomass (t ha ⁻¹)	Carbon (t ha ⁻¹)
10.0 – 19.9	39.31	6.63	45.93	22.97	35.62	6.00	41.61	20.81
20.0 – 29.9	48.29	8.00	56.29	28.15	41.97	6.95	48.92	24.46
30.0 – 39.9	53.70	9.10	62.80	31.40	36.53	6.18	42.71	21.35
40.0 – 49.9	65.35	11.44	76.78	38.39	38.03	6.66	44.69	22.35
50.0 – 59.9	58.29	10.60	68.89	34.45	40.72	7.42	48.13	24.07
≥ 60	219.07	44.87	263.95	131.97	198.05	41.56	239.61	119.81
Total	484.01	90.64	574.65	287.32	390.92	74.76	465.68	232.84

AGB: Above-ground biomass, BGB: Below-ground biomass

3.2 Carbon Stock

As for the carbon (C), the estimated carbon contents in the study areas ranged from 20.81 to 287.32 t ha⁻¹, followed the same proportional pattern as total tree biomass. Total carbon stock for the entire area of Deramakot FR (55 083 ha) and Tangkulap FR (27 550 ha) were 15.83 and 6.41 million tonnes or 287.32 and 232.84 t C ha⁻¹ respectively with approximately 19% occurring belowground. Other findings of carbon stocks related studies on various forest types in Malaysia also showed variable results which is summarized in **Table 2**.

Generally, the total carbon stock in this study area (i.e. Deramakot FR) of logged-over forest was comparable with or even higher than those of several sites of various forest types except for Semangkok and Bukit Lagong FRs (Abd Rahman & Philip 2009). Therefore, it indicates that the residual stands in the RIL area of Deramakot FR are capable to retain a substantial amount of carbon stock after harvesting relative to mature secondary and undisturbed primary forests.

Table 2. Above-ground and below-ground carbon stock values in different forest types of Malaysia

Forest type	Carbon stock (t ha ⁻¹)		
	Above-ground	Below-ground	Total
HF-Semangkok FR	282.0	67.90	349.92
HF- Bukit Lagong FR	281.1	68.30	349.42
LF-SungeiMenyala FR	177.2	35.70	212.86
LF- Pasoh FR	157.1	31.1	188.22
PSF-Pekan FR	171.3	34.40	205.74

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MSF-Matang FR	203.70	76.06	279.76
LF- Deramakot FR*	242.01	45.32	287.32
LF- Tangkulap FR*	195.46	37.38	232.84

HF: Hill forest, LF: Lowland forest; PSF: Peat-swamp forest; MSF: Mangrove-swamp forest.

(*): Denotes the results from present study

Source: Adapted from Abd Rahman & Philip (2009)

The study shows that the regenerated forest areas under RIL (Deramakot FR) had greater carbon stock by 54.48 t ha⁻¹ or 23.40% more carbon than area of CL (Tangkulap FR). Extrapolating for the entire area, RIL brought a net addition of about 3.0 million tonnes of carbon for 55 083 ha. Comparatively, it can be concluded that Deramakot FR had a relatively higher amount of total tree biomass corresponding to its higher carbon stock than Tangkulap FR, due to its greater number of stems and larger dbh trees. This probably demonstrates that by improving harvesting practices, such as via RIL, fewer trees are killed or damaged during logging thereby creating healthier residual stands and, consequently, more carbon remains in the forest in living trees.

Based on reviews of forest carbon market prices and voluntary carbon market, Campbell et al. (2008) had suggested that the value of forest carbon is likely to range from USD1–15. At USD4 t⁻¹, the total carbon stocks in Deramakot and Tangkulap FRs would be around USD63.31 and 25.66 million respectively. On the other hand, to convert carbon loss (due to the conventional logging practice against RIL) to financial values, the difference of carbon value (54.48 t ha⁻¹) are multiplied by the default conversion factor of 3.66 to obtain tCO₂e (IPCC 2007). The CO₂ equivalent tonnes are then multiplied by carbon price (USD4 tCO₂e⁻¹) to provide an estimate of the total financial value of carbon emissions, thus, hypothetically, the value of carbon loss due to conventional logging would be about USD22 million for the whole area of Tangkulap FR.

4.0 CONCLUSION

The study has succeeded to determine the status of biomass and carbon stocks of tree communities of two regenerated lowland dipterocarp forests of Deramakot and Tangkulap FRs. Perhaps the main significance of this study is that it shows, a well-managed harvesting practice could reduce damage to the residual stands and capable in maintaining a level of richness and composition of forest tree communities comparable to mature secondary or undisturbed forests. Secondly, it could substantially reduce carbon loss from forest degradation due to logging. A good and healthier forest would certainly provide a range of environmental benefits and ecosystem services. Besides that, the information from this study can serve as reference to the potential productivity of a different forest type in Malaysia.

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**INFORMATION PAPER 24: ANIMAL MAGNETISM: VISITOR
TRENDS AND PROFILE FOR FOUR NATURE-BASED ATTRACTIONS
IN SANDAKAN**

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Abstract

The tourism industry uses the tagline Sabah's Gateway to Nature to promote Sandakan. The four nature-based attractions within a short drive from Sandakan Town are the Sepilok Orang Utan Rehabilitation Centre (SOURC), the Bornean Sun Bear Conservation Centre (BSBCC), the Rainforest Discovery Centre (RDC), and the Labuk Bay Proboscis Monkey Sanctuary (LBPMS). Over the last 10 years, visitor numbers have been increasing steadily for all these places, with the SOURC receiving the highest visitor numbers. Due to the significance of nature tourism as one of the major income earner for Sabah, a study was carried out to assess visitor trends and profile visiting four main nature attractions in Sandakan. Visitor data from the sites were collected and additional data was collected from tourists respondents through questionnaires. A total of 461 respondents were obtained during the survey. In 2017, SOURC received 123,387 visitors, followed by the BSBCC (72,673), the RDC (34,340), and the LBPMS (28,576). Direct revenue collected by 3 sites was estimated at RM 5.2 million, largely derived from entry fees. It is also estimated that tourism contributed not less than RM 126.4 million into Sandakan's economy in that year. The SOURC was visited by 91.3 % of respondents, followed by 81.4 % for the BSBCC. About 49 % of respondents visited the SOURC, BSBCC and the Lower Kinabatangan. A popular opinion that RDC was omitted in tour packages to favour the Kinabatangan was proven to be untrue.

Keywords: Sandakan, Sepilok, Kinabatangan, visitor trends, tourism, SOURC, BSBCC, RDC, Labuk Bay.

1.0 INTRODUCTION

Sandakan is the second largest town in Sabah, East Malaysia, on the north-eastern coast of Borneo. It was the bustling centre of the timber industry from the 1960s to the mid-1980s. With the Sabah State Government's thrust for sustainable forest management beginning in 1989 (Sabah Forestry Department Annual Report, 1989), the timber industry's grip on Sandakan's economy was gradually weakened by the growing interest in palm oil. In the 1990s, the palm oil industry grew at a brisk rate in the east coast, centred around towns like Sandakan, Lahad Datu and Tawau. It is currently the largest industry in the east coast.

The tourism industry has also benefitted from the decline of the timber industry and the rise of the palm oil industry. Firstly, in the early 1990s, timber-based or related companies realising the looming decreased long-term opportunities in the industry—diversified or ventured into the tourism sector, providing the much-needed injection of funds for the development of basic tourism infrastructure in the region. Secondly, with the growing palm oil industry came land clearing of logged-over or secondary forests, and for ecologically sensitive forests like peat

swamps, riverine forests and freshwater swamp forests. From 1990 to 2003, land planted with oil palm increase by about 311 % to 1.135 mil ha. To reduce or halt the spread of oil palm plantations, many environmental NGOs advocated nature tourism in ecologically important forests. Thus, the tourism industry developed concurrently with the palm oil industry. In 1995, Sabah received about 0.5 mil visitors. In 2002, the number of arrivals doubled to 1.1 mil. By 2017, it reached 3.7 mil with RM7.82 bil in tourism receipts (Sabah Tourism Board Statistics).

With the well-known Sepilok Orang Utan Rehabilitation Centre (SOURC) as its main attraction, Sandakan served as a gateway to nature tourism in Sabah's east coast. In May 2004, Sandakan was declared a Nature City. The remarkable wildlife (*e.g.* Bornean pygmy elephants, proboscis monkeys, birds, *etc.*) of the floodplains of the lower Sg. Kinabatangan provided the definitive land-based nature experience. Riverside lodges near villages, such as Kg. Sukau, Kg. Bilit, Kg. Batu Putih and Kg. Abai, soon became well-known destinations in wildlife and nature tour packages. The Turtle Islands (and, later, Langkayan Island) were also tourists magnets for marine-based tours based in Sandakan.

The growing tourism industry in Sandakan also saw increased number of service providers for accommodation and transportation. Historical sites and buildings, previously only known and appreciated by locals, were refurbished to complement its natural attractions. Examples include the Sandakan Memorial Park, Agnes Keith House, St. Michael's and All Angels Church, English Tea House, Pu Ji Shih Temple and the Bao Gong Temple.

2.0 OBJECTIVES OF STUDY

In May-July 2018, the RDC conducted a survey to study visitor trends in Sandakan, focussing on the 4 major nature-based attractions within and near Sepilok. Being a major nature-based tourist destination, there are numerous tour operators offering tour packages in Sandakan with diverse activities (*e.g.* diving, trekking, bird-watching, sight-seeing, wildlife safari, boat cruise, *etc.*) with equally diverse levels of accommodations (*e.g.* 5-star hotels, budget hotels, backpackers, homestays, glamping, *etc.*). Sea-bound tours include the Turtle Island and Lankayan Island tours while land-bound tours commonly start with the SOURC and head towards the Lower Kinabatangan floodplain. Almost all tour packages include the SOURC and the adjacent BSBCC in the itinerary. There are also an increasing number of Free Individual Travellers (FITs) coming to Sandakan, mostly travelling by bus from KK, preferring the cheaper mode of transport as opposed to air travel, the main choice for packaged tourists.

However, very little is known about visitor trends in Sandakan, especially relating to the four nature attractions in Sandakan. There is an apparent lack of research in this field. Current knowledge on visitor trends are based primarily on individual experiences and perceptions of those involved in the tourism sector, such as local tour operators, guides, taxi drivers and hoteliers. For example, the common explanation for the lack of tour packages that include the RDC is that the packages were designed to skip RDC after SOURC and BSBCC, so that tourists will be able to go on boat cruises at 4 pm along the Kinabatangan River, thus minimising total package-days and costs. However, there was no way to confirm this assumption. It is further hoped that the understanding of the dynamics of the local tourism sector can be improved and be used to inform future development and planning works at the four sites.

3.0 SITE PROFILES

3.1 Sepilok Orang Utan Rehabilitation Centre

Established in 1964, the SOURC opened its doors to visitors in 1974. Visitation rates were low then and consisted of mainly local visitors. The completion of the Malaysian-Australian Road Project (MARP) in 1972, which linked Kota Kinabalu to Sandakan (now known as Federal Route 22), contributed to the accessibility of Sandakan to visitors from the west coast of Sabah, albeit only when the KK-Sandakan bus routes were active in the early 1990s. By the mid-1990s, SOURC had commendable visitor facilities and was considered the most popular visitor site in Sandakan.

However, its earlier developments did not anticipate the rising annual visitation rates. From the mid-1990s, there was about a 10-year period of stagnation of its development. Beginning 2009, after numerous complaints from tour operators and the public, the SOURC made significant improvements to its visitor-centred services and facilities, while maintaining its core objective of rehabilitating orphaned orangutans. Located just 13 km from the Sandakan Airport, it currently remains the most visited tourist destination in Sandakan. It is managed by the Sabah Wildlife Department.

3.2 Rainforest Discovery Centre

Having been around for more than five decades, the word ‘Sepilok’ is synonymous with the SOURC. However, since the early 2000s, two other nature-based attractions have been increasingly associated with Sepilok. Situated about 2 km away is the Rainforest Discovery Centre, primarily an environmental education (EE) centre established by the Sabah Forestry Department in 1996. In 2000, with supporting the local tourism industry in mind, development began in earnest to provide better services to local school groups and walk-in visitors. In August 2007, RDC was officially launched and opened to visitors, with the aim to increase awareness on forest conservation in Sabah. Its major attractions include the sturdily built Canopy Walkway, currently at 347 m long, and a network of well-maintained and well-designed forest trails. Over the years, the RDC has become a go-to site for bird watchers to get a glimpse of the rare Bornean Bristlehead and the 12 other Bornean endemic birds.

3.3 Bornean Sun Bear Conservation Centre

The newest attraction in Sepilok is the Borneo Sun Bear Conservation Centre (BSBCC). It is suitably located within the grounds of the SOURC. Opened in 2014, the centre is managed by an NGO that aims to educate visitors about the sun bear—the smallest bear in the world and it is only found in Southeast Asia. BSBCC also rescues captive sun bears and rehabilitates them using methods that mimics the natural conditions whereby bears search for food. A viewing platform and raised walkways makes it easy for visitors to observe sun bears in their large natural forest enclosures. Its location close to the SOURC makes it very popular for visitors, as they are able to view two iconic Bornean species in the same area and in a short span of time.

3.4 Labuk Bay Proboscis Monkey Sanctuary

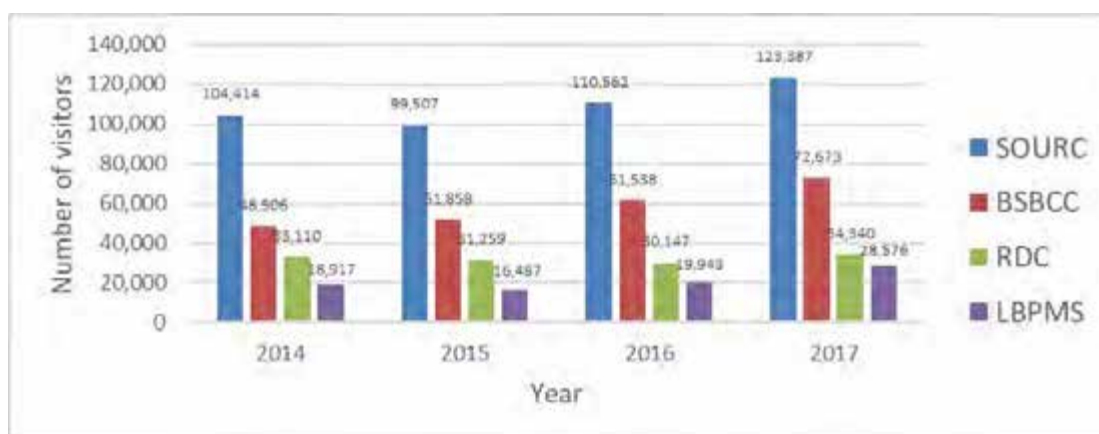
Located only about 15 km from Sepilok, the Labuk Bay Proboscis Monkey Sanctuary (LBPMS) is a privately owned centre that offers visitors close-up views of the proboscis monkey, a Bornean endemic. Visitors can view these amazing animals from two

viewing platforms during designated feeding times. Added attractions include the Sabah grey langurs and habituated Oriental Pied Hornbills. The management also provides accommodation, some of which are built in the mangrove. Due to its proximity to the Sandakan Airport (38 km) and its nearby townships, LBPMS is perfect for visitors who have limited time in Sandakan and do not want to travel to the Lower Kinabatangan to view the proboscis monkeys.

4.0 TOURISM VISITATION RATES AND ENTRANCE FEES

Over the last 10 years or so, visitor numbers have been increasing steadily for all the above-mentioned places, with the SOURC receiving the highest visitor numbers annually. From 2014 to 2017, Table 1 shows that the SOURC attracted the most visitors. Despite having just opened in 2014, the BSBCC attracted more visitors in that year compared to the older RDC and LBPMS, possibly due to its location within the SOURC. The reduced number of visitors in SOURC, RDC and LBPMS in 2015 may have been due to the 4 incidents of abductions conducted by the infamous Abu Sayyaf of the Southern Philippines.

Table 1: Number of visitors from 2014 to 2017 in all four centres.



In 2017, SOURC received 123,387 visitors, followed by the BSBCC (72,673), the RDC (34,340), and the LBPMS (28,576) (Table 2). Non-residents (foreign tourists) were more than Malaysian residents in all sites except at LBPMS. At the RDC, the two categories were roughly similar in number, with non-residents being greater in number by just 184 individuals.

Table 2: Number of Malaysian residents and non-residents in 4 sites in 2017.

	Malaysian residents	Non-residents	Total visitors
Sepilok Orang Utan Rehabilitation Centre	55,076	68,317	123,393
Bornean Sun Bear Conservation Centre	25,401	47,272	72,673
Rainforest Discovery Centre	17,078	17,262	34,340
Labuk Bay Proboscis Monkey Sanctuary	15,818	12,758	28,576

18th Malaysian Forestry Conference

Direct revenue collected by the 3 most-visited sites was estimated at RM 5.2 mil, largely derived from entry fees, with the SOURC accounting for about 59 % of the total collection (Table 3). This data was unavailable from LBPMS. However, based on their fees for Malaysian residents and non-residents, without taking into account the fees for children for both categories, the LBPMS collected and estimated amount of RM 1.0 mil in 2017.

Table 3: Total revenue for collected in the 4 sites in 2017.

	Entrance fees collected (RM)
Sepilok Orang Utan Rehabilitation Centre	2,477,637
Bornean Sun Bear Conservation Centre	1,397,889
Rainforest Discovery Centre	327,730
Labuk Bay Proboscis Monkey Sanctuary	1,002,750*

*Estimated maximum amount

Concerning entrance fees for non-residents of Malaysia, the RDC has the lowest rates amongst the 4 sites with the LBPMS being the highest (Table 4). The SOURC and the BSBCC both have similar fees.

Table 4: Comparison of entrance fees amongst the 4 sites.

Site	Entrance fees (RM)			
	Malaysian residents		Non-residents	
	Child [†]	Adults	Child [†]	Adult
Sepilok Orang Utan Rehabilitation Centre	2	5	15	30
Bornean Sun Bear Conservation Centre*	2	5	15	30
Rainforest Discovery Centre	3	7	7	15
Labuk Bay Proboscis Monkey Sanctuary	5	15	30	60

[†]Ages vary between sites

*Free admission for children below 12 years old.

4.0 METHODOLOGY

Basic and existing visitor data were obtained from the four sites, collated and analysed. Additional data was collected using a set of questionnaires and the targeted respondents were Sandakan tourists. The questionnaire (in English) was designed to obtain information about the respondents and their travel particulars, their experiences and opinions of the four main sites. Respondents answered the questionnaires by themselves or assisted by interviewers. To target visitors on packaged tours, the main location was the departure hall of the Sandakan Airport. The airport is a major exit point to Kota Kinabalu International Airport and Kuala Lumpur International Airport. For FITs, RDC was chosen, as FITs are the most common group of foreign visitors to the centre. To acquire more respondents, we collaborated with the management of the SOURC, BSBCC and LBPMS, and the popular lodges in Sepilok to get visitors to fill in the questionnaires before they leave the centres and accommodations

respectively. The information from the questionnaires were then tabulated in a spreadsheet using Microsoft Excel and analysed using common qualitative methods.

5.0 RESULTS AND DISCUSSIONS

A total of 461 respondents were obtained during the survey. About 65 % (300 persons) of the respondents were from the Sandakan Airport, 23 % from the RDC with the rest from BSBCC and the other lodges in Sepilok. We observed that respondents at the airport were more willing to participate in the survey compared to other locations due to having ample time while waiting for their flights.

5.1 Respondent Profiles

Male and female respondents comprise 52 % and 48 % respectively of the total. Foreign nationals made up the majority (94 %) of the respondents, with the UK, Australian and Germany nationals making up about 30.7 %, 18.0 % and 9.5 % of the total respectively (Fig. 1). Generally, Chinese-speaking nationals, such as those from Taiwan, China and Hong Kong, did not want to participate in the survey, even though Mandarin-speaking interviewers were available.

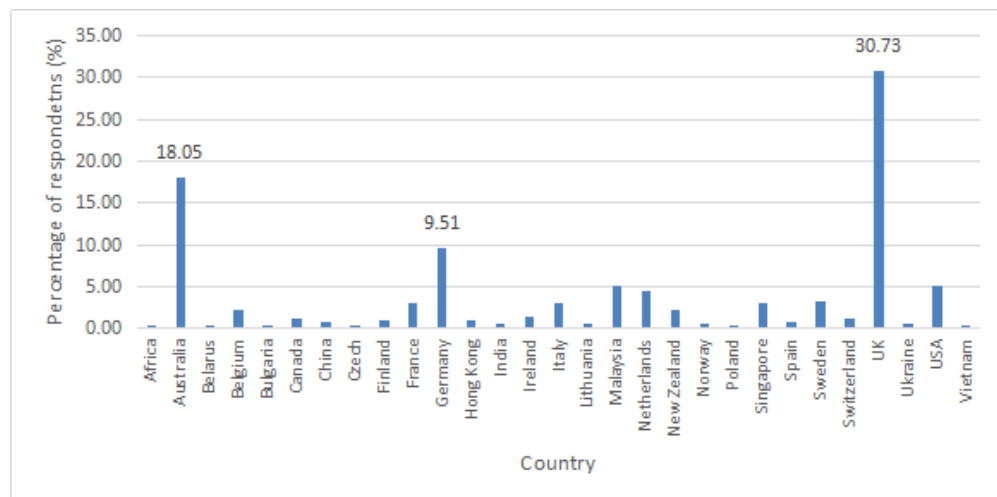


Fig 1. The respondents of the survey were from 29 countries, with those from the UK, Australia and Germany making up about 58 % of the total number of respondents.

Visitors aged between the age of 25 and 40 years old were the majority of the respondents at 41 % (Fig. 2).

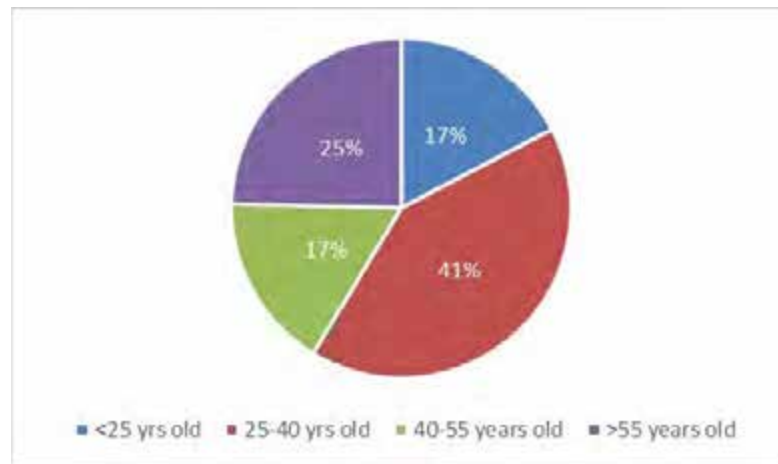


Fig 2. Respondents aged from 25 to 55 years old make up 58 % of the total.

5.2 Visitor Trends in Sepilok

From the basic visitor data collected from the 4 sites, the SOURC remains the most visited tourist site from 2014 to 2017, as shown in Fig 3. The relatively new BSBCC was gaining in visitor numbers, receiving 58 % of SOURC's total visitors in 2017. RDC received about 28–31 % of the SOURC's total during the same period. In 2017, the LBPMS only received about 23 % if the SOURC's total visitors.

From the data acquired from the questionnaires, about 93 % of the respondents stated that it was their first visit to Sandakan. When asked what their primary reason for visiting Sandakan was, 62 % stated 'Nature-related' was their main interest. About 33 % stated that 'Leisure' was their primary reason. About 5 % chose 'Education', Visiting friends/relatives' and 'Business'.



Fig 3. Number of visitors by sites. The SOURC is the major tourist destination in Sandakan, followed by the BSBCC. Visitor numbers for RDC were 28-31 % of the total visitors to SOURC since 2014.

When asked to indicate the places they had visited in Sandakan, 91.3 % of respondents stated that they visited SOURC (Figure 4). Some 81.4 % visited BSBCC, which is situated within the former's grounds. If we excluded the 5 % of respondents who chose 'Education', Visiting friends/relatives' and 'Business' as their primary reason to visit Sandakan, it could be assumed that almost all nature-related respondents visitors to SOURC.

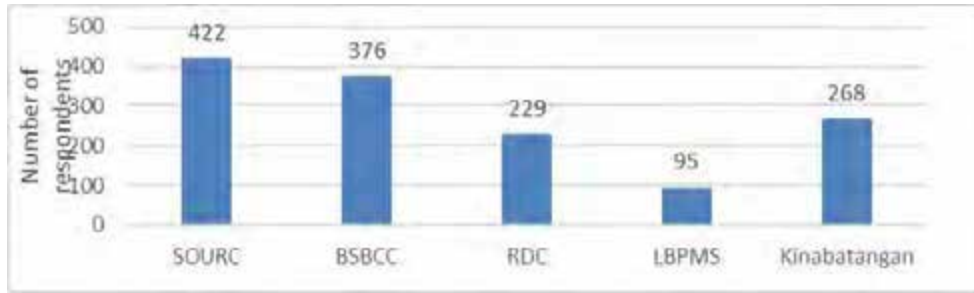


Fig 4. Number of respondents who visited the 5 sites. The SOURC and BSBCC were the most visited by respondents and the LBPMS was the least visited.

About 49.5 % of the respondents also visited the RDC. Compared to the value of about 28 % in Figure 3, this rather high figure could be attributed to the fact that the survey was also carried out actively at the RDC where 23 % of respondents filled in the questionnaires at RDC.

The figure for the LBPMS is only 20 % although it is the nearest location to view proboscis monkeys in Sandakan, thus negating the need for visitors to travel to the Kinabatangan. The figure is consistent with the primary data for LBPMS shown in Figure 3. The low percentage for the LBPMS may be due to the distance from the SOURC (25 km) which necessitate using taxis or ride-hailing services, and thus, incurring higher total travel costs. In addition, its high entrance fees for non-residents (RM 60 for adults) may deter potential visitors, especially cost-conscious FITs. About 61 % of respondents who visited the SOURC and the BSBCC respectively went to the Kinabatangan (Figure 5), while 53 % of them visited the RDC.



Fig 5. A comparison of the number of respondents who visited various sites attractions in Sandakan. Most respondents who visited the SOURC and the BSBCC also visited the Kinabatangan. About 50 % of those who visited RDC also visited the Kinabatangan.

Figure 5 shows the flow of respondents based on the combination of sites they visited. As expected, about 80 % of respondents visited both the SOURC and the BSBCC. As more sites are visited, the number of respondents reduces: about 49 % visited the SOURC, BSBCC and the Kinabatangan while 42 % visited SOURC, BSBCC and RDC; 25 % visited 4 sites and only 8 % managed to visit all 5 sites.

5.3 Visitor Trends from Sepilok to the Kinabatangan Floodplain

As mentioned above, most land-based tour packages to Sandakan includes the SOURC, the BSBCC and the Kinabatangan, and these were believed to omit the RDC to minimise total package days and costs. However, Figure 5 shows that only 49 % of respondents visited the SOURC, BSBCC and the Kinabatangan. Figure 6 shows that only 23 % of respondents had visited the 3 places but not RDC. In fact, 50 % of those who went to the Kinabatangan had also visited the RDC. Thus, the long-standing assumption by most tour operators and guides that RDC is omitted in tour packages is not supported by this study.

It is also interesting to note that about 32 % (146 respondents) who came to Sandakan were not on packaged tours, but 268 respondents went to Kinabatangan later. These were presumably FITs who bought tour packages to Kinabatangan after arriving in Sandakan. This was probably the case as going on tour packages to Kinabatangan were more convenient as it is a rather complex matter for foreigners to organise transportation, accommodation and tour activities on Kinabatangan on their own.

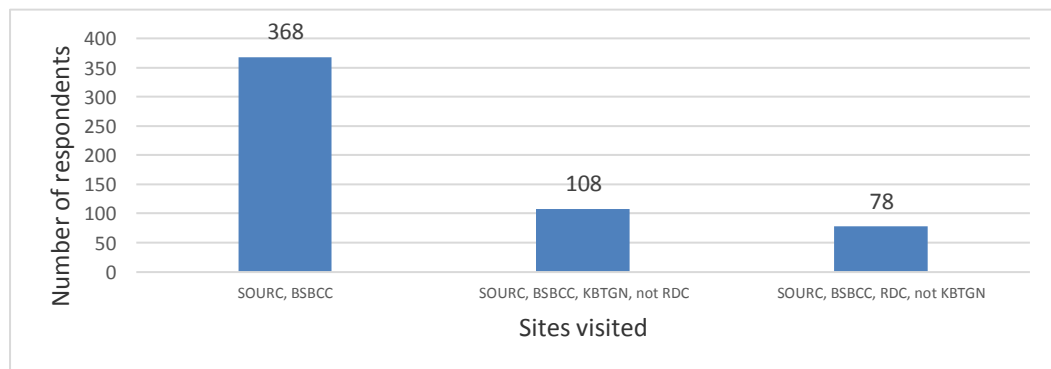


Fig 6. From the 368 respondents who visited SOURC and BSBCC, only 108 went to the Kinabatangan without visiting RDC, and even less went to RDC without going to the Kinabatangan.

However, Table 5 shows that respondents who visited the SOURC were likely to visit the BSBCC as well, although the correlation is weak ($r=0.54$). The table also showed that respondents' choices to visit the other sites were rather random. Respondents who visited Kinabatangan were most likely not to go to LBPMS. This is mainly due to the Kinabatangan, specifically Sg. Menanggul, being the most popular site in Sabah to view proboscis monkeys.

Table 5: Correlation coefficients between visits to SOURC, BSBCC, RDC, LBPMS and Kinabatangan

	SOURC	BSBCC	RDC	LBPMS	Kinabatangan
SOURC	1				
BSBCC	0.536271	1			
RDC	0.096686	0.145849	1		

LBPMS	0.150717	0.211547	0.169568	1	
Kinabatangan	0.148719	0.127593	-0.0363	-0.04596	1

5.4 Duration of Stay

About 90 % of respondents spent more than one day in Sandakan (including Kinabatangan). In terms of accommodations, 40 % of respondents stayed in Sepilok, 44 % stayed elsewhere, 14 % stayed in Sepilok and elsewhere, and only 3 % were presumably day-trippers from KK. For respondents who visited the RDC, about 48 % of them stayed only in Sepilok, 33 % stayed elsewhere and 17 % stayed both in Sepilok and elsewhere. The latter may be due to the respondents having to stay at different accommodations during their tours. On average, respondents spent 3.7 days in Sandakan.

5.5 Mode of Transportation

The main mode of transportation for the respondents was on tour buses or vans (57 %). This percentage may also represent tour package tourists. Just over 19 % of respondents used the increasingly popular Grab ride hailing service, which is more than the more expensive taxi service (14 %). As more tourists have flexible data roaming packages from their ISPs, Grab may be increasingly popular transportation options in Sandakan. About 9 % prefer to self-drive rented vehicles.

5.6 Economic Impact

Taking into account the average cost of one-day tour packages (inclusive of accommodation, food, entrance fees, guides and transportation) in Sandakan and Kinabatangan as RM 500, and the average duration of stay of 3.7 days, the average tourist will spend about RM 1,850. Assuming that the SOURC is the main attraction in Sandakan, with a total of 68,317 foreign visitors in 2017, it is estimated that tourism contributed not less than RM 126.4 mil to the economy of Sandakan in 2017.

6.0 ACKNOWLEDGEMENTS

The authors would like to thank the management of the Sepilok Orang Utan Rehabilitation Centre, the Bornean Sun Bear Conservation Centre (BSBCC), the Labuk Bay Proboscis Monkey Sanctuary, Sepilok Jungle Resort, Sepilok Forest Edge, Sepilok B & B, My Nature Resort and Nature Lodge Sepilok for their invaluable contributions towards this survey. We are grateful to the interns from the RDC and the Forest Research Centre who carried out the interviews at the Sandakan Airport and at the RDC, and without whom this survey would have taken longer to conclude. They were Jennifer Andrew, Kelvin Luke Petol, Leadora Mikal, Suriyani binti Sulaiman, Tang Pui Ling and Hoo Pui Kiat.

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INFORMATION PAPER 25: THE SIGNIFICANCE OF KAWANG FOREST RESERVE AS AN IMPORTANT PROVIDER FOR FOREST ECOSYSTEM SERVICES IN PAPAR DISTRICT, SABAH

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Abstract

Kawang Forest Reserve covered an area of 1,551 ha, located in the eastern part of Sabah, Malaysia. The forest has been gazetted as a forest reserve since 1957 and was reclassified in 2014 from Class III (Domestic Forest) to Class I (Protected Forest). The reclassification of the forest area is an effort to preserve the main function of the area to sustain the immense amount of biodiversity of the protected area. Therefore, this study aims to evaluate the local community perceptions' on the contributions of Kawang Forest Reserve to support their livelihood. The ecosystem services that are provided by the forest are categorized into three main services namely provisioning, regulating, and cultural services. The study was conducted using structural administered questionnaires in a Likert scale (scale of 1.00 – very low to 5.00 - very high) settings. Local community living vicinity to Kawang Forest Reserve were selected as the research respondents using convenient sampling. A total of 102 respondents were selected from villages located around the forest reserve namely, Tanaki, Mook, Tampasak, Kaiduan, Bisuang and Bolotikon to assess their perceptions on the forest ecosystem services that contributing to their livelihood development. The regulating services based on soil fertility and erosion control shows the highest value with an average of 4.58 min score, followed by the provisioning services based on the 'source for clean water supply & filtration' sub-services with a min score of 4.48 and cultural services based on 'provides tourism area (interesting area, climbing, hiking and waterfall with an average min score of 4.42. Hence, the conservation of Kawang Forest Reserve is vital to support the welfare of the local community residing within the protected area as well contributing to a more sustainable forest management by the decision makers.

Keywords: Forest ecosystem services, Kawang forest reserve, perception, local community, provisioning, regulating and cultural.

1.0 INTRODUCTION

Ecosystem services are increasingly being encouraged as an approach of documenting human well-being, prudent ecosystem and evaluating the benefits derived from natural resources (Costanza et al., 1997; De Groot et al., 2002; Millenium Ecosystem Assessment, 2005). One of the basic categories of ecosystem services is the multitude of services that connect with human well-being. With the illustration of the issue, this scheme draws the distinction between three different categories of ecosystem services namely regulating services, provisioning services and cultural services (Benjamin Burkhard et al., 2014).

According to Pargan (2009), the total area of Sabah is 7,371 million ha and about 48.76% of the area is forest reserve consisting of Protection Forest, Commercial Forest, Domestic Forest,

Amenity Forest, Mangrove Forest, Virgin Jungle Forest and Wildlife. While the rest is about 51.24% comprised of land use diversity. There are 7 classes of forests in Sabah based on their uses. Kawang Forest Reserve was reclassified into Class I (Protection Forest) in 2014.

1.1 Objective

The purposes of this study were to identify local communities' views of the importance and contribution of the forest to them, identifying the functions of the ecosystem services provided by the forest to the community and finally obtaining the perception of the local community regarding land use and the factors contributing to land use.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study area is (Kawang Forest Reserve) is located in Papar with an area of 1,551 hectares was gazetted as Domestic forest reserve (Class III) before being reclassified to Class I Forest in 2014. The area is located at 116° 01'- 116° 04 ' East Longitude and 05° 45'- 05° 47 'North latitude. This forest reserve has a hilly terrain with an altitude of about 250-2000 ft. and the highest peak reaches 2010 ft. The soil types of the forest are from the Lokan and Crocker groups of 'sandstone' and 'mudstone' (Husain, 2010).

The forest is drained by several streams and its main river is the Tanaki River used by nearby villagers as water catchment areas. It has also become as one of the places of tourism and recreation around Kota Kinabalu and Papar. Among the nearby settlements are Kaiduan village, Bisuang village and Bolotikon village. Data collection for the study area divided into two parts (see Figure 1 below) namely the Kaiduan area (Kaiduan, Bisuang and Bolotikon villages) and the Mook area (i.e, Mook, Tampasak and Tanaki villages).



Fig. 1 Map of Kawang Forest Reserve, Papar
(Source: Google Image and GPX Viewer 2017)

2.2 Sampling Design

The research was conducted in accordance with the convenient sampling method (Krippendorff, 2004) in January 2017 until June 2017. The questionnaires were

distributed to the villagers of Kawang Forest Reserve in the Kaiduan area (i.e, Kaiduan, Bisuang and Bolotikun villages) and the Mook area (i.e consists of Mook, Tampasak and Tanaki villages).

The questionnaire consists of a set of section comprising three parts: the socio-demographic, the dependence and use of forest to the village and the functions of forest ecosystem services to the population. The Likert scale is a psychometric scale commonly involved in a study using a questionnaire. It is used extensively in monitoring and to scale responses in research studies. In relation to the responses of the selected types of Likert questionnaire form, the respondents are more specific in determining whether to agree on each of the symmetry scale agree-disagree statement. A total of 100 respondents were interviewed representing their home, respectively.

3.0 RESULTS AND DISCUSSION

Respondents' knowledge of forest ecosystem services in the study area is divided into three parts namely provisioning, regulating and cultural services. For the provisioning services, most of the respondents chose the forest as a source of filter and clean water supply. The communities living in vicinity of the Kawang Forest Reserve has been using the clean water channeled from the forest reserve. Similar result of the provisioning services in regard to clean water reported by Mojiol et al. (2017) in their study entitled “Visitors’ Willingness To Pay (WTP) at Kionsom Recreation Centre, Kota Kinabalu Sabah”. Table 1 shows the types of provision services (in mean score) where the source for clean water supply and filtration is 4.48 and the source of traditional medicines by the local community is 4.44. The source of food from the forest is 4.12 and the source of raw materials (bark, fuel and others) is 4.30. The genetic source type (genetic tubes) is 4.04. Meanwhile, the hydro power source is 2.49 which is very low. The mean score of decorative source (beauty and decoration) is 4.05. According to Mojiol et al. (2016), most of the communities agreed and aware on the fact that activities such as cultivation and gathering of forest products and encroaching the forest reserve are strictly prohibited where amples of signboards were visible along the forest boundary.

Table 1. Provisioning Services

Optional answer	Very high	High	Moderate	Low	Very low	(Mean-Score)
Source for clean water supply & filtration	72.55%	11.76%	8.82%	4.90%	1.96%	4.48
Source ethno-medicines	69.61%	14.71%	8.82%	3.92%	2.94%	4.44
Source of fuelwood & raw materials	65.69%	12.75%	11.76%	5.88%	3.92%	4.30
Food resources	53.92%	16.67%	20.59%	4.90%	3.92%	4.12
Source of beauty & decoration	51.96%	20.59%	16.67%	1.96%	8.82%	4.05
Genetic resources (genetic pool)	53.92%	20.59%	10.78%	4.90%	9.80%	4.04
Source energy (Hydro power)	18.63%	7.84%	18.63%	13.73%	41.18%	2.49

(Mean-score: 5 = Very high; 4 = High; 3 = Medium; 2 = Low; 1 = Very Low)

Table 2 shows the mean score for each types of regulating services. Prevention of soil erosion and soil fertility is the highest by 4.58. The second is to stabilize the extreme weather (disaster and flood) by 4.52 and followed with treated water and clean water 4.52. Meanwhile, regulating local climate and local air quality (heat and pollution), and regulates carbon sequestration by reducing carbon dioxide mean score is 4.46 and 4.27, respectively. According to Blanco-Canqui and Lal (2009), forest ecosystem provides basic services such as soil erosion control, ecosystem stabilization, and climate simplicity and flux energy. Based on the findings, locals are less concerned with managing waste and detoxification, most of which use insecticides in controlling pests damaging their crops. Thongsanit & Imkarajang (2015) stated that smokes or haze from forest fires and dust fall especially during drought seasons with high concentration affect human health and the presence of the tree canopy help in filtering and absorb those particules. Suardi et al. (2016) opined that the acting as carbon sequestration forest reserved is higher than monoculture plants or plantation forest.

Table 2. Regulating Services

Optional answer	Very high	High	Moderate	Low	Very low	(Mean-Score)
• Prevention of soil erosion and soil fertility.	76.47%	10.78%	8.82%	1.96%	1.96%	4.58
• Stabilize extreme weather (disasters and floods).	75.49%	8.82%	8.82%	5.88%	0.98%	4.52
• Treating water and clean air.	73.53%	12.75%	7.84%	3.92%	1.96%	4.52
• Regulating local climate and local air quality (heat and pollution).	72.55%	8.82%	13.73%	1.96%	2.94%	4.46
• Regulate and acting as carbon sequestration	68.63%	8.82%	11.76%	2.94%	7.84%	4.27
• Biological control; ecosystems control pests and diseases through predatory and parasitic activities.	49.02%	10.78%	28.43%	5.88%	5.88%	3.91
• Pollination; insects and winds for trees pollination.	47.06%	11.76%	31.37%	4.90%	4.90%	3.91
• The decomposition of toxic waste and decryption (detoxification).	50.98%	16.67%	14.71%	4.90%	12.75%	3.88

(Mean-score: 5 = Very high; 4 = High; 3 = Medium; 2 = Low; 1 = Very Low)

Table 3. Cultural Services

Optional answer	Very high	High	Moderate	Low	Very low	(Mean-Score)
• Provides tourism area (interesting area, climbing, hiking and waterfall).	70.59%	12.75%	8.82%	3.92%	3.92%	4.42
• Provide education and learning areas (research, study and school visits).	68.63%	9.80%	14.71%	5.88%	0.98%	4.39
• Provide recreational, mental and physical services to improve health (leisure, sports and relaxation).	65.69%	14.71%	12.75%	2.94%	3.92%	4.35
• Improve cultural, artistic and aesthetic value (inspirational sources).	50.00%	12.75%	24.51%	2.94%	9.80%	3.90
• Increase the spiritual, historical and approaches to the creator (religious and customs).	38.24%	20.59%	19.61%	5.88%	15.69%	3.60

(Mean-score: 5 = Very high; 4 = High; 3 = Medium; 2 = Low; 1 = Very Low)

Table 3 shows the mean score for each types of cultural services providing tourism area (interesting area, climbing, hiking and waterfall) is the highest scoring (4.42). Providing education and learning areas (research, study and school visits) (4.39). Providing recreational, mental and physical services to improve health (leisure, sports and relaxation) is the third highest with 4.35. The mean score of service of to improve cultural, artistic and aesthetic value (inspirational sources) is 3.90. Meanwhile, the function in increasing spiritual, historical and approaches to the creator (religious and customs) is the lowest compared to other forest cultural services. According to Mojiol et al. (2017), undisturbed forest provides high attraction of tourism destination area

4.0 CONCLUSION

In conclusion, the objectives of this study have been achieved as it involves the local community's views on the importance and contribution of the forest to them. The forest ecosystem functions are divided into three important categories such as provisioning, regulating and cultural services. Most of the respondents understand in identifying their views on the importance and contribution of the forest to them. In general, some of them are still dependent on crop yields as well as the use of forest resources such as clean water supply. The Kawang Forest Reserve, Papar, Sabah should be conserved and protected in order to sustain the forest for future generations.

5.0 ACKNOWLEDGEMENTS

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**INFORMATION PAPER 26: THE ESTABLISHMENT OF PERMANENT
SAMPLE PLOT NETWORK IN SARAWAK**

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Abstract

The Permanent Sample Plot (PSP) Network in Sarawak is carried out to collect baseline data on tree growth that is currently lacking from the logged-over forest. This data is necessary for the calculation of Annual Allowable Cut (AAC), which is a critical aspect in Sustainable Forest Management (SFM) to achieve Forest Management Certification (FMC). Plots measuring 100m x 100m each were established according to field manual specifically designed for the project in selected areas throughout the State. All trees above 10 cm diameter at breast height were enumerated, measured and identified. To-date, 12 plots have been established representing different years after logging. Preliminary results show that the basal area of dipterocarps after logging is 4.4 m³/ha and 10.1 m³/ha in 1 year and 20 years respectively. The completion of the sufficient growth data collected will be used to calculate reliable AAC for Sarawak.

Keyword: Annual Allowable Cut (AAC), tree growth, PSP network

1.0 INTRODUCTION

Understanding the growth potential and regeneration status of logged-over forests is important in ensuring the sustainable production of forest. The only study of timber growth and mortality in the mixed dipterocarp forest in Sarawak was dated back in 1980 based on scarcity of information and minimum research data (Mackay, 1980). Availability of reliable data for estimating growth, mortality and regeneration is one of the major issues in sustainable forest management (SFM). Analysis for predicting annual stem diameter increment of major timber species in logged-over forests in Peninsular Malaysia used a total of 8 censuses data collected over a period of 17 years (Rahman et al., 2016).

Extensive and reliable growth data from logged-over forest is important for reliable prediction of growth and yield of forest stand and is a basis for calculation of annual allowable cut (AAC). Due to unavailability of reliable growth data from logged-over forest in Sarawak, the state government has awarded a project to establish permanent sample plot (PSP) network in Sarawak in 2017. The pressure to collect reliable growth data is mounted when the government announced that all forest management units (FMUs) in the State need to obtain sustainable forest management (SFM) certification by 2020 (Tawie, 2017).

The main objective of the project is to establish PSP in logged-over production forest throughout Sarawak. The plots are to provide reliable growth data which later will be used to develop growth model and to calculate annual allowable cut. This paper described the principles of the project, challenges and way forward.

2.0 MATERIALS AND METHODS

2.1 Site description

The PSP network was targeted at logged-over hill mixed dipterocarp forests within the production forest areas. Production forests from three regions were selected for the network: Sibu region at upper Rejang river, Bintulu region at Tatau and Linau and Long Lama area in Miri region. To date, 17 plots measuring 100 m x 100 m. each were established at the operable area of the production forest. All trees with 10 cm dbh and above were tagged, measured and identified to species level. Plot design and assessment was following an unpublished guideline specifically written for this project.

2.2 Data structure and analysis

The data analysis was conducted for 6 plots from upper Rejang River. The data were analysed for species composition and stand structure: stand density and basal area.

3.0 RESULTS AND DISCUSSION

A total of 3445 trees were enumerated from 6 ha plots belonging to 59 families of 188 genera and 637 species. Relative density of 10 largest families showed that Dipterocarpaceae was the most dominant families followed by Euphorbiaceae, Lauraceae, Myristicaceae and Actinidiaceae (Fig. 1).

Relative density of dipterocarps was calculated at 22.8% which means that the dipterocarps cover 22.8% of stand density in a 1-ha plot. The high importance value index of *Shorea parvifolia*, *Shorea pinanga* and *Shorea parvistipulata* indicated the domination or fast recovery of some dipterocarp species in logged-over forest species (Fig 2). *Shorea parvifolia* and *Shorea pinanga* are light tolerance and fast growing species thus contributed to high density of dipterocarps in the 10-years and above forest after logged (Fig. 3).

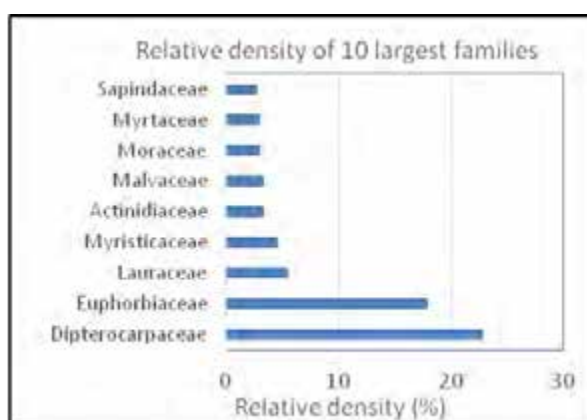


Fig 1: Relative density of 10 largest families

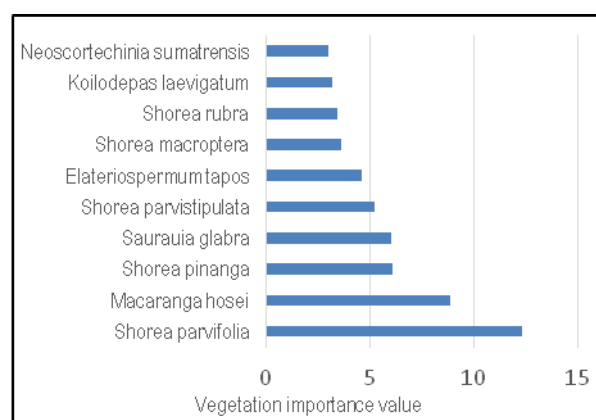


Fig 2: Species important value

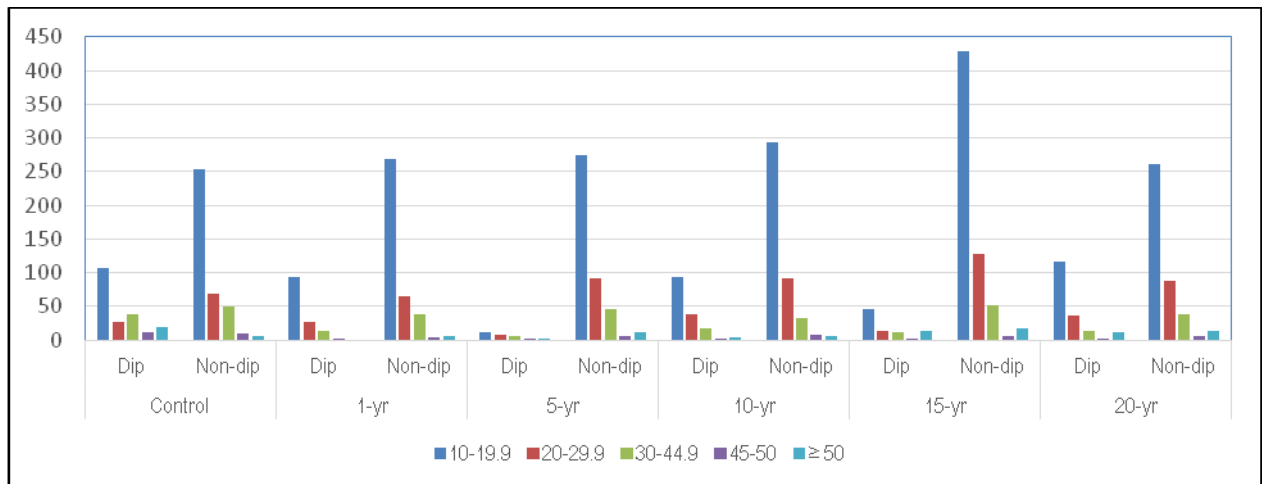


Fig 3: Tree density of dip vs non-dip

Common non-dipterocarp species is represented by members of Euphorbiaceae particularly *Macaranga hosei*, a pioneer species in the open canopy area. Other pioneer species dominated the open areas include are *Saurauia*, *Elaterio spermum* and *Koilodepas*. The occurrences of these species were well observed in the early years of forest after logging and survived for up to 10 years after logging depending on the species. Figure 3 showed that the reduction of stand density of non-dipterocarp contributed by the gradual disappearance of secondary and pioneer forest species. On the other hand, it showed a positive recovery of dipterocarp trees in terms of both stand density and growth. This finding was further supported by analysis of basal area (Fig. 4). The basal area of dipterocarps after logging is 4.4 m³/ha and 10.1 m³/ha in 1 year and 20 years after logging respectively.

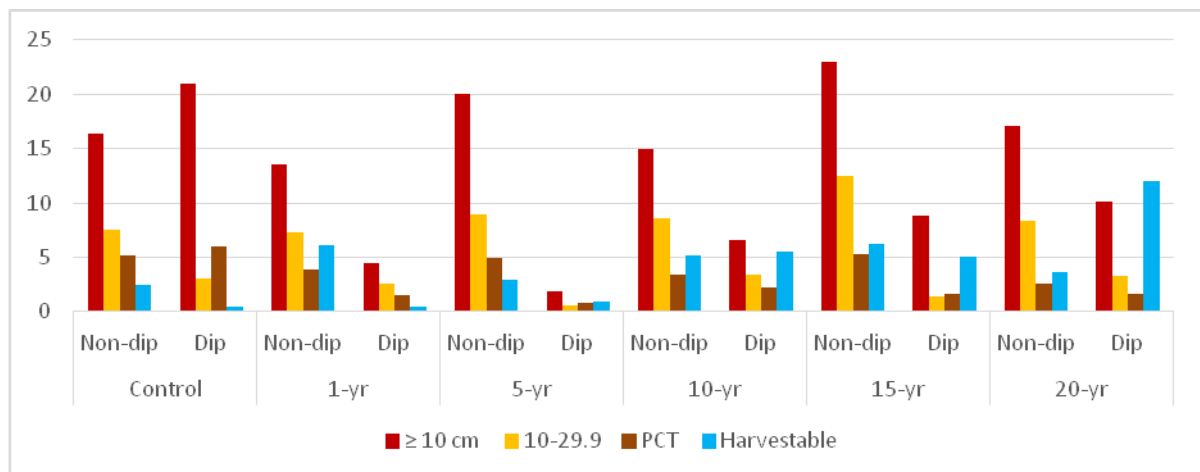


Fig 4: Basal area (m²ha⁻¹)

The recovery process and growth of tree species in logged-over forest not only contributed by the presence of remaining adult trees, saplings and seedlings but also influenced by the environmental factors such as intensity of logging, light intensity in the forest, terrain, altitude, temperature, humidity, rainfall and soils. All the factors are contributed to the natural survival and mortality of trees in the forest showed by the increased and fluctuation of tree

densities and basal areas at several points of forest age (e.g., Fig. 4 at age of 10-yr after logged).

4.0 CONCLUSIONS

The PSP data collected is targeting to address lack of information on timber stocking available both on species composition as well as tree density. Mostly, long term monitoring and observation of the plots is significantly important to understand the recovery process of logged-over area particularly on growth rate of timber species. This empirical information is important to support sustainable management of natural production forest and future timber supply.

5.0 ACKNOWLEDGEMENT

Ministry of Urban Development and Natural Resources, Sustainable Forest Management Department of Ta Ann Holding Berhad, Botanical Research Centre of Sarawak Forestry Corporation, Sibu Regional Office of Sarawak Forestry Corporation, Managers of Sarawak Forestry Corporation.

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INFORMATION PAPER 27: HIGH CONSERVATION VALUE FOREST (HCVF) ASSESSMENTS IN FOREST MANAGEMENT UNITS (FMUS) IN SARAWAK: ISSUES, CHALLENGES AND WAY FORWARD

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Abstract

State Government of Sarawak is committed to manage its forest resources sustainably and all the long term forest timber licences in Sarawak are to be certified by 2022. The standard use for forest management certification is the Malaysian Criteria and Indicators [MC&I (Natural Forest) 2012]. Principle 9 of the MC&I describe the maintenance of the High Conservation Values Forest (HCVF). Identification of HCVF is conducted based on WWF's HCVF Toolkit. To-date, eight HCVF assessments for natural forests has been conducted. This paper highlights issues, challenges and way forward in conducting HCVF assessment in Sarawak.

Keywords: Forest Management Certification, High Conservation Values Forest & Sarawak

1.0 INTRODUCTION

Tropical rainforests form the dominant natural terrestrial ecosystem in the country and is recognized as the richest ecosystem in the world in terms of structure and species diversity (Yamakura et al., 1986, Lee et al., 2002, La Frankie et al., 2006) with the mixed dipterocarp forest as the dominant habitat.

Malaysia is one of the mega-biodiverse countries (Mittermeier et al., 1997), however, the country is also facing a rapid loss of biodiversity (Sodhi et al., 2004). Logging and forest conversion are the major threats to biodiversity of the tropical rainforest (Curran *et al.* 2004 & Sodhi et al., 2004). In fact, Achard et al. (2002) and Sodhi et al. (2004) reported that the deforestation rate in Southeast Asia is the highest among the major tropical regions. Like other Southeast Asia countries, the major causes of deforestation in Sarawak are the timber extraction and forest conversion to agricultural lands and plantation areas.

In addition to conservation of forest as protected area, there is an opportunity for conservation beyond protected forest within the Permanent Forest Estate (PFE), which accounts for more than six million hectares of total Sarawak land mass. Sustainably managed forest in PFE will benefit not only the timber industry but also conservation (Meijaard & Sheil, 2007). An example of such practices is setting aside High Conservation Value Forest (HCVF) areas within the PFE which is important not only to conserve ecological functions but also local communities' livelihood.

2.0 SUSTAINABLE FOREST MANAGEMENT & HIGH CONSERVATION VALUE FOREST IN SARAWAK

Sarawak is blessed with rich forest resources which play a key role in the economic development of the State. Its land area of approximately 12.4 million ha encompass beach to montane forests with mixed dipterocarp forest being the main forest type. Despite on-going logging activity, preservation and protection of forested area in Sarawak is working well as a result of Sarawak's commitment to achieve Sustainable Forest Management (SFM).

The State Government adopts SFM to maintain a balance between commercial use of the forest and environmental protection, in which six million ha for sustainable timber production (including one million ha of forest plantation), one million ha as totally protected areas, four million ha for agriculture, of which three million ha are for oil palm and the remaining 1.4 million ha are for miscellaneous development.

SFM involves not only the continuous functions and services provided by the forest but also about meeting the global concerns and expectations in managing the forest with greater emphasis on environmental protection and conservation of biological diversity.

Realizing the importance of SFM practices especially in logging concessions, the State Government of Sarawak has made it mandatory for all long term timber licenses in Sarawak to obtain Forest Management Certification (FMC). Once certified, a 60-year tenure will be awarded to the successful licensees.

The *Malaysian Criteria and Indicators for Forest Management Certification (Natural Forest)* [or in short the MC&I (Natural Forest)] contains key elements for SFM covering the economic, social, and environmental aspects. It is currently the standard used for forest management certification of natural forests at the forest management unit (FMU) level in Malaysia (MTCC, 2012). The Malaysian Timber Certification Scheme (MTCS) operated by MTCC is in line with international practice and the standard setting process for the development of timber certification standards (MTCC, 2012).

Malaysian Timber Certification Scheme (MTCS) is motivated by the country's commitment to ITTO's Guidelines for Sustainable Forest Management of Natural Tropical Forests and its Criteria for the Measurement of Sustainable Tropical Forest Management. Malaysia took actions to build on and operationalize this guideline for two reasons:

- i) Certification is seen as a step toward ensuring the production of a continuous flow of desired forest products and services from the forest reserves; and
- ii) In doing so, it also commits to ensuring that production be conducted without undue reduction of the forest's inherent values and future productivity, and without undue undesirable effects on the physical and social environment.

The assessment and maintenance of HCVF is prescribed under Principle 9 of MC&I (Natural Forest). HCVFs are forests with especially high ecological and/or social value. The HCVF concept is to provide a framework to identify forest areas with exceptional environmental, social-economic, biodiversity or landscape values and to manage them in order to maintain/increase its value.

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To date, SFC had conducted full HCVF assessment in eight FMUs and four LPFs (Table 1) and using the HCVF Toolkit for Malaysia by WWF-Malaysia.

No	Area	Report Submitted
Forest Management Unit		
1	Ulu Trusan, Lawas FMU T/9115 and No. T/0280	2018, February
2	Danum FMU, Kapit T/3342	2017, July
3	Raplex FMU, Kapit, T/0560	2017, June
4	Linau FMU, Kapit T/3228	2016, December
5	Ravenscourt FMU, Lawas, Miri T/0294	2016, August
6	Lawa Sengayan FMU, Ulu Baram, Miri T/0398	2016, August
7	Sector A, T/3343, Baleh, Ulu Kapit	2016, May
8	Kubaan Puak FMU, T/0342 Miri	2012, March
Licence Planted Forest		
1	Marudi LPF	2018, July
2	Lana Reforestation LPF/0006 Kapit	2016, November
3	Shin Yang Masama Tree Plantation (LPF 0019)	2015, August
4	Shin Yang Kuala Baram Tree Plantation	2014, April

Table 1: HCV Assessment conducted by SFC

3.0 CHALLENGES & ISSUES ON HCVF IN SARAWAK

The challenges and issues encountered before, during and after conducting the HCVF assessments in these FMUs were merely based on our experiences in conducting HCVF assessments in Sarawak. The main challenges and issues faced in the application of HCVF's concept in Sarawak are as outlaid below:

- The FMU's management perceives the HCVF as a "new principle" and most of them are not aware of the same concept outlined in the MC&I (Natural Forest). Therefore, the identified HCV attributes had significance impacts and should be taken into consideration in the establishment of forest management plan. Furthermore, the conservation requirements of MC&I (Natural Forest) requires full integration of HCVF and conservation strategies into overall management plans and field operations;
- Level of awareness on the HCVF concepts is still low among the workers in FMUs and some even never heard about it. Therefore, it is very challenging to conduct the HCVF assessment. Awareness on HCVF among the workers is fundamental in ensuring the HCV attributes can be securely monitored;
- The assessment is very time consuming and costly as most of the area are located in the interior of Sarawak. Travelling time to the site can take up to two days. In such cases, the field assessment can only commence on the third day onwards;
- Most of the FMUs in Sarawak cover vast areas (e.g., Ulu Trusan FMU >90K ha, Linau FMU > 70K ha). Accessibility to those areas can be time consuming or in some areas, it is inaccessible due to its remoteness or some of the roads or bridges are not usable as the areas are no longer in operation or not yet started;
- Some of the recommendations and monitoring proposed in the HCVF report are hard to be adhered to by the FMUs. It is noted that there is lack of capacity and Standard

Operation Procedures (SOP) to maintain and enhance the HCV attributes highlighted in the HCVF report; and

- f) Certified FMUs had to undergo rigorous surveillance audit each year for three consecutive years with a recertification on every fourth year. Thus, this can be seen as a burden to the management of FMUs.

4.0 WAY FORWARD

Challenges and issues are part and parcel of any implemented projects. Thus, precautionary approaches should be put into considerations to ensure the assessments conducted run smoothly. The key messages on the way forward can be summarised as follows:

- a) Awareness program and briefing on the concept of HCVF should be delivered to the FMU management (both the camp manager and the workers). This is to ensure that they have the clear ideas on HCVF and its significance in FMC;
- b) Proper planning and flexible schedule with several alternatives or options are important for the assessment at vast and remote area, especially when there are unforeseen circumstances;
- c) The management and monitoring recommendations recommended to FMUs should be clear and implementable; and
- d) The State Government of Sarawak is committed to manage its forest sustainably. In order to be certified, the FMU owner must conduct a HCVF assessment within their area. However, most of the FMU are not capable to conduct the in-house assessment due to the lack of capacity. We optimist that with the close co-operation between the FMU owners and relevant stake holder such as SFC & FDS, the assessments can be completed and thus paving the way towards forest management certification.

5.0 CONCLUSION

The HCVF is outlined in the Principle 9 of MC&I and Forest certification and seen as a step toward ensuring the sustainable supply of desired forest products and services from the PFE. Having done that, it also ensure the production does not affect the forest's inherent values and future productivity, as well as causing undesirable effects on the physical and social environment.

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INFORMATION PAPER 28: SARAWAK PLANT RED LIST FOR DIPTEROCARPS IN SARAWAK: BEYOND THE RED LISTING

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Abstract

Sarawak has the highest dipterocarp species diversity in Borneo with 90% of the Bornean species are found in different forest types throughout the State. Most of the species are traded as commercial timber which contributes up to 43% of the log production. However, the IUCN has listed more than 70% of these dipterocarp species as threatened which may have implication on timber trade. Hence, a project to re-evaluate the conservation status of all dipterocarp species in Sarawak has been implemented since 2008. The findings of the study showed that 103 out of 262 taxa of the dipterocarps in Sarawak are threatened. Of the threatened taxa, 20 taxa are considered as Critically Endangered. Monitoring of threatened taxa, *ex-situ* conservation, and awareness and training of relevant stakeholders are some of the actions that has been carried out for the conservation of these Critically Endangered taxa.

Keywords: Dipterocarps, timber, threatened, conservation

1.0 INTRODUCTION

The Dipterocarpaceae family comprises about 500 species in 17 genera worldwide. In Borneo, Sarawak shows the highest dipterocarps diversity with 262 taxa in nine (9) genera representing about 90% of the species recorded from Borneo. Of these, 22 taxa are endemic to Sarawak (Ashton, 2004; Meekiong et al. 2014; Meekiong, 2015). The dipterocarps grow in various forest types throughout Sarawak particularly in mixed dipterocarps forest. The dipterocarps are the major commercial timber species traded internationally since the early seventies (Ashton, 2004). In the past five years, the dipterocarp contributes 43% of the volume of Sarawak's log productions. Besides their economic importance, the dipterocarps are also important ecologically as they form one of the major forest types (i.e., mixed dipterocarp forest) in Borneo's forests.

Due to the continuous harvesting and trade of dipterocarp timbers, coupled with rapid decline of forest cover in Sarawak, more than 70% of Sarawak dipterocarp species has been listed as threatened in the IUCN Red List of Threatened Species. The IUCN Red List is widely recognised as the most comprehensive and objective global approach for evaluating the conservation status of a species. The goal of the IUCN Red List is to provide information and analyses on the status, trends and threats to species and is aimed as catalyse for biodiversity conservation (IUCN, 2001). The fact that high percentage of dipterocarps listed in the IUCN Red List has been used by certain parties to impose restriction on the export of dipterocarp timbers from Sarawak. Due to the possible negative implication this restriction on the timber industries in the State and in line with Sarawak's commitment to utilize its forest resources sustainably, a project was initiated in 2008 to re-assess the conservation status of all dipterocarps in Sarawak. The findings of this re-assessment are important to support sustainable utilization and conservation of these commercial timber species in Sarawak.

2.0 METHODOLOGY

The conservation status assessment of the dipterocarps taxa in Sarawak was carried out by adopting the work done in Peninsular Malaysia (Chua et al., 2010). Geo-referencing of all specimen data (e.g., herbarium specimens available in various herbaria, data from published and unpublished literatures) was done by referring to the Sarawak Gazetteer (Mohizah et al., 2006) and other relevant maps. However, the great majority of the data used in this assessment were obtained from over 400 sample plots of 1-ha each established throughout the State and various field works carried out between 2008 to 2015. The distribution map, value of AOO (Area of Occupancy) and EOO (Extend of Occurrence) of each taxon was done and calculated using ArcView and Conservation Assessment Tool while the conservation status of each taxon was determined based on the categories and criteria outlined in the IUCN Red List Categories and Criteria version 3.1 (IUCN, 2001). At the same time, the IUCN Guideline for Application of IUCN Red List Criteria at Regional and National Levels (IUCN, 2012) was also used as reference. In addition to the categories in Fig. 1, category Rare (RA) as defined by Chua (2012) was also applied in this assessment.

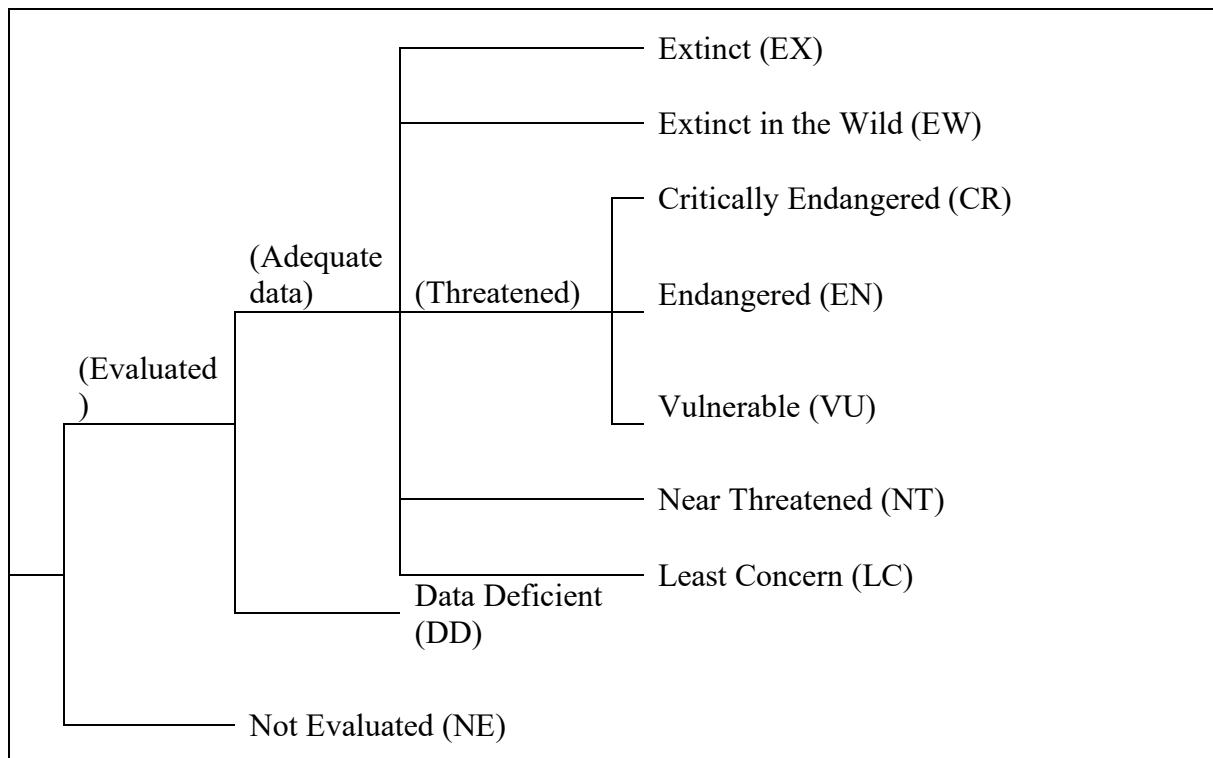


Fig. 1: IUCN Red List Categories

3.0 RESULTS AND DISCUSSION

3.1 Conservation status of dipterocarp taxa in Sarawak

A total of 262 taxa of dipterocarps that occur in Sarawak were assessed and the findings have been published in the Sarawak Plant Red List for Dipterocarps Series I

and II (Julia et al., 2014; Julia & Vilma, 2016). Of the 262 taxa assessed, 156 taxa are categorised as not threatened (i.e., NT or LC). Three (3) taxa are considered RA while the remaining 103 taxa are considered threatened (i.e., CR, EN or VU) in Sarawak (Table 1). The taxa are considered not threatened in Sarawak when the populations of these taxa occur in a network of TPAs, are common and widespread throughout the State and occupy various habitats and forest types. RA taxon is defined as a taxon that is not exposed to any known or potential threat such (e.g., a taxon that occurs in a well-protected TPA) but only recorded from less than two (2) localities and has an $EOO \leq 100 \text{ km}^2$ or $AOO \leq 10 \text{ km}^2$ (Chua, 2012).

Of the threatened taxa in Sarawak, 20 taxa are considered CR, 41 EN and 42 VU. The taxa are considered threatened based on one or more of the following factors: (i) taxa with all known populations that occur in fragmented and/or highly threatened habitats; (ii) all or most populations occur outside the network of TPAs; (iii) taxa that are confined to known threatened habitats (e.g., peat swamp forest, lowland mixed dipterocarp forest); (iv) taxa with narrow distribution range. The list of taxa in all the threatened categories (i.e., CR, EN, VU) and RA category are as in Appendix 1.

Table 1: Summary of assessments

Genus/Category	EX	EW	CR	EN	VU	NT	LC	DD	NE	RA	Total
<i>Anisoptera</i>	0	0	0	2	1	0	2	0	0	0	5
<i>Cotylelobium</i>	0	0	0	0	0	0	3	0	0	0	3
<i>Dipterocarpus</i>	0	0	2	5	10	6	11	0	0	1	35
<i>Dryobalanops</i>	0	0	1	1	0	0	4	0	0	0	6
<i>Hopea</i>	0	0	3	6	3	13	15	0	0	1	41
<i>Parashorea</i>	0	0	0	1	0	2	2	0	0	0	5
<i>Upuna</i>	0	0	0	0	0	0	1	0	0	0	1
<i>Shorea</i>	0	0	10	19	23	24	51	0	0	1	128
<i>Vatica</i>	0	0	4	7	5	3	19	0	0	0	38
Total	0	0	20	41	42	48	108	0	0	3	262

The findings revealed that 40% of taxa occurring in Sarawak are considered threatened compared to 70% taxa in the IUCN Red List. Approximately 30% of the taxa that are considered threatened in Sarawak are also considered threatened globally; however, one taxon (*Shorea cuspidata* or locally known as 'Lun daun runcing') that was listed as EX in the IUCN Red List is categorized as NT in Sarawak. Of the 22 taxa which are endemic to Sarawak, 14 taxa are considered threatened (i.e., 8 CR, 4 EN, 1 VU), seven taxa are considered not threatened (6 LC, 1 NT) while one taxon (*Shorea bakoensis*) is considered RA.

Quick analysis of the distribution of all taxa throughout the State showed that 85% of the taxa occur in the network of TPAs. Continuous and effective protection of these TPAs will minimize the threats to their natural habitats and indirectly safeguard the populations of the dipterocarps and other species in Sarawak. In contrast, 15% of the dipterocarp taxa are only recorded from forest areas outside the TPAs network. As such, the habitats of these taxa are highly susceptible to various threats such as habitats conversion to other land use and thus threatened the continuous survival of the

taxa in their natural habitats. Therefore, priority and effort for conservation of these threatened taxa are needed.

3.2 Beyond the red listing

The conservation of the threatened taxa, particularly the Critically Endangered taxa, should be given the top priority to prevent the taxa from becoming extinct in Sarawak in line with Malaysia's National Policy on Biological Diversity 2016-2025 (i.e., Goal 3, Target 9) (MNRE, 2016). Beyond the red list assessment, various efforts have been initiated by Sarawak Forestry Corporation (SFC) regarding the conservation of threatened dipterocarps in Sarawak. These initiatives include:

(i) Monitoring and *ex-situ* conservation of the threatened taxa particularly the CR

The population survey and phenology monitoring of the threatened taxa particularly the CR taxa is on-going. However, due to the limited resources (e.g., man power, funding) and vastness of the forest areas to be covered, only selected taxa have been monitored so far. Wherever possible, seeds were collected for *ex-situ* conservation. To date, six threatened taxa (*Anisoptera reticulata*, *Dipterocarpus coriaceus*, *Hopea enicosanthoides*, *Shorea inaequilateralis*, *Shorea induplicata* and *Shorea praestans*) are available in *ex-situ* collections. Effort to establish *ex-situ* collection of all threatened dipterocarp taxa is hampered by the unavailability of the seeds as most taxa are not fruiting regularly or annually. At the same time, the skill and knowledge to propagate planting materials using other methods are still lacking; thus, long-term and continuous commitment is important to conserve the threatened dipterocarps.

(ii) Awareness and training program on Sarawak Red List and threatened dipterocarps

In collaborations with Sarawak Timber Association (STA) and the timbers concessionaire, public awareness sessions on the Sarawak Plant Red List and the threatened dipterocarps have been carried out, for examples, briefing sessions for STA members and training for the staff and workers for identification of threatened taxa at Anap Muput FMU. Posters showing the threatened taxa were produced as reference materials for the workers at the FMUs.

(iii) Management recommendation to conserve rare, threatened and endangered (RTE) dipterocarps within FMUs and LPFs

The publications of Sarawak Plant Red List Series I and II for the dipterocarps (Julia et al., 2014; Julia & Vilma, 2016) is used as reference in the implementation of Principle 6 and Principle 9 as required in the Malaysian Criteria and Indicators (MC&I) for Forest Management Certification. MC&I is a standard for certification of natural forest and forest plantation under the Malaysian Timber Certification Scheme. Thus to comply with the requirement of certification standard, the timber industries are to protect the RTE species as specified in Principle 6 and maintaining the HCVPs in Principle 9. Appropriate measures to conserve and/or enhance conservation of threatened dipterocarp taxa within their license areas were recommended by SFC and are incorporated in the management plan.

The outcome of this assessment is important in setting priority for the conservation of threatened species in Sarawak. The effort to conserve threatened taxa of other plants in general and the threatened dipterocarps in particular will directly contributing to Malaysia's policy of conservation and sustainable utilization of biodiversity particularly with regards to threatened species. Various initiatives, both at national and international levels are being implemented to address issues and drawbacks related to the conservation of dipterocarps and dipterocarp forests. The issues that are under investigation cover a very wide spectrum, from basic management issues by Food and Agriculture Organization (FAO) and International Tropical Timber Organisation (ITTO), to producing quick field identification guides, biodiversity, ecology, economics and propagation (Appanah & Turnbull, 1998).

4.0 CONCLUSION

The findings of this assessment provide local insight on the conservation status of the dipterocarps in Sarawak. Positive results were obtained with more downgraded conservation status from species that been listed as threatened in IUCN Red List. With the identification of taxa that are really threatened in Sarawak, more concerted efforts should be done to prevent the threatened taxa from becoming extinct in Sarawak. More efforts from all stakeholders are needed to ensure the continuous economic benefits from exporting of the not threatened dipterocarps as well as to conserve the threatened ones.

5.0 ACKNOWLEDGEMENT

We acknowledge the financial assistance for this project from the Ministry of Natural Resources and Environment, Sarawak Timber Association and Sarawak Forestry Corporation. We are also sincerely grateful to Forest Research Institute Malaysia (FRIM), Dr Peter Ashton, timber concessionaires and various state government departments for their assistance and support during the implementation of this project. Within SFC, we would like to thank the current and previous management team, staff from Regional Offices well as all our colleagues for their direct or indirect support and assistances.

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7.0 APPENDIX

Appendix 1: List of threatened taxa

Threatened category	Taxon
Critically Endangered (CR)	<i>Dipterocarpus coriaceus</i> , <i>D. cuspidatus</i> <i>Dryobalanops fusca</i> <i>Hopea depressinerva</i> , <i>H. obscurinerva</i> , <i>H. vaccinifolia</i> <i>Shorea bullata</i> , <i>S. dispar</i> , <i>S. foraminifera</i> , <i>S. inaequilateralis</i> , <i>S. induplicata</i> , <i>S. praestans</i> , <i>S. revoluta</i> , <i>S. rotundifolia</i> , <i>S. tenuiramulosa</i> , <i>S. virescens</i> <i>Vatica adenanii</i> , <i>V. endertii</i> , <i>V. latiffii</i> , <i>V. patentinervia</i>
Endangered (EN)	<i>Anisoptera marginata</i> , <i>A. reticulata</i> <i>Dipterocarpus conformis</i> subsp. <i>borneensis</i> , <i>D. glabrigemmatus</i> , <i>D. humeratus</i> , <i>D. stellatus</i> subsp. <i>stellatus</i> , <i>D. sublamellatus</i> <i>Dryobalanops rappa</i> <i>Hopea aequalis</i> , <i>H. altocollina</i> , <i>H. andersonii</i> subsp. <i>basalticola</i> , <i>H. centipeda</i> , <i>H. enicosanthoides</i> , <i>H. ferruginea</i> <i>Parashorea malaanonan</i> <i>Shorea alutacea</i> , <i>S. andulensis</i> , <i>S. calcicola</i> , <i>S. chaiana</i> , <i>S. cordata</i> , <i>S. flemmichii</i> , <i>S. guiso</i> , <i>S. hemsleyana</i> subsp. <i>grandifolia</i> , <i>S. lamellata</i> , <i>S. macrantha</i> , <i>S. materialis</i> , <i>S. mujongensis</i> , <i>S. pachyphylla</i> , <i>S. pallidifolia</i> , <i>S. platycarpa</i> , <i>S. resinosa</i> , <i>S. teysmanniana</i> , <i>S. uliginosa</i> , <i>S. woodii</i> <i>Vatica chartacea</i> , <i>V. congesta</i> , <i>V. glabrata</i> , <i>V. havilandii</i> , <i>V. maingayi</i> , <i>V. oblongifolia</i> subsp. <i>elliptifolia</i> , <i>V. venulosa</i> subsp. <i>venulosa</i>
Vulnerable (VU)	<i>Anisoptera costata</i> <i>Dipterocarpus applanatus</i> , <i>D. caudatus</i> subsp. <i>penangianus</i> , <i>D. eurynchus</i> , <i>D. geniculatus</i> subsp. <i>geniculatus</i> , <i>D. gracilis</i> , <i>D. mundus</i> , <i>D. pachyphyllus</i> , <i>D. rigidus</i> , <i>D. stellatus</i> subsp. <i>parvus</i> , <i>D. tempehes</i> <i>Hopea longistrata</i> , <i>H. megacarpa</i> , <i>H. mengerawan</i> <i>Shorea acuminatissima</i> , <i>S. agamii</i> subsp. <i>agamii</i> , <i>S. albida</i> , <i>S. almon</i> , <i>S. biawak</i> , <i>S. collaris</i> , <i>S. confusa</i> , <i>S. dealbata</i> , <i>S. domatiosa</i> , <i>S. elliptica</i> , <i>S. falcifera</i> , <i>S. flaviflora</i> , <i>S. foxworthyi</i> , <i>S. hypoleuca</i> , <i>S. inappendiculata</i> , <i>S. isoptera</i> , <i>S. ladiana</i> , <i>S. macrobalanos</i> , <i>S. obovoidea</i> , <i>S. slootenii</i> , <i>S. smithiana</i> , <i>S. splendida</i> , <i>S. subcylindrica</i> , <i>S. superba</i> <i>Vatica compressa</i> , <i>V. granulata</i> subsp. <i>sabaensis</i> , <i>V. rotata</i> , <i>V. rynchocarpa</i> , <i>V. vinosa</i>

**INFORMATION PAPER 29: RESEARCH & DEVELOPMENT OF
INDUSTRIAL FOREST IN SARAWAK: AN OVERVIEW**

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Abstract

Establishment of industrial forest plantation in Sarawak is aiming to overcome the expected shortage in timber supply and to reduce pressure on natural forest. To-date, the rate of planting has been unsatisfactory for not meeting its targets. Therefore Research and Development (R&D) is one of the main strategies in maneuvering this industry forward. In general, research activities in Sarawak have covered various aspects but mainly focusing on high quality planting materials, nursery management, pest and disease management, silviculture treatments and soil suitability. R&D efforts have been intensified with the implementation of Planted Forest Research Program in collaboration with the License Planted Forest holders. This paper attempts to compile and highlight the R&D that have been carried out and progressed for the past 10 years.

Keywords: Licensed Planted Forest (LPF), fast growing species, pests and diseases, silvicultural practices, site-species matching.

1.0 INTRODUCTION

Sarawak as the largest state in Malaysia represents the biggest forested area in the country. Thus, Sarawak is continuously considered as the leading producer for timber in Malaysia. Timber has been one of state's major income earner for the past few decades. However, forested area in the state is depleting and this trend will eventually affect the supply of timber from natural forest over time. Sarawak log's production for the period of over ten years is shown in Fig. 1.



Fig. 1: Sarawak's logs production 2000-2017

Even though tree plantation has a long history in the State, very little is known on production at a commercial scale. When Sarawak first ventured into commercial industrial forest two decades ago, we were still at an infant stage regarding the basic knowledge on species and site selection. These were the experiment stages where the industry was going through trial and error of various species to various regions within Sarawak.

First embarkation on forest plantation was in the 1920s where focus was on indigenous species such as *Shorea macrophylla*, *Durio zibethinus* and other hardwood species. It was part of agroforestry program and were conducted on small scale basis (Kendawang, 1996). Major shift into plantation happened in the 1960's when Reforestation Program for past shifting cultivation lands was initiated. Several conifer species were chosen and tested in the field (Varmola, 2002). However, due to the poor performance of conifers (Fahlman, 1975), in the 1970's, fast growing tropical hardwoods were introduced objectively to restore lands that underwent shifting cultivation. Encouragingly in 1995, a total of approximately 13,000 hectares had been restored with various timber species. During this time, planting was merely for restoration and rehabilitation purposes, and not with the intention of timber production and for commercial purposes.

1.1 Industrial forest for commercial purposes

Establishment of large scale tree planting for commercial purposes had emerged as industrial forest in mid-1990. The aim is to sustain timber resources while reducing pressure on naturally existing forested area. Sarawak's then Chief Minister had proposed one billion trees to be planted using three billion ringgit (Chan et. al., 1998). It is envisioned that 1 million hectares of industrial forest will be planted by 2020. However, various level of uncertainties alongside with investment risk due to long profit making cycle may have hindered the State from reaching its 1 million ha target. Therefore in order to move forward new knowledge and technologies need to be generated to facilitate the rapid expansion of industrial forest in the State to expedite the timber supply to downstream industries.

In view of this, Sarawak's government is committed in reducing the pressure on its natural forest by encouraging industrial forest. Thus, to regulate the establishment and to ensure successful implementation of industrial forest, Forest (Planted Forests) Rules 1997 came into force on 1st March 1997 (Lee, 1998).

1.2 Research and Development team

The Government has always been supportive to maintain competitive environment for both upstream and downstream activities of the industrial forest initiatives. Sarawak Forestry Corporation (SFC) through its Applied Forest Science Industry Development (AFSID) division has been actively involved in most of its research and development (R&D) activities. The Licensed Planted Forest (LPF) holders have also established their own research teams to conduct trials and various research undertakings. Collaboration studies among stakeholders are also ongoing, with Sarawak Timber Association (STA) plays an important role in bringing together the industry (tree planters), collaborating with experts and academicians to build up strong deposit of knowledge to maneuver this industry forward. It is deemed prudent to integrate all aspects of research findings into the planning process and implementation stages.

2.0 NOW AND THEN

Progress of planting throughout the state is behind targeted schedule. As of December 2017, the total area of industrial forest planted was 403,017 hectares (Forest Department Sarawak), which was approximately 60% way behind the target of 1 million hectares. The rate of planting appears to be hurdled with many obstacles such as disease, manpower, availability and supply of high quality planting materials (HQPM) and other external concerns such as land dispute issues. From the R&D perspective, many efforts were conducted on the need basis and are in progress to assist the industry achieving the planting target. In 2014, a state-wide inventory was conducted to evaluate the readiness of the LPF holders to undertake their respective planting plan. The focus of this inventory was on the availability of the HQPM. Findings of the inventory suggested that beside the needs on the availability of HQPM, preparation of comprehensive planting plan (based on end-use) and R&D support for site-species matching and quality control of planting materials are also crucial. Consequently, a HQPM project was initiated and far advancing into the establishment of research program known as Planted Forest Research Program (PFRP). PFRP took off with a more aggressive collaborative R&D program between SFC and LPF holders. This program should be able to create a solid platform for planters to work together in improving their growth and yield through R&D.

2.1 The importance of R&D

It is sensible to conduct studies to better understand our planted species; its performance on the ground, potential and market value. These are some basic information needed to equip the industry in managing the industrial forest prior planting establishment:

- 2.1.1 Planting materials such as seed and its availability, cutting and its skill and technology;
- 2.1.2 Silviculture practices include growth and tending, both at nursery stage and in the field, nutrient deficiency symptoms, fertilization program, pruning and thinning, weed control, pests and diseases incidence, both at nursery stage and in the field and pests and diseases management; and
- 2.1.3 Management as in stand establishment guidelines, site-species matching procedures, fertilization program and weeding guidelines, early financial returns, labor recruit management and growth performance analysis.

Beside R&D in planting establishment and field maintenance, R&D in timber downstream industry is also important. Since 90's, the Malaysian Government has imposed log export quota which has facilitated the growth of domestic wood processing industry. This in turn has indirectly encouraged more R&D for downstream wood industry. End use for finished and semi-finished product has come into interest. Value added products such as engineered wood, wood-polymer and wood composite are now within scope of interest.

2.2 R&D conducted by AFSID (2007-2016)

For the past 10 year, AFSID has conducted various research activities to better understand various planted species. Four most planted species for commercial industrial forest in Sarawak during this period are *Acacia mangium*, *Eucalyptus*

pellita, *Falcataria moluccana* (Batai) and *Neolamarckia cadamba* (Kelampayan). Even though species such as *Acacia* has been widely planted in other part of the world and many studies had been conducted for this particular species, yet there is a necessity to evaluate this species' performance in local environment. It is the second most studied planted species in the state, after the indigenous *N. cadamba* (Fig. 2). *A. mangium* as the most site-tolerant exotic tropical species remains the most studied species among the other two, as it is widely planted within LPF sites throughout Sarawak. *N. cadamba* stays top in the R&D favorite list as it is one of the indigenous that promotes great potential and so much information are required to better understand this particular species.

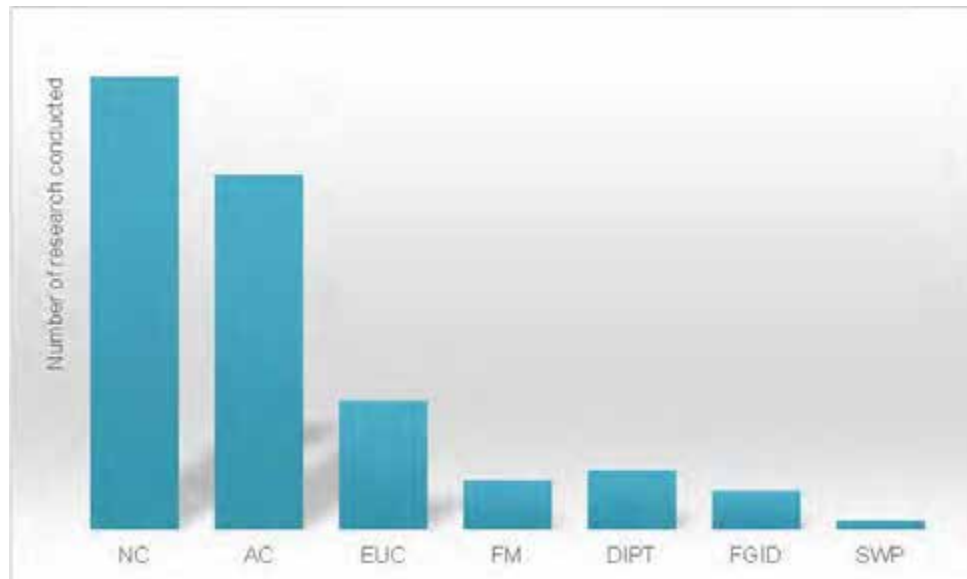


Fig. 2: Most commonly studied planted species (2007-2016)
NC: *N. cadamba*, AC: *Acacia* spp, EUC: *Eucalyptus* spp., FM: *F. moluccana*, DIPT: Dipterocarp species, FGID: fast growing indigenous species, SWP: swamp species.

Field of studies ranged from the nursery stages to field maintenances up to wood properties and utilization (Fig. 3). Diseases incidence and its management was the most studied subjects for the past ten years, followed by growth assessment studies. R&D on pest was also among the top concerns. Disease and pest are considered as an immediate threat, and therefore may have attracted the need to conduct research to understand the issues which will facilitate the mitigation measures. Silvicultural studies which includes early planting preparation and soil fertility and suitability were also on the priority list for R&D. The least studied subject was on the genetic studies of wood properties.

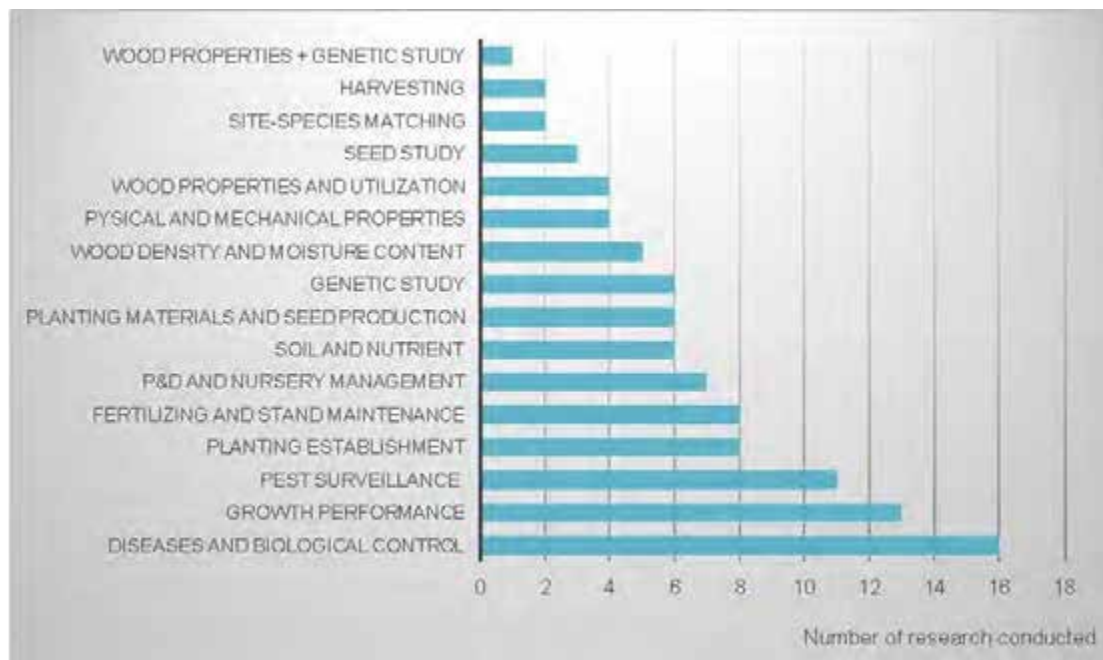


Fig. 3: Most researched subjects for the four most planted species within the LPF sites (2007-2016)

Most research was carried out on two species namely *A. mangium* and *N. cadamba* followed by *E. pellita* and *F. moluccana*. Most research subjects for the four most common planted species are shown in Figs. 4 - 7. The type of research carried out appears to be influenced by the species. For example, disease and biological control seems to be the priority research for *Acacia* spp. while pest surveillance for *N. cadamba*.



Fig. 4: Most researched subjects for *Acacia* spp. (2007-2016)

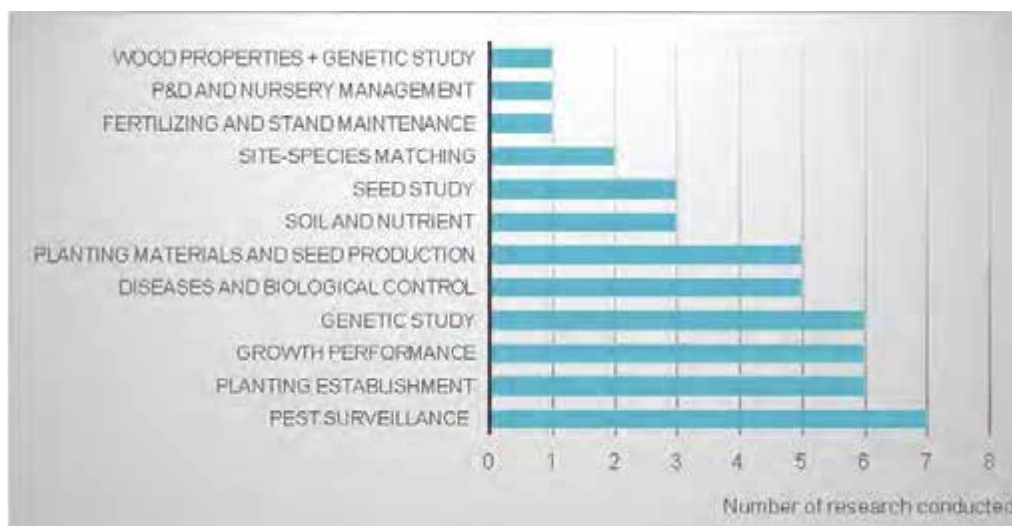


Fig. 5: Most researched subjects for *N. cadamba* (2007-2016)

As expected, research on exotic species such as *Eucalyptus* spp was focused on fertilizing, stand maintenance and growth performance (Fig. 6). This suggest that there is interest in exploring fast growing species based on reports published elsewhere.

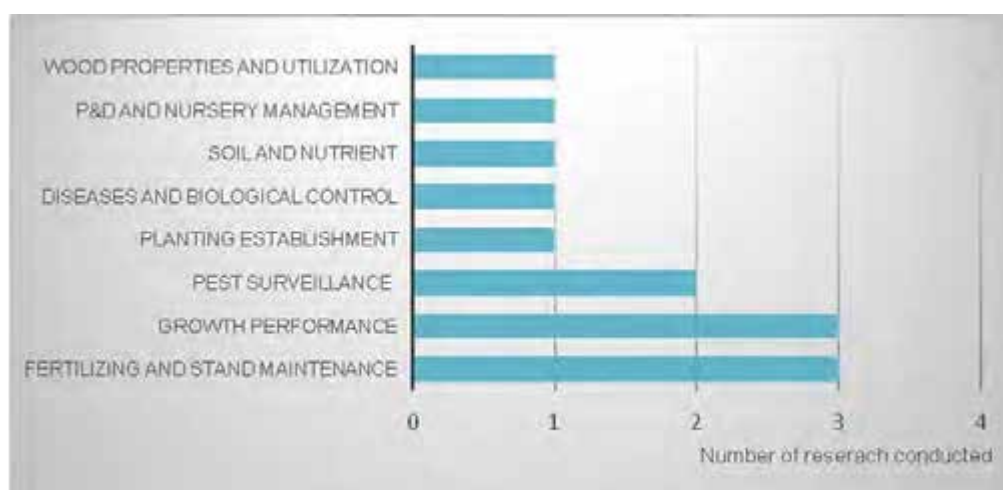


Fig. 6: Most researched subjects for *Eucalyptus* spp. (2007-2016)

Research for *F. moluccana* is still very scarce as shown in Fig. 7. Both *F. moluccana* and *Eucalyptus* spp. only came into interest for industrial forest well ahead if compare to *Acacia* spp.

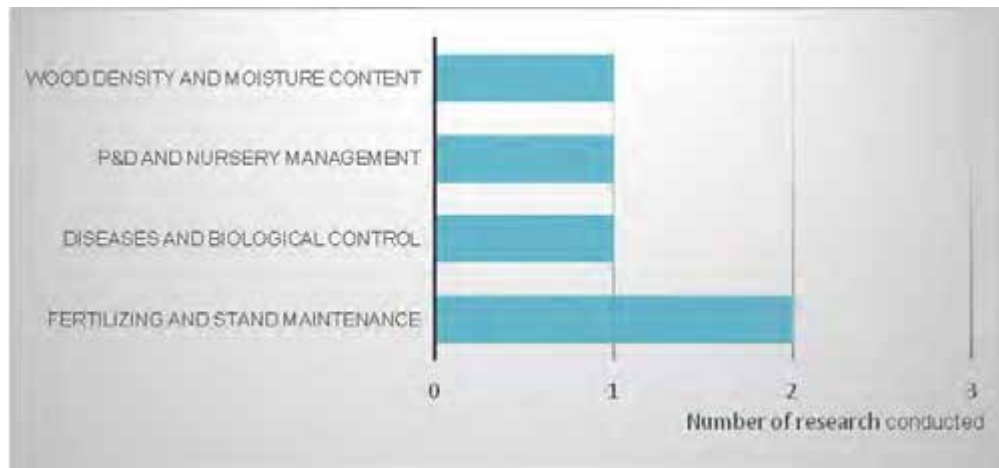


Fig. 7: Most researched subjects for *F. moluccana* (2007-2016)

2.3 R&D collaboration and Planted Forest Research Program

Most of the research works were based on technical advice required by selected LPF holders. Fig. 8 shows the accumulative number of LPF that have been collaborated with AFSID in numbers of research activities from 2008 to 2015. This is partly due to the challenges and concerns experienced by the LPF during and after the implementation of industrial planting of various species. In many instances, understanding on planting the right species at the right site is fundamental and much information are lacking from the aspects of planning to planting itself. It is an evident that there is a need to collaborate, to enhance and strengthen the R&D effort between SFC and LPF. Therefore, team of researchers from AFSID and concerned LPF holders worked together in coordinating various research activities to better understand the selected planted species in their domestic environment. Both parties played important roles and contributed in ensuring the success of these research undertakings. However most of the research activities conducted were based on short term and on need basis and only able to produce preliminary results.

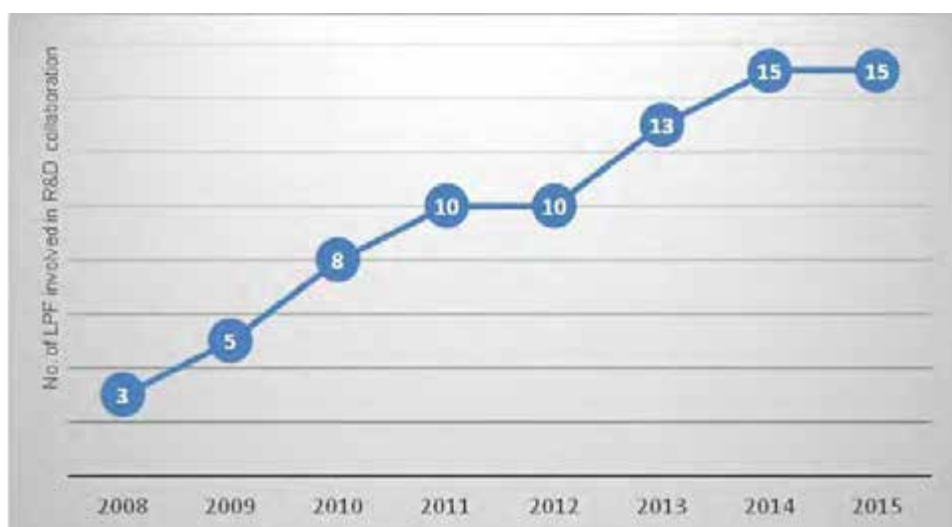


Fig. 8: Accumulative number of LPF involved in R&D involving industrial forest in AFSID from 2008 to 2015

In 2016 PFRP came into action, with more progressive and long term objectives. Through this program, various research trials were established, targeting the four main species, *A. mangium*, *N. cadamba*, *F. moluccana* and *E. pellita*. Initially, the program was developed to overcome the shortage of high quality planting materials and to carry out research activities in tree breeding. Well along, the program broadened to support other R&D undertakings such as establishment of good silvicultural practices, pest and disease survey and monitoring, and wood property studies.

Within a short period of time, this program has successfully involved a total of 11 LPF companies that has participated as collaborative partners which covered 13 LPF areas throughout the state. To date, there are about 80 trials that have been established state-wide which comprises different trial types, including the establishment of trials for alternatives species. Trial types established under the PFRP includes taxa-seed source trial, progeny trial and silviculture trial. The summary of trial established by type is listed in Table 1.

Table 1: List of trials established under Planted Forest Research Program from 2016 to 2018 throughout Sarawak showing most of the studies extends a period of one year.

Trial Type	Species Code	< 6-months	> 6 months	> 1 year	> 2 years	Total
Taxa Seed Source	AM	1	2	4	7	14
	EP		3	4	7	14
	FM	1	3	2	7	13
	NC		1	2	4	7
	AC	1	2			3
	AA	1				1
	MX (indig.)	2				2
Silv (fertilizer)	AM			2		2
	EP		1	6		7
	FM			1	1	2
	NC		1			1
Progeny	EP			4	1	5
	FM	1		5		6
	NC			1	1	2
Grand total		7	13	31	28	79

(AM: *Acacia mangium*, EP: *Eucalyptus pellita*, FM: *Falcataria moluccana*, NC: *Neolamarckia cadamba*, AC: *Acacia crassicarpa*, AA: *Acacia auriculiformis*, MX: Mixed of selected indigenous species)

Under this program, there were numerous Standard Operating Guidelines that had been documented and produced which was disseminated to involving plantation holders. The guidelines cover various aspects of commercial industrial forest such as planting, trial establishment, pest and disease, silvicultural practices, and various others. List of guidelines and technical notes produced under the program is stipulated in Table 2.

Table 2: List of guidelines and technical notes that were produced under Planted Forest Research Program

Field / Area	Title of Standard Operating Practice
Nursery	1. Guidelines to Produce Good Quality Seedlings in Sarawak 2. Raising Seedlings for Research trials under the Planted Forest Research Program
Trial establishment	1. Establishing Research Trials under the Planted Forests Research Program 2. Trial assessment guidelines 3. Guidelines to design and layout trials under Planted Forests Research Program
Silviculture and Fertilizer	1. A review of nutritional requirements for <i>Eucalyptus pellita</i> 2. Silviculture guidelines to establish seedlings in Sarawak
Pests and Diseases	1. Field guide to identify pests of Eucalyptus 2. Guidelines to service insect traps and collect and store specimens 3. Guidelines to detect and monitor Pests and Diseases in Planted Forests
Grafting	1. Guidelines to graft research material under the Planted Forests Research Program
Growth and Yield	1. Growth and Yield Manual for Planted Forests in Sarawak 2. Establishment & Management of <i>Acacia mangium</i> for solid wood products
Harvesting	1. Guidelines to carry out good harvesting practices in Sarawak

3.0 THE WAY FORWARD

In general, research activities in the State have covered various concerns and issues in plantation establishment for commercial scale industrial forest. Among most covered subjects are supply of planting materials, nursery management, pest and disease management, silvicultural treatments, wood properties and utilization. R&D activities have increased in recent years which have provided substantial recommendations to the industry in achieving the planting target. R&D is indeed one of the important components that can expand the knowledge and experience in successful implementation of the industrial forest in Sarawak.

Planted Forest Research Program is a pioneer program in the state that has received the support from collaborators of LPF holders with the financial aid from State Government of Sarawak. This suggest that the State is serious in the sustainable forestry and in improving timber industry related economy. It is hoped that this program will progressively move forward with its positive momentum for the advancement of the industry. The implementation of new development from the findings is expected to achieve the research goals under this program. It is predicted that in five years to come, PFRP will comprehensively provide findings that are beneficial to the industry, particularly in developing main source for high quality planting materials through its tree breeding program.

In conclusion there are many more crucial research activities (e.g. Carbon Sink & Stocks, Climate Change, Growth Enhancement) can be proposed that will benefit the industry.

However, the R&D proposal should be focused on the need to facilitate the growth based on comprehensive regime for a minimum of three years. Funding for the proposed period should also be secured by the relevant stakeholders. In addition, a reliable technical working group, which involved all the relevant stake holders should be formed to better coordinate and manage all the research activities so that the generated knowledge can be shared and used for the benefit of the State and its people.

4.0 ACKNOWLEDGMENT

I have taken efforts in this report. However, it would not have been possible without the kind support and help of many individuals. I would like to extend my sincere thanks to all of them.

I would like to extend my gratitude to Mr Julaihi Abdullah, DGM of AFSID for his approval and guidance in getting this report done. I am highly indebted to Dr Alik Duju and Mr John Sabang for providing necessary information regarding the report. Deepest appreciation to Mdm Evelyn Jugi for her constant support and advice throughout the process. My thanks and appreciations also go to my colleagues at Timber Training Unit and Seedbank for their co-operation and encouragement which help me in completion of this report.

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**ABSTRACTS / EXTENDED ABSTRACTS
OF POSTERS (P)**

ABSTRACT FOR POSTER

**P1: DEVELOPMENT OF A FIELD SENSING APPROACH FOR LOGS
LEGALITY VERIFICATION**

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Abstract

Sarawak is rich in species diversity which comprise of high diversity of timber-producing species. The valuable tropical timbers are not only important economically but also serves as a keystone ecological resource of wood in tropical southeast Asia. However, important timber resources are still being illegally extracted and the main concern here is when it comes to protected timber species in Sarawak. In this study, four common illegally logged species (*Koompassia malaccensis*, *Koompassia excelsa*, *Shorea macrophylla* and *Shorea ochracea*) are selected due to their close similarity in log form to the non-protected timber species and are illegally declared by the unscrupulous loggers in their effort to avoid detection by the authorities. As sole dependence on morphological traits exhibit several limitations resulting in misidentification of these timber species, near-infrared spectroscopy provides an opportunity in identifying these unlawful logs. In this study we showed the potential of adopting spectroscopic techniques as a tool for the field enforcement crew to distinguish between the similar timber species group. The results are expected to be useful in the detection of unlawful camouflage timbers during the enforcement of illegal logging in Sarawak.

Keywords: Protected timber, enforcement, near-infrared spectroscopy, illegal logging.

P2: PENCEGAHAN DAN PENGUATKUASAAN HUTAN DI SARAWAK

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Asminie Wati Belaja and Carole Lenan**

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Abstrak

Penguatkuasaan merupakan salah satu fungsi Jabatan Hutan Sarawak yang penting. Sejak dahulu lagi fungsi ini telah banyak memberi kesan yang positif terhadap perkembangan industri perikanan di Sarawak. Buktinya sehingga ke hari ini Sarawak masih mampu mengeluarkan kayu balak bukan sahaja untuk kegunaan industri tempatan malah 30 pertatus daripada pengeluaran adalah untuk export. Sepanjang lima tahun yang lepas banyak kaedah penguatkuasaan terkini telah diadaptasi oleh Jabatan Hutan Sarawak bagi memastikan hutannya senantiasa terpelihara. Penggunaan Imej satelit, dron dan hiperspektral diantara yang telah digunakan sehingga kini untuk mengesan dan membenteras kegiatan pembalakan haram. Penggunaan teknologi terbaru ini telah dapat memberi pengesanan diperingkat awal

aktiviti disesuatu kawasan sehingga pihak jabatan dapat mencegah dan seterusnya mengambil tindakan pemantauan yang agresif bagi mengekang kegiatan lanun-lanun balak. Statistik sepanjang empat tahun lepas (2014-2017) menunjukkan kadar penurunan kes dan jumlah rampasan kayu balak di Sarawak dapat membuktikan ketegasan jabatan dalam memerangi kegiatan haram ini sepanjang masa. Jabatan Hutan Sarawak tetap komited memastikan kelestarian hutan Sarawak untuk generasi yang mendatang.

P3: CONSERVATION INTERNSHIP PROGRAM (CIP) AS CAPACITY BUILDING IN FOREST MANAGEMENT CERTIFICATION

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Abstract

The State of Sarawak is committed to have all long term forest timber licenses certified by 2022. However, the shortage of expertise faced by the timber industry especially on High Conservation Value Areas (HCVA), flora and fauna management, ecology and sociology has hindered the Forest Management Units (FMUs) from achieving Forest Management Certification (FMC). The Conservation Internship Program (CIP), which rides on the Research for Intensified Management of Bio-rich Areas (RIMBA) of SARAWAK platform, is designed to address this issue. This program provides hands-on training by local and international expertise. Eight (8) training modules were designed and developed in relation to the Malaysian Criteria and Indicators (MC&I) for FMC. Graduates from this internship program are expected to have working knowledge to assist the FMUs undergoing the forest management certification. Fifteen interns had graduated from this program and have been absorbed by the FMUs.

Keywords: Forest Management Certification (FMC), High Conservation Value Areas (HCVA), RIMBA, Conservation Internship Program, Malaysian Criteria & Indicator (MC&I)

**P4: SPECTRAL VARIATION OF GENUS *Dryobalanops* Gaertn
(DIPTEROCARPACEAE) BASED ON CROWN CHARACTERISTICS
AND LEAF BIOPHYSICAL PROPERTIES**

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Abstract

The genus is one of the ecologically dominating groups in the mixed dipterocarp forest Gaertn(MDF) of Sarawak due to their high distribution. *D. beccarii* and *D. lanceolata* are currently being placed in endangered category of the red list which among others requires a country to report on its taxonomic population prior to removal from the threatened category and be able to be recommended for sustainable use and trade. However, there exists a complexity in distinguishing *D. aromatica* and *D. beccarii* in the field due to their similar visual appearance based on taxonomic properties. Hyperspectral image datasets have been widely used as a tool in studying forest ecology. It provides the capability to discriminate between different taxonomic groups of trees which are not possible with visual observation and imaging systems due to their high similarity. This study aimed to observe and compare the biophysical properties of *D. aromatica*, *D. beccarii*, and *D. lanceolata* based on their observed crown spectral variations. The study involved the collection of airborne hyperspectral image datasets over field plots established within the Lambir Hills National Park. These were then correlated with the analysis of leaf pigments and biophysical properties sampled from the sunlit canopies of the three species types. Results showed that spectral variations were attributed to differences in the biophysical properties and also pigments that were present in the leaves.

Keywords: Dipterocarp, *Dryobalanops*, crown characteristics, leaf biophysical properties, spectral variation.

P5: THE TERRESTRIAL FAUNA COMPOSITION OF THE PEAT SWAMP FOREST OF SEDILU NATIONAL PARK, SARAWAK, MALAYSIA

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Abstract

Surveys of terrestrial fauna were carried out in the western part of Sedilu National Park (SeNP) which consisted of logged over peat swamp forests surrounded by oil palm plantation. This project is a collaborative effort between Sarawak Forestry and Malaysian Palm Oil Council (MPOC) to survey the presence of wildlife at SeNP. The surveys concentrate on primates, small mammals, birds and amphibians. Methods employed during the surveys included aerial survey, line transects, mist-netting and live-trapping. This study recorded 4 primate species, 7 small mammal species, 63 bird species and amphibian species. Orangutans are still found in the area as evidenced by nests seen during aerial and line transect surveys. Significant findings from this survey include a totally protected and near threatened hornbill species, Black Hornbill (*Anthracoceros malayanus*) and two potentially new frog species (*Hylarana* sp. and *Microhyla* sp.). Information gathered in this study will be useful for the management and conservation of wildlife in SeNP.

Keywords: Peat swamp forest, primates, small mammals, birds, amphibians

P6: SIBU BUTTERFLY CONSERVATORY

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Abstract

Sibu Butterfly Conservatory or previously known as Sibu Butterfly Farm (SBF) was established in 1997 and open to public the following years. It was closed and inactive when the new management took over in 2003. When it was fully functioning, SBF housed more than 100 species of butterflies, 20 species of host plants and recorded more than 12,000 visitors. The conservatory consists of the main enclosure, breeding room, nursery and basic facilities for visitors.

In 2014 Forest Department Sarawak was allocated an amount of RM 255,000.00 to re-establish the conservatory under the Mid-term Review of the Tenth Malaysian Plan (10MP). The main objectives of re-establishing of the conservatory are to function as tourist destination, centre for education, recreation, and scientific research. Among the main components of this project are to renovate and upgrade the present facilities. New host plants

and work stations were introduced to facilitate breeding activities. The surrounding areas were given a new facelift with planting of many new flowering plants, repainting and new rest areas to cater for more visitors.

The new well-landscaped within and outside the main enclosure were completed in 2016 and ready to be opened for the public and other interested parties. Hopefully the Sibul Butterfly Conservatory will serve its purposes and as a new attraction to the central region of Sarawak. It will benefit the local communities especially the school children for their nature education, awareness programme and also for conservation purposes.

Keywords: Sibul Butterfly Conservatory, host plant, main enclosure, breeding room, nursery

P7: WILD ORCHID CONSERVATION IN SEMENGGOH NATURE RESERVE, KUCHING, SARAWAK

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Abstract

The Wild Orchid Garden was established in 1982 covering an area of approximately 2-ha with the aim to conserve wild orchids of Sarawak. To-date, at least 300 species from 120 genera have been planted in the garden. The wild orchids were collected from various localities throughout Sarawak including the species from threatened habitats such as the logged-over areas, dams and quarry sites for *ex-situ* conservation. This paper highlights some of the interesting species that are rare, endemic, or newly described in Sarawak.

Keywords: orchid, conservation

P8: SOIL TYPE OF TOTALLY PROTECTED AREAS IN SARAWAK

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Abstract

Totally Protected Area (TPA) in Sarawak refers to forest lands designated and established under the provisions of the National Parks Ordinance, 1998 and Wild Life Protection Ordinance, 1998. These forest lands are managed to generate sustainable benefits for the society. Soil survey has been carried out since 2013 to document the soil information at several TPAs in Sarawak, which covered Gunung Gading National Park, Kubah National

Park, Bako National Park, Lambir Hills National Park, Mulu National Park, Pulong Tau National Park and Santubong National Park. There are two methods for soil study: soil augering and pit digging. From the survey done, the most commonly found soil group is Red Yellow Podzolic, followed by Grey White Podzolic, Alluvial and Thionic.

Keywords: TPA, National Park, Augering.

P9: *AQUILARIA* SPECIES OF ULU MENTAWAI, MULU NATIONAL PARK

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Abstract

Two species of *Aquilaria* namely *Aquilaria beccariana* and *Aquilaria malaccensis* were recorded during two years research in Ulu Mentawai, Mulu National Park. A total of 113 trees of both species with diameter from less than 5 m to more than 40 cm dbh were tagged, recorded and mapping by using Global Positioning System (GPS). Based on the preliminary results, Ulu Mentawai of Mulu National Park has set a new record for the distribution of *Aquilaria malaccensis*. Three species of *Aquilaria*; *Aquilaria beccariana*, *Aquilaria malaccensis* and *Aquilaria microcarpa* listed as protected plants in Wild life Protection Ordinance of Sarawak, 1998 because of the highly valuable resin known as agarwood or gaharu for incense, traditional medicines and in the perfumery industry. Thus, survey on population of gaharu in Ulu Mentawai, Mulu National Park had been conducted to check the population of the species in the area and as efforts in conservation of the protected species in Sarawak.

Keywords: *Aquilaria* sp., Sarawak, conservation and population

**P 10: THE SOILS OF GUNUNG LESONG NATIONAL PARK: A
REVIEW**

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Abstract

Effective forest management plan requires sufficient baseline information on forest condition. Among the key factors that influencing the forest health are its geological and soil characteristics. Geological characteristics such as development of parent materials will influence the development of soils of a particular area. Variability in soils formation and development following geological processes could affect the type and forest composition. Thus, understanding the soils formation at the national parks deserve genuine priority to provide clear overview of the existing physical environment before any forest management plan can be recommended towards conservation of the forest resources in a sustainable manner. According to the Sarawak soil classification system and *in-situ* morphology observations, our findings indicated that the soil morphological characteristics of Gunung Lesong National Park resemble Lingga soil series as a dominant unit in association with Silantek and Meluan soil series and were categorised mainly under the soil group types of Oxisols, Podzols and Skeletal, respectively. Moreover, the recommendation on the potential use of the forest within GLNP based on land use capability classification will be reviewed and discussed in this paper.

Keywords: Gunung Lesong National Park, soil morphology, soil series, land use capability classification, Sarawak

**P 11: A REVIEW ON THE GEOLOGICAL AND MINERAL
RESOURCES OF GUNUNG LESUNG NATIONAL PARK**

**Wasli, M.E.^{1,2*}, Meekiong, K.^{1,2}, Perumal, M.¹, Ho, S.Y.¹, Azahari, O.³, Marconi S.J.³,
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Abstract

The diversity in geological properties in a certain area contributes to the existing biological diversity. Theoretically, the diverse the geological setting, the more diverse biological composition/ communities are to be expected. On a threshold, understanding the geology of an area allows land managers to possess clear overview on how the ecosystem functions but also, provide information on the bio-related aesthetic importance as well as geological hazardous locations within an area. The West Sarawak, can be described as comparatively stable continental core, formed by the orogenic movement during the late Neogene. Gunung Lesong National Park (GNLP), located at the western region of Sarawak specifically, in Lingga District in the Sri Aman Division. One of the most iconic physical features available in GNLP is a striking flat-topped mountain, over 3000 feet high, and extending roughly 6km east to west and about 3km north to south, giving it a resemblance to an inverted padi mortar, after its name of Lesong padi, thus, termed as Gunung Lesong. The present landscape of Gunung Lesong's physiography was mainly shaped by 3 cycles of erosion and deposition during Pleistocene period and categorized under two physiographic units namely; Penrissen physiographic unit and Pueh and Stapok physiographic unit where both units took place in early to mid Pleistocene epochs, dated back to 2.6 million years ago. Considering the unique geological features and formations of one of the smallest national park in Sarawak, this paper provides an overview on the geology and mineral resources available in GNLP. Such information will be useful for park managers in identifying specific location of interest that may require specific care and attention in planning their forest management practices.

Keywords: Gunung Lesong National Park (GNLP), geological formations, parent materials, rock types, mineral resources

P 12: *VATICA* OF SARAWAK (DIPTEROCARPACEAE): ENDEMIC SPECIES AND ITS CONSERVATION STATUS

Meekiong, K.¹, Nizam, M.S.², Noorhana, M.S.³, Wasli, M.E.¹, Mohizah, M.³Yahud, W.³, Yazid, K.³, Nur Safinas J.³ and Latiff, A.²

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Abstract

The family Dipterocarpaceae is an important tropical forest trees with 15 genera and over 600 species worldwide. The genus *Vatica* first described by Linnaeus in 1773 and was the third largest genus in the family with approximately 80 species in the world. *Vatica* has about 71 species in Malesia with 44 species distributed in Borneo. Those make the Borneo Island as the best representative and considered as epicenter of the genus. *Vatica* is the most difficult genus in family Dipterocarpaceae to study as it has excessive variations in-term of habit, habitat, morphological and anatomical features. Informally the genus has divided into three sections; *Sunaptea*, *Vatica* and *Pachynocarpus*, based on the calyx morphology. The objectives of this study are to document the populations of genus *Vatica* in Sarawak and identify the status of the species. The study has been conducted from 2011 until 2017, consisted of fieldworks, examination of specimens in herbaria and literatures. Out of 44 species in Borneo, 38 species (42 taxa) are recorded in Sarawak and eight species (including 1 variety) are identified as endemic to the State. The endemic species are; *V. abang-zoharii* sp. nov. ined., *V. adenanii*, *V. badiifolia*, *V. compressa*, *V. latiffii*, *V. pedicellata*, *V. oblongifolia* var. *selakoensis*, and *V. rynchocarpa*. The distributions of the aforementioned endemic species are restricted to specific habitat or areas in Kuching Division, except *V. rynchocarpa*, a riverine species that recorded only from Limbang Division. All species are considered as ‘Critically Endangered’ as density of their wild populations surveyed are very low.

Keywords: *Vatica*, Dipterocarpaceae, endemic species, conservation status, Sarawak

**P 13: A PRELIMINARY ASSESMENT OF ANURAN DIVERSITY IN
TRUSAN SUGUT FOREST RESERVE, SABAH**

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Abstract

This study was carried out to determine the species diversity of frogs and toads in the Trusan Sugut Forest Reserve (TSFR), a protected area located in the north-eastern coast of Sabah, covering an area of about 8,680 ha. Sampling was carried out over a three-day fieldwork using the visual encounter survey (VES) method in both lowland mixed dipterocarp forest and kerangas forest. Of the 329 individuals caught, a total of 17 frog and toad species, belonging to four families, were recorded from five sampling sites. The most common species was *Hylarana megalonesa*, representing 17% of total individuals. The anuran diversity was moderately high; with overall Shannon Wiener Index (H') were 2.54. Six Bornean endemic species were recorded during the survey, namely, *Hylarana ranicep* (Ranidae), *Polypedate sotiophus* (Rhacophoridae), *Limnonectes singeri*, *Occidozy gabaluensis* and *Limnonectes leporinus* (Dicroglossidae), and *Metaphrynella sundana* (Microhylidae). This study is limited by the short duration of sampling. Nevertheless, it provides useful baseline information on which to build future studies on anurans in Trusan Sugut, as well as to contribute to our current knowledge of anuran diversity and distribution in Sabah.

Keywords: Diversity, Class 1 Forest Reserve, frogs and toads

**P 14: A STUDY ON MEDICINAL PLANTS USED BY LOCAL PEOPLE
IN KG KANAWAHON, TRUSMADI, TAMBUNAN, SABAH**

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Abstract

A study on medicinal plants used by local people in Kg Kanawahon was conducted from the 5th to 10th June 2017. The village is located adjacent to Nuluhon Trusmadi Forest Reserve also known as Forest Management Unit (FMU) 10. The data was gathered from interviews followed by field visits to the nearby forest and villager's garden. This paper recorded 21 species of plants and their medicinal values.

Keywords: Medicinal plants, local communities and knowledge of medicinal plants

P 15: CULTURING SABAH ENDEMIC BEGONIAS VIA SEED CULTURE TECHNIQUE

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Abstract

Begonia has become one of the favourite garden species and is commercially marketed worldwide for its rich colour on the flowers, striking foliage, and flowering habit. The conventional propagation methods for *Begonia* are through direct seed sowing and vegetative means. However, past experiences showed that the endemic *Begonias* from Sabah has low survival rate through the direct seed sowing method due to unstable stem development during the seedling stage. Thus, a study was conducted to look into alternative ways to germinate endemic *Begonias*, such as using the optimized conditions of seed culturing technique. *B. postarii*, *B. ruthiae*, *B. tawauensis*, *B. bernadusii* and *B. gueritziana* that were collected from Danum Valley and Tawau area were selected as test subjects. High survival of the germinated plantlets was obtained. Therefore, optimization of seed sterilization is critical to ensure minimal contamination, at the same time, achieving optimize growth of the plantlets before undergoing the acclimatization stage.

P 16: CURRENT RESEARCH ON FUNGUS DIVERSITY UNDERTAKEN BY SABAH FORESTRY DEPARTMENT

Viviannye Paul, Momin Binti, John Lee Yukang, Dayang Fazrinah Awg Damit and Arthur Y.C. Chung

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Abstract

Fungi are closely related with plant pathology as they cause the majority of plant diseases. It is estimated that approximately 70% of the macro fungi still remain to be discovered. It is important to conduct research on fungus diversity in order to understand their roles in the forest. Fungus diversity study is one of the many research activities undertaken by the Forest Research Centre of the Sabah Forestry Department, especially within the Heart of Borneo area in Sabah. Opportunistic sampling is the method used in conducting the study of fungi in the forest in which “fungal forays” or survey is conducted along the way. The fungi sighted in the field were photographed and identified. Among the common fungi that can be found in the forest reserves comprise gilled fungi (e.g. *Amanita* sp.), jelly (e.g. *Dacryopinax* sp.), shelf and bracket fungi (e.g. *Fomitopsis* sp.), cup fungi (e.g. *Cookeina* sp.) as well as tooth fungi (e.g. *Hydnum* sp.). In 2017, surveys conducted in five forest reserves, namely Trusan Sugut Forest Reserve, Tambulanan Forest Reserve, Batu Timbang Research Station in Imbak

Canyon, Nuluhon Trusmadi (Extension) Forest Reserve, Ulu Segama Malua Forest Reserve and Danum Valley Conservation area.

P 17: DISCOVERY OF ONE OF THE WORLD'S TALLEST TROPICAL TREES IN SABAH – A SIGNIFICANT CONTRIBUTION TOWARDS FOREST CONSERVATION AND NATURE TOURISM

**John Sugau¹, Joan Pereira¹, Reuben Nilus¹, Jupiri Titin¹, Eyen Khoo¹, Rebecca Chong¹,
Viviannye Paul¹, Jikos Gidiman², Yap Sau Wai² and Arthur Y.C. Chung¹**

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Abstract

One of the world's tallest tropical trees was discovered in 2016 through Advanced Hyperspectral & LIDAR technology in Carnegie Airborne Observatory (CAO) by Prof. Gregory Asner & his team from Stanford University, USA, in collaboration with Sabah Forestry Department (SFD). The 94.1 m tree is located within the Danum Valley Conservation Area in eastern Sabah. As assigned by the Chief Conservator of Forests, the researchers from SFD, together with officials from Yayasan Sabah identified the tree species and verified the height captured via CAO by manually measuring the tree by a tree climber in early 2017, using a single rope system. The species was determined to be *Shorea faguettiana* or locally known as 'Seraya Kuning Siput' because of its snail-like exudations. The discovery of this towering tropical tree in the Bornean forest of Sabah highlights the importance of continuing and expanding conservation and management in this special region.

P 18: BIODIVERSITY CONSERVATION OUTSIDE OF TOTALLY PROTECTED AREA (TPA): THE CASE OF SARAWAK PLANTED FOREST (PULP AND PAPER) PROJECT IN BINTULU, SARAWAK

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Abstract

Planted forest and other land development projects can contribute more on biodiversity conservation through proper planning and continuous management. These areas can contribute and support biodiversity conservation in Sarawak by targeting areas outside of totally protected areas (TPAs). In the case of an industrial tree plantation, the Sarawak Planted Forest (Pulp and Paper) Project (SPFP) in Bintulu has been developed a conservation

program to conduct surveys and identification of High Conservation Value Areas (HCVAs) to set aside key areas for biodiversity conservation. Binyo Penyilam, Bukit Sarang and Bukit Mina Wildlife Corridor have been identified as key HCVAs for SPFP. Bukit Mina Wildlife Corridor being the largest contiguous corridor in Sarawak was designed to accommodate wildlife conservation in SPFP. These areas are conserved not only for conservation of Rare, Threatened and Endangered (RTE) species of flora and fauna but also for their unique landscape. Results of surveys especially on presence of RTE species can also be used as Ecotourism attraction within the HCVAs which will strengthen the conservation management in the areas.

Keywords: Biodiversity conservation, Wildlife Corridor, RTE, Management Plan.

**P 19: EFFECT OF TREATMENT ON GROWTH PERFORMANCE OF
Aquilaria microcarpa IN GUNUNG SELANG RESEARCH PLOT**

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Abstract

The genus *Aquilaria* Lam. from family Thymelaeaceae is well known for the ability to produce aromatic resin that is widely traded as agarwood or locally known as gaharu. One of the species from the genus *Aquilaria* Lam. that can be found in Sarawak is the *Aquilaria microcarpa*. This species is listed as endangered under IUCN Red List. Planting of seedlings had been done in Gunung Selang as part of the conservation effort of the species. This paper aims to discuss on growth performance of this species based on different treatment in two research plot at Gunung Selang, Kuching. Both plots namely Selang A and Selang B were planted with 192 seedlings and after 3 years, the survival rate recorded are 95.83% and 89.58% respectively. The mean annual increment (MAI) for height are 0.65m and 0.62m while MAI diameter are 0.39cm and 0.76cm respectively for Selang A and Selang B.

Keywords: *Aquilaria microcarpa*, growth, agarwood

**P 20: FLORA DIVERSITY ALONG ARUR DALAN TRAIL, PULONG
TAU NATIONAL PARK**

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Abstract

Gazetted on 24 March 2005, Pulong Tau National Park (PTNP) has become the 17th national park of Sarawak. One of the routes that are also an access points to enter the Park is Arur Dalan trail. Arur Dalan is known as one of the tourist route to Pa Tik. The main vegetation of this trail is mixed dipterocarp forest (MDF) and the area is hilly with the present of small stream along the trail. This study is aim to identify the flora (trees and herbs) along the trail as well as to document all the specimens data collected for future management and reference. A total of 95 trees belonging to 32 family, 56 genera, 80 species, 2 subspecies and 1 variety have been observed and recorded during a survey along the Arur Dalan eco trail in Pulong Tau National Park. At the family level, Euphorbiaceae is found to be the most common along the trail with 11 trees consist of 5 genera and 9 species. The herbaceous plants recorded along the trail consist of 16 families, 23 genus and 25 species. Zingiberaceae (2 genera and 3 species) and Rubiaceae (3 genera and 3 species) are found to be the most common.

Keywords: Arur Dalan, Pulong Tau National Park, Flora, Diversity

**P 21: DIVERSITY OF UNDERSTORY HERBACEOUS PLANT IN
FALLOWS SHIFTING CULTIVATION**

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Abstract

Shifting cultivation is frequently identified as one of the main causes of tropical forest disturbance and retrogression to secondary forest vegetation. Although forest ecosystem is typically defined by the over-story species, the study on herb layer is also important because the herb layer always showed the greatest diversity and the most responsive to harvest mediated disturbance. Thus this study aims to determine the diversity and floristic composition of understory herbaceous plants comparatively at five different aged of fallows shifting cultivation represented by 1, 3, 5, 10 and 20-years of fallow. Based on the survey conducted in Sabal Agroforestry Centre Sarawak, a total of 15,348 individuals were recorded

comprising of 178 species in 145 genera and 70 families. Both 1 and 10-years of fallows showed the highest diversity index ($H' = 3.24$) while having the lowest similarity index (SI). Cluster analysis indicated 3 clusters, resulting 1-year of fallow to form one cluster itself, 3 and 5-years of fallows in another cluster, while 10 and 20-years of fallows fall in another cluster. The study indicates that the species composition of understory herbaceous vegetation are very responsive to the disturbance and may changed considerably over time, thus reflected to the site condition.

Keywords: Herbaceous, fallow, diversity, similarity, cluster.

P 22: SPATIAL VARIATIONS OF TOTAL PRODUCT BIOMASS OF PLANTED *Rhizophora mucronata* POIRET BASED ON SITE CHARACTERISTICS OF THE SARAWAK MANGROVE FOREST

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Abstract

Mangroves are salt-tolerant forest ecosystems found mainly in tropical and subtropical intertidal regions of the world. *Rhizophora mucronata* Poiret is one of the most important species in mangrove forest. It is also one of the commercial mangrove timber species in Asia-Pacific Region which leads large areas of mangrove in this region. In order to estimate the total product biomass of *R. mucronata* Poiret, the development of species-specific allometric equation is needed based on their site characteristics. The objectives of this study are to develop the site-specific allometric equations to estimate the total product biomass of *Rhizophora mucronata* Poiret for four selected sites of the Sarawak Mangrove Forest and comparison of the accuracy of developed site-specific allometric equations with general allometric equations particular species across varying site conditions. Our study has showed that a better fit is found for site specific model as compared to relying on a general model for that particular species across varying site conditions.

Keywords. Total product biomass, allometric equation, site characteristics, *Rhizophora mucronata* Poiret

**P 23: FOREST PLANTATION SITE-SPECIES MATCHING BASED ON
SOIL TYPES IN SARAWAK: A DESKTOP STUDY**

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Abstract

Site-species matching is one of the most important factor for successful establishment of forest plantation. However, it is often overlooked by the plantation forest operators. A desktop study of site species matching can be used as a reference to predetermine species to be planted based on soil suitability. The study was carried out using the 1:50,000 Scale Soil Map of Sarawak on four main species; *Acacia mangium*, *Falcataria moluccana*, *Eucalyptus pellita*, and *Neolamarckia cadamba*. Site requirement of each species was deduced from their ecology and possible adaptation to the various soil types. Soil types were classified as “Feasible,” “Fairly feasible,” and “Not feasible.” The site suitability distribution of feasible areas within Licensed Planted Forest areas in Sarawak were projected at 31% (902,820 ha) for all four species, and 49% (1,427,724 ha) for *A. mangium* and *F. moluccana* only. The remaining areas of about 20% (585,466 ha) were classified as not feasible. Site-species matching in this study was based on soil suitability classification that was lacking in good supporting research data. Therefore, fairly extensive ground verification works and more detailed soil maps are needed to enhance the validity of site-species matching method used in this study.

Keywords: Forest plantation, site-species matching, feasible areas

**P 24: SAWING AND MACHINING PROPERTIES OF PLANTED
Falcataria moluccana IN SARAWAK**

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Abstract

Falcataria moluccana or locally known as Batai is now widely planted in Sarawak as an alternative source of material for wood based industries. These plantation logs are of fast grown, small diameter with high growth stress and high variability that would affect the sawn timber quality. As such, sawing efficiency and machining properties for juvenile plantation logs need to be conducted. This paper describes the assessment approach on 10-year-old planted Batai for sawing volumetric recovery, quality yield and grades of sawn timber. It also examines the various machining characteristics, namely: planning, sanding, boring,

mortising, shaping and turning. Specimens were prepared and tested according to the ITTO harmonized Testing Methods for Plantation Grown Tropical Timbers and ASTM D-1666 87 Standard Test Methods for Conducting Machining Tests of Wood and Wood-Base Materials. The study showed that Batai has achieved 32% recovery rate by using Modified Cant sawing pattern. The sawing properties of Batai were graded at 77% 'Standard' and 'Serviceable' based on the Malaysian Grading Rules. Wood machining properties were graded as 'Easy' to work, with 'Fair' to 'Excellent' grades by visual grading.

Keywords: Batai, sawing, machining, wood quality, utilizations

P 25: UTILIZATION OF 5-YEAR-OLD PLANTATION TIMBER: BATAI-POLYMER COMPOSITE

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Abstract

In response to our YAB Chief Minister's challenge in utilising planted 5-year-old trees, SFC has embarked on projects to conduct R&D on effective utilisation of the timber species. Fast-growing timber species are always associated with lower density, strength, durability, quality and high proportion of juvenile wood, thus innovative processes and technology shall be looked into to overcome these problems. One of the innovative technology is wood impregnation in which chemical substances are impregnated into the wood in order to improve its characteristic and impart new properties. This technique will increase wood strength, and reduce cracking and resistance to water, moisture and chemicals. In this study, Batai wood-polymer composites was prepared by impregnating the Batai wood with methyl methacrylate (MMA). The catalyst-thermal treatment was employed for the polymerisation process to take place. At the highest chemical loading, polymerised Batai wood showed an increased in dimensional stability. The modulus of elasticity improved 63% and modulus of rupture also improved 47% respectively. The basic density of the wood increased significantly by approximately 90% from 274 kgm-3 (untreated) to about 522 kgm-3.

Keywords: Wood impregnation, impregnation technique, wood-polymer composites, mechanical properties

P 26: NEW RECORDS OF INSECT DEFOLIATORS ASSOCIATED WITH TALISAI PAYA (*Terminalia copelandii*) IN SABAH

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Abstract

Talisai Paya or *Terminalia copelandii* is potentially an important timber species of the freshwater swamp and floodplain in Sabah. It is a fairly large tree, growing up to 40 m tall with a straight and cylindrical bole supporting a dense spreading crown at different heights. This species is a lightweight hardwood which is suitable for furniture, veneer, plywood, musical instruments, block board, joinery, toys and turnery. It is also potentially suitable as a riverbank stabilizer in down-river areas. Talisai Paya is one of the indigenous tree species that have been given much attention by the Sabah Forestry Department in enrichment planting and forest rehabilitation. Hence, the knowledge on insect pests of this species is important and serves as baseline information for action to be taken should there be any infestation of pests that could affect the tree health. A total of 4 newly recorded defoliator species were documented from trial plots and nurseries in Sabah. All of them are from the order Lepidoptera. This paper highlights the description and ecology of the documented species, many of which are new records. The management of some of the insect pest species is also discussed in this paper.

P 27: THE POTENTIAL OF KETAPANG (*Terminalia catappa*) LEAVES AS HERBAL TEA

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Abstract

The use of natural or herbal medicine as an alternative in maintaining good health and treatment of various illnesses has increased tremendously over the past three decades. One of the most popular and convenient forms of herbal medicinal products is herbal tea. Herbal tea also known as tisane is usually produced by using plant parts such as leaves, flowers, tubers, bulbs or roots. The health benefits of the tea are dependent on the plant parts or herbs being used. *Terminalia catappa* is a well-known herb that is widely used as folk medicine in Southeast Asia. Senescence or mature fresh leaves of *T. catappa* in particular have been reported to possess a wide range of pharmacological activities such as antioxidant, anti-inflammatory, anti-diabetic, antifungal and even anti-viral for instance, anti-HIV. Studies on the local species have also reported high antioxidant values. In Taiwan, India and Philippines, the leaves of *T. catappa* are popularly boiled or brewed in water as tea to prevent hematoma, to treat hepatitis and liver related diseases. Therefore, *T. catappa* leaves have a huge potential to be used as a herbal tea product.

Keywords: *Terminalia catappa*, herbal medicinal product, herbal tea

P 28: WOOD ANATOMICAL FEATURES OF SOME MEDICINAL PLANT SPECIES IN SABAH

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Abstract

A study on wood anatomical features of some medicinal plant species in Sabah was carried out. The microscopic features, namely vessel diameter, ray height and ray width of some medicinal plant species were determined, measured and documented. This information would help in the identification and authentication of these medicinal plants on the basis of wood anatomy. These data are also useful for a variety of scientific applications as well as for future references.

P 29: WATER QUALITY OF FIVE RIVERS IN ULU SEGAMA-MALUA SUSTAINABLE FOREST MANAGEMENT PROJECT AREA

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Abstract

Periodic water quality sampling was carried out by Hydrology Unit of the Forest Research Centre, Sepilok, for over 4 years in five rivers, namely Sg. Kawag, Sg. Bole, Sg. Segama, Sg. Danum and Sg. Malua in Ulu Segama-Malua Sustainable Forest Management Project Area (USM), which is under totally protected conservation management. This periodic exercise sampled 6 points of the five rivers to monitor part of the ecosystem functions of the project area as catchment, and also contamination level due to human induced-disturbances. All rivers were characterised as clean water over the period of monitoring activities. The importance of continuous monitoring of water and quality proper management intervention is discussed in the paper.

P 30: THE SIGNIFICANCE OF KAWANG FOREST RESERVE AS AN IMPORTANT PROVIDER FOR FOREST ECOSYSTEM SERVICES IN PAPAR DISTRICT, SABAH

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Abstract

Kawang Forest Reserve covers an area of 1,551 ha, located in the western part of Sabah, Malaysia. The forest has been gazetted as a forest reserve since 1957 and was reclassified in 2014 from Class III (Domestic Forest) to Class I (Protection Forest). The reclassification of the forest area is an effort to preserve the main function of the area to sustain the immense amount of biodiversity of the protected area. Therefore, this study aims to evaluate the local community perception on the contributions of Kawang Forest Reserve to support their livelihood. The ecosystem services that are provided by the forest are categorized into three main services, namely provisioning, regulating, and cultural services. The study was conducted using structural administered questionnaires in a Likert scale (scale of 1.00 – very low to 5.00 - very high) setting. Local communities living adjacent to Kawang Forest Reserve were selected as the research respondents using convenient sampling. A total of 102 respondents were selected from villages located around the forest reserve, namely Tanaki, Mook, Tampasak, Kaiduan, Bisuang and Bolotikon to assess their perceptions on the forest ecosystem services that contribute to their livelihood development. The regulating services based on soil fertility and erosion control show the highest value with an average score of 4.58, followed by the provisioning services based on the ‘source for clean water supply & filtration’ sub-services with a mean score of 4.48 and cultural services based on ‘provides tourism area (interesting area, climbing, hiking and waterfall’ with an average score of 4.42. Hence, the conservation of Kawang Forest Reserve is vital to support the welfare of the local community residing within the protected area as well as contributing to a more sustainable forest management by the decision makers.

Keywords: Forest ecosystem services, Kawang Forest Reserve, perception, local community, provisioning, regulating and cultural services.

**P 31: LOCAL COMMUNITY PARTICIPATION IN MANAGING TPA:
SEMENGGOH NATURE RESERVE'S EXPERIENCE**

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Abstract

Local community participation is essential to ensure effective management of the Totally Protected Area (TPA). The Semenggoh Nature Reserve (SNR) is unique because it is surrounded by many villages and residential areas. Their participation through the annual Communication Education and Public Awareness (CEPA) programme has contributed to successful park management. Another collaboration with the local community is through the Special Park Committee (SPC) programme carried out to gain their support in conservation. This paper is presented to share Semenggoh Nature Reserve's (SNR) successful experience and collaboration with 12 villages.

Keyword: Semenggoh Nature Reserve (SNR) Special Park Committee (SPC), Collaboration of local stakeholder, Communication Education and Public Awareness (CEPA)

**P 32: INTERPRETING GUNUNG PUEH NATIONAL PARK'S
NATURAL, CULTURAL AND HISTORICAL HERITAGE AS NEEDED
IN ITS MANAGEMENT PLAN**

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Abstract

Gunung Pueh National Park (GPNP) is in need of a functional management plan that can serve as the benchmark for all its operations and conservation activities. Interpretation as a persuasive conservation communication tool can very much assure relevance and behavior compliance of the various audiences through effective "call for actions," designed to specifically to affect people's emotion. Emotions affects behavior and at times behavior can affect people's emotion. Every personal and non-personal interpretive product for managing GPNP will have its very own objective in the form of measurable "call for action" that will be aligned to GPNP's management needs. GPNP's ROI will be through the objectively designed interpretive products, with relevant call for actions, measured to indicate interpretive products' success as effective management tool s in the conservation of GPNP's natural, cultural and historical resources. The "call for actions " will be built into thematically

organized products carrying very relevant messages that are revealing, thought provoking, attractive and have multiple sensory overloads that will affect people's emotion, leading to behavioral changes.

**P 33: COMMUNITY RESOURCES, COMMUNITY DEVELOPMENT
AND SOCIAL CAPITAL INTERACTION FOR BIDAYUH
INDIGENOUS TOURISM DEVELOPMENT**

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Abstract

Tourism development in Malaysia is closely aligned to eradicate poverty, rural community development, reduce the disparity between the rich and poor, leading to the cohesion of the Malaysian culture and ultimately, the promotion of national unity. The Bidayuh, a minority indigenous group in Sarawak, is well known for their long-houses and unique culture that excels them in the field of tourism. However, many leading scholars in the field of community-based tourism development agree that tourism development will not sustain without adequate community resources, community development and social interaction which there is still no significant research done among the Bidayuh. Therefore, it is crucial to determine the level of community resources, community development and social capital interaction for the Bidayuh indigenous tourism development to sustain. Quantitative method was used where the level was measured using a four-point Likert scale. The data gathered were analysed using descriptive analysis where the level was categorized into low, moderate and high levels. Results indicated the Bidayuh have high level of community resources, but moderate level of community development and social capital interaction. Hence, the stakeholders within the indigenous tourism sector should take serious consideration to help the Bidayuh community to produce a tourism that is sustainable.

Keywords: Indigenous tourism, Tourism development, Community resources, Community development, Social capital, Sustainable tourism

**P 34: GUNUNG LESONG NATIONAL PARK: ECOTOURISM
POTENTIAL**

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Abstract

Gunung Lesong or locally known as Bukit Lingga is located in the small Lingga District in the Sri Aman Division, about 35.8 km from Sri Aman town. The Gunung Lesong National Park (GLNP) is the 30th national park under the National Parks and Nature Reserves Ordinance, (NPNRO 1998), gazetted on 26th Sept 2013 (Gazette No. 128), with 595 Ha, is the smallest national park in Sarawak. The GLNP and its adjacent areas are bestowed with rich biodiversity, special natural features and significant cultural elements that enhance ecotourism attraction. The elements in and adjacent of the GLNP such as river networks, nature and sceneries, cultural and traditions are highlighted that potentially for the ecotourism attraction. The major rivers found adjacent to GLNP are highly potential for ecotourism, providing the 'wild Borneo' experience. The rivers are important to specialized segments of visitors with in activities such as boat cruise, bird watching, crocodile sighting adventure, viewing fireflies, sightseeing and sport fishing. Nature features such as geological, waterfalls, flora and fauna in the GLNP are amazing. Waterfalls are often seen as significant natural physical features for recreation and ecotourism activities. The flora diversity in the GLNP is tremendous, more than 375 plant species from 250 genera and 90 families are recorded in this small park area. Bird watching is considered the fastest growing nature-based recreation activity participated by nature based tourists. The major elements of birds that tend to be of interest to birders comprise of diversity of bird species, endemic species, congregation birds, specialty birds or 'hot' species, rare bird family and bird species with specific behavior. With a total of 46 species from 26 families in a such small area, the GLNP possibly can be listed as one of Important Birds Area (IBA) for Sarawak. Local communities living adjacent to GLNP are noted to be rich in cultural diversity that influenced livelihood and cultural practices. The cultural features identified include Gunung Doa, Telaga Kumang, Gelanggang Sabong, Kayu Ambun, Lubang Nabau, Tukong Pembulak, Pahlawan Ijau Lang. The unique cultural practices of local villagers, essential include Iban ngajat, miring rituals. With development of infrastructures and facilities and a proper Management Plan, GLNP recognized to be highly potential ecotourism spot in Sri Aman Division.

Keywords: Gunung Lesong National Park, ecotourism, river systems, nature features, bird watching, cultural diversity

**P 35: PARADIGM SHIFT IN SUSTAINABLE FOREST MANAGEMENT
IN SARAWAK THROUGH LOCAL COMMUNITIES ENGAGEMENT**

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Abstract

In the past, involvement of local communities in the management and operations of forest timber license areas in Sarawak was near to none existence. The engagement and consultation with the local communities were only carried out in certain cases or issues concerned. The Forest Management Certification (FMC) that is currently pursued by the State Government offers an opportunity for integrated and multidisciplinary solutions. The forest certification emphasizes human dimension particularly local communities whose depend on forest resources for livelihood. The Forest Department Sarawak had developed a multi-stakeholder guideline to facilitate stakeholder engagement and conflict resolutions at the community level: Community Representative Committee (CRC), Forest Management Units: Community Representative Committee (FMUCRC) and stakeholders level that integrates CRC, FMUCRC and other relevant agencies (Forest Management Certification Liaison Committee, FMCLC).

Keyword: Sustainable Forest Management, Forest Management Certification, stakeholders engagement and conflict resolution, platform

P 36: A SUMMARY OF POTENTIAL ECOTOURISM SITES IN SABAH

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Abstract

The number of tourists coming to Sabah is increasing, thus, new potential areas need to be introduced as additional attractions for tourism products in Sabah. The effort to develop new ecotourism site is also timely as some popular ecotourism spots are reaching a saturation point with the number of tourist arrivals. The objective of this study is to compile the notable attractions that can be developed into tourism products at some areas in Sabah. The study also provides data of the potential ecotourism sites while promoting them for ecotourism market. Places surveyed were Darvel Bay in Lahad Datu, Tibow in Tawau, Tongod, Northern Gunung Rara Forest Reserve and Tambulanan Forest Reserve in Kalabakan, Kawag Danum Rainforest Lodge in Ulu Segama Malua Forest Reserve, Lahad Datu, Tundon Buhangin in Kinabatangan, Imbak Canyon Studies Centre in Imbak Canyon, Kampung Gana in Kota Marudu and Nuluhon Trusmadi (extension) Forest Reserve in Tambunan. In the surveys, elements, such as cultural values, interesting and significant flora and fauna, landscapes, communities, tradition and lifestyle were identified and recorded. Interviews with the stakeholders on ecotourism development in the surveyed area were also conducted

**P 37: THE STRENGTH OF SOCIAL CAPITAL AMONG COMMUNITY
IN GUNUNG PUEH NATIONAL PARK, LUNDU, SARAWAK**

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Abstract

Social capital dimension is a set of network bonding, bridging and linking of relationships among individuals who live or work in a particular community. In order for the communities to function effectively, social capital has to be well developed. This research discusses the strength of social capital based on the instrument developed by Onyx and Bullen. A questionnaire survey was carried out among 400 respondents covering three communities in Lundu, Sarawak. The measuring instrument was comprised of 53 items covering six different indicators that have been assigned according to its dimension. The preliminary analysis demonstrated positive social capital strength. The dimension of social capital is compared within the three communities to reveal which dimension is pre-imminent among them. The findings of this study support the generally discussed theory within the scope of community development and tourism development. This study does not contradict against the social capital theory. The community strongly feels that bridging, bonding and linking are very important to run tourism in a sustainable manner. The limitation of this study includes language barrier and lack of participation during the interview session.

Keywords: social capital, bonding social capital, bridging social capital, linking social capital, community

P 38: MOTIVATIONAL FACTORS OF WOMEN TO BECOME SOCIAL ENTREPRENEURS IN GUNUNG PUEH NATIONAL PARK, LUNDU, SARAWAK

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Abstract

Social entrepreneurship has become the attention of the scholars and practitioners for years in various countries as it is a tool which plays important roles in developing individuals, societies, and communities socially and economically. However, it is essential to study the motivations of the social entrepreneurs as it is yet to be theorised. Therefore, this study is to determine what motivates the women to become social entrepreneurs. A set of designed questionnaires with dual languages was used for the data collection. Nine motivational factors were studied through this study by using five-point Likert Scale as the measurement. This study was targeted at women social entrepreneurs in Gunung Pueh National Park, Lundu, Sarawak. The data collected was analysed by using the IBM SPSS. Through the preliminary study which included 30 women social entrepreneurs, the descriptive findings show that “Financial Independence” is the motivational factor that motivates women the most, which followed by “Self-Sustainability in Business” and “Need for Achievement”. On the other hand, “Past Experience” is the least motivational factor for the women to join the ventures in social entrepreneurship. In a nutshell, this study provides the picture on what motivates the social entrepreneurs which can then be the reference for management to design strategies to attract more people to join social entrepreneurship as well as the reference for future related studies.

Keywords: Social Entrepreneurship; Motivation; Women; Lundu District; Sarawak

P 39: FOREST RESOURCE INVENTORY IN THE HEART OF BORNEO (HOB), SARAWAK

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Abstract

Forest resource inventory (FRI) is a major concern as it is contributing towards the management and forest planning. The inventory will explain on the estimated timber stocking and carbon storage of Sarawak logged-over forest within the HoB area. The objective of the FRI in Sarawak is to provide the latest forest resource inventory information at state level including estimating the potential area for production and volume. The area covered in the study are inclusive of national park (Mulu National Park and Lanjak Entimau Wildlife Sanctuary) and timber licensed areas. The study method used is the combination of ground survey and remote sensing (RS) technology. 21 grids of 100km² were established within the 2.1 million hectare of HoB area by utilizing RS technology and the ground survey is in the form of circular plot, a modified version of Winrock International. The parameters obtained in the survey are tree stand density, biomass content, carbon stocking and wildlife presence, which are essential for a comprehensive data collection. The integration of RS in this inventory is to enhance the information quality. This information provides insights on the forest condition and realizing the potential of forest value in formation a better management planning for Sarawak forest.

Keywords: Inventory, Tree, Carbon, Remote Sensing

P 40: FORENSIK PERHUTANAN

Mohd Khairul bin Abdullah

P 41: FOCAL ACTIVITIES IN ENFORCEMENT AND COMPLIANCE

P 42: ASIA-PACIFIC FOREST NETWORK: COMMUNITY BASED SFM OF SUNGAI MEDIHIT WATERSHED SARAWAK: A STORY OF CHANGE

P 43: MEMPERKASAKAN PENGURUSAN HUTAN SECARA MAMPAN DI SEMENANJUNG MALAYSIA MENERUSI PENGGUNAAN E-GEOSPATIAL PERHUTANAN (e -GP)

P 44: COMMUNITY INNOVATION FOR SUSTAINABLE MANAGEMENT OF WETLANDS RELATED PERMANENT FOREST RESERVES IN SELANGOR

P 45: STATE WIDE DEPLOYMENT OF 45 OSCC

- P 46: SEPARABILITY BETWEEN SPECIES AS OBSERVED FROM SAMPLED TREE CROWNS.**
Shirley Poh
- P 47: MULTI-TEMPORAL ANALYSIS OF MANGROVE RESTORATION SITE AT SUNGAI LEMIDIN, KUCHING WETLAND NATIONAL PARK.**
Khadeeja Abdul Wahab
- P 48: FLORA CONSERVATION IN HIGH IMPACT ECONOMIC DEVELOPMENT AREAS**
Arifhadi bin Johari Affandi
- P 49: ENHANCING FOREST BIODIVERSITY CONSERVATION IN THE TROPIC THROUGH ESTABLISHMENT OF CENTRAL FOREST SPINE (CFS)**
Mohd Shukri bin Aziz
- P 50: KEPENTINGAN PEMELIHARAAN HUTAN SIMPAN TANJUNG TUAN SEBAGAI KAWASAN PERSINGGAHAN BURUNG PEMANGSA (*RAPTOR BIRD*)**
Azni Rahman bin A. Wahid
- P 51: MANGROVE AND COASTAL REHABILITATION: FROM DEPARTMENT TO THE COMMUNITIES**
Jamal Shuhaily bin Shahrar
- P 52: WILLINGNESS TO PAY FOR ECOTOURISM SERVICES AT CHEMERONG FOREST ECO-PARK, TERENGGANU**
Zulnaidah binti Manan, Izaidah binti Talib and Muhammad Fekri bin Taib
- P 53: HUMAN RESOURCES TRAINING PROGRAMMES**
Amsari Mahmud
- P 54: A COLLABORATIVE PROGRAMME IN FORESTRY TRAINING**
Noorshatiroh binti Saidin
- P 55: KURSUS SIJIL PERHUTANAN, FORESTRY TRAINING INSTITUTE (FOTRAIN), FORESTRY TRAINING DIVISION**
Noorshatiroh binti Saidin

9.0 18th MALAYSIAN FORESTRY CONFERENCE RESOLUTIONS

**18th MALAYSIAN FORESTRY CONFERENCE
CONFERENCE RESOLUTIONS**

<i>Resolutions 1</i>	
<i>Recognizing the importance of good forest governance in implementing sustainable forest management, the conference resolved that:</i>	
1.1	Forest Policies be widely accepted to ensure their long-term relevance.
1.2	Legislation be periodically reviewed to ensure effectiveness in managing forest.
1.3	Latest and appropriate technologies be used to enhance the effectiveness of forest law enforcement.
1.4	Cross-sectoral efforts including sharing of information between three regions be enhanced to curb forest offences.
1.5	Skilled human resources in investigation and prosecution of forest offences be made available and strengthened.
<i>Resolutions 2</i>	
<i>Recognizing the importance of technology, innovation and good practices in Sustainable Forest Management, the conference resolved that:</i>	
2.1	Adequate skilled manpower be made available and capacity building be continuously implemented for sustainable forest management.
2.2	The use of latest and appropriate technology in managing forest resources be explored and embraced.
2.3	Research, development and innovation to support decision making in sustainable forest management be intensified.
2.4	Forest management certification be vigorously pursued to ensure highest management standards.
2.5	Sufficient and sustainable financial support be made available for sustainable forest management.
2.6	Stakeholder education and awareness to influence mindsets towards effective management of forests be given special emphasis.

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Resolutions 3

Recognizing the importance of conserving forest biodiversity for maintaining healthy ecosystems, the conference resolved that:

3.1	Restoration and rehabilitation of degraded forest areas be intensified.
3.2	Nature-based tourism activities to support forest conservation be regulated and promoted.
3.3	Landscape approach be adopted in conservation and eco-tourism planning.
3.4	Identification and management of unique ecosystem of the forest for the purpose of conservation be intensified
3.5	Conservation status of rare, threatened and endangered flora and fauna be continuously monitored and updated.
3.6	Sufficient funding and innovative means of conservation financing be further explored and implemented.
3.7	Skilled human resources be made available to intensify assessments and documentations of flora and fauna.
3.8	Collaboration with relevant partners and stakeholders in conservation assessments be enhanced.

Resolutions 4

Recognizing the importance of forest plantation to sustain wood production and wood based industry, the conference resolved that:

4.1	Research and development on pests and diseases, high quality planting materials and suitable trees with emphasis given to indigenous species be intensified.
4.2	Application of latest and appropriate technologies and innovations in forest plantation nurseries be intensified to produce high quality planting materials.
4.3	Private sector and small holders participation in forest plantations be encouraged.

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4.4	Best management practices in forest plantations be actively pursued and implemented.
4.5	Sharing of R&D findings and germplasms exchange among planters be encouraged.
4.6	Sufficient and sustainable financing for forest plantation programmes be made available.
4.7	Special attention be given to enhance downstream processing to support forest plantation industries.
<i>Resolutions 5</i> <i>Recognizing the importance of forest ecosystem services for the benefit of present and future generations, the conference resolved that:</i>	
5.1	Landscape approach to forest restoration and rehabilitation to improve forest ecosystem quality and mitigate climate change be intensified.
5.2	Long-term management and continuous monitoring on forest quality and services using effective approaches be encouraged.
5.3	Mechanisms for Payment for Ecosystem Services (PES) in generating new wealth be further explored.
5.4	The establishment of forest parks in all urban environments be further encouraged.
5.5	Knowledge sharing among the three regions on management of ecosystem services be further intensified.
<i>Resolutions 6</i> <i>Recognizing the importance of forest and its produce to local communities or affected local public, the conference resolved that:</i>	
6.1	Social Forestry programmes be designed to uplift community livelihoods and reducing forest encroachment.
6.2	Appropriate participatory approaches (Grievance Mechanism, Social Impact Assessment and Free Prior Informed Consent) in managing forests and forest resources be given due attention.
6.3	Building partnership with local communities in forest monitoring and ecotourism be encouraged.

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Resolutions 7

Recognizing the importance of good leadership and professionalism in forest management, the conference resolved that:

7.1	Special attention be given to succession planning and mentoring.
7.2	Forestry training at all levels be intensified and supported by the three regions.
7.3	Staff exchange programme between the three regions be revived.

Resolutions 8

Recognizing the importance of regulating and providing legal recognition to the forestry profession in Malaysia, the Conference resolved that;

8.1	The proposed Foresters Bill by Institute Rimbawan Malaysia (IRIM) to be studied and reviewed by three regions.
8.2	State governments' views and jurisdictions over forestry matters be given due consideration, including their prerogative to enact their own respective statutes and regulations.
8.3	All qualified and eligible forestry practitioners be encouraged to join as IRIM members.

10.0 CLOSING CEREMONY

**CLOSING REMARKS BY
YB TAN SRI DATUK AMAR HAJI MOHAMAD MORSHIDI ABDUL GHANI
SARAWAK STATE SECRETARY**

Yang Berusaha, Encik Hamden bin Mohamad, Director of Forests, Sarawak,

YBhg. Datuk Sam Mannan, Chief Conservator of Sabah Forestry Department,

YBhg. Datuk Borhanudin bin Haji Arshad, Deputy Director General of Forestry Department Peninsular Malaysia,

YBhg. Datuk-Datuk, Ladies and Gentlemen,

Assalamualaikum and good afternoon to all.

Terlebih dahulu saya ingin merakamkan ucapan terima kasih dan penghargaan kepada pihak penganjur kerana sudi menjemput saya untuk merasmikan penutupan Persidangan Perhutanan Malaysia kali yang ke-18 atau MFC ke 18.

It is great to note that this conference is participated by officers, administrators and researchers from forestry agencies in Malaysia and other observers from institutions related to forestry, timber industries and NGOs who come to gather in Kuching with the common objectives to discuss and share on what's new and to best manage our nation's forest resources sustainably.

After four days of intensive discussions, presentations, debates and plenary sessions, we have come to the last formal session of the 18th Malaysian Forestry Conference under the theme "***Advancing Sustainable Forestry Through Digitalization & Technology***". I trust that you are as pleased as I am with the outcomes of this conference. Let us all play our part in actively implementing the resolutions from this conference in order to sustainably manage our rich natural resources for the benefit of nature and our people. All of you have deliberated at length on the key issues related to the theme and the real work of implementation starts now.

I believe that all of you have learned a lot from the field visits and are now preparing to go back to your respective homes. I have no doubt that the future of the sector is in good hands. Events like this presents an opportunity to bring together foresters, researchers, NGOs and all forestry agencies in Malaysia under one roof.

I further believe that this conference has given us an opportunity to gain valuable knowledge, shared experiences on viable technological advancements, and to establish partnerships. I cannot overemphasise more on the importance of strong partnerships to improve our forestry sector. I therefore urge all of you to share the recommendations from the papers, posters and implement these at all levels. The outcomes should be informed to all stakeholders and in the

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long run, lead to improved policies, increased investment and better institutions that will build a more resilient and sustainable forestry sector across the nation.

The future projects emanating from this conference will ensure that the key issues identified are addressed in order to benefit the sector. I hope that after this you will go back ~~home~~ and implement everything you have learnt since the beginning of this conference.

As we close this event, we are proud that we have hosted this Conference successfully. The Conference Resolutions reflects issues that we are facing and their mitigation measures, conservation and innovation for improving our forestry sector, are precisely the same issues that we as a country is currently grappling with. Therefore, this conference addressed the real issues affecting the country and the world at large.

I understand that over 800 participants attended this conference with representations from forestry agencies in the three regions in Malaysia. This conference was also attended by representatives from other departments, international organisations such as civil society, non-governmental organisations, researchers, academia, private sector and many more. This demonstrates the eagerness of different stakeholders in building a future of resilient and sustainable forestry in Malaysia.

On behalf of the State Government of Sarawak, I would like to express my sincere gratitude to the organizing committee, for hosting us and organizing this conference successfully and also for ensuring robust discussions and participation of all members. I would also like to recognise the good work done by all our keynote speakers, as well as taking this opportunity to thank our generous sponsors who supported this prestigious conference. Let me also acknowledge all the chairpersons for chairing the sessions and all presenters for their posters and papers.

I believe that it has been a good week and a time of creating sustainable working relations by making new friends and meeting old friends. From the look at the programme, the briefings I got, indeed, this has been a great learning and knowledge sharing experience that has enhanced everyone's knowledge.

To all delegates, although you were here for a short period, I hope all of you will be bringing back very happy memories of this visit to Sarawak, especially to Kuching. Some of you may not have had the opportunity to see Sarawak and Kuching City itself, but this event will make the visit to Sarawak always memorable. As a host, I would like to extend my apologies to everyone if there are any inconvenience caused during your stay here. If it has added colour in your stay, we are also willing to get credit for it but if it has caused inconvenience to you, I would like to extend my utmost apologies on behalf of the State Government of Sarawak.

With these few words, ladies and gentlemen, it is an honour for me to declare the 18th Malaysian Forestry Conference officially closed.

Wassalamualaikum Warahmatullahi Wabarakatuh

Sekian, terima kasih.

12.0 PHOTO GALLERY



OPENING CEREMONY



18th Malaysian Forestry Conference



18th Malaysian Forestry Conference



CLOSED SESSION



SEMINAR SESSION



MFC DINNER



SPORTS – FUTSAL



SPORTS – BOWLING



SPORTS – GOLF



SITE VISIT – KUCHING WETLAND NATIONAL PARK



SITE VISIT – BAKO NATIONAL PARK



18th Malaysian Forestry Conference

CONFERENCE ORGANISING COMMITTEE

NO.	COMMITTEE	NAME
1	Chairman	Jack Liam
2	Secretariat	Haji Happysupina Sait
3	Protocol	Mohammad Saiful Amrie Abdullah
4	Seminar	Runi Sylvester Punga
5	Equipment	Ricky Jonathan Alek
6	Transportation	Rusmaliza Mat Darus
7	Accommodation	Alexander Anthony Banyan
8	Stage Management: Presentation, Decoration, Gimmick, Montage & Backdrop	Zarina Haji Shebli
9	Dinner Reception	Arifin Awang Zulkifli
10	Field Excursion	Suliman Jamahari
11	Sports	Ahmad Ashrin Mohammad Bohari
12	Safety & Security	Afriezul Abdul Rahman
13	Programme Book	Hajah Latifah Teh
14	Publicity	Mohammad Nur Firdaus Haji Sariee
15	Liaison Officer	Haji Azahari Omar
16	Gift & Souvenir	Salina Haji Hamdi
17	Master of Ceremonies	Mohammad Saiful Amrie Abdullah
18	Poster & Exhibition	Wilhelmina Cluny

SEMINAR ORGANISING COMMITTEE

NO.	COMMITTEE	NAME
1	Chairman	Runi Sylvester Punga Julaihi Abdullah
2	Secretariat	Paulus Meleng, Asmah Musa, Angel Kho, Mahmud Merdek & Mohd. Yazid Hossman
3	Resolution	Abg Ahmad Abg Morni Oswald Braken Tisen
4	Rapporteur	Oscar Johin Ngayop, Madeline George Pau, Hajah Mohizah Hj. Mohamad & Evelyn Jugi, Audrey Cassandra Kawi, Hjh. Halipah Bujang, Norhana Sepawi, Khairunnisa Othman
5	Proceedings	Runi Sylvester Punga, Paulus Meleng, Aurelia Dulce Chung, Khairunniza Othman, Angel Kho, Vincent Wong Thian Fook, Mohd. Shahbudin Sabki
6	Speaker/Presenter	Marfaisal Marzuki, Patricia Au Yong, Nur Bazillah Ismail, Mohd Nafri Ali, Yusuf Abdul Rahman, Karin Kerman
7	Time Keeper	Dulles Leo Balan, Willy Chin Siaw Min, Stafannie Nilla Marshall Rio, Sharifah Rohaidan Wan Alam, Ahmad Zaidi
8	Session Chairman	Ricky Jonathan Alek Mohamad Kasyfullah Zaini

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FORESTRY
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DIGITALIZATION & TECHNOLOGY