# Enhancing Sustainability of Forestry Practices on Peatlands

## APFP – SEApeat


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# Abbreviations

| | |
|---|---|
| **AMS** | ASEAN Member States |
| **APFP** | ASEAN Peatland Forests Project |
| **APMI** | ASEAN Peatland Management Initiative |
| **APMS** | ASEAN Peatland Management Strategy |
| **ASEAN** | Association of South East Asian Nations |
| **BD** | bulk density |
| **BMPs** | Best Management Practices |
| **BR** | Biosphere Reserve |
| **FR** | Forest Reserve |
| **GDP** | Gross Domestic Product |
| **GEC** | Global Environment Centre |
| **GHG** | greenhouse gas |
| **Gt** | gigatonnes (billion tonnes) |
| **ha** | hectares |
| **HCV** | High Conservation Value |
| **ISPO** | Indonesian Sustainable Palm Oil |
| **Mt** | megatonnes (million tonnes) |
| **NGO** | non-governmental organisations |
| **NTFP** | non-timber forest products |
| **PSF** | peat swamp forest |
| **REDD** | Reducing Emissions from Deforestation and Forest Degradation |
| **RSPO** | Roundtable on Sustainable Palm Oil |
| **SEA** | Southeast Asia |
| **$tCO_2e$** | tonnes of carbon dioxide equivalent |
| **Tg** | terra gram |

# Foreword

ASEAN Member States have agreed that enhancing conservation and utilisation of peatland sustainably in the ASEAN region is a high priority need.

We are all aware that peatland ecosystems play a very important role in harmonizing the environment, such as water supply/storage, flood control, natural habitat for biodiversity, and as carbon storage. Peat has very high carbon (C) content. Carbon stored in the form of peat around the world is as much as 329-525 gigatonnes (Gt) or about 35% of the total global carbon. Due to greenhouse gas (GHG) accumulation in the atmosphere and the potential change to peatland ecosystem function, it has encouraged us to continuously make efforts for mitigation, adaptation, and conservation of peatland ecosystem functions to maintain global climate stabilization and support development planning and implementation.

It has been identified that the largest area of peatland in Southeast Asia is located in Indonesia covering about 15 million hectares over three big islands – Sumatera, Kalimantan, and Papua. This is followed by Malaysia with about 2.5 million ha, Brunei Darussalam with about 100,000 ha, Thailand with about 60,000 ha, Viet Nam with about 3,000 ha, Philippines with about 11,000 ha, Myanmar with at least 3,500 ha and Lao PDR with about 19,000 ha.

These are some facts on the impacts on degradation of peatland ecosystems:

1. Water crisis
   - Only a small portion of water can be used due to lack of water management
   - Floods and droughts are due to a very large water flow fluctuation in the dry and rainy season
2. Air pollution which hinders public health and economic activities
3. The emission of GHGs due to peat material decomposition which will affect global climate stability

Regarding the rehabilitation and sustainable use of peatland forests, efforts are being conducted jointly by ASEAN member countries. Moreover, the Government of Indonesia has set up various policies to reduce GHG emissions by 26% until year 2020. One of the comprehensive policies of the Government of Indonesia is in the area of protection and management of peatland ecosystems that aims to support the rehabilitation and sustainable use of peatland forests involving related stakeholders in Indonesia.

The scope of the above-mentioned policy on protection and management of peatland ecosystems are as follows:

1. **Planning**
   Policy on planning covers inventory of peatland ecosystem area, determination of peatland ecosystem area, and preparation of protection and management of peatland ecosystems.

2. **Utilisation**
   Based on the planning policy, the protection and management of peatland ecosystems will consider sustainability of peatland ecosystem function, process, productivity, and life safety which covers quality and prosperity of people.

3. **Control**
   Policy on control of peatland ecosystem degradation, which consists of prevention, counter-measures and recovery of peatland ecosystem degradation.

4. **Maintenance**
   Through inventory and conservation of peatland ecosystems, which include High Conservation Value Areas (HCVA) in peatland area, as well as rehabilitation of peatland ecosystems.

5. **Controlling and law enforcement**
   Ministers, Governors, or Regents/Mayors, according to their respective authority, control the activities related to peatland ecosystems, and initiatives are conducted by environment supervision officials.

The Ministry of Environment of Indonesia appreciate the involvement of experts and individuals from government institutions, private sectors, international organisations, donors and NGOs, who have contribute to this compilation by sharing their knowledge and experiences. A strong cooperation among various actors may play a very important role in sustainable peatland management, particularly in the protection and management of peatland ecosystem.

Finally, I would like to express our sincere gratitude to the ASEAN Secretariat and Global Environment Centre, which have been working cooperatively with the Ministry of Environment of Indonesia in the organisation of the workshop in June 2012 and this publication. Similar appreciation goes to the ASEAN Peatland Forests Project funded by the International Fund for Agricultural Development -Global Environment Facility and the SEApeat project funded by European Union.

Mr. Ir. Arief Yuwono
*Deputy Minister of Environmental Degradation Control and Climate Change in the Ministry of Environment of Indonesia*

# Preface

Peat swamp forests (PSFs) are a unique ecosystem where the forest grows on a thick peat or organic soil layer, formed in waterlogged conditions over thousands of years. Wet and nutrient poor, this environment is nonetheless an important resource which plays an important role in the socio-economy of the region as well as climate change mitigation by storing carbon. It also provides many valuable timber and non-timber forest products while maintaining water resources and biodiversity. Southeast Asia (SEA) has more than 25 million hectares of peatlands, comprising 60% of global tropical peatland resources.

PSFs can be harvested on a sustainable basis, generating significant local and national benefits – however in much of the region, heavy levels of extraction have led to degradation of many peatlands. Degradation and conversion of peatlands is a major cause of greenhouse gas (GHG) emissions, fires and associated transboundary haze, which has been identified as a major environmental problem in the ASEAN region.

At present, more than 10 million ha of peatland forests have been logged and 1 milion ha of forest plantations have been developed on peatlands in SEA – especially in Indonesia. Most of the plantations are *Acacia crassicarpa* plantations, developed for the pulp and paper industry. However, there are also plantations of other species especially *Dyera*, *Melaleuca* and also *Anthocephalus cadamba*. Many plantations and logged over PSFs have faced challenges due to fires, subsidence and poor water management as well as difficulties in rehabilitating degraded areas with indigenous species. Unless peatland forests can be rehabilitated or used sustainably, there will be more pressure to convert remaining areas for agriculture or other uses.

This publication has been developed based on papers presented at the Workshop on "Enhancing Sustainability of Forestry Practices on Peatlands" held from 27-28 June 2012 in Bogor, Indonesia. The workshop was attended by over 100 participants from six countries from federal and state government agencies, NGOs, research institutions and private companies.

The workshop was jointly organised by the ASEAN Secretariat and Global Environment Centre (GEC, as Regional Project Executing Agency of the APFP) in collaboration with the Ministry of Environment of the Republic of Indonesia. The workshop was part of the ASEAN Peatland Forests Project (APFP) and SEApeat Project which promotes sustainable management of peatlands in the SEA region, and being supported by IFAD-GEF and European Union, respectively.

The workshop provided an opportunity to share experiences and knowledge on the impact of forest plantations on peatlands and best practices for sustainable forest management on peatlands. It was also used as a platform to gain feedback and ideas to the development of a Regional Guideline for Forestry Practices on Peatlands.

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Global Environment Centre<br>
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# Workshop Report

# Workshop Summary Statement

The workshop on Enhancing Sustainability of Forestry Practices on Peatlands was held from 27-28 June in Bogor, Indonesia and attended by more than 100 participants from six countries. The meeting was organised by the Global Environment Centre, ASEAN Secretariat and the Ministry of the Environment of the Republic of Indonesia. The meeting was undertaken in the framework of the ASEAN Peatland Forest Project (APFP) and the SEApeat Project, and supported by IFAD-GEF, and European Union. The meeting was officiated by Ir Arief Yuwono MA, Deputy Minister of the Environment of the Republic of Indonesia.

A total of 21 presentations were made on a various topics including forest and plantation management on peatlands as well as rehabilitation of Peat Swamp Forest and certification of forestry activities on peatlands. Breakout groups discussed forest management/rehabilitation and plantation management on peat.

The main conclusions from the workshop included:

1) Peat swamp forest (PSF) is the main wetland forest type in Southeast Asia (SEA) – originally covering about 25 million hectares and provides many benefits for water resource management, climate regulation, biodiversity conservation, production of timber and non-timber forest products and support for local livelihoods.

2) The area of PSF in SEA has been significantly reduced in the last 30 years and it is estimated that less than 34% remains in a relatively intact condition in the western part of the region with 20% converted to plantations and the remaining 50% in a degraded or fragmented situation. Contributing factors include; forest encroachment, heavy forest harvesting rates and poor recovery; conversion and degradation from fires especially in periods of drought. The sustainability of the remaining peatland forests (both primary & secondary forests) is critically threatened.

3) Clear and strong policies for peatland protection and sustainable use are needed and the meeting supported and encouraged others to follow the action taken by the Indonesian Government to impose a moratorium on further development of plantation on peatlands and primary forest areas, and put in place various regulations especially related to enhanced water management and conversion of PSF.

4) Over the past 15 years, nearly 1 million ha of former PSFs have been converted into industrial tree plantations for the pulp and paper industry in the region – mainly using *Acacia crassicarpa*. Various enhanced management practices have been developed in particular related to water management and land preparation – but further work is needed to sustain productivity of forest plantations. Plantation companies have also worked to maintain and rehabilitate adjacent PSFs as well as work with local communities to enhance livelihood and prevent fires. Some plantations have been successfully developed through serious investment on severely degraded and burnt peatlands by focusing on good water management, appropriate silvicultural practices, fire prevention, and partnership with local communities.

5) Significant experiences have been gained in recent years on the rehabilitation of peatlands with indigenous tree species including some with potentially high economic and environmental values and this has potential for both enhancing the forest as well as bringing benefits to local communities.

6) Water management is the most critical issue for the sustainable management for peatlands: further drainage of natural forest should not be allowed and existing drains blocked; the water level in plantation areas should be maintained as high as possible to reduce the rate of subsidence, optimise production and prevent fires in the plantation and adjacent areas.

## Recommendations

Given the serious recent decline in PSFs, the meeting urged immediate action by the governments and other stakeholders to:

1) Protect all remaining intact PSFs in SEA and not allow further conversion for agriculture or plantation purposes. Remaining PSFs should be protected or rehabilitated as necessary and either conserved or managed according to Sustainable Forestry Management principles and practices.

2) Manage remaining PSFs in the context of environmentally sound and sustainable development to maintain their natural roles and functions as well as ensure equitable allocation of benefits to key stakeholders including the local communities.

3) Any future plantation development in the peatland shall be prioritised on severely degraded areas and such development shall contribute to enhancing the quality of the hydrological landscape.

4) Manage all peatlands in an integrated manner for each complete hydrological unit with water management enhanced to reduce subsidence, GHG emissions and fire risk.

5) Develop practical guidelines and best practice manuals for the sustainable management of PSFs; the rehabilitation of PSFs with indigenous species; and the operation of existing industrial tree plantations on peat. These should be supported with appropriate certification standards, safeguards or regulations.

6) Strengthen the implementation of the ASEAN Peatland Management Strategy (APMS) and associated National Action Plans (NAPs), including development of incentives and financing mechanisms.

7) The private sector especially those companies involved in managing of the PSFs and the forest plantations in peatland areas should increase their support for the conservation of PSFs by supporting conservation and rehabilitation measures and development of appropriate integrated multi-stakeholder management mechanisms.

8) Undertake further action to enhance the protection and sustainable use of the Tasik Besar Serkap Landscape (Kampar Peninsula) and the Giam Siak Kecil Biosphere Reserve in Riau province, and other significant similar hydrological landscapes elsewhere in the region, through integrated management and enhanced partnership between the government, local communities and private sector.

9) Key stakeholders, including national and local government agencies, private sector, research institutes and civil society organisations, need to work actively together to enhance the level of protection and rehabilitation of the remaining PSFs.

10) Maintain and enhance regional and national cooperation and exchange knowledge and experiences among related stakeholders to advance the sustainability of forestry practices on peatlands.

# Working group discussions and conclusions

## Group 1
## Peat Swamp Forest Management and Rehabilitation

**Facilitators: Dr. Lailan Syaufina and Dr. Hendrik Segah**

**1) The key elements (parameters) of the management and rehabilitation of the PSFs:**

- Manuals and concepts of peatland protection and management.
- Water management (proper/ systematic canal system), ecosystem (plants i.e. endemic species that are non-flammable), fire management and awareness of stakeholders.
- Peatland allocated for resettlement, agriculture, conservation purposes etc. – sustainable development.
- Effective and competent managers to manage the area.
- Commitment of multi-stakeholder to sustainable peatland management.
- Unclear institutional arrangement and cross-sectoral issues.
- Incentives for rehabilitation.
- Ecosystem services.
- Management – hydrological management units – integrating the rehabilitation of vegetation/ peat forest as well as rehabilitating peat.
- Regulations (enforcement), spatial support/ planning of peatland, social issues (challenges – local communities as well as other stakeholders), ecosystem management – certification from Forest Stewardship Council (FSC).
- Private sector – production management, sustainable.
- Rehabilitation – social issue, water management (especially on degraded area).
- Coordination and working together with other sectors (local communities and NGOs for benefits sharing).
- Sustainable management of remaining and existing peatland forests in perpetuality for multiple uses and functions.
- Sustainable management of existing and degraded peatland for continued economic production.

**2) The challenges and gaps in PSF management and rehabilitation in SEA (e.g. lack of technical guide, lack of resources etc):**

- Smart partnership of multi-stakeholder (e.g. private sector and international funders) in rehabilitating degraded peatlands.
- Production sector – set aside part of concession land to fulfil promises towards REDD+ programme.
- APMI and APMS as a guided document in conserving peatlands (objectives and strategies – National Action Plans for Peatlands (NAPP) of each country).
- Lack of up-to-date information, competency in managing peatland forest, REDD+ mechanism (readiness?).
- APMS adopted by AMS. It is a living document that will be reviewed and implementation of the strategies is spelled out in the APMS.
- Coordination (mis-coordination between central government, provincial government and local government), fire management (strong commitment of local government and stakeholders in fire prevention).

**3) What are the effective ways that you think can overcome these challenges and gaps? In what area is more guidance needed?**

- Water control (management) by water level measuring, water level control, and predicting water effects on ecosystem.
- Planning and addressing the root causes.
- Identifying appropriate management intervention – e.g. water management, reforestation, natural succession?
- Enrichment planting and species selection.
- Maintenance of rehabilitation activities/sites.
- Stakeholder engagement.
- Land ownership/incentive mechanism.
- How to integrate and manage all data for PSF management such as using satellite data, various types of ground observation data, GIS and so on.
- Monetary (most important) – sustain funding.
- Responsibility (relevant authorities, land owners).

**4) Next steps:**

- Institutional arrangements.
- Policy implementations.
- More detailed research.
- Networking and communication within the stakeholders.
- Compilation and dissemination of research results and best practices.
- Solve poverty issues and improve the livelihood.
- Socialisation of each country for National/Provincial Master Plans on sustainable peatland management.

## Group 2: Existing Forest Plantation on Peat

**Facilitators: Mr. Faizal Parish and Mr. Chai Ah Sung**

**Challenges and problems:**

- Need a variety of species/sub-varieties and not just one (alternatives have lower yield/grow slowly).
- Enhance water management (future difficulties for gravity drainage) – telemetry, electronic gates and dry season irrigation.
- Reducing GHG emissions/maintain carbon stores.
- Identification of suitable sites.
- Adopting a landscape approach – with plantation as part of the landscape.
- Adequate land allocated for conservation to be viable (in Indonesia only 10% of land allocated and normally too small/narrow – minimum 1km wide).
- Understanding nature of peat including nutrients.
- How to zone and manage the entire hydrological unit and get all stakeholders to agree (important role of the government).
- Enhancing management of existing land bank.

**1) Key principles for responsible/sustainable plantations on peat:**

- Under current arrangements – plantations on peat may not be sustainable as in the medium term (30-60 years) they will subside to levels where further drainage will be difficult.
- Move to sustainable plantation model – which can allow long term use (100+ years).
- Balance economic viability with social acceptability and environmentally friendly nature.
- Early engagement of community and generate benefits for local community and stakeholders, not just plantation company.
- Clear understanding of peat characteristics.
- Site suitability.
- Scientific-based knowledge.
- Adequate control of the entire unit (non-fragmentation).
- Integrated multi-stakeholder approach.
- Integrated water management.
- Clear government standards/guidance to create a level playing field and promote good practices.
- Maintain biodiversity.

**2) Best management practices:**

Need to document and share good practices:

***Operational***

- Fire prevention and control
- Zero burning
- Plantation
- Community
- Water management
- Health and safety issue and worker capacity
- Zoning and management planning
- Planting zone of indigenous (beneficial) species
- Certification
- Silviculture regime – planting, harvesting, maintenance

- Land preparation
- Harvesting/Transportation
- Management plan development

***Environmental***

- Managing GHG emissions
- Natural forest rehabilitation techniques
- Environmental assessment
- Conservation area design and management
- Human- animal conflict

***Social issues***

- Land claims
- Free, Prior and Informed Consent (FPIC)
- Community development
- Community based planning
- Monitor GHG flux/carbon stock
- Water management etc.
- Community
- Recognizing traditional wisdom
- Livelihood for local community

**3) Next Steps:**

- Compile a best management practice manual/guideline
- Guidelines – experience on new area
- Multi-stakeholder working group
- 2-3 meetings over 12 months with field visits and exchanges
- Standards & regulations – by governments
- Implementation/Monitoring/Reporting

# MANAGEMENT OF PEAT SWAMP FORESTS AND FOREST PLANTATIONS ON PEATLANDS IN SOUTHEAST ASIA

Faizal Parish
*Global Environment Centre, APFP Regional Project Executing Agency*

## Background

Peat swamp forests (PSFs) are the main wetland forest type in Asia, covering approximately 25 million hectares of land in Southeast Asia (SEA). They provide water, prevent floods, and feed and supports communities. Peatlands have a unique biodiversity, are able to regulate climate change and store large amounts of carbon. Peatlands in SEA store 70 gigatonnes (Gt) of carbon, twice as much as all forest biomass combined. Unfortunately, only 34% of PSFs remain relatively intact while 20% of peatlands have been converted to plantations and the balance is degraded or fragmented.

***Table 1.*** Peatland area in Southeast Asia

| Country | Area (ha) | Source |
|---|---|---|
| Brunei | 90,900 | Page *et al.*, 2011 |
| Cambodia | 4,580 | Quoi, 2012 |
| Indonesia | 20,695,000 | Page *et al.*, 2011 |
| Lao PDR | 19,100 | Page *et al.*, 2011 |
| Malaysia | 2,588,900 | Page *et al.*, 2011 |
| Myanmar | 122,800 | Joosten, 2009 |
| Philippines | 64,500 | Page *et al.*, 2011 |
| Singapore | 50 | NEA |
| Thailand | 63,800 | Page *et al.*, 2011 |
| Viet Nam | 53,300 | Page *et al.*, 2011 |

## Importance of peatlands

Peat accumulates in thick layers over thousands of years. They provide water and prevent floods, feed communities, fish and edible plants; and support communities with commercial produce such as rattan, Jelutong latex and timber.

Peatlands possess unique biodiversity, being home to amazing creatures, for example the Emerald fighting fish (*Betta livida*), sunbears, false gharial and clouded leopards. Peatlands help to regulate the climate by storing large amount of carbon, up to 70 Gt, twice as much than all forest biomass combined. It is the most important carbon sink in SEA. Unfortunately, the relatively intact PSFs left in the region is only 34%, while 20% have been converted to plantations and the other remaining are degraded or fragmented.

## Drivers of Peatland Degradation

The main drivers of peatland status change from 1960 to 1995 were commercial logging, nature conservation (establishment of nature reserves and parks), agricultural drainage programmes, transmigration and swamp development programmes, which enjoyed limited success.

***Table 2.*** Status of Peatlands in 2010 Malaysia, Sumatra, Kalimantan

| Vegetation cover | Area (ha) | Percentage (%) |
|---|---|---|
| Peat swamp forest | 5,249,000 | 34 |
| Secondary PSF | 4,186,000 | 27 |
| Mosaic PSF | 1,326,000 | 9 |
| Open | 1,536,000 | 10 |
| Plantation | 3,120,000 | 20 |
| Other | 120,000 | 1 |
| **TOTAL** | **15,528,000** | **100** |

*(Source: Miettenen et al., 2012)*

***Table 3***. Detailed status of peatlands in Southeast Asia

| | Peat swamp forest 1000 ha | % | Regrowth 1000 ha | % | Mosaic 1000 ha | % | Open 1000 ha | % | Industrial plantation 1000 ha | % | Other nonforest 1000 ha | % | Total 1000 ha |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Peninsular Malaysia | 230 | 26 | 182 | 20 | 128 | 14 | 76 | 9 | 262 | 29 | 13 | 1 | 890 |
| Aceh | 108 | 39 | 94 | 34 | 18 | 6 | 10 | 4 | 46 | 17 | 0 | 0 | 277 |
| North Sumatra | 25 | 7 | 69 | 20 | 33 | 9 | 21 | 6 | 200 | 57 | 0 | 0 | 348 |
| Riau | 1382 | 34 | 1051 | 26 | 326 | 8 | 263 | 7 | 968 | 24 | 24 | 1 | 4014 |
| West Sumatra | 20 | 9 | 62 | 29 | 34 | 16 | 17 | 8 | 78 | 37 | 1 | 0 | 211 |
| Jambi | 181 | 25 | 255 | 36 | 75 | 10 | 60 | 8 | 146 | 20 | 1 | 0 | 717 |
| Bengkulu | 0 | 0 | 24 | 46 | 14 | 26 | 7 | 14 | 7 | 13 | 1 | 1 | 52 |
| South Sumatra | 107 | 7 | 537 | 37 | 134 | 9 | 220 | 15 | 449 | 31 | 2 | 0 | 1450 |
| Lampung | 3 | 3 | 24 | 26 | 6 | 7 | 45 | 49 | 10 | 11 | 3 | 3 | 92 |
| Other provinces | 24 | 32 | 33 | 45 | 4 | 6 | 11 | 15 | 0 | 0 | 1 | 1 | 74 |
| Total Sumatra | 1850 | 26 | 2150 | 30 | 643 | 9 | 655 | 9 | 1904 | 26 | 32 | 0 | 7234 |
| Sarawak | 380 | 26 | 403 | 28 | 47 | 3 | 82 | 6 | 525 | 36 | 6 | 0 | 1443 |
| Sabah | 39 | 20 | 49 | 26 | 15 | 8 | 33 | 17 | 52 | 27 | 3 | 2 | 191 |
| West Kalimantan | 1042 | 60 | 318 | 18 | 94 | 5 | 101 | 6 | 157 | 9 | 31 | 2 | 1743 |
| Central Kalimantan | 1454 | 48 | 780 | 26 | 291 | 10 | 357 | 12 | 118 | 4 | 8 | 0 | 3009 |
| South Kalimantan | 4 | 1 | 96 | 29 | 46 | 14 | 149 | 45 | 31 | 10 | 3 | 1 | 329 |
| East Kalimantan | 250 | 36 | 207 | 30 | 62 | 9 | 110 | 16 | 53 | 8 | 7 | 1 | 688 |
| Total Borneo | 3169 | 43 | 1853 | 25 | 555 | 7 | 832 | 11 | 936 | 13 | 57 | 1 | 7403 |
| Total | 5249 | 34 | 4186 | 27 | 1326 | 9 | 1563 | 10 | 3102 | 20 | 102 | 1 | 15528 |

*(Source: Miettenen et al., 2012)*

Between 1995 and 2010, the threats changed to agriculture and plantation development, illegal logging and fires. For example, the failed Mega-Rice project was spread over 1.5 million ha of peatlands in the heart of Kalimantan, Borneo. Other major developments are oil palm and pulpwood plantations, as well as agricultural smallholdings. This is accompanied by widespread illegal logging, especially in Sumatra and

Kalimantan. A combination of these contributed to widespread fires that decimated 1 million ha in Kalimantan in 1982/83 and over 3 million ha in the 1997/98 El Niño episodes. Significant areas were burnt in 2002 and 2006.

The keys to sustainable forest harvesting are protecting peatland forest resources, avoiding drainage, encouraging post-harvest regeneration and promoting reduced impact logging extraction methods.

**Extent of plantations on peat and Transboundary Haze**

Up to 2010, there were 897,718 ha of forest plantations and more than 2 million ha of oil palm plantation on peatlands in Indonesia and Malaysia. Peatland clearance and drainage for plantations may lead to fires, GHG emissions and haze; leading to transboundary smoke haze, which has been a problem that has led to various regional and national efforts to combat this pressing ASEAN problem.

One of the results is the development of the ASEAN Peatland Forests Project (APFP) which aims to support the implementation of the ASEAN Peatland Management Strategy (APMS). Some of the project targets are the development of pilot projects in four (4) ASEAN countries – Indonesia, Malaysia, Philippines and Viet Nam; identification and promotion of Best Management Practices (BMPs) for peatlands; reduction in peatland fire and degradation and the development of innovative finance options. The project started in 2009 and should be completed in 2013. Since 2002, the problem has stimulated regional cooperation.

Among the efforts are:
- The ASEAN Agreement on Transboundary Haze Pollution (2002)
- ASEAN Peatland Management Initiative (2003)
- ASEAN Peatland Management Strategy (2006)
- ASEAN Peatland Forests Project (2009-2014)
- Peatlands and Climate Change
- Recognition by CBD and UNFCCC (2007-9)
- REDD+ (2006-2014)
- 26–41% GHG emission reduction target in Indonesia

**ASEAN Peatland Forests Project (APFP)**

The APFP was developed to support the implementation of the ASEAN Peatland Management Strategy (APMS) 2006-2020. It has aided in the development of pilot projects in four ASEAN countries namely Indonesia, Malaysia, Philippines and Viet Nam.

Among the activities are identification and promotion of BMPs for peatlands in order to reduce peatland fires and degradation as well as the development of innovative finance options. This project was implemented from 2009 and will end in 2014.

Some national actions that have been taken in recent years are:
- New policies and regulations related to peatland conservation and fire prevention
- Regulation on oil palm development on peatlands since 2009 in Indonesia
- Presidential Instruction for Mega-Rice Project (2009)
- Moratorium on peatland and natural forest development (2011)
- National Action Plan on Peatlands (Malaysia 2011)
- Rehabilitation programmes
- Climate change, forest and peatlands in Indonesia (2002-2007)
- Central Kalimantan Peatlands Programme (2006-2009)
- Netherlands-Malaysia Programme in Sarawak (2005-2008)
- Raja Musa PSF rehabilitation programme, Malaysia (2008-2012)

## Future directions

The first is the business as usual (BAU) scenario, where there will be further conversion of remaining peatlands for plantations; continued overharvesting of PSFs; further degradation, haze from fires and GHG emissions; plus encroachment of conservation areas. There would be serious subsidence and unsuitable soil conditions, leading to lower yields and conflict between users. Eventually, there will be a cycle of abandonment and fires.

On the other hand, with Scenario 2, climate finance and national policies would support peatland protection and maintenance. Further plantation or agricultural development on peat would be restricted to mineral soils or severely degraded land. All deep peatlands are retained for nature, carbon or water resource conservation, or sustainable forest management while degraded peatlands are rehabilitated. Existing plantations would be managed according to best management practices to enhance yield on current lands. There is already progress in this area.

For example:

- The oil palm sector has already established new regulations for oil palm on peat
- Major industry players have pledged to stop new plantations in peat
- The Roundtable on Sustainable Palm Oil (RSPO) has adopted BMP manuals while Indonesia has established the Indonesian Sustainable Palm Oil (ISPO) Standard
- Forest plantation companies have initiated conservation measures such as forest conservation zones and land swaps
- Improved management especially water management has been introduced
- Reducing Emissions from Deforestation and Forest Degradation (REDD+) projects have been initiated
- Fire prevention and community development programmes are in place

## Conclusions

PSFs are the main wetland forest type in SEA and play a critical role for climate regulation, water supply and livelihood support.

Unless the situation is changed, the long term scenario is of continuing degradation, fires and large scale land subsidence. Therefore it is critical that new strategies are implemented in partnership with all stakeholders to conserve remaining intact forest, rehabilitate or better use of the degraded land and improve management on plantation land and bring benefits to local community. There is also a need to enhance regional cooperation and partnership between government, private sector and local communities.

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# THE CURRENT POLICY AND STATUS FOR FORESTRY AND PLANTATIONS ON PEATLANDS IN INDONESIA

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## Abstract

Peatlands cover approximately 15 million hectares in Indonesia. The area is utilised for various purposes, governed by Indonesian Forestry Laws. The National Forestry Plan 2011-2030 provides direction of macro-spatial forest area and forest administration in the future through the sustainable and multi-functional use of forest resources. It serves as a reference in the preparation of development plans, investment plans and business plans in various geographic scales, time frame and main functions of forests.

According to the Spatial Directive, natural forest and peatland ecosystems are to be protected and used for the provision of carbon (carbon stock). Utilisation of peatlands in the future can be done without diverting from the main goal while carbon trading projects can be implemented through the utilisation of these regions. This relates to the Indonesian government's plan to reduce carbon emissions by 26% (from BAU) and as much as 41% with international aid through conservation of natural and peatswamp forests.

In conclusion, forest and forestry in Indonesia is the key factor in dealing with the problems of deforestation, climate change, poverty, job opportunities and contribution to Gross Domestic Product (GDP).

***Keywords:*** *Indonesia, forestry, emission reduction*

## Indonesian forest: based on function and coverage

Indonesian forests can be classified according to function and coverage. In total, Indonesia has over 130 million ha of forest (Table 1, Figure 1, Figure 2). Of this, there are about 15 million ha of peatlands in Papua, Kalimantan and Sumatera (Figure 3).

***Table 1.*** Function and coverage of Indonesia's forests

| Function | Area (million ha) | Coverage | Area (million ha) |
|---|---|---|---|
| Conservation | 26.82 | Primary | 41.26 |
| Protection | 28.86 | Secondary | 45.55 |
| Permanent Production | 32.60 | Plantation | 2.82 |
| Limited Production | 24.46 | Non-forest | 41.05 |
| Convert. Production | 17.94 | | |
| **Total** | **130.68** | | **130.68** |

## Chronology of Forestry Law

Over the years, Indonesia has implemented various laws related to forestry. It was not until after the massive El Niño fires in 1998, that true reform began to show in Indonesia's forestry laws. It began with Law 41/1999, which promoted sustainable use of forests and involving the local community in forest management and developing partnerships through its cooperatives. It also stipulated that forest plantations could only be developed on non-productive areas such as grasslands. In addition, PP 34/2002 gave further control back to the Ministry of Forestry by ensuring that only the Ministry has authority to issue licenses for harvesting and large-scale forest concessions among others.

In the 2009 UNFCCC Copenhagen Summit, President Yudhoyono voluntarily committed to cut GHG emissions by 26% by 2020 from "business as usual" (BAU) levels, or up to 41% with international support. In direct response to this the President later issued a Presidential Instruction in 2011 (INPRES 10/2011), which suspended all new concessions for conversion of peat and natural forest for a 2 year period. This was one of the key deliverables of a bilateral agreement between the governments of Indonesia and Norway on “Cooperation on reducing greenhouse gas emissions from deforestation and forest degradation”.

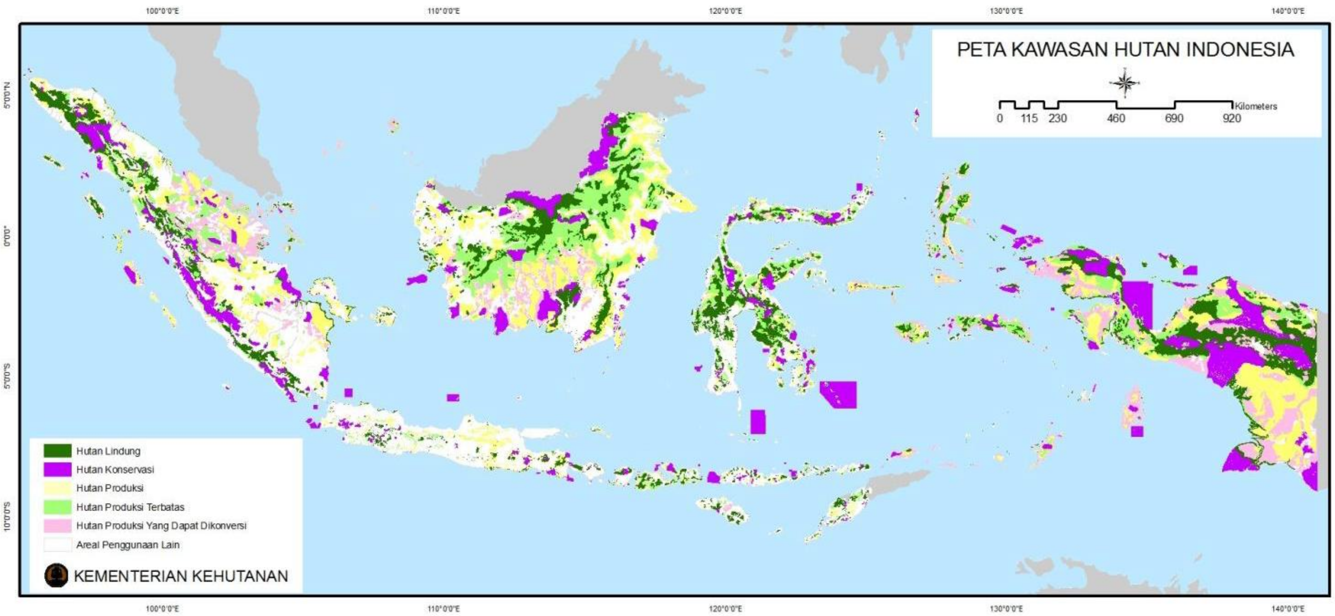


***Figure 1.*** Map showing the function of forests in Indonesia

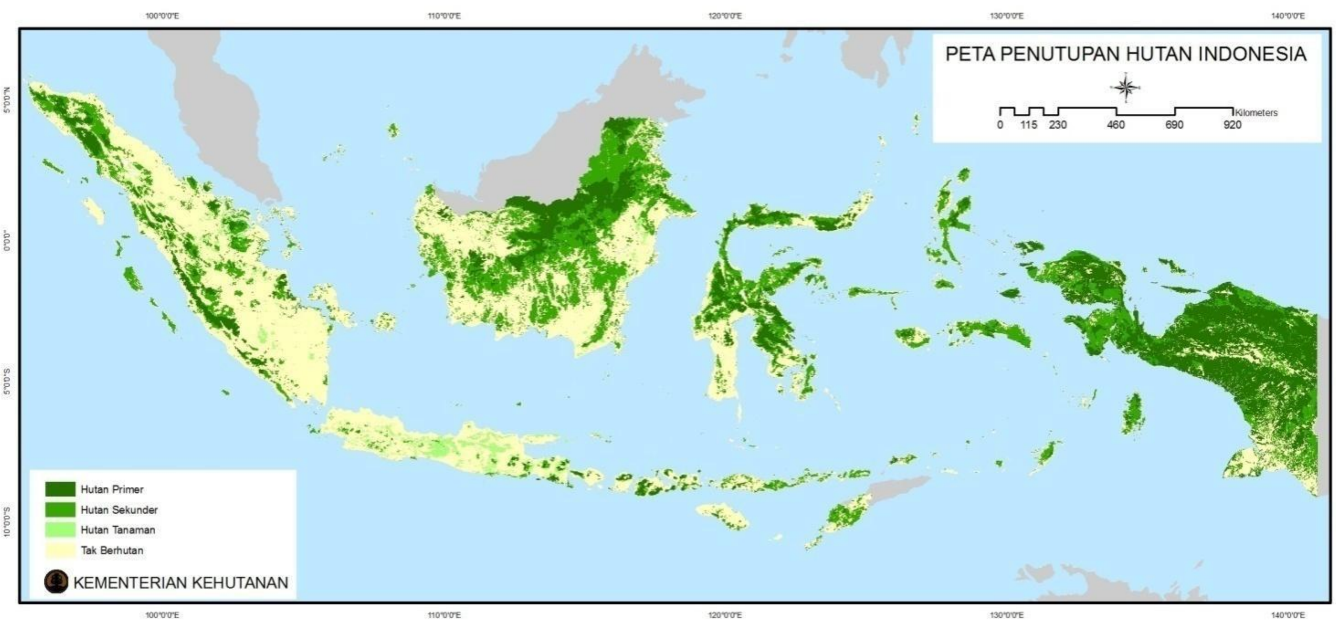


***Figure 2.*** Map showing the coverage of forests in Indonesia

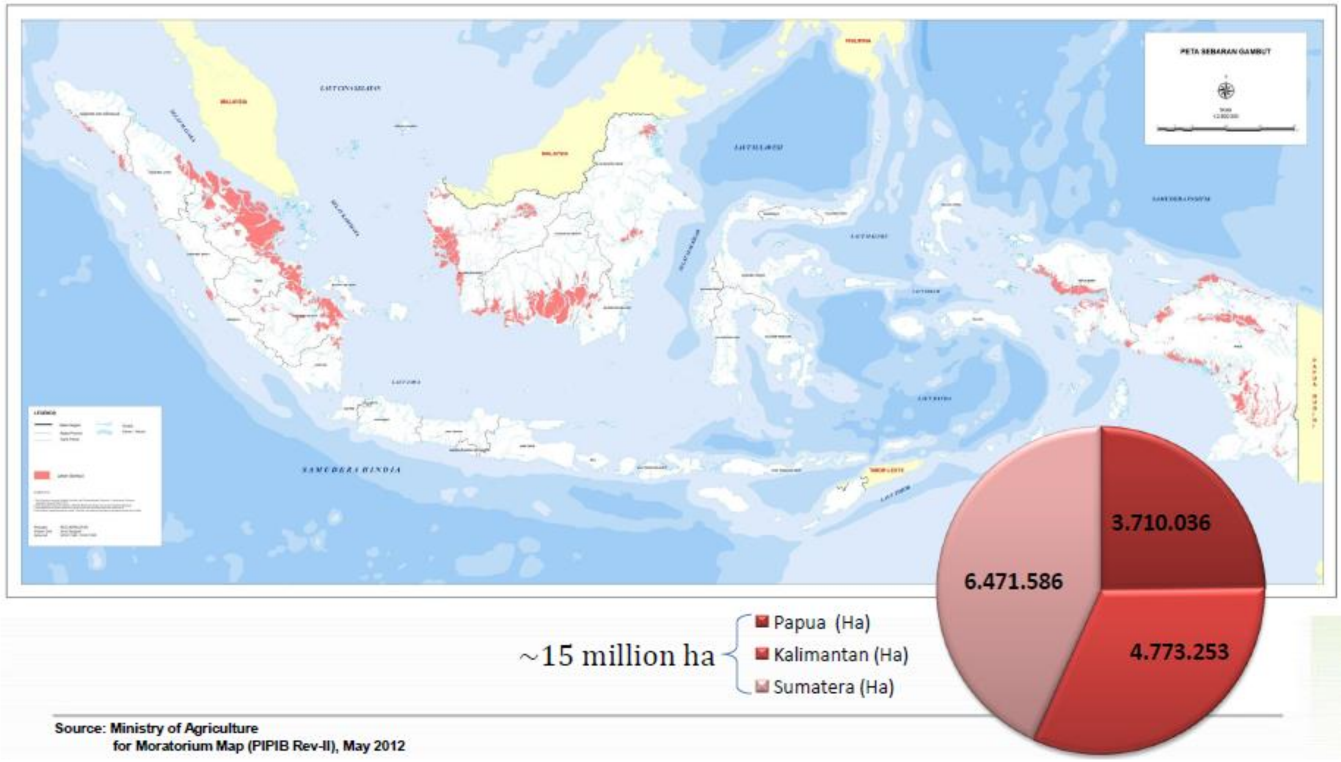


***Figure 3.*** Map showing peatland coverage on Indonesia's three main islands

As of now, Indonesia is implementing better prudence in permit issuance in natural forests and practising tighter law enforcement. They are also taking into account customary rights of local communities and accelerating rehabilitation processes and planting.

### Utilisation of forest area

As of January 2012, Indonesia had 23,591,469 ha (295 concession units) of natural forest and 13,117,743 ha (229 units) of plantation forests.

### National Forestry Plan

In 2011, the Ministry of Forestry, Indonesia developed the National Forestry Plan 2011 – 2030 to provide future direction to the forest administration on the use of forest resources in a fair and sustainable way and multi-functional use of forests.

The Plan is based on spatial analysis and rationalisation of forest area which groups different forest types into 21 themes. Each forest area is then analysed against key criteria and given a spatial directive which determines their use. The results of the analysis are shown in Table 2.

Based on the analysis, 28 million ha of forest is classified as 'Primary Forest and Peatland Area'. The main goal for these areas is to protect them as natural forest and peatland ecosystems and for the provision of carbon. Utilisation of these areas in the future can be done with without straying from the main goal as they can be used in carbon trading schemes.

***Table 2.*** Total amount of forest area in each spatial directive after analysis

| **Spatial Directives** | **Area (million ha)** |
|---|---|
| Conservation Area | 23.20 |
| Primary Forest and Peatland Area | 28.40 |
| Rehabilitation Area | 13.53 |
| Large scale Concessionaire Area (Company) | 54.52 |
| Small scale Concessionaire Area (Community) | 6.97 |
| Other Sector Area | 4.06 |
| **Total** | 130.68 |

## National Government Program on Emission Reduction

On September 20, 2011 President Yudhoyono signed another Presidential Instruction (INPRES 61/2011) for the National Action Plan to Reduce Greenhouse Gas (GHG) Emissions. The key focus of the decree was the forestry sector, although it also touched on energy, agriculture and industry, and was meant to address ways in which Indonesia was going fulfill their commitment to reduce GHG emissions between 26%, or up to 41% with international aid.


***Figure 4.*** Summary of Indonesia's national government program on emission reduction

Based on the plan, the forestry and peatland sector is responsible for a large majority of the total emission reduction in both scenarios (26% or 41% reduction).

The third dictum to the Minister of Forestry states:-

- The suspension of the issuance of new permits on primary natural forests and peatlands based on the indicative map of the New License Suspension (Moratorium Map).
- Governance policies to permit and license the utilisation of timber in the natural forest.
- Effectiveness of critical land management (ecosystem restoration).

- Revision of the Indicative Map of New license Suspension (Moratorium Map) in forest areas every 6 months.

***Table 3.*** Proposed contribution of each sector to the National Action Plan for GHG Emission Reduction

| | Emission Reduction Plan ($GtCO_2e$) | | | | | |
|---|---|---|---|---|---|---|
| **Sectors** | **26%** | **Percentage** | **+15% (Total 41%)** | **Percentage** | **Total** | **Percentage** |
| **Forestry and Peatland** | **0,672** | **87,6%** | **0,367** | **87,0%** | **1,039** | **87,4%** |
| Waste | 0,048 | 6,3% | 0,030 | 7,1% | 0,078 | 6,6% |
| Agriculture | 0,008 | 1,0% | 0,003 | 0,7% | 0,011 | 0,9% |
| Industry | 0,001 | 0,1% | 0,004 | 0,9% | 0,005 | 0,4% |
| Energy and Transportation | 0,038 | 5,0% | 0,018 | 4,3% | 0,056 | 4,7% |
| Total | 0,767 | 100,0% | 0,422 | 100,0% | 1,189 | 100,0% |

The Moratorium Map is revised based on the data from the latest ground surveys, spatial planning progress, land cover data and public input and comments. This process involves multiple parties including BPN-RI, BIG/BAKOSURTA NAL, KEMENHUT, UKP4 and KEMENTAN. Since the INPRES 10/2011 came into effect, the first revision of the Moratorium Map was completed on 22 November 2011 and the second revision was completed on 16 May 2012.

### Deforestation rate

Deforestation constitutes about 20% of GHG emissions, and Indonesia accounts for more than half of that total. Since 2000, the deforestation rate in Indonesia has been going down (Figure 5).

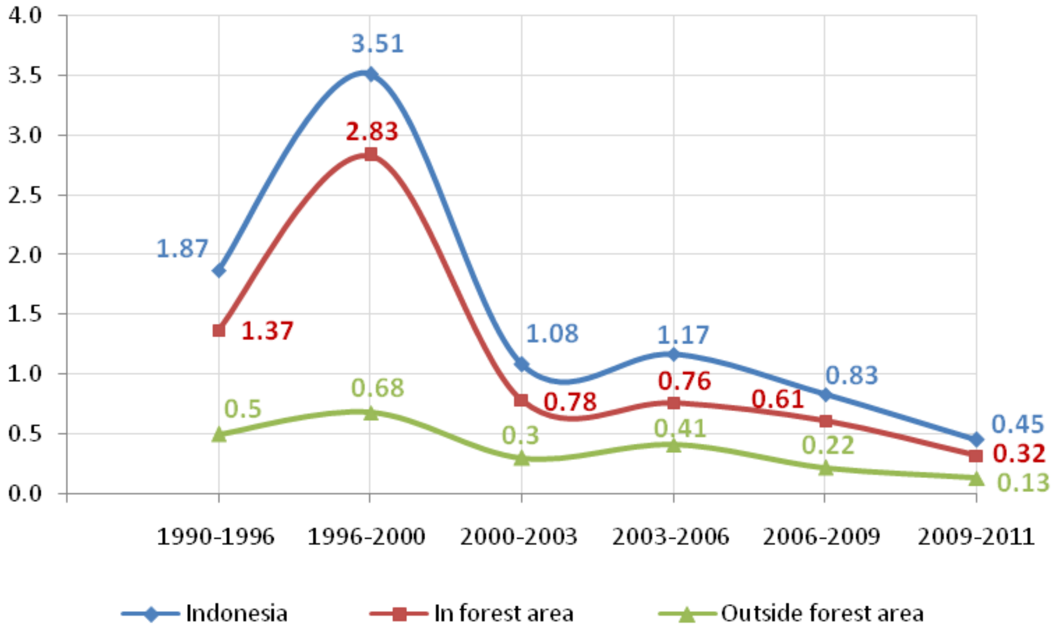


***Figure 5.*** Deforestation rate in Indonesia from 1990 - 2011

## Conclusion

Policies and laws on forestry is a key factor in dealing with the problem of deforestation. It also deals with climate change, poverty, job opportunities and contribution to GDP. The recent national action plan and regulations have set forth a path for better awareness on natural forest and peatland management and a better planning process to place the economy on a more sustainable footing.

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# POLICY ON PROTECTION AND MANAGEMENT OF PEATLAND ECOSYSTEMS IN INDONESIA

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**Abstract**

Peatland ecosystems have been considered by the Government of Indonesia as a unique and important ecosystem, playing a key role as a source of biodiversity and balancing the environment condition. In recent years, policies have been developed to strengthen sustainable peatland management in Indonesia both in general as well as in sectoral views. The policies include: Government regulation, Presidential decrees, National Strategy, and National Action Plan. Among such policies is the National Strategy for Sustainable Peatland Management in Indonesia which was generated from the ASEAN Peatland Management Strategy (APMS) and Government Regulation Plan on Environmental Degradation Control in Peatland Ecosystem. Besides these, there are some peatland-related policies that have been formulated, such as the: National Strategy for REDD implementation, National Action Plan for Green House Gas Inventory, National Action Plan for Green House Gas Reduction, National Action Plan for Mitigation and Adaptation on Climate Change and other sectoral policies. All the policies need to be implemented on a regional level, especially into regional spatial planning in provincial as well as in district levels. Currently, all the policies are in dissemination stage to various stakeholders involved and some pilot projects are being demonstrated.

***Keywords:*** *peatland ecosystem, sustainable peatland management, National Strategy, APMS*

## Introduction

Southeast Asia (SEA) has more than 25 million hectares of peatland, of which about 15 million ha are in Indonesia. This is the fourth largest peatland area in the world after Canada, Russia and USA and the largest tropical peatland area in the world. The total peatland hydrological unit area is about 32,656,106 ha, storing about 46 gigatonnes (Gt) of carbon, which is about 8 – 14% of the total global carbon stock.

Of its total unit volume, peat comprises of more than 90% water and functions as a water storage and supply for surrounding areas. They also have a production function by supplying forest products such as Jelutong, honey, sago, rattan and fresh water fish, and can be used as a cultivation area for traditional farming and plantations. Besides having hydrological and production functions, peatlands are also important in global climate control and biodiversity conservation. They also provide a great opportunity for tourism and education and research.

## Effects and constraints on peatland management in Indonesia

Over the years, unsustainable peatland management has led to problems such as: (1) 2.669 million ha or 37% of destroyed and unproductive peatlands in Sumatera, (2) unsustainable peatland development (ex-mega rice project – 1 million ha), (3) biodiversity degradation, (4) peatland fires, smoke haze, floods, etc. (5) socio-economic loss (loss of livelihood/ local business opportunity, poverty, etc.).

There are some major constraints to peatland management in Indonesia which include limited knowledge, awareness and commitment of related stakeholders and the local community in understanding the value of sustainable peatland ecosystems and to support sustainable peatland uses. There is also population pressure and the increase of land demand for cultivation in and around peatland areas, as well as a lack of effort in sustainable peatland development.

## Policies on peatland ecosystem management in Indonesia

Policies for peatland management in Indonesia is based on protecting peatland hydrological units (KHG), defined as peatland ecosystems that are bordered by a river and/or river branch and/or elevated land. Each KHG can be used as a peatland ecosystem management unit and the peat dome for each unit is identified to ensure the function of each peatland ecosystem is protected and used in accordance with the function and carrying capacity, supported by related policies and laws.

Peatland management is regulated by a number of national level policies including:

- Law No. 32 Year 2009 on Environmental Protection and Management
- Government Regulation No. 26 Year 2008 on National Spatial Plan
  Presidential Instruction No. 1 Year 2007 on Acceleration of Rehabilitation and Revitalization of Peatland area in Central Kalimantan
- Presidential Instruction No. 1 Year 2010 on Acceleration of National Development Implementation
- Minister of Agriculture Regulation No. 14/Permentan/PL.110/2/2009 on Guidelines of Peatland Uses for Oil Palm Cultivation
- Minister of Environment Decree No. 5 Year 2000 on Guidelines of EIA Preparation of Development Activities in Wetland Area
- Presidential Instruction No. 10 Year 2011 on Moratorium of New Permit and Management Improvement of Primary Natural Forest and Peatland
- Presidential Regulation No. 61 Year 2011 on National Action Plan for GHG Emission Reduction
- Presidential Regulation No. 71 Year 2011 on National GHG Inventory
- Government Regulation Plan on Peatland Ecosystem Protection and Management

The strategy for sustainable peatland management incorporates:

i) Institution and human resource development
ii) Technology utilisation and adaptive commodity selection
iii) Community empowerment and participation enhancement
iv) Data and information provision
v) Peatland degradation and peatland fire control
vi) Funding sources and mechanisms

The current efforts on rehabilitation and sustainable use of peatland/forest are in line with, and support, peatland ecosystem management.

# SUSTAINABLE FORESTRY AND REDUCED IMPACT LOGGING PRACTICES OF PEAT SWAMP FORESTS IN MALAYSIA

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## Abstract

Peat swamp forests (PSFs) grow on waterlogged areas upon layers of poorly decomposed organic materials, hence the origin of black water. In Malaysia, this type of forest is of significant size, particularly in states such as Selangor, Pahang, Sabah and Sarawak. In terms of management, in Peninsular Malaysia and Pahang in particular, PSFs are being managed by using Modified Selective Management System (MSMS), originally used for the hill forest. However, the PSF is physically and ecologically different from the dry inland forests. It is denser though with less species, and the timbers are smaller. The peat soil is also unstable, making the forest less accessible, and it is sensitive to disturbances. Therefore, a specific harvesting management system that takes into account the unique conditions of this forest is crucial for ensuring its sustainable timber production. In PSFs of Malaysia, only harvesting systems that adhere to the Reduced Impact Logging (RIL) methods are allowed to be used in Forest Reserves. This paper elaborates on the PSF management and RIL practices in this country.

***Keywords:*** *sustainable forest management, forest harvesting, timber production, forest conservation*

## Introduction

PSFs grow on waterlogged areas upon layers of poorly decomposed organic materials, hence the origin of black water. In Malaysia, this type of forest is of significant size particularly in states such as Selangor, Pahang, Sabah and Sarawak. Based on the statistics of 2007, there was estimated about 1.14 million hectares PSF in Sarawak and 0.12 million ha in Sabah. However, all PSFs in Sabah are classified as conservation forests. As for Peninsular Malaysia, PSFs occur behind coastal lines along both the west and east coasts, and estimated to be about 0.30 million ha.

The east and west coasts of Malaysia differ in the types of underlying sedimentary deposits. The peat along the west coast was formed over heavy alluvial clay and protected from strong waves by a strip of mangrove vegetation. On the other hand, peat along the east coast developed over white clay and coarse sand, and is exposed directly to the strong waves of the South China Sea.

The economic development of people living within the PSF area depends heavily on trees growing. Most of the trees growing are marketable, and about 10 species, particularly the *Gonystylus bancanus,* have been commercialised and fetch high timber prices. Besides the economic contribution, PSFs also have important environmental roles such as being a source of water supply, flood control and carbon sequestration. The peat swamp acts as an important catchment area in regulating water supply for rice cultivation. An excellent example is the paddy fields extending about 20,000 ha at Tanjung Karang, Kuala Selangor that receive continuous water supply from the adjacent PSFs through the Sungai Tengi and Sungai Dusun. The role of PSFs in flood control has also been recognised. During the monsoon season, excess water from the river is diverted through feeder canals to PSFs in order to minimise the risk of flooding to the agricultural or residential areas downstream.

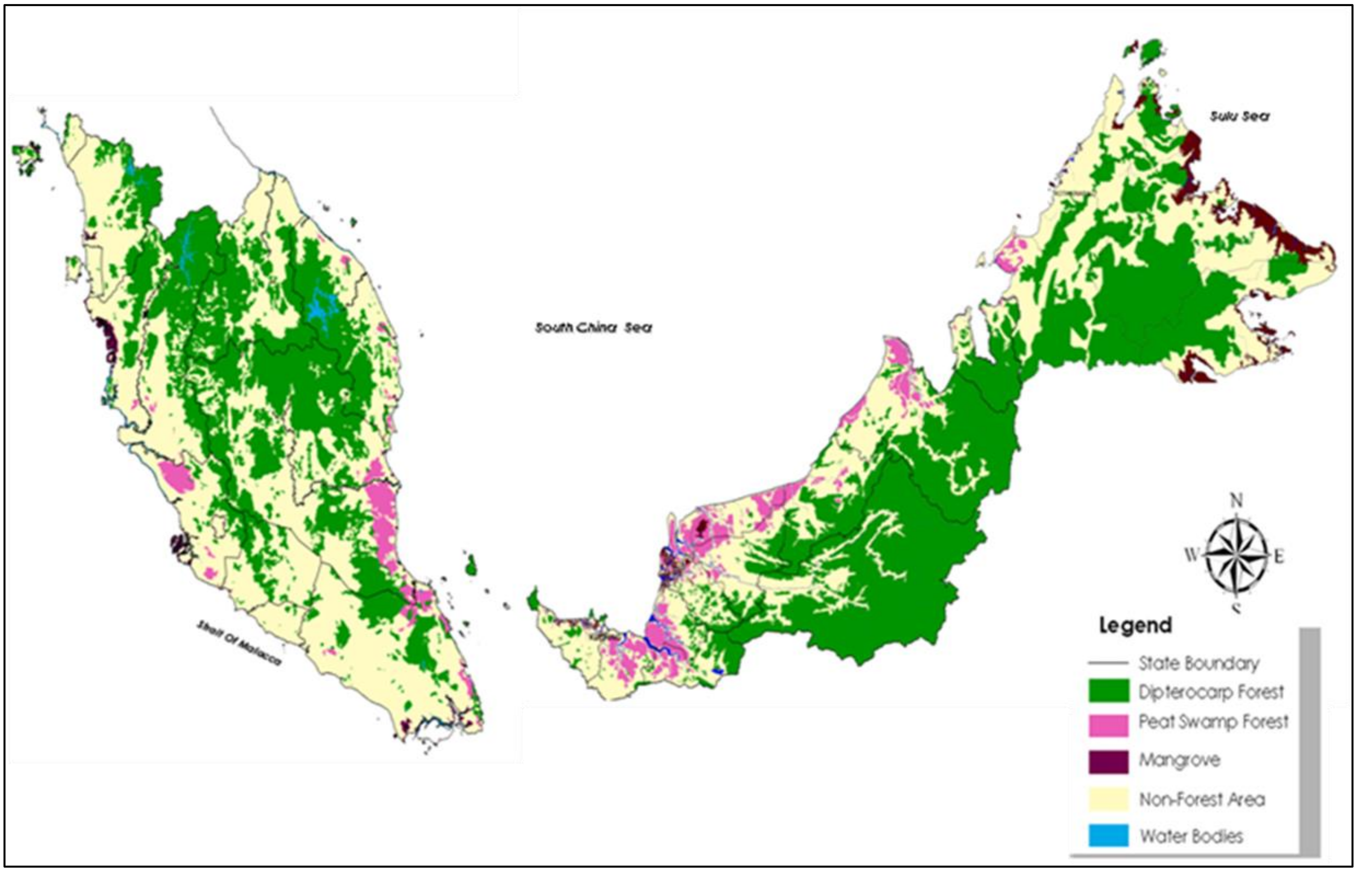

***Figure 1***. Distribution of PSFs in Malaysia

### Sustainable forestry of PSFs

Harvesting should be regarded as the first silvicultural intervention as its impacts will be reflected on the logged area as a whole. Consequently, the impact of harvesting is closely related to the silvilculture operation taken on the area (Abd Rahman *et al*., 1992). If the impacts are severe, major and extensive silviculture treatments need to be done, whereas, if the impacts are low only minimum silviculture operation is needed. In fact, to a certain extent, the area can be left to recover naturally.

The management of PSF in Peninsular Malaysia currently adopts a selective cutting approach, also known as the Selective Management System (SMS), where all trees above specified diameter limits within species groups are felled (Ismail, 2009; Mohd Hizamri, 2006; UNDP/GEF 2008). The SMS was originally developed for dry inland forests (Thang, 2002). Meanwhile, according to Lee (1982) as cited in Chai (1997), PSFs in Sarawak are being managed by using Modified Malayan Uniform System (MMUS). As the stand conditions in dry inland forests differ from those of the PSF in terms of species composition, stand structure as well as the habitat condition, it is only appropriate that PSF management prescription should be developed based on its own characteristics (Ismail *et al*., 2005).

In addition, the method of harvesting in PSF should use reduced impact logging (RIL) to minimise impacts on the residual stands. Zulkifli (2005), Mohd Hizamri (2006) and Ismail (2009) had showed that the RIL method could be implemented successfully in the PSF environment. Thus, they recommended that the RIL method should be continued to be used, promoted and enforced in PSF harvesting.

## Reduced impact logging practices in PSFs

The only harvesting machine used in Pekan Forest Reserve (FR) of Pahang is the Rimbaka Timber Harvester, or simply called the *Rimbaka*. The machine employs the RIL method (Elias & Khali Aziz, 2008) developed by *Syarikat Upayapadu Sdn. Bhd.* Since 1999, when the Pekan FR started to be harvested, this has been the only system used for timber harvesting (Forestry Department of Pahang, 2006). The *Rimbaka* is a modified tractor machine with an extended boom and powerful winching system (Chong & Latifi, 2003). It operates the same way as a mobile highlead yarding system. A cable was dragged into the forest from the skid trail called as *'Jalan Tarik Rimbaka'* (JTR) and was attached to the log as far as 150m away, although its safety extraction distance was 125m (Elias & Khali Aziz, 2008).

The log was lifted and then winched to the track by the *Rimbaka*; the long boom enables the front of the log to be raised off the ground, thereby reducing damage caused by the passage of the log through the forest. Logs extracted by the *Rimbaka* were placed along the JTR (Figure 2) and were then pulled to a temporary log yard at a forest road by traxcavator. The logs were then transported by lorries to a permanent log yard for further processing. The extended arm of the Rimbaka allows it to control the winching of the log and keep the leading end of the log off the forest, which greatly reduces damage. The application of the *Rimbaka* allows harvesting operations being conducted without access of machinery into the forest (apart from forest roads and JTR), which contributes to high improvement of the forest environment.

In this FR, canals were not allowed to be built but it was replaced with permanent forest roads. In the forest roads construction, small logs and waste woods were used as its foundation. Sand was brought from outside of the FRs and placed on top of the foundation, and subsequently the roads were compacted by a mechanised compactor. The cost of forest road construction was estimated at about RM100,000 per km (Salleh *et al*., 2011). Studies by Zukifli (2005) and Ismail (2009) shows that this method recorded considerably low damage impacts on the residual stands (Table 1).

***Figure 2.*** The Rimbaka timber harvester

***Table 1.*** Summary of results from the studies

| Parameter | Zulkifli (2005) | Ismail (2009) |
|---|---|---|
| Trees felled (stems $ha^{-1}$) | 8.8 | 36.9 |
| Log production ($m^3$ $ha^{-1}$) | 43.6 | 87.0 |
| Undamaged trees (%) | 82.4 | 63.5 |
| Light and medium damaged trees (%) | 5.6 | 10.8 |
| Heavy damaged trees (%) | 5.1 | 11.4 |
| Dead trees (%) | 6.9 | 14.3 |

Besides Pahang, other important PSF areas in Peninsular Malaysia are located in the state of Selangor. Before 1999, conventional harvesting methods of using traxcavators with canals, or railways, were used in the PSF at Selangor. However, since 1999, harvesting in Selangor PSF has adopted the RIL method called as 'pre-determined skid trail' (Jonas & Shamsudin, 1999). The technique consists of a minimum 50m cable mounted on a traxcavator that will winch the logs from a pre-determined corridor outside the felling block. Canal construction is prohibited and only railway is allowed. The railway is used to transport the logs from the harvesting areas to the temporary log yards, of which the logs are then transported to the permanent log yards by either using existing forest roads or a river. As a note, there is no more logging in the peat swamp FR in Selangor as all logging operations in the reserve has been ceased by the state government.

In Sarawak, mixed swamp forest (MSF) is the most extensive forest subtype and covers approximately 80% of its PSF (Chai, 1997). The MSF is worked on an empirical harvesting period or rotation of 45 years with fixed minimum cutting diameter of two groups of species. Selective felling system, with the sequence of operations is adopted in the harvesting of the PSF. It is aimed at removing selectively, in a single felling operation, the mature and over-mature trees, while at the same time leaving behind a residual stand with a sufficient number of trees in the intermediate diameter classes to form the next crop. Annual coupe system is a format to control and monitor harvesting activities and yield of harvest. The sequence of operations in the annual coupe system, commonly known as Permit to Enter Coupe (PEC) for PSF in Sarawak is shown in the Table 2.

***Table 2.*** Sequence of operational activities in the Annual Coupe System of PSF in Sarawak

| Sequence of Operations | Operational Activities |
|---|---|
| **1** | Cut '*rentis*' for rail lines, and demarcate and survey coupe and block boundaries. |
| **2** | Carry out 100% enumeration of annual coupe. |
| **3** | Construct rail lines. |
| **4** | Construct "*Kuda-Kuda*", fell and extract timber. |

*(Source: Forestry Department Sarawak at www.forestry.sarawak.gov.my)*

Every operational activity has to be approved before the next operation is executed. Selective logging using the '*kuda-kuda*'system in PSF (Figure 3), though labour intensive, is considered environmentally friendly as only commercial trees attaining merchantable sizes were harvested (Sawal, 2005). At the same time, the logged-over MSF within the permanent FR was silviculturally treated to regenerate, rehabilitate and improve the condition of the residual forests.

***Figure 3.*** '*Kuda-kuda*' system in timber harvesting in PSF of Sarawak
*(Source: Sawal, 2005)*

## Conclusions

It is important to develop a specific harvesting system for the PSF based on its own physical and ecological characteristics. Among the critical aspects of the harvesting system is a minimised impact of the harvesting operations on the residual stands. This will then in return minimise the cost of silviculture treatments and speed up the natural recovery of the trees in the harvested areas. Studies show that the implementation of the RIL method in PSF helps to minimise damage to the residual stands. It showed that the RIL method had successfully produced relatively low damage and mortality of the residual stands and therefore should be continued and encouraged to be used in harvesting of the productive PSF areas.

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# ASSESSING THE SUCCESS OF TROPICAL PEATLAND RESTORATION: A REVIEW

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## Abstract

Tropical peatland, particularly in SEA has experienced serious degradation pressures in the last two decades, particularly from peat forest conversion, drainage and fires. In response, as well as to avoid further degradation problems, peatland scientists and practitioners have called for restoration measures to be urgently put in place. In addition, many restoration initiatives have been carried out in the region in recent years and these initiatives are embodied in various activities such as blocking drainage channels, planting trees, fire prevention and developing livelihood alternatives for local people. However, to what extent these peatland restoration interventions have succeeded in restoring and rehabilitating degraded peatland is still unclear. No comprehensive assessment has been undertaken. In addition, a proper assessment framework does not exist, which has also hindered the assessment process of current peatland restoration. There is a critical need to develop a comprehensive and applicable assessment framework for examining the success of peatland restoration initiative.

The main aim of this paper is develop an assessment framework for assessing tropical peatland restoration activities by reviewing available literatures.

***Keywords:*** *degradation, restoration, assessment framework, successful, peatland*

## Introduction

Tropical peatlands accounts for 11% of the global peatland area, and 56% of the tropical peatland is located in SEA. Of this, 47% is located in Indonesia (Page *et al*., 2011). Tropical peatlands play an important role in terms of ecology, economy and society through its functions and services, both human and non-human (Table 1). These include:

- Provisioning/production services (e.g. timbers, NTFPs, wild plants/medicine)
- Regulation Services (e.g. climate change, flood control & prevention)
- Cultural/informational services (e.g. ecotourism, educational, religious practice); and
- Supporting Services (e.g. biodiversity, nutrient cycling) (Joosten & Clark, 2002; Kimmel & Mander, 2010)

One example out of a major regulation service that tropical peatlands provide is climate regulation, where tropical peatlands are considered the biggest and most efficient carbon storage and sink in above ground biomass and peat soil (Parish *et al*., 2007). Page *et al*. (2011), for instance, revealed that tropical peatlands held about 88.6 gigatonnes (Gt) of carbon, equal to 15-19% of the global carbon pool. Out of this, SEA shared about 68.5 Gt (77%), where Indonesia is the largest contributor (65%). In addition, it has been estimated that peatlands in Indonesia store between 15.93 Gt to 58.33 Gt of carbon in its depths (Page *et al*., 2011; Shimada *et al*., 2011; Sorensen, 1993).

***Table 1.*** Peatland ecosystem services and beneficial functions

| **Ecosystem services of inland wetlands** *(Source: MEA, 2005)* | **Beneficial functions of peatlands** *(Source: Joosten & Clark, 2002)* | **Explanation/examples in context of Central Kalimantan peatlands** |
|---|---|---|
| **Provisioning Services** | **Production Functions** | |
| Fibre & fuel | Peat extracted & used/wild plants (incl. forests & energy biomass) | Peat use in agriculture/horticulture (ash fertilizer), timber, etc. |
| Food | Wild plants/wild & domestic animals | Used as food for people and domestic animals/wood, fur and medicine (e.g. ornamental fish, orchid, traditional medicine) |
| Fresh water | Water | Limited agriculture irrigation, drinking water & domestic use |
| | Peat substrate | Agriculture/horticulture/forestry planting medium (e.g. vegetables, fruits, seedlings) |
| | Carrier functions | Space in peatlands is used for water transportation, irrigation infrastructure (e.g. channel, logging transportation, etc.) |
| **Regulating services** | **Regulation services** | |
| Climate regulation | Regulation of global climate/ regional and local climates | Regulation of GHGs, regulation of climatic processes (storage & sink carbon) |
| Water regulation | Regulation of climate hydrology | Water storage, groundwater recharge and discharge |
| Water purification and waste treatment | Regulation of catchment hydrochemistry | Retention, recovery and removal of excess nutrient and pollutants |
| Erosion protection | Regulation of soil conditions | Peat blanket protecting the underlying soils from erosion |
| **Cultural services** | **Information functions** | |
| Recreational & aesthetic | Recreation & aesthetic functions | Opportunities for recreation & tourism (ecotourism & scientific tourismand appreciation of nature |
| Spiritual & inspirational | Spiritual & existential functions | Personal feeling & well-being, religious significance (traditional religious ceremony, traditional sacred sites) |
| Educational | Signalization & recognition functions | Opportunities for education, training & research (natural laboratory, research sites, arboretum) |
| **Supporting services** | | |
| Biodiversity | Habitat for species | Biodiversity |
| Soil formation | Accumulation of organic matters (peat) | Soil formation |
| Nutrient cycling | Storage, recycling, processing & acquisition of nutrients | Nutrient cycling |

*(Source: Adopted & modified from Kimmel & Mander, 2010)*

## Degradation of peatlands

Although tropical peatlands are considered important ecosystems, this fragile ecosystem, particularly in the SEA (e.g. Indonesia), is under significant threats of degradation resulting from mostly anthropogenic activities and misguided policies (Aldhous, 2004; Anshary, 2010; Parish *et al*., 2007; Rieley & Page, 1996; Safford & Maltby, 1998). The main drivers of degradation can be categorised into 4 main aspects:

- Policy & institutional: Agriculture policy, absence of responsible agency
- Socio-economic and market: Bio-fuel market
- Technology: Land clearing technology, e.g. fires
- Biophysical: Decomposition, drainage, shrinkage, peat properties changed

Conversion to other land uses, mainly industrial plantation, agriculture, logging, drainage and repeated fires are considered major drivers of peatland destruction and degradation in SEA, notably in Indonesia. For instance, Koh *et al.* (2011) found that there were about 880,000 ha of tropical peatlands in Peninsular Malaysia, Sumatera and Borneo that were converted into oil palm plantations in 2005.

Construction of massive drainage canals and repeated fires following peat swamp forest (PSF) conversion have major impacts due to peat oxidation and subsidence leading to the release of huge carbon dioxide ($CO_2$) emissions to the atmosphere (Hooijer *et al*., 2006, 2010, 2012, Hoscilo *et al*., 2011; Jauhiainen, 2012; Koh *et al*., 2011; Meittinen, 2012; Page *et al*., 2002, 2011). Table 2 and 3 below shows the estimated amount of $CO_2$ emissions released in different real-life scenarios over the past few years. For instance, Parish *et al.* (2007) estimated that about 2.00 Gt $CO_2$e have been released into the atmosphere resulting from fires and drainage of peatlands in SEA in 2006.

In addition, Page *et al*. (2002) predicted that the single 1997/98 El Niño episode released between 0.12-0.15 Gt $CO_2$e to the atmosphere from peatland fires in Central Kalimantan. Figure 1 below shows the estimated amount of $CO_2$ emissions from peatlands as a result of the various land-clearing and conversion techniques practiced in Indonesia in 2006.

Apart from creating severe impacts to local, regional and global climate patterns, peatland conversion has significant negative impacts to the reduction of peat forest cover, extensive derelict/degraded bareland, loss of biodiversity and impacts on the socio-economic and socio-culture of the local people (Aldhous, 2004; Koh *et al*., 2011; Miettinen & Liew, 2010).

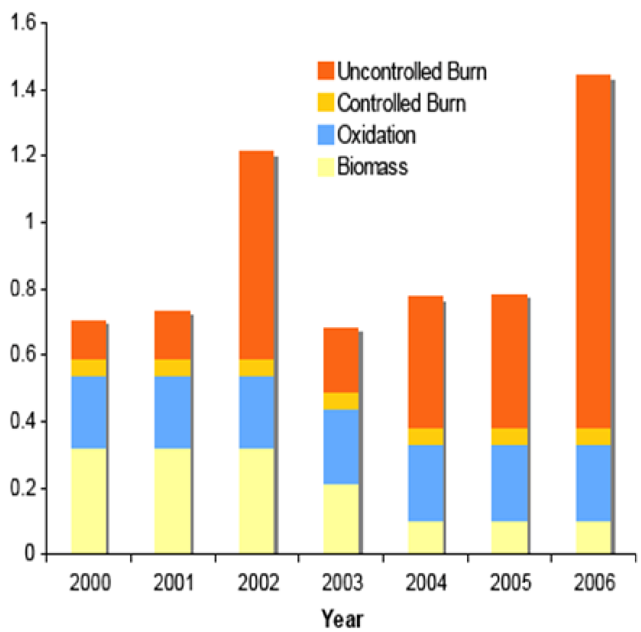
***Table 2.*** Relationship between peatland drainage, fire and peat decomposition with $CO_2$ emissions

| Source of $CO_2$ emission/year | Geographic scale | $CO_2$e emission released | Reference |
|---|---|---|---|
| Fires and drainage (2006) | SEA | 2,00 Gt | Parish *et al*., 2007 |
| Fires (1997/98) | Central Kalimantan | 0.12–0.15 Gt | Page *et al*., 2002 |
| Peat decomposition (2006)*) | SEA | 355 MtYr-1–855 MtYr-1 | Hooijer *et al*., 2010 |
| Peat decomposition (2010)**) | Peninsular Malaysia, Sumatera & Borneo | 233 MtYr-1$CO_2$e+) | Meittinen, 2012 |
| Peat & forest fires (2000-2006) | Borneo | 74 ±33 TgCYr-1 | Vander Werf, 2008 |
| | Indonesia | 470 Mt $CO_2$Yr-1 | |

Notes:
Tg= Terra gram (T =1012)
*) 82% from Indonesia's Peatland
**) Industrial plantation (Oil Palm, Tree Plantation)
+) Oil Palm industrial plantation contributed 161 MtY-1$CO_2$e

***Table 3.*** Relationship between peatland drainage, fire and peat decomposition with $CO_2$ emissions

| Drainage depth | $CO_2e$ emissions released ($tCO_2e\ ha^{-1}yr^{-1}$) | Reference |
|---|---|---|
| 10 cm | 9 | Couwenberg *et al.*, 2010 |
| 75 cm (first 5 years of oil palm) | 178 | Hooijer *et al.*, 2012 |
| 70 cm (after 5 years of oil palm) | 73 | Hooijer *et al.*, 2012 |
| 63 cm | 63 | Meittinen, 2012 |
| 75 cm (in oil palm plantation) | 100 | Meittinen, 2012 |
| 10 cm | 9 | Couwenberg *et al.*, 2010 |



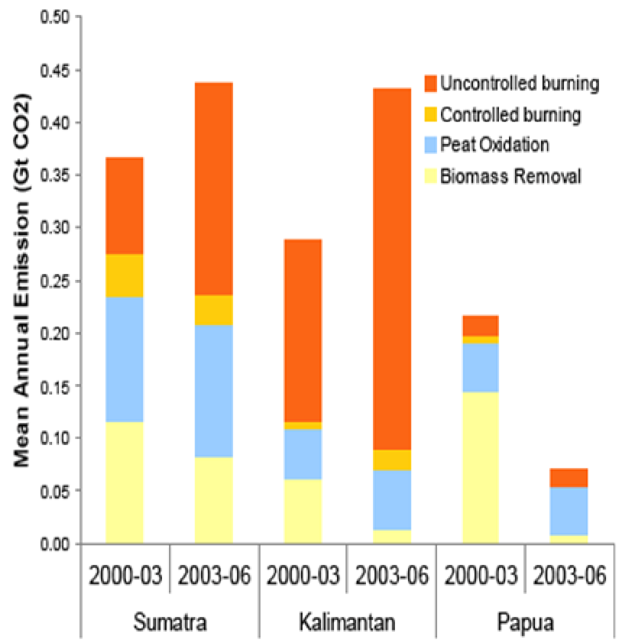




***Figure 1.*** Estimated $CO_2$ emissions from peatlands in Indonesia in 2006 resulting from below-above biomass loss, peat oxidation and fires
*(Source: BAPPENAS, 2006)*

To reduce the scale of peatland degradation, tropical peatland scientists have highlighted the need to stop drainage, rehabilitate areas and prevent fires (Hooijer *et al.*, 2006, 2010, 2012; Jeanicke, 2011; Page *et al.*, 2009; Parish *et al.*, 2007).

### Importance of tropical peatland restoration measures

Restoration is generally aimed at restoring the degraded ecosystem so that its major functions and services are returned and recovered close to its original state (Hobbs, 2007; Hobbs & Walker, 2007; Page, 2009; SER, 2012). Restoration efforts are targeted to stop or reduce drainage, enhance peat vegetation, maintain carbon storage and sink and prevent and control fire (Couwenberg, 2010; Jeanicke, 2011; Joosten & Clarke, 2002; Hooijer *et al.*, 2006; Page, 2009; Parish *et al.*, 2007). In addition, rewetting of degraded peatland is seen by many tropical peatland scientists as the most effective and efficient way to reduce peatland degradation caused by drainage. In addition, this method is also believed to be one of the most effective ways to settle down peatland fires (Couwenberg, 2010; Jeanicke, 2011; Page, 2009; Parish *et al.*, 2007).

Many tropical peatland restoration activities have taken place since the last decade but it is unclear how effective these have been. Therefore, there is a need to develop an assessment framework to evaluate the success of tropical peatland restoration initiatives.

### Tropical peatland restoration trajectories and decision-making

Before embarking on a peatland restoration project, there are different trajectories to consider before the correct combination of initiatives can be implemented. Should the goal be to restore the ecosystem back to its original condition or should it be brought to a new state for future use options (Figure 2)?

As part of the planning process, it is important to address the following questions:

- What is a realistic goal?
- What are the major ecological and socio-economic constraints?
- What are the key ecosystem elements and functions to be restored?
- Will the restored peatland be sustainable in the long term?
- Will the technology and lessons learnt be available and applicable?
- What are the potential institutional, policy and management constraints?

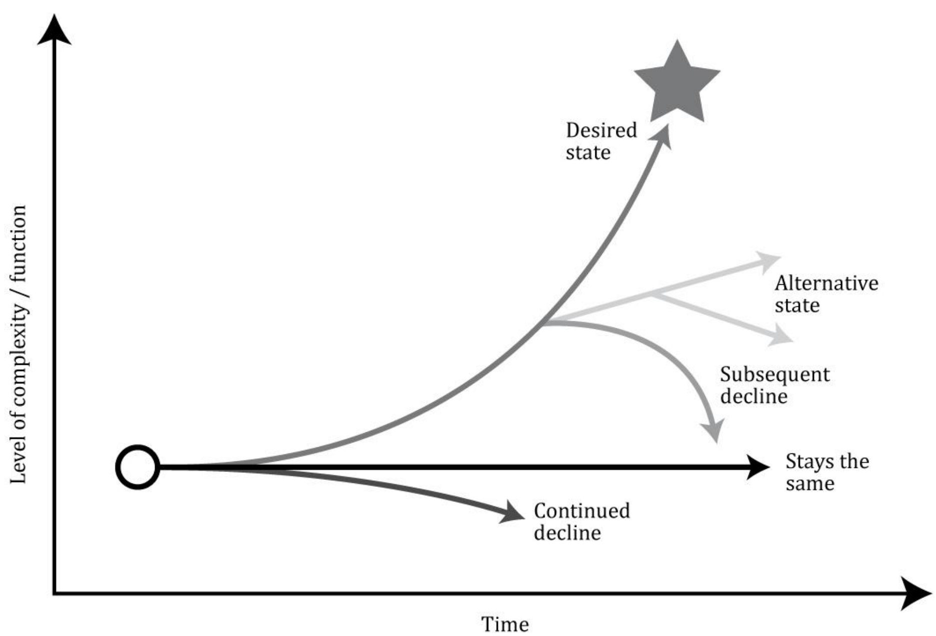



***Figure 2.*** Traditional view of restoration options for a degraded system: possible trajectory alternatives

### Current knowledge and practices

Current intervention approaches include hydrological restoration (rewetting/canal blocking), re-vegetation (tree planting), protection of carbon storage and sink, fire prevention and control and livelihood development. They are often site-specific, project-based and not integrated. Consequently, the success and sustainability is mixed. There is a lack of comprehensive assessment and monitoring and there is no integrated framework for assessing the success. Some examples of success indicators that can be verified are water level management, reduction of fire incidence, employment level and organic matter concentration.

## Drivers and measures of success of tropical peatland restoration

Figure 3 provides a conceptual framework for assessing tropical peatland restoration success and the drivers that contribute to the success. There are a few key aspects that need to be considered when measuring the success of tropical peatland restoration, such as:

- What is the major element to be measured?
- What are the success indicators to be used?
- What are the major steps in measuring success?
- What is the procedure to be used?

Additionally, there are various attributes and elements that can be used as a measure of success, and in order to measure success quantitatively and qualitatively, there are numerous success indicators that can be used (Figure 3).

Ecological attributes:

- Vegetation characteristics (vegetation structure, forest dynamics)
- Species diversity (plant & fauna)
- Ecosystem processes (water/hydrological cycle, mineral cycle, energy flow, community dynamic)
- Peat properties changing

Socio-economic attributes:

- Income and employment impacts
- Business opportunity
- Tenure system
- Social cohesion
- Community participation and involvement etc.
- TOC (Total Organic Carbon)
- pH, water content, DBD, TN, TS, etc.

The suggested major steps in measuring success are:

- Developing monitoring design and protocol
- Conducting the baseline study
- Establishing a reference site
- Implement monitoring both within reference & restored sites
- Evaluating the success (direct comparison & trajectory analysis)
- Improving restoration strategy & measures

The procedure above should be used to develop the general framework for measuring success and develop standard operating procedures for measurement.

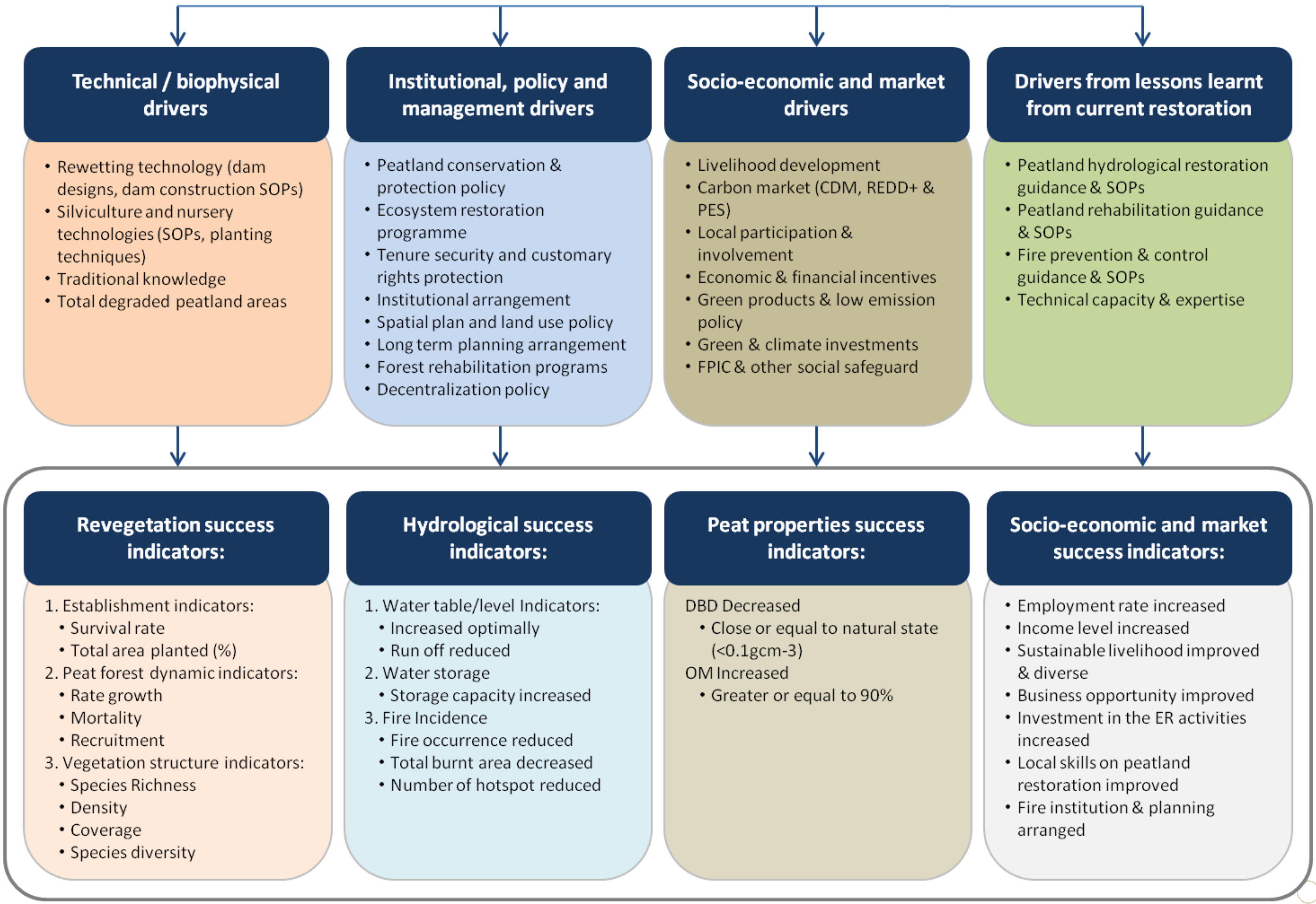



***Figure 3***. A conceptual framework for assessing tropical peatland restoration success

# GIAM SIAK KECIL – BUKIT BATU BIOSPHERE RESERVE: A PUBLIC-PRIVATE SECTOR INITIATIVE FOR MERGING BIODIVERSITY CONSERVATION AND SUSTAINABLE USE OF TROPICAL PEAT SWAMP FOREST

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## Abstract

A Biosphere Reserve (BR) was established in Riau to promote and demonstrate sustainable development models and a balanced relationship between humans and the biosphere. The Giam Siak Kecil-Bukit Batu (GSK-BB) Biosphere Reserve is the first BR in the world to be nominated and co-managed by a private sector company. The GSK-BB BR totals 7,053 square kilometers and was officially approved as a BR by the International Coordinating Council of the Man and the Biosphere Programme (ICC/MAB) - UNESCO on 26th May 2009. It seeked to integrate the conservation of biodiversity and cultural diversity, economic development and logistic support for research, monitoring, environmental education and training.

The Core Area of 178,722 ha, for permanent conservation purposes, is dominated by peat swamp forest (PSF) and consists of two wildlife reserves and 72,255 ha of natural production forests managed by Sinar Mas Forestry and its partners. The buffer zone of 222,426 ha, largely consists of pulpwood plantation forests for providing better protection of the core area and enhances sustainable plantation forest management by implementing best management practices. The transition area, the outermost zone, totals 304,123 ha and dominant land uses include oil palm plantation, small-holder farms and villages or settlements.

It is an important public-private partnership initiative for merging biodiversity conservation and sustainable use of tropical PSF.

***Keywords:*** *biodiversity conservation, sustainable development, public-private sector initiative, multi-stakeholder, landscape management, biosphere reserve*

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## Brief about the company

Sinar Mas Forestry (SMF) is a pulpwood plantation management organisation that has over 1 million ha of company-controlled forests in Indonesia. It is an exclusive supplier of pulpwood to Asia Pulp & Paper (APP) Indonesia which is a major producer of pulp, paper and paper products.

## Spatial plan of Riau and peatlands

Riau is home to major pulp and paper mills in Indonesia. It has over 8.9 million ha of land surface (Figure 1), of which over 4 million ha is peatland.

## Challenges and opportunities

To manage peatland and PSF in Riau, there are challenges such as illegal logging, forest encroachments, development pressures, fire & haze pollution, rural poverty, biodiversity loss, etc. But there are also opportunities to conserve PSFs through institutional arrangements like the practical application of the UNESCO Man and the Biosphere (MAB) landscape management approach.

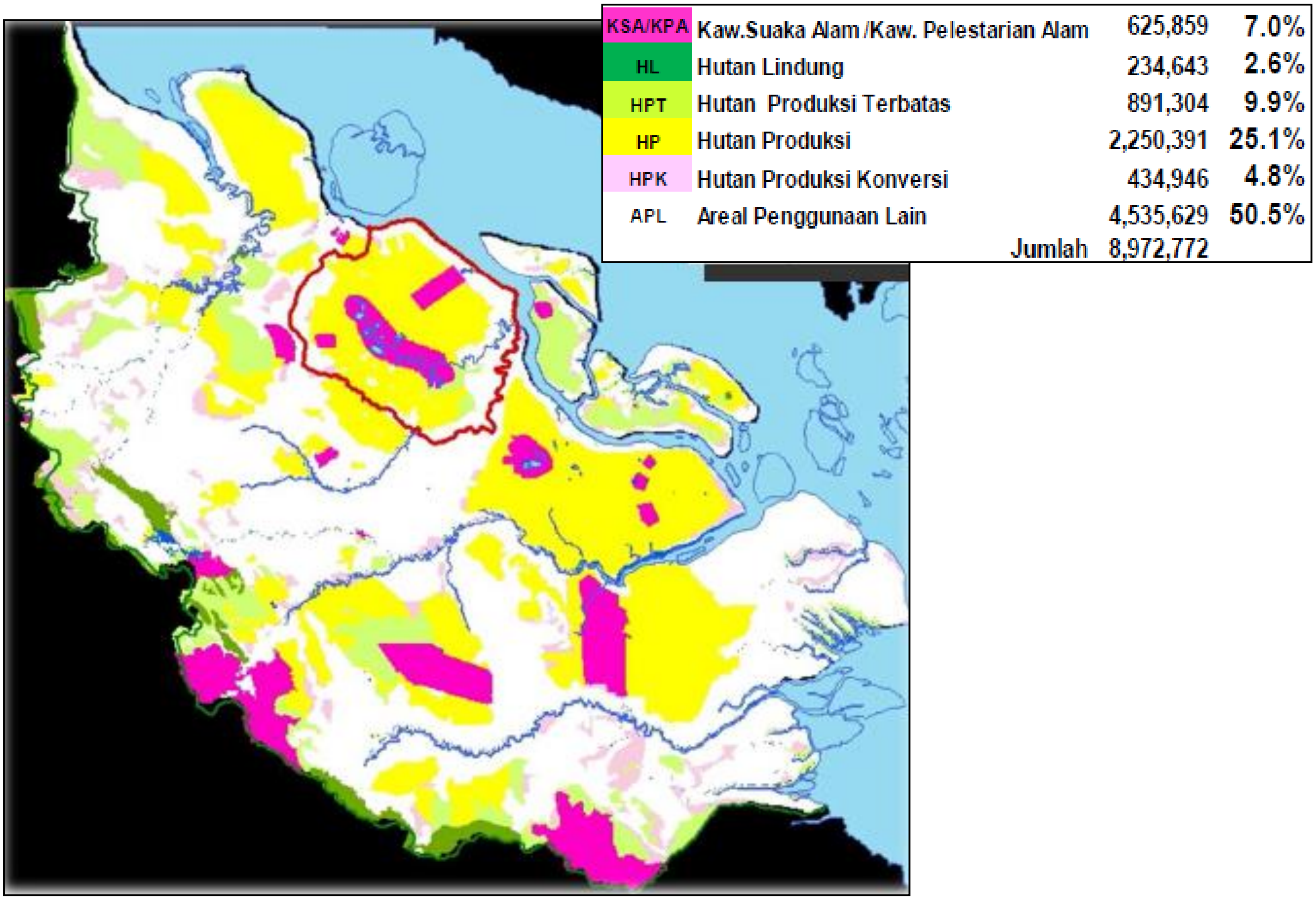


***Figure 1.*** Proposed spatial plan of Riau Province

### UNESCO- MAB approach

A BR is an area of terrestrial and coastal/marine ecosystems, or a combination thereof, which is internationally recognised within the framework of the UNESCO's Program on Man and the Biosphere (MAB) (*Seville Strategy, 1995*). It was established to promote and demonstrate sustainable development models and balanced relationship between humans and the biosphere.

There are three functions of BR:

1. Conservation – conservation of biodiversity and ecosystems
2. Development – association of environment with development
3. Logistics – international network for research and monitoring

A BR is a landscape which includes one or more protected areas and its surroundings are managed to combine both conservation and sustainable use of natural resources. The design of a BR is quite simple and consists of 3 main zones – Core Area, Buffer Zone, and Transition Area (Figure 2). Frequently, BRs are an extension of an existing protected area, e.g. a National Park, Wildlife Reserve, or Strict Nature Reserve and are characterised as such:

- The Core Area is usually a permanent conservation area like a National Park, Wildlife Reserve or Strict Nature Reserve, which has been 'expanded' by designating a BR around it with the reserves as the Core Area.
- The Buffer Zone is a forest area around the core area which may be used for economic purposes especially for local communities.
- The Transition Area can be various types of development surrounding the Buffer Zone, such as farms, estate crops, settlements and infrastructures.

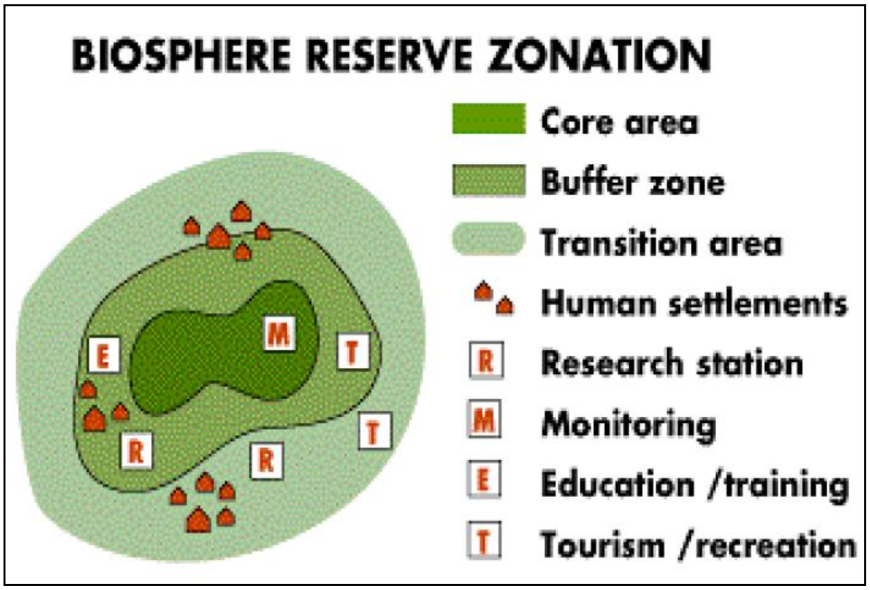

***Figure 2***. Biosphere Reserve zonation

#### The GSK-BB Biosphere Reserve

In 2009, LIPI (Indonesia) proposed Giam Siak Kecil to UNESCO to be a Biosphere Reserve. On February 19, 2009, the Bureau of Research and Development of Riau Province, LIPI, BBKSDA of Riau, Sinar Mas Forestry and University of Riau signed a Memorandum of Understanding for research and development in the Giam Siak Kecil-Bukit Batu landscape.

The areas of collaboration are:

- Research and development of science and technology which encompasses, among others, eco-hydrology and natural resources of the PSF, as well as the socio-economic condition of the local communities
- Compilation and arrangement of documents, scientific publications, and the dissemination of the results of research and development, in order to formulate the management policy of the GSK-BB landscape
- Establishment and the development of a "research station" to support the joint co-operational activities

The GSK-BB was officially approved by UNESCO and designated for inclusion in the World Network of Biosphere Reserves in Jeju City, Republic of Korea in May 26, 2009 during the 21st MAB/ICC – UNESCO meeting. The Reserve is the first BR in the world to be nominated and co-managed by the private sector and joined the network of 564 other BRs in 109 countries (as of 2010).

The BR is located in the regencies of Bengkalis and Siak of Riau Province and covers 705,271 ha. More than half the area is characterised with very deep and thick peat (>400cm). The zonation of the BR is presented in Figure 3 with a detailed breakdown of the area shown in Table 1. The development of each zone has been determined as follows:

<u>Core area development</u>

- Research station in Tasik Betung (Siak Regency) and Air Raja (Bengkalis Regency)
- Education and training
- Ecotourism
- Carbon credits (e.g. REDD+)
- Payment for environment services (PES)

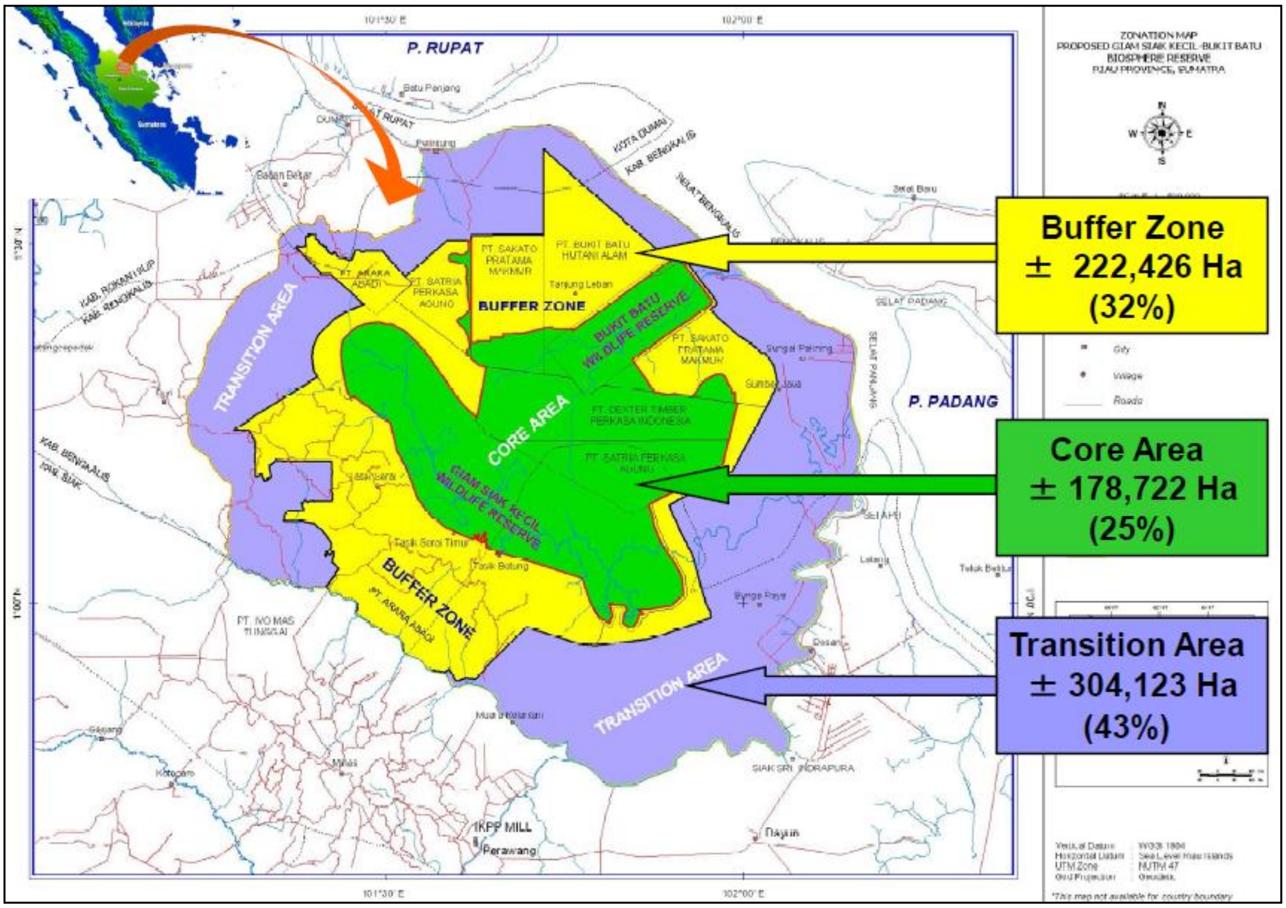


***Figure 3.*** The Giam Siak Kecil – Bukit Batu Biosphere Reserve

<u>***Table 1.*** Zonation breakdown of the GSK-BB Biosphere Reserve</u>

| Zonation | Area (ha) |
|---|---|
| **Core area** | **178,722** |
| Giam Siak Kecil Wildlife Reserve | 84,967 |
| Bukit Batu Wildlife Reserve | 21,500 |
| **Sinar Mas Forestry & Partners (production forest)** | **72,255 (40%)** |
| **Buffer zone** | **222,246** |

| | |
|---|---|
| **Sinar Mas Forestry & Partners (plantation forest)** | **195,259 (88%)** |
| Others (production forest) | 27,167 |
| **Transition area** | **304,123** |
| Estate crops, agriculture, settlements, etc. | 298,458 |
| Sinar Mas Forestry & Partners (plantation forest) | 5,665 |
| **Total area** | **705,271** |

<u>Buffer zone development</u>

- Composed mainly of 88% pulpwood plantation managed by Sinar Mas Forestry and partners
- Well-managed pulpwood plantation forest which supports the protection of the core area

<u>Transition area development</u>

- Dominated by oil-palm plantations, small-holder food crops and other farms and village settlements
- Area for collaborating and developing community-based livelihood development models

There is potential to create a REDD+ pilot project involving some 150 – 350 Mt $CO_2$. It is important to maintain development of GSK-BB as a potential REDD+ project as it will fund the management of GSK BR (in addition to other fund sources such as APBN and APBD). GSK-BB is a REDD+ pilot project because there are more than 100 cubic metres of sea level carbon stored within it.

The management of the GSK-BB BR is done through collaboration between the government, scientific committee and Sinar Mas Forestry. Figure 4 shows the coordinating board of management of the GSK-BB BR, which was decreed by the Governor of Riau (No. 920/V/2010 dated 14 May 2010).

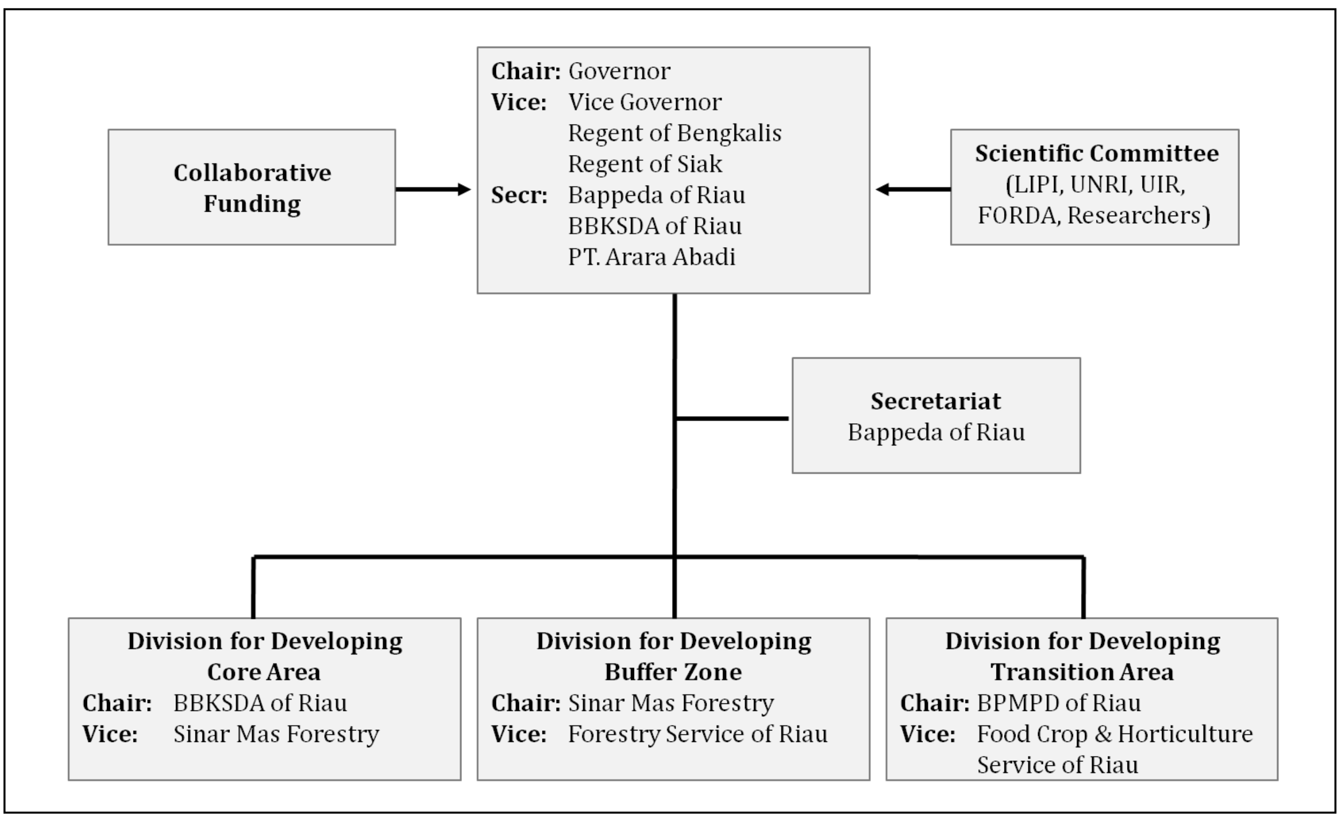


***Figure 4.*** Coordinating Board for the management of the GSK-BB Biosphere Reserve

The responsibilities of the Coordinating Board are to:

- Carry out and implement the coordination and communication between various authorised institution/agencies and stakeholders
- Assign and share roles and responsibilities
- Implement the management approach for GSK-BB BR, which encompasses the conservation areas, natural landscapes, and cultivated areas

All the expenses required for the execution of the activities of the Coordinating Board are charged to the financial resources of the concerned institutions/agencies and/or individual institutions, as well as, other resources that are legal and not binding.

### Concluding remarks

GSK-BB BR is a practical public-private partnership for merging biodiversity conservation and sustainable use of tropical PSF. It is an effective approach, through the involvement of local communities and the participation of key stakeholders in the management of the landscape, where scientific knowledge and governance modalities are combined to reduce biodiversity loss, improve livelihoods and enhance the social, economic and cultural conditions for environmental sustainability.

In the future, it is hoped that the GSK-BB BR will function as a model for coordinating and integrating every development policy and taking into consideration the historical land rights and resources.

# DEVELOPMENT OF SILVICULTURAL TECHNIQUES FOR NATIVE TREE SPECIES OF PEAT SWAMP FORESTS IN INDONESIA

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## Abstract

Indonesia has the largest area of tropical peat swamp forests (PSFs) in the world. However, most of the area has been damaged or has undergone conversion to plantation estate, plantation forest, or to degraded PSF. For the recovery of such degraded forest ecosystem, there is a need for rehabilitation efforts through planting. Planting with exotic species such as *Acacia mangium, Acacia crassicarpa* and *Eucalyptus spp.* has been commonly practiced in industrial plantation forest. The authors have conducted research to develop silvicultural techniques for native tree species of PSFs, such as Ramin (*Gonystylus bancanus*), Belangiran (*Shorea balangeran*), Tumih (*Combretocarpus rotundatus*), Geronggang (*Cratoxylon arborescens*) and Jelutong (*Dyera lowii*). Plant propagation techniques with shoot cutting for species of Ramin, Belangiran, Tumih and Geronggang produced growth percentages of respectively 95%, 70%, 89% and 70%. Meanwhile, planting trial of species of Ramin, Belangiran and Jelutong produced height increment of nearly 1m per year. The Belangiran species constitutes a native species which has high potential for planting in the degraded PSFs.

***Keywords:*** *native species, shoot cutting, planting, Ramin, Belangiran, Tumih, Geronggang*

## I. INTRODUCTION

Failure in the application of sustainable forest management, weakness in supervision and clearing of peatland constitute the cause of peatland degradation in Indonesia. Around 50% of PSFs in Indonesia have been degraded due to illegal and legal logging (which are often followed with canal construction for log transportation) and conversion to plantation estate area.

Planting of PSF with native tree species such as *Shorea balangeran* (Korth.) Burck., *Gonystylus bancanus* (Miq.) Kurz., *Cratoxylon arborescens* (Vahl) Blume., and *Combretocarpus rotundatus* (Miq.) Danser. (Newman *et al*., 1999; Soerianegara and Lemmens, 1994) constitutes an appropriate solution for alleviating peat degradation, but the procurement of planting stocks is still problematic due to difficulties in obtaining large quantities of seeds. Cheap and rapid planting stock procurement is conducted by applying the cutting propagation method to rehabilitate peatland.

In the effort of peatland rehabilitation, there is a need for large quantities of planting stocks, and such quantity is difficult to be achieved from generative methods of planting stock production. This phenomenon is due to the flowering and fruiting season which is not always in conformity with the rehabilitation period, and the low viability of the seeds. Alternative methods, such as shoot cutting, can be relied upon in planting stock production. One effort which could be conducted for increasing rooting percentage of the cutting is by applying plant growth substance such as hormones IBA, IAA and NAA.

In this article, research results on propagation techniques will be described. It will focus on propagating important tree species, either vegetatively or generatively, which grow in degraded peatland such as Ramin (*Gonytylus bancanus*), Belangiran (*Shorea balangeran*), Tumih (*Combretocarpus rotundatus*) and Geronggang (*Cratoxylon arborescens*). Besides that, rehabilitation of a degraded PSF was also evaluated, including evaluation of the success rate for tree plantings which have been conducted.

## II. MATERIALS AND METHOD

### A. Research method for shoot cutting

Research was conducted under cooperation with the Division of Silviculture, Research and Development Center for Forestry and Nature Conservation (Indonesian Ministry of Forestry) in Bogor, West Java. Experiments were conducted in a greenhouse and nursery under the KOFFCO System. Materials for shoot cuttings were collected from Central Kalimantan.

Plant materials being used were seedlings of Belangiran *(Shorea balangeran*), Tumih (*Combretocarpus rotundatus*) and Geronggang (*Cratoxylon arborescen*). Materials being used were hormone IBA 100 ppm, NAA 100 ppm, and mixture of hormones IBA and NAA 50 – 50 ppm. Media being used were coconut fibers, rice chaffs and vermiculite.

The equipments used were *pot* – *tray* covers for as many as 15 pairs, writing materials, label papers, measuring glasses, ruler, stopwatch, and twig cutter.

The experiment was designed as a Completely Randomized Design (CRD) with the following treatments:

1. Hormone IBA with dosage of 100 ppm (A)
2. Hormone NAA with dosage of 100 ppm (B)
3. Hormone IBA with dosage of 50 ppm mixed with NAA with dosage of 50 ppm (C)
4. Water of young coconut fruit (100%) (D)
5. Control (O)

Data were processed under Completely Randomized Experimental Design with the following model:

$$Y_{ij} = \mu + \tau_i + \varepsilon_{ij}$$

where,

$Y_{ij}$ = Respond value from observation in experimental unit which was subjected to $i^{th}$ treatment and $j^{th}$ replication
$\mu$ = General average value
$\tau_i$ = Value of treatment effect of $i^{th}$ level.
$\varepsilon_{ij}$ = Error value of experimental unit which was subjected to $i^{th}$ treatment and $j^{th}$ replication.

Hypothesis in this treatment was:

$H_o = \tau_1 = \tau_2 = \tau_3 = .... = \tau_i$
(Levels of hormone treatment create similar effect toward the experimental units)

$H_1$ = At least there is a pair of treatments which do not have similar effects, or $\tau_i \neq \tau_{i'}$; $i \neq i'$

The observed and measured variables were survival percentage of cutting, number of roots, length of roots, fresh weight of roots, dry weight of root, fresh weight of shoot and dry weight of shoot. A cutting was categorised as surviving (alive) if the stem of the cutting is fresh and the bottom (lower part) of the cutting produced roots.

## B. Method of plant growth measurement

Location for plant growth evaluation in peatland was the forest concession area of PT. Diamond Raya Timber for Ramin species in Sebangau National Park. In the area of Sebangau National Park, planting was conducted by World Wide Fund for Nature (WWF) in cooperation with several of its partners, while planting which was conducted by the Provincial Forestry Service of Central Kalimantan was conducted through a project by the National Movement for Land Rehabilitation (Gerhan). The size of the planting area was 265 ha.

To observe plant growth in terms of growth percentage and growth quality, observation sample plots were constructed in the planting location. The shape of the observation sample plots (OSP) was rectangular, each measuring 50m x 50m (0.25 ha) and were placed randomly in each planting block. If the number of plants being planted per ha was 400 planting stocks, then the number of plants which should grow in each OSP was as many as 100 plants. In each planting block, there was construction of 2 - 4 OSP.

In each OSP the plant code number, live and dead plants, plant species and plant height were recorded. Besides that, the OSP position in each planting block was recorded using GPS.

# III. RESULTS AND DISCUSSION

## A. Ramin cutting (*Gonystylus bancanus*)

Herman and Istomo (1997) had conducted research on shoot cutting of Ramin (*G. bancanus*) seedlings by using plant growth substances Rootone F in various media and at various levels of Rootone F treatment in the forest concession area of PT. SBA Wood Industries, South Sumatera for 11 weeks, which resulted in 100% of the shoot cutting growing successfully, producing shoots and roots. Therefore, the application of plant growth substance Rootone F in various dosages did not have significant effect toward growth percentage of live cutting, shoot production of cutting, rooting of cutting, and time required for shoot emergence and root length.

Time required for shoot emergence of each cutting varied from 1 to 10 weeks, with an average per treatment of 3.4 to 6.4 weeks. The largest number of leaves was 3 blades and the longest root length was 34cm, where average root length of each treatment was 10.1 – 23.5cm.

After reaching 5 months of age (5 months after planting) there were repeated measurements. The average length of shoots of the cutting varied from 2.2cm to 11.2cm**.** The longest average length of shoots was surprisingly found in treatment without hormone and using peat media, whereas the shortest shoot length was found in hormone treatment of 50 mg/cutting and medium of mixture between peat and sand.

These research results proved that the establishment of a hedge orchard for Ramin, using cutting from seedlings, could be easily conducted, without growth hormone, and the available medium (peat), created a 100% result in shoot growth with appropriate and constant temperature and humidity. The ideal temperature for growing this cutting was not more than $30^0$C and humidity which approached 100%.

## B. Cutting of Belangiran (*Shorea balangeran*)

These research results on shoot cutting of *Shorea balangeran* with five treatments of plant growth substances showed that the treatments produced an effect towards the percentage of shoot growth of the cutting, which ranged from 50.67% to 77.33%. Budiman (2000), which studied shoot and stem cutting of *Shorea balangeran* with water medium (water rooting system), produced root growth percentage of 62.33% out of the total rooting percentage of stem and shoot cutting in 8 weeks of observation. Meanwhile, Subiakto *et al.* (2005), reported that the trial of cutting growth on several dipterocarp species in Bogor showed rooting percentage of 42% for *Shorea balangeran*. Data of the surviving percentage (rooting percentage) for *Shorea balangeran* (Korth.) shoot cutting of this study can be seen in Table 1.

***Table 1.*** Data of rooting percentage of *Shorea balangeran* shoot cutting

| No. | Treatments | Number of cuttings being planted (stems) | Number of rooted cuttings (stems) | Percentage (%) | SE (%) |
|---|---|---|---|---|---|
| 1. | IBA 100 ppm | 150 | 76 | 50.67 | 2.40 |
| 2. | NAA 100 ppm | 150 | 116 | 77.33 | 10.70 |
| 3. | **IBA 50 ppm – NAA 50 ppm** | 150 | 87 | 58.00 | 0.00 |
| 4. | Coconut water 100% | 150 | 94 | 62.67 | 11.00 |
| 5. | Control | 150 | 98 | 65.33 | 2.91 |

Table 1 shows that  the rooting percentage varied from 50.67% (the lowest) produced by treatment A (hormone IBA 100 ppm), to 77.33% (the highest) created by treatment B (hormone NAA 100 ppm). Results of analysis of variance for various variables of shoot cutting from *S. balangeran* seedlings can be seen in Table 2.

***Table 2.*** Results of analysis of variance for various growth variables of Belangiran shoot cutting

| No. | Variables | P-value |
|---|---|---|
| 1. | Root length | 0.4900 |
| 2. | Root fresh weight | 0.1700 |
| 3. | Root dry weight | 0.7900 |
| 4. | Shoot fresh weight | 0.2500 |
| 5. | Shoot dry weight | 0.0330 * |

*) significant at 5% level

Table 2 shows that treatment of plant growth substance showed significant effect toward shoot dry weight, whereas for other variables, there were no significant effects.

### C. Cutting of Tumih (*Combretocarpus rotundatus*)

Measurement results on average percentage of shoot growth of Tumih cutting could be seen in Table 3, which also showed the total quantity of surviving (alive) shoot cutting from the three replications in each treatment. Cutting was categorised as surviving if the stem condition of the cutting was still fresh and has produced roots on the lower portion of the cutting.

From Table 3, it could be shown that survival percentage of the cutting varied from 70.67%  produced by treatment C (IBA 50 ppm+NAA 50 ppm), to 90.67% produced by treatment D (control ) 90.67%. Results of analysis of variance for various variables of shoot cutting from Tumih seedlings, can be seen in Table 4, which shows that treatment of plant growth substance created highly significant effects on the number of roots, whereas for other variables, there were no significant effects.

***Table 3.*** Surviving percentage of Tumih shoot cutting

| No. | Treatment | Number of planted cuttings | Number of surviving cuttings | Average survival percentage (%) | SE |
|---|---|---|---|---|---|
| 1. | A 1 | 50 | 39 | 78 | |
| 2. | A 2 | 50 | 44 | 88 | |
| 3. | A 3 | 50 | 41 | 82 | |
| | **Average A** | **50** | **43** | **82.67** | **0.050** |
| 4. | B 1 | 50 | 40 | 86 | |
| 5. | B 2 | 50 | 42 | 80 | |
| 6. | B 3 | 50 | 40 | 84 | |
| | **Average B** | **50** | **42** | **83.33** | **0.031** |
| 7. | C 1 | 50 | 24 | 80 | |
| 8. | C 2 | 50 | 45 | 84 | |
| 9. | C 3 | 50 | 43 | 48 | |
| | **Average C** | **50** | **48** | **70.67** | **0.197** |
| 10. | D 1 | 50 | 39 | 90 | |
| 11. | D 2 | 50 | 44 | 86 | |
| 12. | D 3 | 50 | 41 | 96 | |
| | **Average D** | **50** | **43** | **90.67** | **0.050** |

Note:
A = Hormone IBA of 100 ppm (A)
B = Hormone NAA of 100 ppm (B)
C = Hormone IBA of 50 ppm mixed with NAA of 50 ppm (C)
D = Control (D)

***Table 4.*** Results of analysis of variance for various growth variables of Tumih shoot cutting

| No. | Variables | P-value |
|---|---|---|
| 1. | Survival percentage of the cutting | 0.1542 |
| 2. | Number of roots | 0.0000 ** |
| 3. | Length of root | 0.3550 |
| 4. | Fresh weight of root | 0.0610 |
| 5. | Dry weight of roor | 0.110 |
| 6. | Fresh weight of shoot | 0.1260 |
| 7. | Berat kering tunas | 0.8070 |

**) highly significant effect at 1% level

## D. Results from shoot cutting of Geronggang (*Cratoxylon arborescens*)

Measurement results on the average survival percentage of Geronggang shoot cutting can be seen in Table 5. Table 5 shows that survival percentage of the cutting varied from 43.33% produced by treatment C (IBA 50 ppm + NAA 50 ppm), to 60.67% produced by treatment B (hormone NAA 100 ppm).

Results of analysis of variance for various variables of Geronggang seedling shoot cutting can be seen in Table 6, which shows that treatment of plant growth substance did not produce significant effect on all growth parameters of shoot cutting of Geronggang seedlings.

***Table 5.*** Survival percentage of Geronggang shoot cutting

| No. | Treatments | Number of planted cuttings | Number of surviving cuttings | Average survival percentage (%) | SE |
|---|---|---|---|---|---|
| 1. | A 1 | 50 | 19 | 38 | |
| 2. | A 2 | 50 | 23 | 46 | |
| 3. | A 3 | 50 | 28 | 56 | |
| | **Average A** | **50** | **36** | **46.67** | **0.090** |
| 4. | B 1 | 50 | 28 | 72 | |
| 5. | B 2 | 50 | 27 | 56 | |
| 6. | B 3 | 50 | 23 | 54 | |
| | **Average B** | **50** | **20** | **60.67** | **0.099** |
| 7. | C 1 | 50 | 22 | 46 | |
| 8. | C 2 | 50 | 20 | 40 | |
| 9. | C 3 | 50 | 22 | 44 | |
| | **Average C** | **50** | **24** | **43.33** | **0.031** |
| 10. | D 1 | 50 | 19 | 40 | |
| 11. | D 2 | 50 | 23 | 44 | |
| 12. | D 3 | 50 | 28 | 48 | |
| | **Average D** | **50** | **36** | **44.00** | **0.040** |

Note:
A = Hormone IBA of 100 ppm (A)
B = Hormone NAA of 100 ppm (B)
C = Hormone IBA of 50 ppm mixed with NAA of 50 ppm (C)
D = Control (D)

## E. Evaluation results of planting in degraded PSF

In 2004, PT. Diamond Raya Timber tried to plant Ramin derived from shoot cutting in three conditions (treatments), namely: (1) open place condition, (2) existence of water inundation effect, and (3) existence of shade under a stand. Measurement results on Ramin seedling growth in the year 2007 are presented in Table 7.

Table 7 shows that Ramin diameter at 3 years old ranged between 3.89cm and 7.23cm, or in other words, an average diameter increment of each Ramin seedling between 1.30 – 2.41cm/year. The corresponding figures for height were 1.9 – to 3.6cm at 3 years old, or with an average increment of 0.63 – 1.2cm/year.

Evaluation of planting in peatland was also performed in the site of the National Movement for Land Rehabilitation project (Gerhan) conducted by the Provincial Forestry Service of Central Kalimantan in Sebangau National Park in the year 2005. Spacing distance of planting by Provincial Forestry Service of Central Kalimantan was 3m x 3m, so that the number of plants per ha was as many as 990 plants. The planted tree species were Belangiran and Jelutong, and the intercropped trees growing between strips of the main tree crops were native tree species, namely Tumih, which were not intentionally planted, but grew naturally. Evaluation results of this planting effort in an area of 0.25 ha can be seen in Table 8.

***Table 6.*** Results of analysis of variance for various growth variables of Geronggang shoot cutting

| No. | Variables | P-value |
|---|---|---|
| 1. | Survival percentage of cutting | 0.0610 |
| 2. | Number of roots | 0.9170 |
| 3. | Length of root | 0.1170 |
| 4. | Fresh weight of root | 0.3930 |
| 5. | Dry weight of root | 0.1950 |
| 6. | Fresh weight of shoot | 0.9750 |
| 7. | Dry weight of shoot | 0.9060 |

***Table 7.*** Ramin growth resulting from field planting at 3 years of age

| Treatments | Diameter growth (cm) | Height growth (m) |
|---|---|---|
| Open place | 7.23 ± 1.62 | 2.9 ± 0.7 |
| Water inundation | 6.82 ± 2.65 | 3.6 ± 1.5 |
| Shady condition under a stand | 3.89 ± 1.62 | 1.9 ± 0.07 |

***Table 8.*** Evaluation results of planting in project of National Movement for Land Rehabilitation (Gerhan) by Provincial Forestry Service of Central Kalimantan, as large as 0.25 ha in Sebangau National Park at the age of 5 years

| No. | Species | Total | Average diameter | Diameter increment (cm/year) | Average height (m) | Height increment (m/year) |
|---|---|---|---|---|---|---|
| 1. | Belangiran | 179 | 9.3 | 1.86 | 3.40 | 0.68 |
| 2. | Jelutong | 46 | 5.39 | 1.08 | 2.50 | 0.50 |
| 3. | karet | 20 | 4.94 | 0.99 | 2.15 | 0.43 |
| 4. | Tumih | 8 | 9.67 | 1.93 | 3.00 | 0.60 |
| | **Total** | **253** | | | | |

Table 8 shows that the number of main tree crops in the area of 0.25 ha was as many as 225 trees or around 900 trees per ha. On the other hand, other tree crops was as many as 28 trees (or 112 trees per ha) comprising rubber and Tumih. Therefore, the success rate of main tree crops in the project (Gerhan) was more than 90%.

In Table 8, it could be shown that diameter increment of Gerhan plants was greatest for the Tumih species, followed in rank by Belangiran and Jelutong, while the lowest diameter increment was for the rubber species. The diameter increment for the Tumih was 1.93cm/year, whereas that of Belangiran was 1.86cm/year. Height increment ranged between 0.43 – 0.68m/year.

On the basis of the explanation described above, it could be shown that the plants in the Gerhan project grew well, particularly in terms of growth percentage and diameter increment. The Belangiran and Tumih species exhibited the highest growth increment to be planted in PSFs.

## IV. CONCLUSION AND RECOMMENDATIONS

### A. Conclusions

1. Plant propagation for Ramin species through shoot cutting produced a survival percentage of 100%, whereas those of the Belangiran species ranged between 50.67 – 77.31%.
2. Plant propagation for the Tumih species through shoot cutting produced a survival percentage of 82.67 – 90.67%, whereas those for the Geronggang species were 43.33 – 60.67%.
3. Hormone treatments of NAA 100 ppm, IBA 100 ppm and IBA 50 ppm mixed with NAA 50 ppm produced significant effect toward the number of roots and shoot dry weight for the Belangiran species.
4. Hormone treatment of NAA 100 ppm, IBA 100 ppm and IBA 50 ppm mixed with NAA 50 ppm produced significant effect toward the number of roots for the Tumih species.
5. The tree species planted by the Provincial Forestry Service of Central Kalimantan in Sebangau National Park, in an area of 400 ha with a planting spacing of 3m x 3m, exhibited survival percentage of more than 90%.

### B. Recommendations

1. Plant propagation with shoot cutting for species of Ramin, Belangiran, Tumih and Geronggang constitutes one of the alternatives for obtaining uniform planting stocks with sufficient quality.
2. Tree planting with the Gerhan model, using the Belangiran species, with a planting spacing of 3m x 3m produced good results so that it could be made as one of the models for rehabilitating degraded PSFs.

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# CONSERVATION AND SUSTAINABLE USE OF *Melaleuca* FORESTS ON PEATLANDS AND MARSH AREAS IN CA MAU PROVINCE, VIETNAM

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## Abstract

U Minh Ha area of Ca Mau province, located in the southernmost part of Vietnam, is covered by *Melaleuca* forests (*Melaleuca cajuputi*) on peatlands and marshes which are rich in diversity of fauna and flora. *Melaleuca* forests on peatlands and marshes are not only valuable environmental assets for biodiversity and carbon storage but also important productive assets in terms of supporting local forestry economies. Therefore conservation and sustainable use of *Melaleuca* forests is absolutely necessary and is a significant issue for local communities in particular. With the rapid increase of farmer immigration into the *Melaleuca* forests in U Minh Ha during the 1980s and 1990s, frequent large-scale forest fires occurred and inflicted serious damages on peatland *Melaleuca* forests. Under these circumstances, Ca Mau provincial government designated *Melaleuca* forests, especially on well developed peatlands, as a national park, and left other *Melaleuca* forests for sustainable use. As for the prevention of forest fires, building a sluice system is a practical and effective technique in *Melaleuca* forest on the peatlands in U Minh Ha. The sluice opens during the rainy season while it closes at the end of the rainy season to keep water level high enough to prevent peat soil from dry up in the time of drought. The system conserves the precious peatlands and ensures that the *Melaleuca* forest ecosystem remains in good condition. On the other hand, in an economic aspect, adapting an embankment method for forest plantation contributes to enhancing the growth of *Melaleuca* trees and increasing income from them. These economical benefits by the embankment method results in promoting conservation and sustainable use of *Melaleuca* forest on the peatlands and marshes in U Minh Ha area.

***Keywords:*** *peatlands,* Melaleuca cajuputi*, conservation and sustainable use, forest fire, sluice, embankment Vietnam*

## Introduction

Ca Mau is located in the Mekong Delta, in the South of Vietnam, with a V-shape, as a peninsula surrounded by sea on three sides. The natural area is 5,294km$^2$ with a population of about 1.2 million people. In 2011, the fishery, agriculture and forestry sector took a possession of 38.8% of the economy, while industry and construction occupied 36.7%, and the remaining 24.5% was for service. The GDP per person is 1,118 USD. The climate is temperate in the subequatorial region and experiences tropical monsoons, with an average rainfall of 2,000 – 2,700mm, and has two clear season - dry and rainy seasons. The rainy season takes place from May to November while the other is from December to April of the coming year. The topography is low and quite flat, with an altitude of 0.2 to 1.5m, an average of 0.5m in comparison to the sea level, and is affected by two tidal regimes of the western and eastern sea. The soil is fertile and rivers interlace.

Ca Mau has 4 types of soil, including salinity, alkaline, alluvial and peat. The area of peatland in 1978 was 30,000 ha. However, economic – social variations, in particular forest fire regularly occurring, has reduced peatland area. Currently, through a survey, peatlands were found to only cover 9,850 ha, of which only 5,647 ha is peat with a thickness of over 50cm, and is covered mainly by *Melaleuca*.

Ca Mau has a wetland forest ecosystem with an area of 100,733 ha including 64,904 ha of mangrove forest, 35,249 ha of *Melaleuca* forest and 580 ha of forest in islands.

U Minh Ha is a famous *Melaleuca* forest on peat-swamp muddy soil in Cuu Long river delta. It is a unique wetland and is a habitat of many wild animal species. It has high conservation value, and is protected by International Natural Conservation Organisations. Peat is a kind of mineral which was formed thousands year ago under anaerobic conditions and without human impact. If they disappear, it will not be able to recover or spend a long time in the similar condition.

U Minh Ha's *Melaleuca* forest has heavy fern cover, peatland and red water, with valuable and rare wild animal species. Vegetation cover of U Minh Ha is a closed tropical rainforest subtype flooded by alum water. The hard leaf forest population of *Melaleuca cajuputi* from the *Myrtaceae* family, developed within flooded, acid soil and is an endemic plant in SEA.

The seasonal submerged forest in peatland in the U Minh Ha National Park has about 79 species of natural plants of 65 genuses and 36 different plant families. This consists of 11 species of woody plants (*Melaleuca*, *Gardenia*, *Alstonia spathulata*) and bushy trees (*Aconychia pedunculata*, *Phragmites*, *Eleocharis*, *Stenochlaena balustris*, *Flagellaria indica*).

Submerged vegetation has created favorable habitat for wild animal species, namely 35 species of mammals (10 species in Red Book); 74 species of birds, (4 species in the Red Book), 36 species of reptiles and 11 species of amphibians.

*Melaleuca* can provide combustible timber and precious forestry products such as forest honey, and the *Melaleuca* forest is home to wild animals and plants; without peatlands, it is very difficult to have anything that benefits the community. However, the content of oil in a *Melaleuca* leaf is high; dry branches and old leaves fall down to the forest canopy, decomposes and forms an inflammable layer which make it a high risk of fire in the dry season. *Melaleuca* fire will cause serious losses, not only for the ecosystem, but for the production and life of people living around the forest and also wider area. Forest fire is the main reason for peatland reduction.

***Table 1***. Statistics of forest fire in over the years

| **Year** | **1983** | **1987** | **1990** | **2002** | **2010** |
|---|---|---|---|---|---|
| **Ha** | 28,000 | 13,000 | 4,700 | 4,420 | 230 |

Most causes of the fires in Table 1 was caused by human activities such as honey collection, hunting, burning agricultural soil, forest exploitation in the dry season, smoking, catching mouses, travelling, etc. which were done with a lack of awareness. Based on the monitoring results over the years, the forest fires where the causes were identified have been classified into some categories as follows:

- By burning agriculture land spreading to forest: 50.7%
- By honey collection: 25.3%
- By catching rodents: 13.8%
- By other activities such as hunting, and ignorantly using fire for exploiting the forest

### Conserving *Melaleuca* in U Minh Ha area

*Melaleuca* is classified into two types, special-use forest and productive forest. For sustainable management of *Melaleuca* forest on peatland, Vo Doi special-use forest with 3,688 ha was established in 1986, which has 3,370 ha (91.38%) of peatland with a thickness of over 50cm. Vo Doi special-use forest was extended and upgraded to U Minh Ha National Park with an area of 8,085 ha (existing forest area of 8,009 ha), including main sub-areas as follows:

- Sub-area for strict conservation sub-area: 2,570 ha (conservation of peatland ecosystem)
- Sub-area for restoration and sustainable use of wetland forest ecosystem: 4,961 ha
- Sub-area for service and administration: 554 ha

Up to 26/5/2009, all of U Minh Ha National Park became an important part of Mui Ca Mau BR that was recognised by UNESCO. The national park has 792 ha of peatland with a thickness of over 100cm, 2,190 ha at 50 – 100cm and 3,448 ha at 30 – 50cm.

Besides the *Melaleuca* area, U Minh Ha still has 170 ha for scientific research forests. The remaining *Melaleuca* forest in U Minh Ha is around 27,070 ha, which has been planned as a buffer zone for productive forests.

#### Forest Fire Prevention

There are various methods of forest fire prevention:

1. Forest on peatland is vulnerable to fire in the dry season because of agglomeration of peat over many years. Fire prevention on this area is a regular and important task. Proper water control enables the creation of a suitable environment for development of a *Melaleuca* ecosystem that limits fire.

2. Establish a fire alarm system based on an alarm criterion related to weather factors: rain volume, humidity, air evaporation, wind speed, average temperature, number of sunny days observed during the last 10-15 years. Develop a 5-level fire alarm system and build fire-watch stations, fire-level alarm boards, and put them at the end of canals and resident areas.

3. Put some communication stations to communicate between all teams involved: 1) Forest management protection stations and fire-watch towers, 2) National Park Central Director Committee, 3) Forestry Company and 4) Forestry fire prevention steering committee. Establish stations for hydrographic and weather observation that serves as fire forecast.

4. Establish fire prevention lines based on existing canals. Plant trees on dykes, clear grass at the beginning of the dry season to limit inflammable material. Keep water in canals to maintain proper humidity of peat layers. Develop the regulation of fire use and monitor people who enter forests in the dry season.

5. Conduct regular patrol and guard duty, provide training on fire prevention for local people living in the buffer zone and around *Melaleuca* ecosystems. Organise training for forest protection workers and ones who use forest firefighting instruments.

#### Sustainable use of *Melaleuca* ecosystem

The total present area of *Melaleuca* is 35,249 ha and has been assigned for management as follows:

| | |
|---|---|
| - U Minh Ha National Park (special-use forest) | 8,009 ha |
| - Wetland Research Center (scientific research forest) | 170 ha |
| - U Minh Ha Forestry Company (productive forest) | 19,466 ha |
| - Households and other organisations | 7,604 ha |

For productive forests, the annual exploitative area is 1,385 ha with a volume of 79,650$m^3$. *Melaleuca* wood is used mainly for construction poles, housing material, furniture and charcoal. Exploited forest recovers within 12 months. Replanting by embankment method has been recently applied in sunken areas where they have been anually inundated over 30cm for at least 3 months (Table 2). The height of embankment depends on the inundation level. The main principle is not touching the alkaline level. Seedlings with an uncovered roof were planted at 20,000 seedlings per ha with a planting space of 0.7 x 0.7m. The annual growth was 8-10$m^3$/ha/year.

***Table 2.*** The result of plantation area in the recent years

| Year | Plantation area (ha) | Plantation by embankment method (ha) |
|---|---|---|
| 2007 | 1,292 | - |
| 2008 | 1,657 | 133 |
| 2009 | 1,149 | 234 |
| 2010 | 1,625 | 28 |
| 2011 | 1,198 | 131 |
| **Average** | **1,384** | **105** |

Besides *Melaleuca*, *Acacia* was recently recommended for planting in productive forest. *Acacia* was planted in the embankment in U Minh Ha with a density of 2,400 seedlings/ha and the annual growth was 25 - 30$m^3$. Some surveys have proven that the growth rate and economic value of *Acacia* are higher than that of *Melaleuca*.

For good management of *Melaleuca* forest, it is important to improve the livelihood of local people who live in or nearby the forest. However, the living standard here is still difficult, with the highest poverty rate of 17.3%. There are 6,000 households living in U Minh Ha who have contracted for forest land use and management. According to the contract, 70% will be used for forest development, leaving the remaining 30% for cultivation. Each household received on average 5-7 ha of forest land. The improvement of livelihood for local people has been addressed through training on techniques for rice cultivation, husbandry, fruit tree planting and aquaculture, and has helped to raise income levels and reduce poverty. Apart from the efforts of local authorities, the government (through national target programs) and the support of the Japanese government through some ODA projects, has helped to develop the infrastructure in U Minh Ha including rural roads, schools, waterspouts, medicine station, etc. This is important for sustainable use and management of the forest.

## Conclusion

In Ca Mau province, Vietnam, peatland is mainly covered by *Melaleuca* forests. *Melaleuca* forest has been conserved in the National Park and sustainably used in production forests. Forest fire prevention is an important affair in the production and sustainable use of the *Melaleuca* ecosystem. Livelihood improvement is also important in sustainable management of *Melaleuca* forest in Ca Mau.

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# RESPONSIBLY MANAGED PLANTATIONS ON PEATLAND: A POSITIVE STORY

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## Abstract

There is a polarising debate underway at the moment about whether a viable and sustainable forestry industry is good for Indonesia, its people, its development agenda and its environmental objectives. That debate gives rise to points of contention relating to operations on peatland.

This presentation will canvas key aspects of plantation operations on peatland and outline key information, including:

- The manner in which Indonesia's Forestry Long Term Development Plan 2006-2025 provides a framework for a sustainable forestry industry as an important part of Indonesia's overall economic development plan and a critical driver of economic advancement
- The practice of High Conservation Value (HCV) assessments being conducted on concessions with objective third party experts prior to establishment of plantations using the Indonesia HCV Toolkit
- The necessity to balance economic imperatives and environmental concerns
- Appreciation of particular regulatory requirements of operating on peatland
- The imperative of effective water management
- Challenges in implementing best management practices on peatland

***Keywords:*** *development, forestry, conservation, carbon, peatland*

## Introduction

It's a fact that the world's population could reach 9.2 billion people by 2050 (UN). To fulfil their need through education, business and entertainment, the global demand for wood fibre and paper based products is increasing. Fibre from planted forests will need to increase from 800 million cubic metres currently to 2.7 billion cubic metres by 2050 (WBCSD Vision, 2050). Responsible plantation development now will enable a sustainable supply of fibre for the future. Indonesia has a real opportunity to lead the world in this sector through its advantages in tree growth rates, land availability, cost of production, ability to invest in technology and capacity, productivity and proximity to key growth markets.

## Riau – driver of national development

Riau is the driver of Indonesia's national development, accounting for 6.5% of Indonesia's national GDP in 2010. With a population of 6 million in 2010, double the numbers 20 years ago, the private sector is the key to increasing Riau's GDP by 250% in the past 5 years. Poverty as a percentage of the population was reduced by almost 30% since 2007.

One of the key industries in Riau is forestry. PT. Riau Andalan Pulp and Paper (RAPP) has helped build the economy by contributing IDR 196 trillion (USD 21.7 billion) to the National Output in 2010. This is equivalent to 6.9% of Riau Province's economic output and 6.1% of Riau's gross regional domestic product (GRDP). It accounts for 5.4% of all household income in Riau; having provided employment opportunities for 90,000 people in Riau in 2010. It has been a multiplier on Provincial output of 2.29 times, 2.36 times on household income and 5.7 times on employment.

Forestry is helping the economy and helping people with a focus on education, health and infrastructure development, covering 140 villages and 3,000 families. So far, RAPP has:

- Provided free medical treatment for 36,700 people
- Trained 500 farmers in integrated farming
- Allocated 76,000 ha for community livelihood projects
- Provided 5,000 local community members with jobs through paper-related small and medium enterprises
- Awarded 2,800 scholarships for children up to senior high school level
- Provided training activities for 150 teachers
- Constructed and renovated 20 school buildings since 2008

Indonesia has a real opportunity to lead the world in this sector: tree growth rates, land availability, cost of production, ability to invest in technology and capacity, productivity and proximity to key growth markets.

### Justification

A key question that has often been asked is, "Why does the company operate on peatland?" Our answer is, we saw a commercial opportunity 20 years ago to become a key plantation-based fibre supplier. To fulfil Riau's development imperative, government concessions on peatland were made available. Most importantly, it is a profitable business, one that supports investment in science and the development of responsible land management.

Consider that 40% of Riau is situated on peatlands. Mineral soils were developed first and are now scarce resources, and 85% of that peatland has already degraded or been converted for agricultural uses. Therefore, only 15% of the peatland remains intact and of strong conservation value. The real questions to our mind are therefore:

- How can the areas of peat already converted or degraded be best managed to further Riau's agenda AND contribute to environmental goals?
- How can the peatland forest in good condition be conserved and protected in the real time and real world?

### Our plantations

The key lessons learnt from our conservation effort, spanning almost 20 years, is that conventional models do not always work. Early day efforts went with the "Western Model" such as contributing land to national parks. Later on we adopted HCVF, which only works under certain conditions. Now our focus is on conservation areas that can be protected; with multiple buffer zones to protect the core and water management to maintain or improve water levels.

Our plantations have been conserving forests since 2005. We have conducted 36 HCV assessments and 200,000 ha of forest have been conserved. We also added 35% to the existing natural forest protected by the government in Riau.

There is continuous community development, a no-burn policy and active fire management in place. It is energy self-sufficient and uses minimal chemicals. There is continual improvement of water, soil and crop management based on science and plantations act as buffers to protect peat domes. The alternative to a managed plantation is unmanaged land and the alternatives are stark:

Unmanaged Land

- Poverty and population pressures drive encroachment
- Highly organised illegal logging
- Slash & burn farming
- No designated conservation areas
- Unregulated development
- No sustainability planning
- Zero care for workers/community development
- Loss of export income

RAPP Sustainable Land Management

- Adhere to regulations
- Protect conservation forests
- Rapidly replanted trees
- Active firefighting -"no burn"
- Sophisticated water management
- Infrastructure for communities
- Significant international scrutiny
- Jobs instead of illegal logging
- Economic multiplier effect

RAPP peatland management protects critical headwater peat areas to maintain the integrity of the peat dome. Water management practices ensure water levels compared to "At Take Over" levels are managed. Plantations that ring conservation areas discourage encroachment, illegal logging and unmanaged drainage of peatlands. A continually treed buffer zone between the plantation and natural forests further influences water levels. We also periodically review and adjust plantation practices to maximise tree canopy cover, improve soil and water protection.

### Peatland & carbon

Our overall goals in regard to carbon emissions and peatland are:

- To establish a verifiable baseline range of carbon emissions from the concessions at the point at which we took them over and variations to current emissions levels;
- Establish a total carbon emissions footprint from all of our current operations and activities combined;
- Measure and progressively improve effectiveness of carbon emission reduction initiatives; and
- Determine a carbon emissions mitigation plan for the long term, towards stable, sustainable land use; now and in the future.

### Next steps

RAPP has embarked on a comprehensive and long-range programme with a number of third-party experts to build knowledge about carbon emission. We have commissioned or are participating in a number of scientific projects to gain a more complete picture of the relationships between peatland, carbon and forestry activities.

The activities include pioneering participation in a Monitoring, Reporting and Verification (MRV) programme undertaken by independent third parties on behalf of the Indonesian government measuring against 19 indicators relevant to peatland; and facilitating field work and other scientific study by the Bogor Institute, Hokkaido University and other academic bodies focused on peatland.

### Conclusion

In summary, while some see plantations and effective peatland management as contradictory, we see responsible plantation development as a real-world solution which balances development, sustainability and conservation. The alternative is unmanaged lands which are lost to unsustainable development. With this in mind, we will continue to develop the knowledge and best practices to ensure sustainable use of peatlands in the fibre production.

# PEATLAND DEVELOPMENT CHALLENGES: A CASE STUDY FROM KAMPAR PENINSULAR, RIAU, INDONESIA

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## Abstract

Riau peatland has been widely developed for economic production. Attention is now turning to management practices that reduce carbon emissions from the developed land. This study provides data on baseline emissions that existed just prior to development – the start point on which to improve. Data has come from high resolution digital aerial photos, forest sampling and topographic leveling surveys. The raised peat landform studied here was severely distorted by subsidence valleys arising from illegal logging ditches dug a decade before formal development by APRIL commenced. Some two-thirds of plantations have been developed on degraded land that was deforested and had high soil carbon emissions at time of takeover. Natural forest remnants set aside on one-third of the study area, have been losing biomass from drainage and other edge effects proportional to severity of previous illegal logging.

Their rehabilitation has commenced by closing the many drainage ditches abandoned from previous illegal logging. Recovery of forest has not been instant; eventual recovery will be a major factor in the carbon balance. Change in land and vegetation measured over the decade prior to development indicate that carbon emission from soil subsidence and forest biomass loss was in the order of $CO_2$ 20-25 t $ha^{-1}$ $yr^{-1}$. To objectively measure the result of improved management practices on carbon balance, carbon assessment must be done at broad landscape scale over long horizons – requiring scientific expertise, patience and deep pockets.

***Keywords:*** *degraded peat forest, monitoring, weirs, carbon*

## Introduction

Clearing of 5 million hectares of natural forest and mass immigration of settlers have transformed Riau province in just 40 years to a dynamic agricultural economy today. Clearing is now largely confined to the peat soils covering 40% of Riau (Bathgate *et al*., 2011). Carbon emissions from drained peat have prompted calls that development be halted (Verchot *et al*., 2010). In reality there are few alternative sources of income for many rural communities that depend on subsistence. Changes that occurred to a 23,000 ha study area while it remained as undeveloped state forest land are described herein. The area is an outcrop to a large peat dome on the Kampar peninsular, on coastal Riau. Conversion of the original forests to agriculture and fiber plantations is described by Bathgate *et al*. (2011). In the study area, initial selection logging had little impact. But from 1997, political upheaval triggered unchecked illegal logging in which many small ditches were dug to extract logs, and then abandoned. This paper describes the landscape level impacts that followed.

## Methods

Remote Sensing: Forest cover changes have been mapped on digital images from aerial photos taken in 2005, 2009, and 2012. Three cover types are mapped: *intact* where most large trees (>8m crown diameter) remain; *degraded* where 50% or more large trees had gone; *non-forest* where majority of cover is non-woody. Logging ditch locations were digitised.

Forest Survey: In 2004 the least modified natural forest was sampled with 22 bounded plots, each 100 x 20m size. Stems were tallied in 20cm diameter classes, peat bored for depth, litter mass samples, canopy height and GPS locations taken. In 2011, 15 plots in forest that remained were re-measured. Meanwhile no new logging had occurred within the plots. Plot stem volume has been scaled to above ground biomass $CO_2$ (t $ha^{-1}$) by a factor of 1.1 (1.5 for all biomass, 0.5 basic density, 0.4 carbon content, 3.67 for $O_2$).

Topographic Survey: Terrain leveling survey was done in 2003 and repeated in 2010 as the developed area was being opened. Surveys used 'double stand' leveling with a tripod instrument, on a 2 x 4 km grid of survey lines. Closure error in elevation was 0.03m $km^{-1}$. Data were processed to DEM then to a 3-D solid to analyse terrain changes 2003-10. Soil carbon loss has been derived from soil volume loss by applying factors of 0.07 bulk density as sampled from water table levels, 0.54 for carbon content, and 0.60 for the oxidation portion of soil subsidence (Hatano *et al.*, 2010).

## Results

Vegetation Change: Figure 1 shows 2009 forest cover. Landscape changes in mapped vegetation cover types are summarised in Figure 3. Sample plot scale changes in forest are given in Figure 4. Forest in plots located far from logged gaps remained intact, whereas margins of canopy gaps lost many trees to 'edge effects'. Plots that sampled the 2004 logged gaps had lost half their biomass to gap expansion and collapse of remaining large trees by 2011. For the period 2005-09, an estimate of mean rate of change in biomass was derived by combining the hectares that changed type in the period with plot-scale biomass change. Estimated loss in biomass totals 1.2 Mt $CO_2$ or 7-8 t $CO_2$ $ha^{-1}$ $yr^{-1}$.

Topographic Change: Figure 2 gives a DEM of the 2003 terrain and 2010 terrain for part of the study area. Most of the area lost elevation over the period. The largest losses have been associated with deforested ditch areas. Elevation loss over the 16,000 ha resurveyed in 2010, averaged 0.17m subsidence. Applying the soil factors in Methods, soil subsidence emission is estimated at 20 t $CO_2$ $ha^{-1}$ $yr^{-1}$.

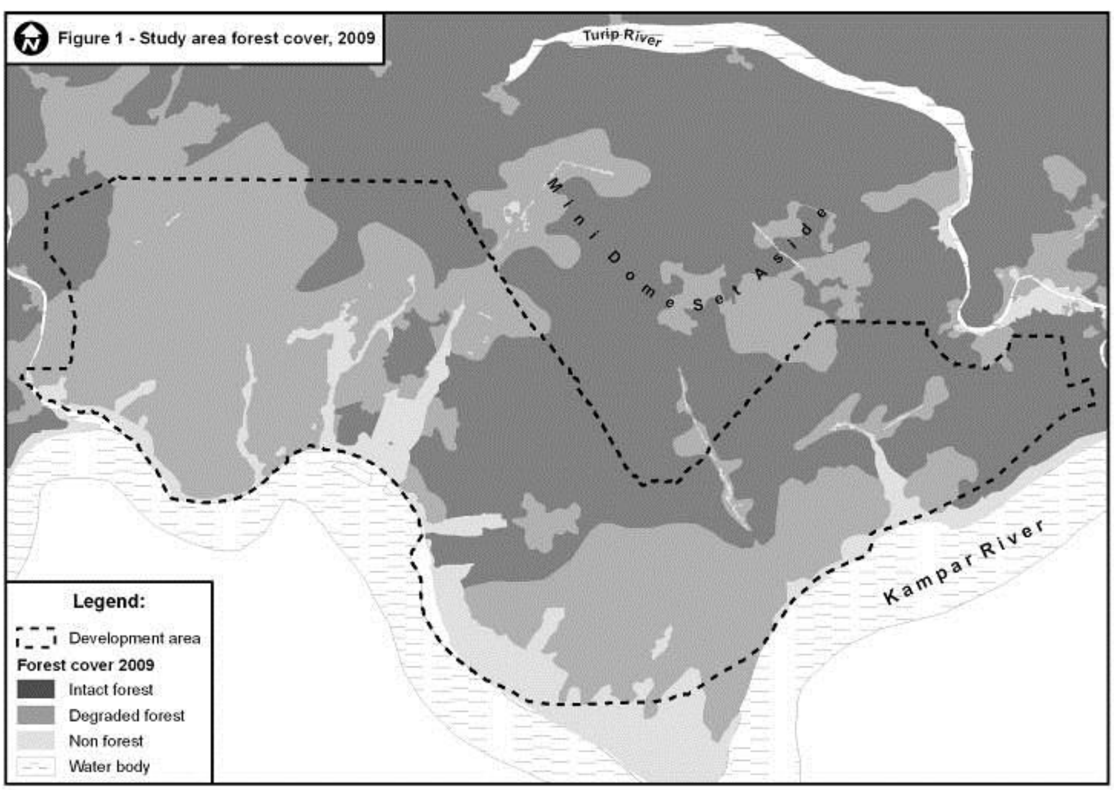

***Figure 1.*** Study area forest cover 2009

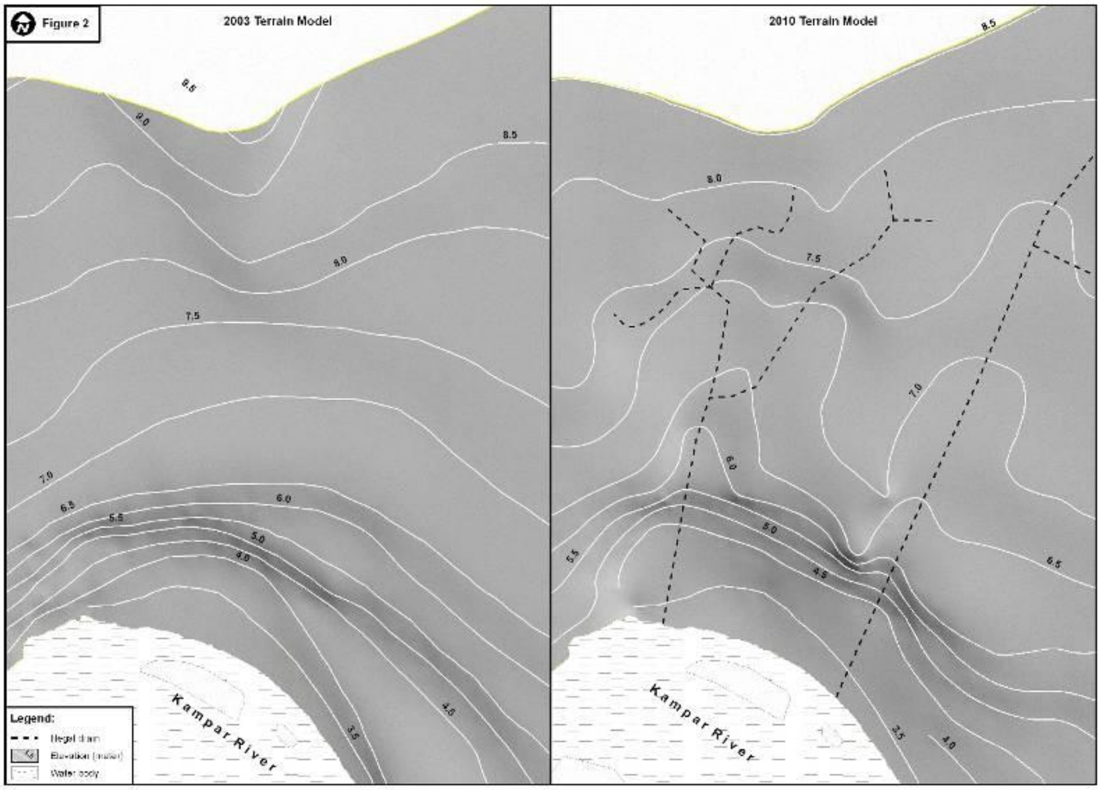


***Figure 2.*** Terrain models in 2003 and 2010

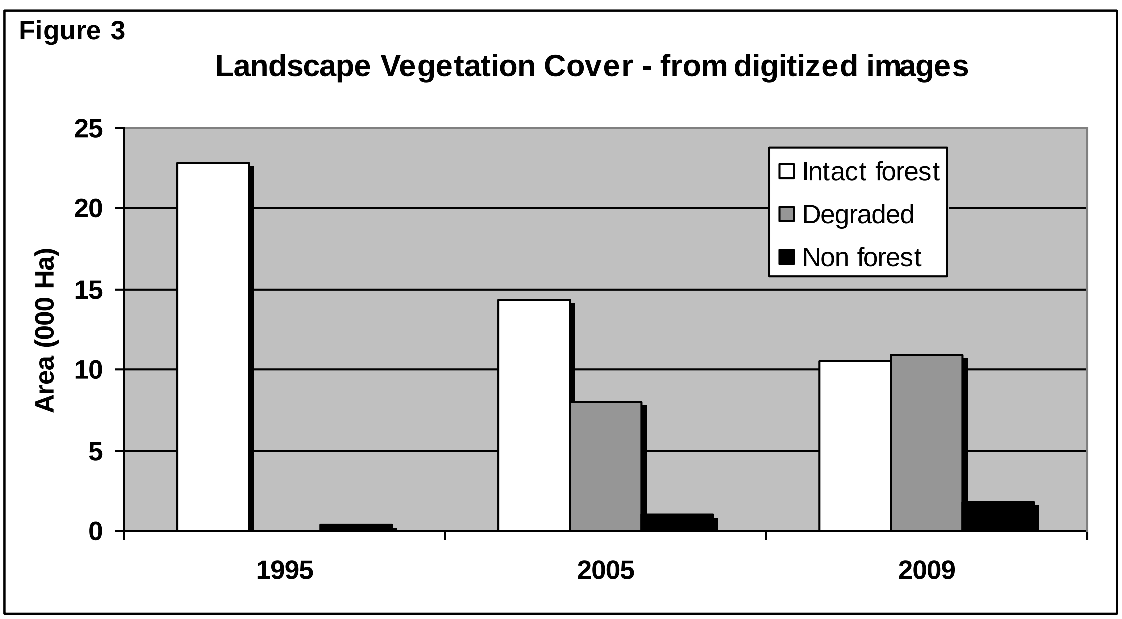


***Figure 3***. Lanscape change in vegetation cover

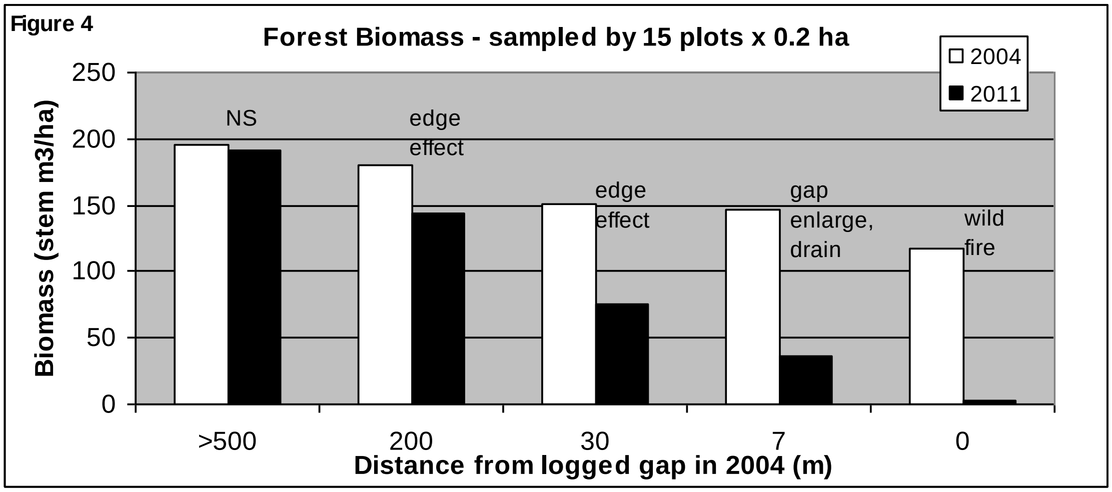


***Figure 4.*** Decline in biomass from 2004 to 2011

## Discussion

When taken over by APRIL in 2010 for development, the study area landscape had become incised by subsidence valleys associated with abandoned illegal logging ditches. It was no longer an intact raised dome with intact hydrology. Soil subsidence was set to continue. Non-development alone was no longer a realistic option to conserve soil carbon or to conserve the natural ecosystem. In 2011 APRIL cleared two-thirds of the study area for development. Of that, two-thirds was non-forest and severely degraded forest that continued to deteriorate, years after and at distance from the original illegally logged canopy gaps. This deterioration was widespread, due apparently to edge effects – exposure to wind and lowered atmospheric moisture as well as lowered soil moisture.

The least degraded one-third of the study area has been set aside by APRIL for nature conservation. In 2010, within 20 km of abandoned illegal logging ditches were closed with 12 geo-textile sand-bag weirs constructed at 20cm intervals of terrain elevation, to rehabilitate the ground water. Weir materials were transported in by helicopter.

Subsequent monitoring has shown that most of the time, water tables now largely follow the ground surface. But in drier spells the water tables drop to a lower profile such that residual ridges between the ditch valleys still experience some drainage, and soil emissions. That is, rehabilitation of the raised peatland to a gently undulating surface that ground water will continually saturate and conserve soil carbon, will be a slow and uncertain process. To date recovery of forest biomass in set-asides has not been detected although the deterioration may be slowing. Eventual recovery, which even optimistically is many decades away, will be a major factor in determining the long run carbon footprint of development – increase or reduction in emissions from pre-takeover situation. Only by assessing soil and biomass stock changes at broad landscape scale and over very long horizons can a footprint be derived.

#### Acknowledgements

Many Riau Fiber technical and estate staff helped to provide the field data. Water monitoring since 2010 development has been within the framework of Government's program of 'Monitor, Record, Verify' the impacts of development. Tony Greer advised on the DEM and 3-D model used to analyse terrain change.

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# CARBON BUDGET IN *Acacia crassicarpa* PULPWOOD PLANTATIONS IN PEATLAND

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## Abstract

Utilisation of peatland is nowadays extensively criticised for losing the earth's carbon (C) to the atmosphere. The critic was mainly based on facts that show depth loss or disappearance of peat following conversion of natural peatland to several uses for agriculture. In Indonesia, the facts are quite obvious in areas where peatland was converted into paddy field or annual crop plantation that resulted in partial loss or even complete disappearance of peat layer. Burning during land preparation of each planting season and uncontrolled drainage are detected to be the main causes of peat loss. Land preparation, water management and biomass production of *Acacia crassicarpa* plantation in peatland are completely different with those of the above uses, thus it is not necessary that the environmental deterioration with respect to carbon balance of this peatland use will resemble the above facts.

Conceptually, the carbon balance can be counted using the so-called carbon budget calculation. However, the widely proposed and published C budget calculation, in fact, contains some weaknesses for use to count C budget in peatland. We show here our own approach in calculating C budget in peatland used for *A. crassicarpa* plantation to seek for best practice management to reduce the environmental risk while enhancing sustainability of the activity. We calculated C budget of the plantation in peatland for one plant rotation using a value of C flux from peat decomposition based on our results of measurements on bare plots. We calculated the biomass left on the land by differentiating all detail of plant parts that could possibly contribute new organic material to the land by considering each retention time. The result shows that the use of peatland for *A. crassicarpa* resulted in C sequestration or a positive C budget and it was more positive when *A. crassicarpa* grew well, resulting in a high amount of biomass. In addition, we found that the best growth of *A. crassicarpa* coincided with land management that fortunately will not increase peat decomposition and that, among others, it can be achieved at quite a shallow water level.

***Keywords:*** Acacia crassicarpa*, carbon, peatland, pulpwood, plantation*

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## Introduction

In recent years, climate change has become a major environmental issue. This has given rise to many efforts aimed to reduce GHG emissions, one of which is by controlling human activities that contribute to GHG emissions. In Indonesia, use of peatlands for development is considered as an important source of carbon emissions, hence, establishment of commercial plantation forests, such as *A. crassicarpa* plantations, is intensively assessed or even challenged. Numerous publications have shown how big tropical peat forest conversion contributes to GHG emissions. Careful review of these publications however shows that there are yet no clear and reliable figures of the magnitude of GHG emissions from plantation forests, hence, varying opinions still exist as to what is the net benefit of plantation forest development in peatland.

Regarding this lack of data stated above, we present here our data from a study on C emissions from peatland used for *A. crassicarpa* plantation. The study was not merely aimed to collect detailed and comprehensive data of the fluxes of C but also to understand the controlling factors and processes of the fluxes, therefore it covers measurement of peat and peatland characteristics that may have relation with C emission including subsidence, bulk density, water level, micro relief (surface level), soil moisture, and rainfall. Based on the real data and a good understanding on the controlling factors and processes, we then formulated an approach in calculating C budget and present here the result as well.

Principally, calculation of the C budget presented here follows the common logic to get a figure of change in C stocks of a certain time and area by calculating the difference between emitted C and sequestrated C. However we do not follow any mathematical formula that is already proposed and published elsewhere by other scientists, such as one that calculates change in C stocks in a landscape from change in biomass, necromass, and soil C due to change in landuses. We use another approach instead, which emphasises on subtracting C emission resulting from decomposition of peat material from total accumulation of new organic matter on the land that comes from plant remains.

### Significance of considering peat and peatland characteristics in C budget calculation

Calculation of C budget is recently becoming a popular counter to seek for net benefit of any human activity on the landscape. An activity will be judged harmful for the environment when it is found to have a negative C budget, meaning that more C is emitted to the atmosphere than the sequestrated C. This budgeting of C in any ecosystem affected by human activities is being extensively carried out, including those performed to make an environmental assessment of utilisation of peatland for plantation.

The general concept of C budget calculation in a landscape is calculated by subtracting emission from C stocks in above and below ground biomass and is mathematically expressed as follows:

$$\Delta C = ABG - \sum E$$

**$\Delta C$** : **change in C stocks**
**ABG** : **above and below ground C**
**E** : **emission**

As an elaboration of the above general concept, there is an approach to calculate C budget such as shown by Agus *et al*. The formula is set to calculate an annual change in C stocks in a landscape by taking into account change in C stocks in living biomass, in dead organic matter, in soils due to changes in landuses. A mathematical expression of the formula is as as follows:

$$\Delta C = \underbrace{\sum_{ij} A_{ij}}_{LUC} [\underbrace{\Delta C_{ij\ LB}}_{Biomass} + \underbrace{\Delta C_{ij\ DOM}}_{Necromass} + \underbrace{\Delta C_{ij\ SOILS}}_{Soil}] / T_{ij}$$

| | |
|---|---|
| $\Delta C$ | Annual change in **C stocks** in the landscape, ton C $yr^{-1}$ |
| **Aij** | **area** of land use type *i* that change to *j*, ha |
| $\Delta$Cij LB | Change in C stocks in **living biomass** from changes of land use type *i* to *j* , tons C $ha^{-1}$ |
| $\Delta$Cij DOM | Change in C stocks in **dead organic matter** from changes of land use type *i* to *j* , ton C $ha^{-1}$ |
| $\Delta$Cij SOILS | Change in C stocks in **soils** from changes of land use type *i* to *j*, ton C $ha^{-1}$ |
| Tij | **Period** of the transition from land use type *i* to land use type *j*, yr |

In fact, using the above formulas for peatland is not as simple as the mathematical expressions. Regarding the general formula, there are crucial characteristics of peat and peatland that make difficulties in getting reliable data of below ground C stocks of the peatland. These difficulties arise when data of below ground C stocks need to be obtained by a calculation since it is difficult to get the value from a direct measurement. The calculation generally used is a multiplication of the area with peat depth or thickness and with bulk density (BD) of peat layer. Mathematically, the calculation is logical and acceptable, but field experience in observing characteristics of peatland shows that data of peat depth or thickness and the BD as the key parameters are not easily reliably collected.

It will be difficult to get a single value of peat depth that is representative of an area, because the depth would vary from point to point at narrow spaces. This variation is highly possible to occur since the surface of peatland is not completely flat, but forms a relief, having peaks and hollows with narrow spacing where the height difference varies from a few centimeters up to more than a half meter. This phenomenon occurs both in natural peatland and in peatland used for plantation. Examples of micro relief of land surface of *A. crassicarpa* plantation on peatland are presented in Figure 1.

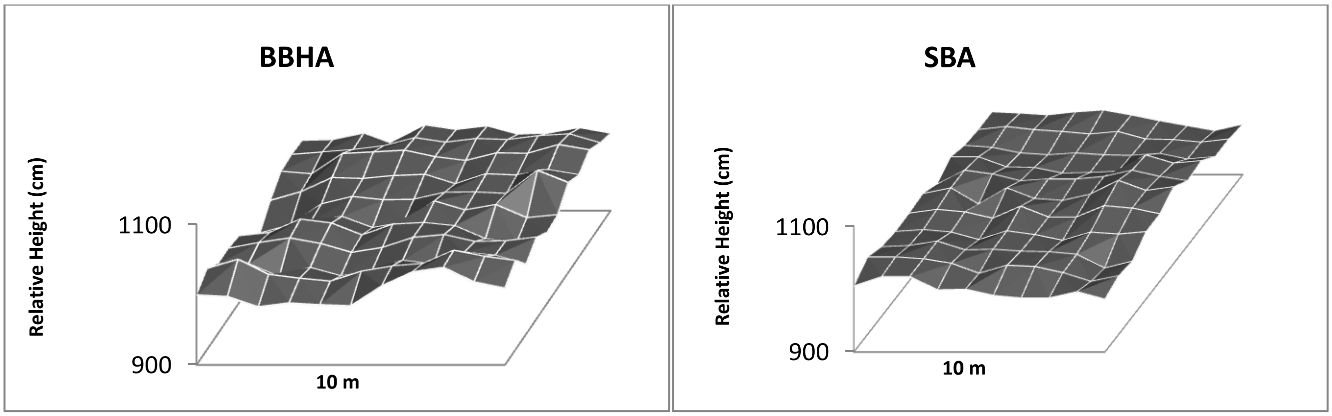


***Figure 1.*** Microrelief of *A. crassicarpa* planted peatland at BBHA and SBA

Figure 1 shows that in an area of 100 $m^2$ the surface is composed of some peaks and hollows. Height difference between the highest point at a peak and the lowest point in the respective hollows vary as shown in Table 1. Data in Table 1 shows that about 30% of an area has a height difference of about 0.3m. If value of BD used to calculate below ground C stocks of a hectare is 0.1 g/cc then it will be a deviation of about 300 ton C that is equal to around 150-200 ton biomass. This amount may exceed the total amount of above ground biomass.

***Table 1.*** Variation of elevation differences of peatland surface in measurement plots in Riau (BBHA), Jambi (WKS) and South Sumatra (SBA)

| Elevation differences (cm) | BBHA / R074 | | | | BBHA / R370 | | | WKS | SBA / P2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 1 | 1 | 2 | 3 |
| 0-10 | 24 | 24 | 17 | 30 | 19 | 41 | 36 | 38 | 19 | 37 | 29 |
| 10-20 | 32 | 18 | 22 | 30 | 32 | 31 | 26 | 38 | 35 | 18 | 25 |
| 20-30 | 19 | 14 | 18 | 18 | 26 | 18 | 16 | 15 | 13 | 15 | 19 |
| 30-40 | 8 | 9 | 10 | 10 | 12 | 9 | 9 | 7 | 6 | 5 | 3 |
| 40-50 | 5 | 12 | 9 | 3 | 6 | 2 | 5 | 1 | 1 | 1 | 1 |
| 50-60 | 3 | 6 | 6 | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 1 |
| 60-70 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 0 |

Using the value of BD to calculate below ground C stocks is also needed to carefully consider that BD of peat mass in the field varies with depth, thus using only a single value for entire depth is unacceptable. Value differences between certain depths cannot be easily attributed to the origin of peatland and the history of landuse, but they have their own local pattern as a result of local disturbances that mostly come from land utilisation activities. Variation of BD with depth of peat mass (peat soils) of different thickness is shown in Figure 2.

Figure 2 also shows corresponding size fraction from each depth. Data shown in Figure 2 describe that the BD of the upper layer of the pristine forest is comparable to and even slightly higher than that of the plantation area. Within the depth of only the upper 1m, which is above the water table, variations can be easily measured. However it will be quite difficult to get data at this detail for the lower depth. The figure also shows that the value of the upper layer BD in shallow peat can be higher than that of the locations with deeper peat but the dominance of coarse fraction is still high indicating that compaction would happen on the entire depth for shallow peat. All these facts indicate that it is not easy to get single reliable data of peat BD to represent a large area for use in calculating below ground C stocks, but instead there is a need to intensively measure density points at both horizontal and vertical extent.

Calculation of below ground C stocks need also to consider the phenomenon of subsidence that will cause changes of peat depth and BD simultaneously. However measurement of subsidence is not easy work. It needs a long monitoring time of some years as we found that one year of monitoring still gave uncertain data. Figure 3 shows that during a year, peatland surfaces of some measurement plots were found to alternately rise and fall a few centimetres, leaving a question of whether the average 3 to 4cm subsidence detected at the end of the monitoring year reflected the real subsidence. In addition, the data shows that variation between plots is quite high even between plots of the same characteristics and utilisation management.

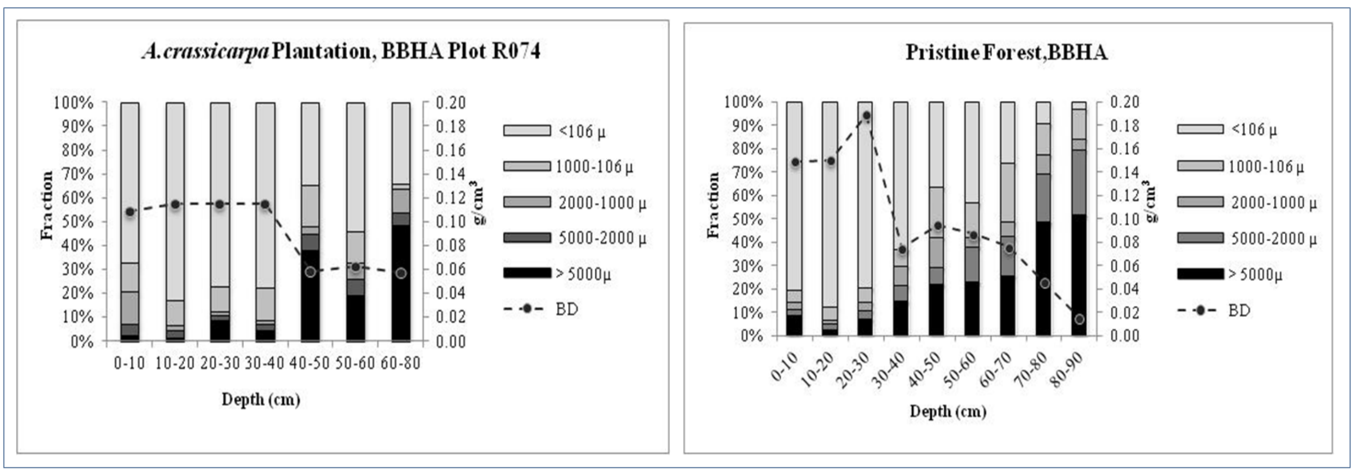


*Figure 2.* Depth-wise bulk density and peat particle size fractionation at BBHA

Difficulties in calculating below ground C stocks described above are also similarly found when we use the detailed calculation that takes into account calculation of change in C stocks in soils, biomass, and necromass. C stocks in soils for peatland is actually C of peat mass that should be calculated in a similar way to calculate the so-called below ground C as described above. Therefore, the value of C in soils will also be difficult to reliably obtain. Another difficulty to perform this formula of calculating annual change in C stocks based on landuse changes comes from calculation of necromass. Necromass calculation will be difficult to perform since it is definitely difficult to separate the necromass from the peat mass because the peat mass, especially at the upper layer, is composed of a continuum of organic material of different decomposition stages. Dead and decaying roots and litter will not easily be differentiated from that of the peat mass.

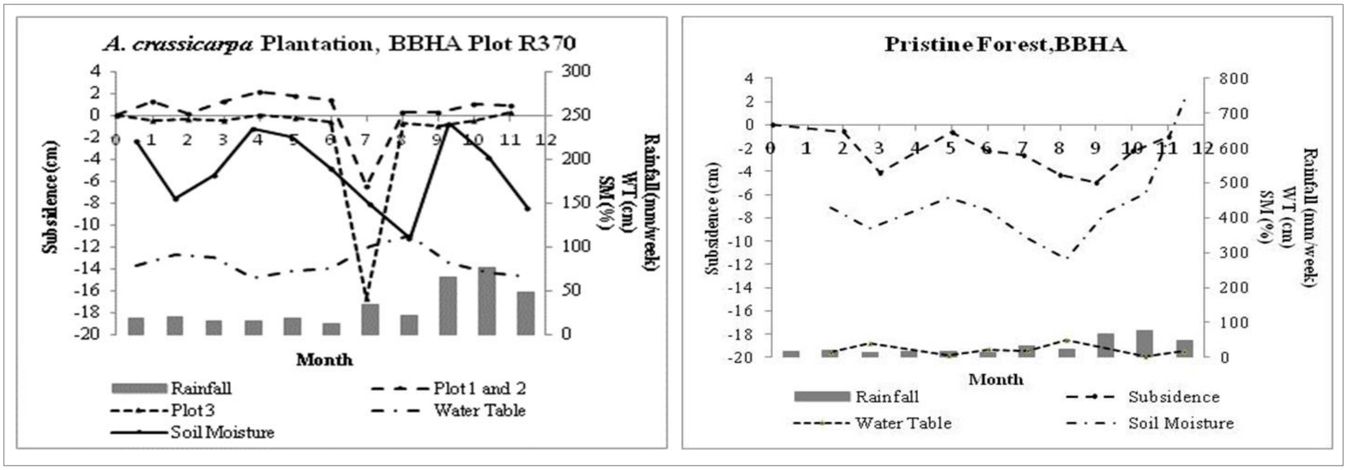


***Figure 3.*** Rate of subsidence at BBHA

### Facts of $CO_2$ emissions from *A. crassicarpa* plantation forest on peatland

Facts of $CO_2$ emissions from *A. crassicarpa* plantation forest on peatland presented here are results of detailed and comprehensive measurements carried out for a year at three locations in Sumatra Island, Indonesia. Measurement plots were selected within each location based on the age of the trees and water level, with additional measurements at adjacent pristine peatland forests, adjacent logged-over peatland forests, at mineral soils planted by *Acacia mangium* and *Eucalyptus spp*., and at an abandoned paddy field that was originally shallow peat and now have completely no peat anymore.

Figure 4 shows differences of $CO_2$ fluxes between land-uses and soil types. $CO_2$ fluxes from a mineral soil in one year old planted *A. mangium* and from the abandoned paddy field are lower than those from the peatlands vegetated by a different age of *A. crassicarpa*. The 1-weekly interval measurements show that for all the selected land characteristics including age of the trees, $CO_2$ fluxes over a year significantly fluctuated, sometimes showing a high difference of more than 100%, indicating that the controlling factors of $CO_2$ flux need to be carefully interpreted.

Positive correlation of $CO_2$ flux with water table is not detected at all. Figure 4 shows, for example, that the highest fluxes of $CO_2$ from plots with 1 year- and 3 year - *A. crassicarpa* occurred at week 7 but the lowest water table occurred at week 30. This finding is contradictive with data published by Hatano *et al*. (2011) and Hooijer *et al*. (2011). Another important fact that can be seen in Figure 4 is that the $CO_2$ flux increased with the age of *A. crassicarpa* trees indicating that a higher proportion of $CO_2$ flux comes from plant respiration compared to that from peat decomposition (see comparison between Figure 4a and b).

The year's fluxes of $CO_2$ and $CH_4$ are presented in Table 2. The table shows that $CO_2$ from the peat are higher than that from the mineral soil. However, it does not necessarily mean that those from the deep peat are higher than those from the shallower peat. Table 2 also shows that $CO_2$ released from decomposition of litter and fine root are significant. All measurements at the condition of no fine root and litter (-R –L) show almost similar results in a range of 20.31 – 26.38 ton C-$CO_2$ $ha^{-1}$ $y^{-1}$ for both the deep and shallow peat, and the pristine forest. The highest $CH_4$ flux of all plots is only 14.83kg C-$CH_4$ $ha^{-1}$ $y^{-1}$, which is surprisingly obtained from the –R –L measurement plot of the 4 year old *A. crassicarpa* plantation that is never inundated. Table 2 also shows that $CO_2$ flux from the bare plot (open area and no vegetation) is about 11 ton C-$CO_2$ $ha^{-1}$ $y^{-1}$ indicating that with no plants (and hence minimal contribution from respiration), the $CO_2$ flux becomes very much smaller.

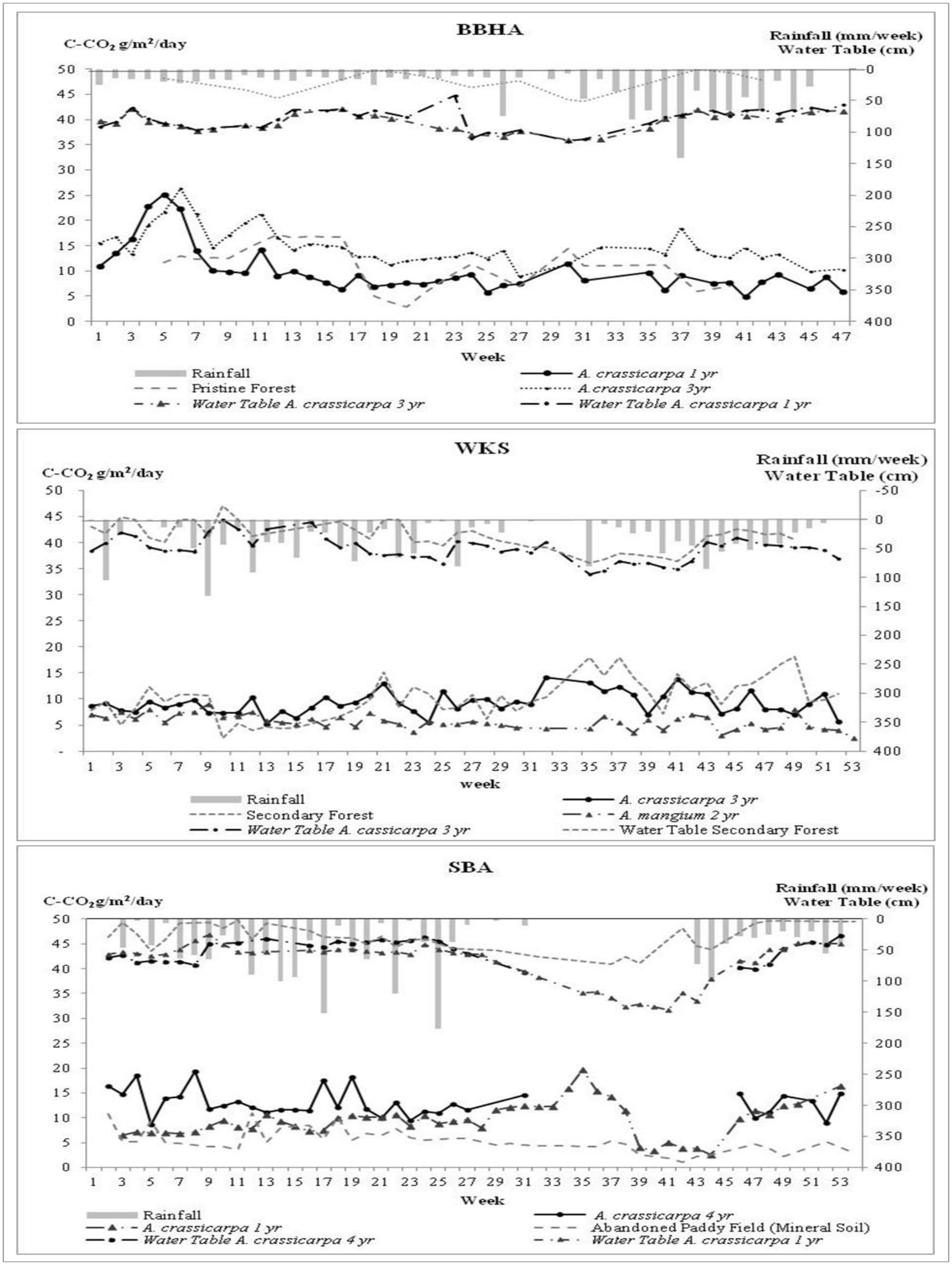


***Figure 4.*** Weekly fluxes of $CO_2$ from various conditions of *A. crassicarpa* planted peatland and from adjacent pristine forest and mineral soils

***Table 2.*** Yearly fluxes of $CO_2$ and $CH_4$ from different plots of *A. crassicarpa* planted peatlands and from adjacent pristine forest and mineral soils

| Land Characteristics | Landuse (age) | $CO_2$ Fluxes (ton C-$CO_2$ha$^{-1}$y$^{-1}$) | $CH_4$ Fluxes (kg C-$CH_4$ha$^{-1}$y$^{-1}$) |
|---|---|---|---|
| Mineral soil | *Acacia mangium* 2y | 20.23 | -2.12 |
| Mineral soil | *Acacia mangium* 2y, -R-L | 11.58 | -9.25 |
| Mineral soil | *Eucalyptus,* sp 2y | 18.10 | -4.94 |
| Mineral soil | Abandoned paddy field | 15.97 | 1.31 |
| Peat soil, deep | *Acacia crassicarpa* 1y | 35.77 | -7.33 |
| Peat soil, deep | *Acacia crassicarpa* 3y | 52.43 | 3.86 |
| Peat soil, deep | *Acacia crassicarpa* 3y, -R-L | 26.04 | 7.62 |
| Peat soil, deep | *Pristine forest* | 33.04 | 5.42 |
| Peat soil, deep | *Pristine forest*, -R-L | 20.31 | 5.15 |
| Peat soil, deep | *Open area (no vegetation)* | 11.06 | -6.67 |
| Peat soil, moderate | *Acacia crassicarpa* 3y | 34.31 | 12.94 |
| Peat soil, moderate | *Acacia crassicarpa* 3y, -R-L | 27.16 | 8.30 |
| Peat soil, moderate | Secondary (logged-over) forest | 36.52 | 8.30 |
| Peat soil, shallow | *Acacia crassicarpa* 4y | 37.59 | -9.25 |
| Peat soil, shallow | *Acacia crassicarpa* 4y, -R-L | 26.38 | 14.83 |
| Peat soil, shallow | *Acacia crassicarpa* 1y | 26.96 | 1.17 |

Note: -R-L: without fine root and litter

The results presented in brief above, which show high variation and fluctuation that depend on many factors, clearly indicates that estimation of total C emission from peat is not easily performed to get reliable estimates. Several experts showed estimations using subsidence data, such as those made by Hooijer *et al.* (2010), saying that the loss of carbon as a result of subsidence is as much as 0.91 ton $CO_2$/ha/cm of soil water table. According to this estimate, then with, for example, the water table at 80 cm, the loss of $CO_2$ during the decomposition process will be about 72 ton $CO_2$/ha/year, which is equivalent to 72/3.67 = 19.6 ton of carbon. However, our results show that subsidence is not easy to be measured and show a high variation and in addition, surface level also varied in narrow spaces that make the depth of water table horizontally varied.

All these suggest that estimation to calculate carbon loss, such as one that from Hooijer *et al.* (2010) is clearly untenable. Another estimation using value of BD is also untenable because it is clear that measurement of BD of the entire depth is extremely hard because of increasing water abundance with depth and will produce a great variation in vertical extent. From the results of our measurement, however, we found that for certain conditions, our data may resemble that of the estimates from Hooijer *et al.* (2010) or from Meine *et al.* (2011). For example, Meine *et al.* (2011) in calculating the carbon footprint under an oil palm system in peatland, provided an estimated C loss from peat decomposition of 0.8 ton $CO_2$/ha/cm of soil water table, which is equivalent to 63/3.67 = 17.3 ton C/ha/year. Our result was about 11 ton C/ha/year from bare plot condition.

## Biomass of *Acacia crassicarpa* plantation on peatland

Calculation of C budget needs to take into account biomass production as a main source of C that would be sequestrated to become part of C stocks. Total amount of biomass produced within a certain landuse cannot be directly used to calculate net addition of C stocks of a certain time. Only parts of vegetation that will be left on the land should be counted and since they will be decomposed gradually then it is necessary to use only the amount of decomposition remains that can be calculated or estimated based on the rate of decomposition of each part. In the case of *A. crassicarpa* plantation on peatland, contribution of C sequestration includes C originating from: (1) accumulation of fallen trees and litter before harvest corrected by decomposition rate (during one rotation of *Acacia* plantation that in general is 5 years), (2) accumulation of roots during 5 years, (3) parts of trees left on the land after harvest, (4) rejected woods, and (5) forest floor vegetation (shrub). Values of some components can be obtained by using allometric equations.

We developed allometric equations and performed the above calculations using data obtained from field measurements in location and plots of the measurements of C emission described above. The allometric equation that we used is as follows:

$$WT = (WTmax) \times \left\{1 - \left|1 - \frac{t}{a}\right|^{b}\right\}^{-c}$$

where:

| | |
|---|---|
| WT | = Total plant weight |
| WTmax | = Maximum of total plant weight obtained from measurement |
| *t* | = Function of DBH*H (A) |
| *a, b*, and *c* | = Constants |
| DBH | = Breast Height Diameter |
| H | = Plant height |
| A | = Plant age |

Parts of the results showing relation between DBH as well as DBH multiplied with H and plant age of *A. crassicarpa* are shown in Figure 5. The figure shows that SBA had the highest growth than other plantations.

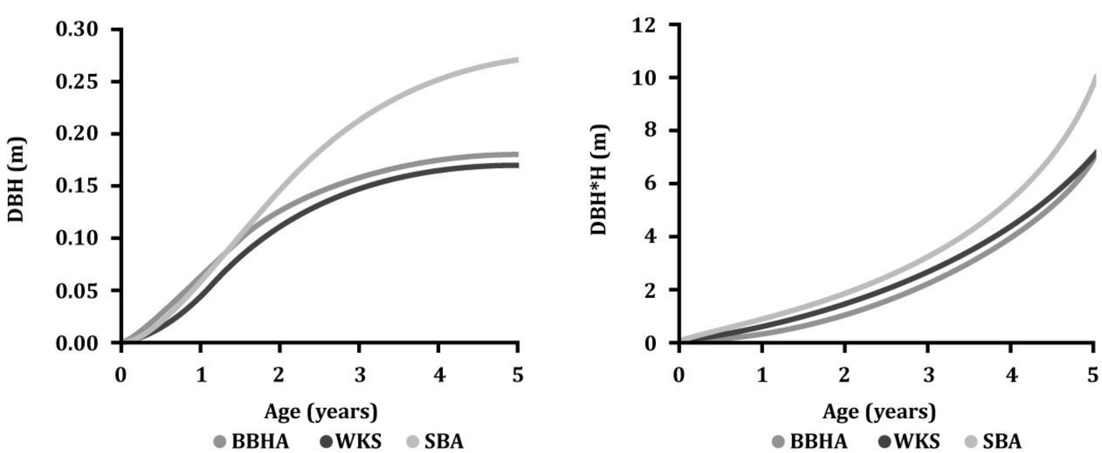


**Figure 5.** Relation between DBH and plant age (left) and DBH multiplied with H and plant age (right) of *A. crassicarpa* planted at three plantation areas

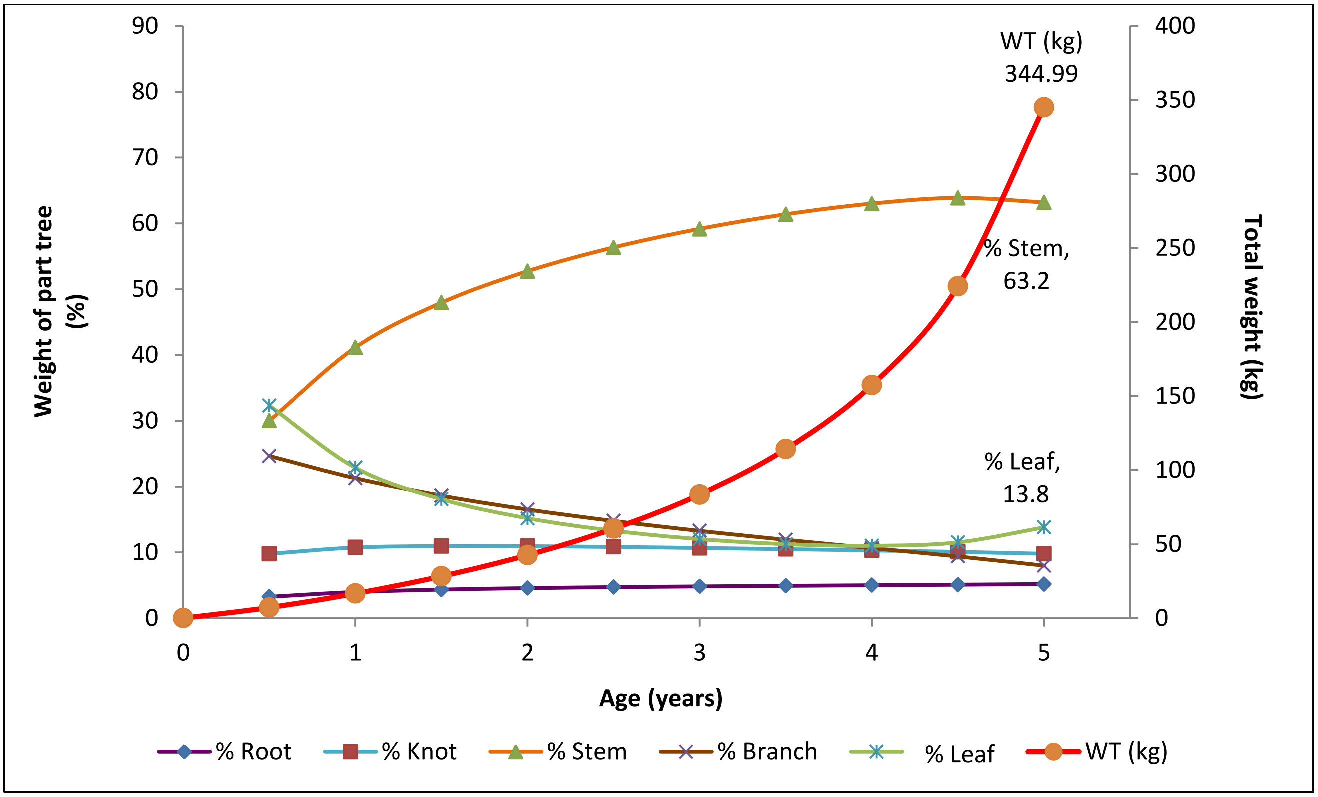


***Figure 6.*** Relation between percentage of weight of plant parts as well as total plant weight and plant age of *A. crassicarpa* at BBHA

Weight of each part of *A. crassicarpa* was measured and the data was used to develop allometric equations of each plant part. The relation between the percentage of weight of plant parts as well as the total plant weight and plant age of *A. crassicarpa* planted on deep peat based on the allometric calculation is presented in Figure 6. The figure shows that the percentage of stem weight significantly increases with age, while other parts including leaf, branch, root, and sleeve show no significant changes with age. Furthermore the figure shows that the percentages of stem at the the 5$^{th}$ year are found to be around 60%. This value therefore can be used in the C budget calculation in that after harvesting there will be only 60% of total plant weight (total of a tree biomass) extracted from the land as wood materials to be sent to the pulp industry.

Dead plants are one of the sources of sequestration of C. Therefore in calculating C budget it is important to record the amount of dead plants (trees of *A. crassicarpa*) for a span of time that can be known by subtracting the amount of living trees from the total amount of planted trees. Result of population counting as well as the total biomass of the population of *A. crassicarpa* at BBHA for different ages is presented in Table 3. Based on the population of each age then the amount of dead plants was calculated and presented in Table 4. The population increased with age until the 2$^{nd}$ year as the result of the growth of wild trees, but decreased from the 3$^{rd}$ year due to the death of some plants.

Sources of C sequestration includes among others litter fall. Result of litter fall measurements of *A. crassicarpa* at BBHA every month for 1 year observation is presented in Table 5. This table shows that production of litter fall of *A. crassicarpa* plantation is higher than that of natural peat forest as the result of higher population and homogeneity.

***Table 3.*** Population and total biomass of *A. crassicarpa* at BBHA

| Age | Population (amount of trees) | Weight/tree (kg) | Total biomass (ton) | 75% of Total biomass (ton) |
|---|---|---|---|---|
| **1** | 1,933 | 16.7 | 32.3 | 24.2 |
| **2** | 2,267 | 42.7 | 96.8 | 72.6 |
| **3** | 1,967 | 83.6 | 164.4 | 123.3 |
| **4** | 1,700 | 157.4 | 267.6 | 200.7 |
| **5** | 1,411 | 345.0 | 486.8 | 365.1 |

***Table 4.*** Amounts and total biomass of dead plants of *A. crassicarpa* at BBHA

| Age | Population (amount of dead trees) | Total biomass (ton) | 75% of Total biomass (ton) |
|---|---|---|---|
| **1** | - | - | - |
| **2** | - | - | - |
| **3** | 300 | 25.1 | 18.8 |
| **4** | 267 | 42.0 | 31.5 |
| **5** | 289 | 99.7 | 74.8 |

***Table 5.*** Litter fall production of 3 year old *A. crassicarpa* and Pristine Forest at BBHA

| Month | BBHA | |
|---|---|---|
| | Plot R074 | Pristine Forest |
| February 2011 | 93.59 | 30.84 |
| March | 71.43 | 65.28 |
| April | 52.17 | 38.72 |
| May | 48.49 | 45.73 |
| June | 45.48 | 50.81 |
| July | 40.91 | 56.68 |
| August | 43.36 | 36.05 |
| September | 51.26 | 49.75 |
| October | 48.52 | 48.29 |
| November | 48.66 | 45.77 |
| December | 40.57 | 37.73 |
| January 2012 | - | - |
| **Total ($g/m^2/yr$)** | **637.54** | **552.69** |
| **Total (ton/ha/yr)** | **6.38** | **5.52** |

Using the data of litter fall from total leaf production of 3 year old plants in Table 5, correlated with previously presented data of leaf percentage of total biomass of tree, and the population of each age, then litter production of each age and the accumulation during 5 years can be calculated. The result is presented in Table 6.

***Table 6.*** Weight of litter fall of each age and the total for 5 years based on calculation at BBHA

| Age (year) | Litter fall (ton/ha) |
|---|---|
| **1** | 1.2 |
| **2** | 3.5 |
| **3** | 6.0 |
| **4** | 9.8 |
| **5** | 17.8 |
| **Total** | **38.2** |

Carbon in the total litter fall as presented in the Table 6 is not 100% sequestrated, but needs to be corrected by the decomposition process. Rate of decomposition of the litter of *A. crassicarpa* is presented in Figure 7. The data in the figure shows that after decomposing for a year, remains of organic matter of the decomposed litter were found to be around 20 – 40% and the rate of decomposition was found too much in decline indicating almost no further decomposition at the end of the year.

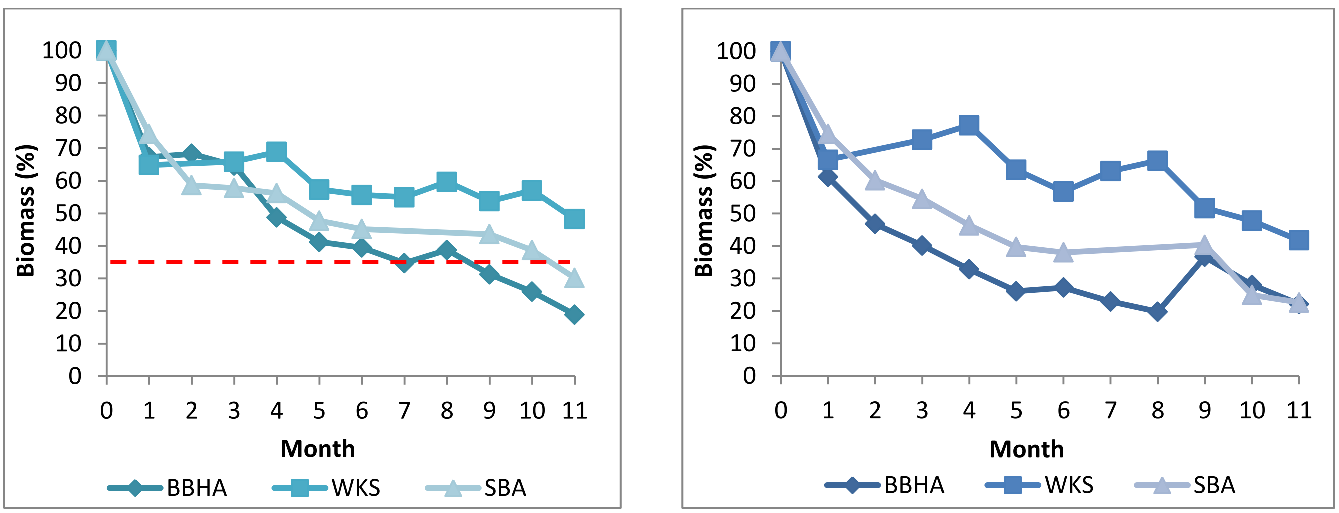


***Figure 7.*** Decomposition rate of litter of *A. crassicarpa* at three plantations of different peat obtained from decomposing litter samples put above (a) and below (b) natural litter layer

Carbon sequestration in *A. crassicarpa* plantation system definitely also comes from roots. For this reason it is important to know total weight of roots accumulated within root zone at harvest time. From field measurements it was found that the weight of roots was 3-14 ton/ha. For C budget calculation it is reasonable to use 5 ton/ha as a representative single value. At harvesting, based on allometric calculation about 40% of plant parts will be left on the land including leaves, branches, and sleeve. Further wood will be left on the land due to technical harvesting reasons and some woods will be rejected by pulp factories. Both are predicted to be around 10% of total biomass of 5 year old *A. crassicarpa*.

By considering the necessity of data and developing and performing necessary calculations as described above then all data needed in calculating C budget of *A. crassicarpa* plantation on peatland can be obtained.

This data, for example, is presented in Table 7. Using the data in Table 7, C budget calculation is performed with the following steps.

1. Components for calculating C sequestration composed of: (1) "decomposition remains of litter" at year 5, (2) "decomposition remains of dead plants" at year 5, (3) "parts of plants left on the land", (4) "roots", (5) "reject woods", and (6) "forest floor plants". Total sums of the components comprise of the total sequestration.
2. The value of "decomposition remains of litter" at year 5 obtained from stepwise calculation of each year because the litter is produced since the first year.
3. Calculation of the value of "decomposition remains of dead plants" at year 5 is similar to that of the litter but started from the year when dead plants are first found.
4. Component for calculating emissions originating from peat decomposition (E0) for 5 years is a flux of C from measurement at bare plots that is 11 ton C-$CO_2$/ha/y.
5. Carbon budget is calculated by subtracting the total sequestration obtained in step 2 by the E0 in step 4.

***Table 7.*** Components of biomass of *A crassicarpa* for C budget calculation (data from plantation on deep peat)

| Components of Biomass | | kg/ha | kg C/ha |
|---|---|---|---|
| **1** | **Upper ground** | | |
| | Dry biomass 1$^{st}$ year | 24,188.3 | 12,094.15 |
| | Dry biomass 2$^{nd}$ year | 72,600.7 | 36,300.35 |
| | Dry biomass 3$^{rd}$ year | 123,330.9 | 61,665.45 |
| | Dry biomass 4$^{th}$ year | 200,685.0 | 100,342.50 |
| | Dry biomass 5$^{th}$ year | 365,096.3 | 182,548.13 |
| **2** | **Additional biomass from litter** | | |
| | Litter fall 1$^{st}$ year | 800.0 | 400.00 |
| | Litter fall 2$^{nd}$ year | 3,998.9 | 1,999.44 |
| | Litter fall 3$^{rd}$ year | 6,000.0 | 3,000.00 |
| | Litter fall 4$^{th}$ year | 7,153.6 | 3,576.81 |
| | Litter fall 5$^{th}$ year | 7,411.4 | 3,705.71 |
| **3** | **Total dry biomass from shrub/bushes** | 2,000.0 | 1,000.00 |
| **4** | **Deadwood** | | |
| | Deadwood 1$^{st}$ year | - | |
| | Deadwood 2$^{nd}$ year | - | |
| | Deadwood 3$^{rd}$ year | 18,810.0 | 9,405.00 |
| | Deadwood 4$^{th}$ year | 31,519.4 | 15,759.68 |
| | Deadwood 5$^{th}$ year | 74,778.8 | 37,389.38 |
| **5** | **Fine root-medium root** | 5,000.0 | 2,500.00 |
| **6** | **Plant remains : root, leave, branches, sleeve)** | 146,038.5 | 73,019.25 |
| **7** | **Reject woods: broken, too short, fold, etc (10% from Total Weight of 5$^{th}$ year old plant)** | 36,509.6 | 18,254.81 |

Values obtained by the steps described above are presented in Table 8. This table at the end shows the final value of the carbon budget using the calculation thoroughly described above, and in the case of this calculation using data from *A. crassicarpa* plantation on deep peat in Sumatra, the results show that this plantation results in a higher C sequestration value than C emission.

***Table 8.*** Carbon budget calculation (data from plantation in BBHA)

| Components of biomass (kg C/ha) | 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year |
|---|---|---|---|---|---|
| Deadwood stock from last year | | | | +7,524.0 | +18,626.9 |
| Litter stock from last year | | +205.9 | +690.2 | +1,291.6 | +2,160.6 |
| Litter fall this year | 588.4 | +1,766.0 | +3,000.0 | +4,881.6 | +8,880.9 |
| Deadwood this year | | | +9,405.0 | +15,759.7 | +37,389.4 |
| Decomposition of litter | -382.4 | -1,281.8 | -2,398.6 | -4,012.6 | -7,177.0 |
| Decomposition of deadwood | | | -1,881.0 | -4,656.7 | -11,203.3 |
| Litter stock this year | +205.9 | +690.2 | +1,291.6 | +2,160.6 | +3,864.5 |
| Deadwood stock this year | | | +7,524.0 | +18,626.9 | +44,813.1 |
| Plant remains | | | | | +73,019.3 |
| Root remains | | | | | +2,500.0 |
| Reject woods | | | | | +18,254.8 |
| Shrub/bushes | | | | | +1,000.0 |
| | | | | **Sequestration** | +143,451.6 |
| E0 | -11,000.0 | -22,000.0 | -33,000.0 | -44,000.0 | -55,000.0 |
| | | | | **Budget** | **+88,451.6** |

## Concluding remarks

Calculation of C budget in peatland using the model of " ΔABG - ∑E "as well as the model using an approach of change in C stocks due to change in land use is facing uncertainty with respect to below ground C stock measurement/estimation due to great variation in land surface and BD. We proposed here that an alternative concept of C budget calculation is by considering all possibilities of C sequestration from produced biomass and the emissions from just the peat material decomposition.

Performing calculation of C budget of *A. crassicarpa* plantation on peatland using the proposed concept shows that the C budget tends to be positive. Although $CO_2$ fluxes from *A. crassicarpa* plantation on peatland were found to be quite high (about 30-59 ton C/ha/year), it does not reflect high emissions because the sequestration is even higher. There are strong indications that the C budget depends on the plantation management, in that the higher the production the higher the sequestration. With the fact that emission from peat decomposition is constant, then high production is a reflection of best fit management and is a measure for reducing emissions.

#### Acknowledgements

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# PLANTATION FOREST FIRE MANAGEMENT AND COMMUNITY PARTICIPATIVE APPROACH

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**Abstract**

PT. Wira Karya Sakti (WKS) manages about 294,000 ha of forest concession area primarily for the production of fiber for the pulp and paper industry. The forest plantations are located in Jambi Province of Sumatra Island.

One of the challenges faced by the Company in its effort to control forest and land fires are the numerous villages (> 140) directly located adjacent to the forest concession blocks whose main livelihood source is farming. Traditional slash-and-burn practice in preparing land for cultivation is common regardless of soil type, and escaped fires repeatedly happen. Another challenge is the need for improving the sense of responsibility among company workers, including contractors, in all phases of the operation.

Recognising the importance of controlling forest and land fires, WKS implemented a Fire Management Policy and strategic policies. Effective fire management is an integral part of WKS' business sustainability.

***Keywords:*** *plantation, forest fire, control, community participative approach*

## Introduction

PT. Wira Karya Sakti is a plantation forest concession license holder which was incorporated in 1997. Its total area is 293,812 ha with 174,200 ha of planted forest (85% of targeted plantable area). Pulpwood is exclusively supplied to APP Indonesia pulp and paper mills and WKS is certified under the Sustainable Plantation Forest Management Standard developed by Lembaga Ekolabel Indonesia (LEI).

The company faces a few challenges and vulnerabilities. Firstly, the plantation forest block areas are located adjacent to community lands and over 140 villages surround the forest blocks. In addition, customary slash-and-burn practices in land preparation often result in escaped fires.

## Fire management policies and practices in WKS

Fire management requires stakeholder collaboration between WKS, the government and local community. It covers prevention, control, post fire handling, and safety issues. WKS objectives and targets with regards to fire management are:

- Zero fire
- Complying with the laws and regulations with regard to forest and land fires
- Organising Community Fire Brigade Teams (Kelompok Masyarakat Peduli Api or KMPA)
- Promoting sustainable use of non-timber forest products as part of the activities in forest and fire prevention
- Improving the sense of responsibility to all about the importance of forest and land fire prevention and control

WKS also has a checklist of all the laws and regulations that apply to fire prevention, forest fire control and post fire handling to which they monitor their progress against the criteria.

Fire management implementation in the WKS Forest Concession Area involves a two-pronged approach between implementing strategic policy and operational actions. The initiatives are listed below:

A. Strategic Policy

1. Implemented a strict no-burn practice in land preparation (Persiapan Lahan Tanpa Bakar or PLTB)
2. Implemented a Water Management System and Procedure in peatland
3. Organised Firefighting Unit and Hotspot Monitoring Team
4. Developed Standard Operating Procedures and Work Instructions
5. Collaborations and partnerships with key stakeholders
6. Sustained information dissemination or socialisation to all stakeholders to increase awareness about forest and land fires
7. Support sustainable use of non-timber forest products as a valuable livelihood source, thus, reducing forest encroachments and slash-and-burn farming practices

B. Operational Actions

1. Human resources
    - Organise a core 20-men Special Firefighting and Safety Unit in each District (a district covers about 30,000 ha)
    - Enhance capability of Team-20 through periodic in-house and external training
    - Conduct simulation drills to test readiness of the Core Teams
    - Involving local communities in fire prevention and control activities through organising community groups or Kelompok Masyarakat Peduli Api (KMPA)

2. Equipment and other facilities
    - Provide sufficient equipment and infrastructure needed
    - Maintain equipment and other facilities in ready-to-use condition

3. Monitoring
    - Identify and map High Fire Risk areas
    - Establish Fire Danger Rating Index
    - Field inspections/investigations: Land and aerial patrols, detection from fire observation towers, satellite monitoring information

4. Campaign
    - *Apel siaga*, exhibitions, and through direct or indirect extension activities

5. Other activities
    - Collaboration in Corporate Social Responsibility (CSR) activities (e.g. sustainable use of non-timber forest products)
    - Work with LP3I and collaborate with other stakeholders in forest fire prevention and control
    - Establish Fire Outposts (Posko), reporting to authorities

The company has also developed numerous standard operating procedures and work instructions related to managing fire outbreaks and maintaining fire equipment to ensure that staff are aware of what to do in the event of fire. In addition, WKS helped establish Community Fire Protection Teams that act as agents to prevent and extinguish fires. Each team has 10 to 20 community members who are trained and supervised by WKS to be able to use firefighting equipment.

### Hotspot observation - 2010 to 2012

WKS' efforts have resulted in vast improvements in fire reduction. Table 1 below compares the number of hotspots observed in the Jambi Province with those in the WKS area from 2010 to 2012. As can be seen, the number of hotspots in the WKS area is much less than the surrounding areas in Jambi.

***Table 1.*** Hotspot observations in Jambi Province and WKS area

| Month | Jambi Province | | | WKS Area | | |
|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2010 | 2011 | 2012 |
| January | 2 | 27 | 69 | 2 | - | - |
| February | 3 | 58 | 6 | - | 1 | - |
| March | - | 15 | 103 | - | - | 5 |
| April | 3 | 80 | 112 | - | - | 4 |
| May | 34 | 105 | 8 | - | 2 | 2 |
| June | 5 | 45 | 29 | - | - | - |
| July | 23 | 131 | - | 3 | 4 | - |
| August | 47 | 371 | - | - | 26 | - |
| September | - | 652 | - | - | 30 | - |
| October | 212 | 39 | - | - | - | - |
| November | 12 | 85 | - | 1 | - | - |
| December | 25 | 6 | - | 2 | - | - |
| **Total** | **366** | **1614** | **327** | **8** | **63** | **11** |

Source:
1) Dinas Kehutanan, Jambi Province
2) PMD/FPD, WKS based on NOAA 018, Singapore

### Concluding remarks

As a result of its efforts, WKS won the Asia Responsible Entrepreneurship Awards 2012 – Southeast Asia. WKS continues its efforts to raise awareness through social campaigns and regular training for its KMPA group and new employees. Fire prevention and control activities are integrated into the WKS Sustainable Forest Management Plan and it is an example of how community participation plays an important role in fire management.

# PEATLAND REHABILITATION: CONSTRAINTS, LIMITATION FACTORS AND LESSONS LEARNT

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## Abstract

Indonesia's peat swamp forests (PSFs) have been deforested and severely degraded as a consequence of some commercial developments (including timber concessions, *Acacia* plantation, agriculture development and oil palm plantation), rampant illegal logging and forest fire. Unlike any other activities, rehabilitation in peatlands is considered to be more difficult, costly and has a smaller success rate. Planting trials and rehabilitation programs carried out by various parties in Indonesia strongly indicated flooding and fire as two main threats to peatland rehabilitation.

From the planting trials and rehabilitation programs, it was learnt that selection of appropriate species and planting sites are very important to achieve success in peatland rehabilitation. Some local species including Jelutong paya (*Dyera lowii)*, Pulairawa (*Alstonia pneumatophora)*, Tumih (*Combretocarpus rotundatus)*, Belangiran (*Shorea balangeran)* are considered to be promising options for ex-burnt areas. While for wet areas, Perupuk (*Lophopetalum spp.)*, Terentang (*Campnosperma spp.)*, Belangiran (*Shorea balangeran)* and Rasau (*Pandanus helicopus)* are strongly recommended. Especially for implementation in Central Kalimantan, replanting would be more effective after hydrology restoration. On top of that, the assurance and security of planted saplings from various threats (i.e. fire threats, land use change or conversion) post program period is crucial to safeguard their survival in the future.

***Keywords:*** *CCFPI, CKPP, WIIP, peatlands rehabilitation*

## Observations from past rehabilitation programs

Methods and results from various other rehabilitation programs are shared below.

Re-greening trials

In 2006, the Center for International Cooperation in Sustainable Management of Tropical Peatland (CIMTROP) in Central Kalimantan conducted a project to re-plant the northern part of Block C of the ex-mega rice project. They planted 6 species - Belangiran (*Shorea balangeran*), Ramin (*Gonystylus bancanus)*, Jelutong (*Dyera polyphylla*), *Palaquium spp*., *Diospyros evena* and *Shorea spp*. Table 1 presents the results of the replanting and shows a survival rate of 21 – 92%.

Rehabilitation of peatlands and establishment of sustainable agro-system in Central Kalimantan

This project was conducted by LIPI and JSPS Core University program on "Environmental conservation and landuse management of wetland ecosystems in Southeast Asia" from 2000 – 2001. The project involved rehabilitating intensively disturbed PSF areas in Central Kalimantan by conducting trial planting of 0.75 ha of disturbed PSF. It applied different regimes (with or without clearing, fertilizer application and mounds) with 5 different species (*Shorea balangeran, S. pinanga, S. seminis, Peronema canescens, Palaquium spp*.). The survival rates were found to be between 65 – 100% (Takahashi *et al*., 2001).

***Table 1*. Results from the re-greening trials in Central Kalimantan**

| No. | Species | Family | Local name | Number planted | Survival rate (%) |
|---|---|---|---|---|---|
| 1 | *Dyera polyphylla* | Apocynaceae | Jelutong, Pantung | 100 | 21 |
| 2 | *Diospyros evena* | Ebenaceae | Uring pahe | 100 | 92 |
| 3 | *Gonystylus bancanus* | Thymelidaceae | Ramin | 100 | 78 |
| 4 | *Palaquium spp.* | Sapotaceae | Hangkang | 100 | 56 |
| 5 | *Shorea balangeran* | Dipterocarpaceae | Kahui | 1073 | 89 |
| 6 | *Shorea spp.* | Dipterocarpaceae | Meranti | 1290 | 37 |

*(Source: Wim Giesen, 2011)*

Jelutong plantation – Jambi Province

PT. Dyera Hutan Lestari (PT. DHL) established a Jelutong plantation in Jambi province. The species that were planted was *Dyera polyphylla*, *Alstonia pneumatopthora* and *Litsea spp*. The concession area was about 8,000 ha and the results showed a survival rate of 90% with a diameter increment of 2cm. In 1997, a massive fire wiped out the planted area, putting an end to the research. The trial showed that it was technically possible for mass production and that fire prevention is crucial to ensure the sustainability of rehabilitation programs.

### CCFPI, CKPP and WIIP Rehabilitation Programs

Under the CCFPI (Climate Change, Forest and Peatlands in Indonesia) and CKPP (Central Kalimantan Peatlands Project), WIIP (Wetlands International Indonesia Programme) carried out peatland rehabilitation with different approaches, adapting to specific local conditions.

Rehabilitation of ex-burnt areas in the core zone - Berbak National Park

In Jambi Province, peatland rehabilitation was conducted in 20 ha of ex-burnt area (4 different sites) (Figure 1) situated in the core zone of Berbak National Park (NP) between 2003 and 2005. With the purpose to adapt to flooding, an artificial mound system was applied in this planting program (Figure 2). The local community was involved to secure this program after the planting period.

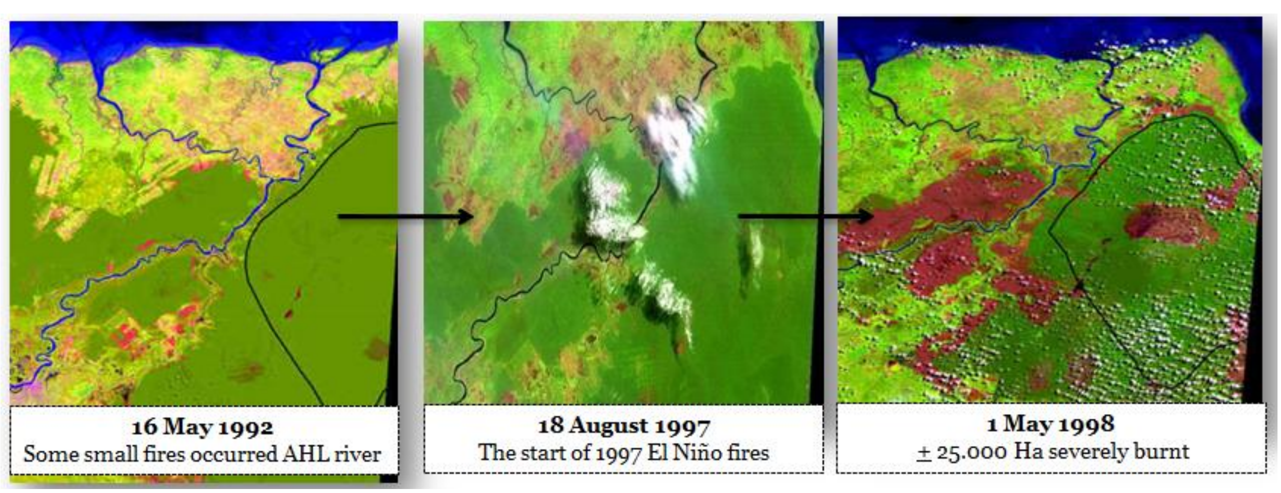

***Figure 1.*** Burnt areas of the Berbak NP after the 1997 El Niño fires

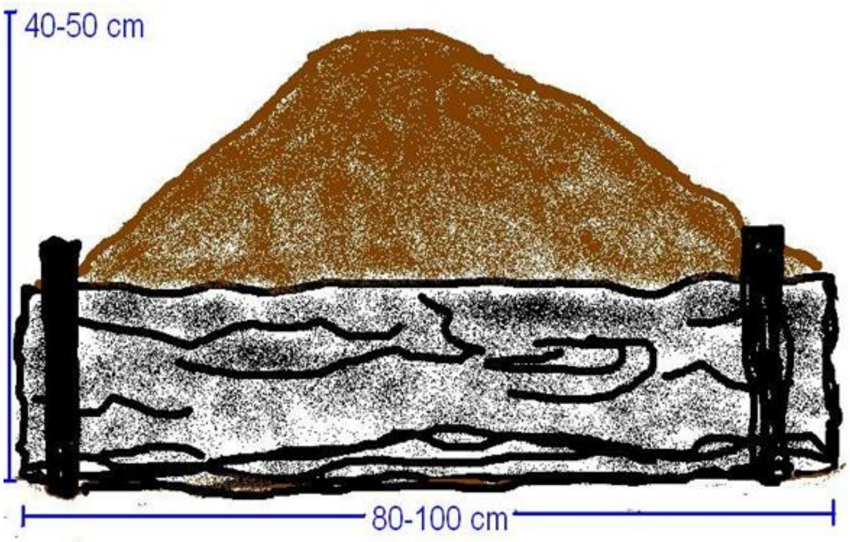


***Figure 2***. Model of the artificial mounds used for the planting program

There were 3 main stages of the rehabilitation program as shown in Figure 3.

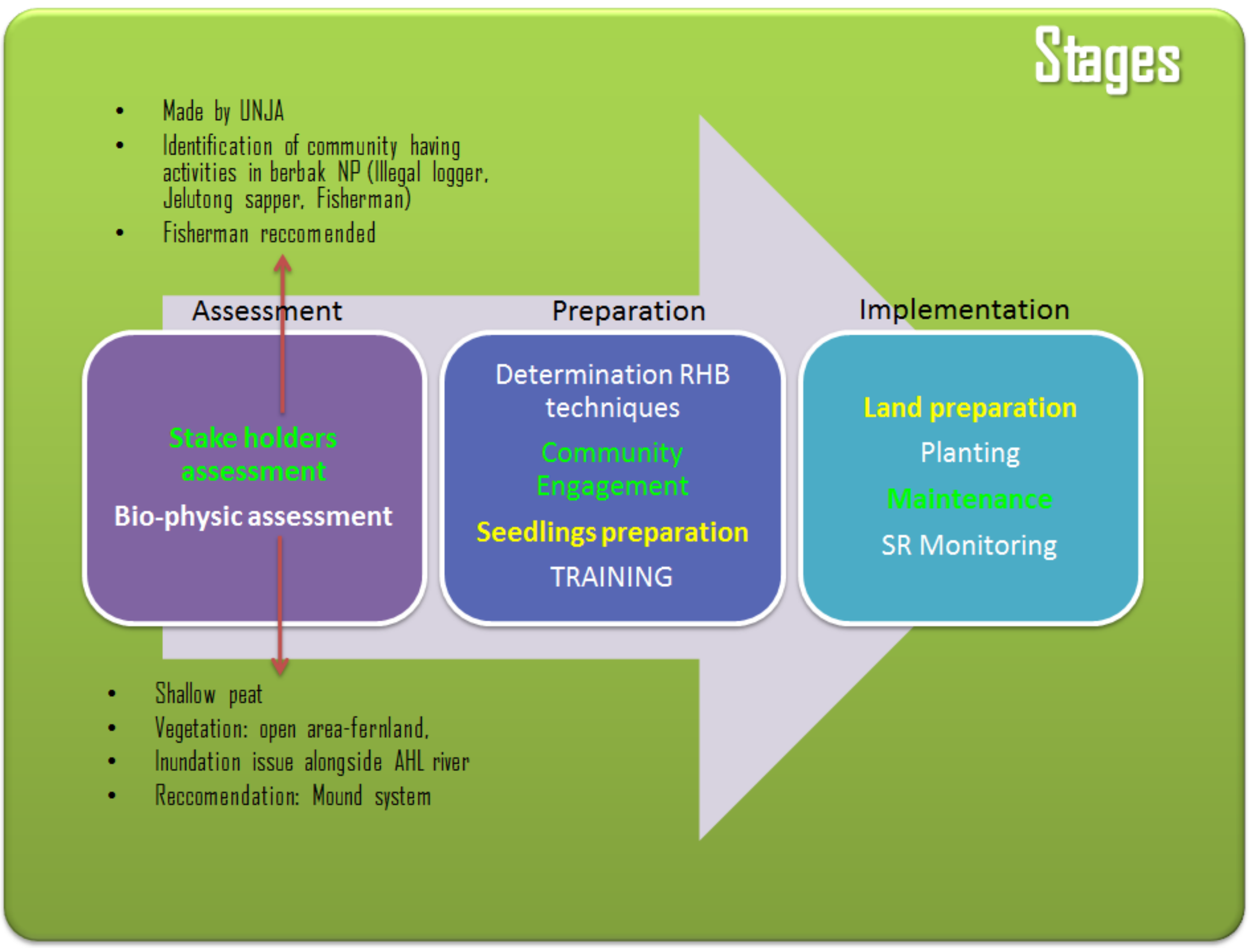


***Figure 3***. The 3 main stages of the rehabilitation program for Berbak National Park

In Central Kalimantan, reforestation was focused in ex-burnt areas situated along the primary canal of Block A North. Eight species were planted: *Melanorrhoea walichii*, *Gonystylus bancanus*, *Shorea pauciflora*, *Zyzigium spp*., *Durio carinatus*, *Combretocarpus rotundatus*, *Dyera polyphylla* and *Alstonia pneumatophora*.

The planting phases are detailed below:

***Phase 1***
- In the first month, survival rate exceeded 80%
- The planting site was later hit by floods, bringing the survival rate down to 4.9% in the third month

***Phase 2***
- Survival rate was at 82%
- Best growth was recorded in *Combretocarpus rotundatus*
- *Gonystylus bancanus* showed promising survival in open area, but is slow growing
- *Syzigium spp*. and *Combretocarpus rotundatus* were found to grow very well in wet areas

<u>Integrated canal blocking</u>

The CCFPI + CKPP Rehabilitation Program (2002-2007) were integrated with canal blocking. The total planted area was 600 ha (CCFPI = +350 ha, CKPP = 250 ha), involving 12 species – *Shorea balangeran*, *Dyera polyphylla*, *Alstonia pneumatophora*, *Campnosperma spp*. *Pandanus spp.*, *Lapophetalum*, *Garcinia spp*., *Stenomorus spp*., *Aglaia spp*., *Shorea spp*., *Callophylum spp*. and *Syzigium spp*. The activities involved planting with local communities where planting was targeted along dikes, at the dam construction site, inland, and alongside canals (Figure 4). The survival rate was 72% at the end of the project, however, certain areas burnt in 2009, two years after the project ended.

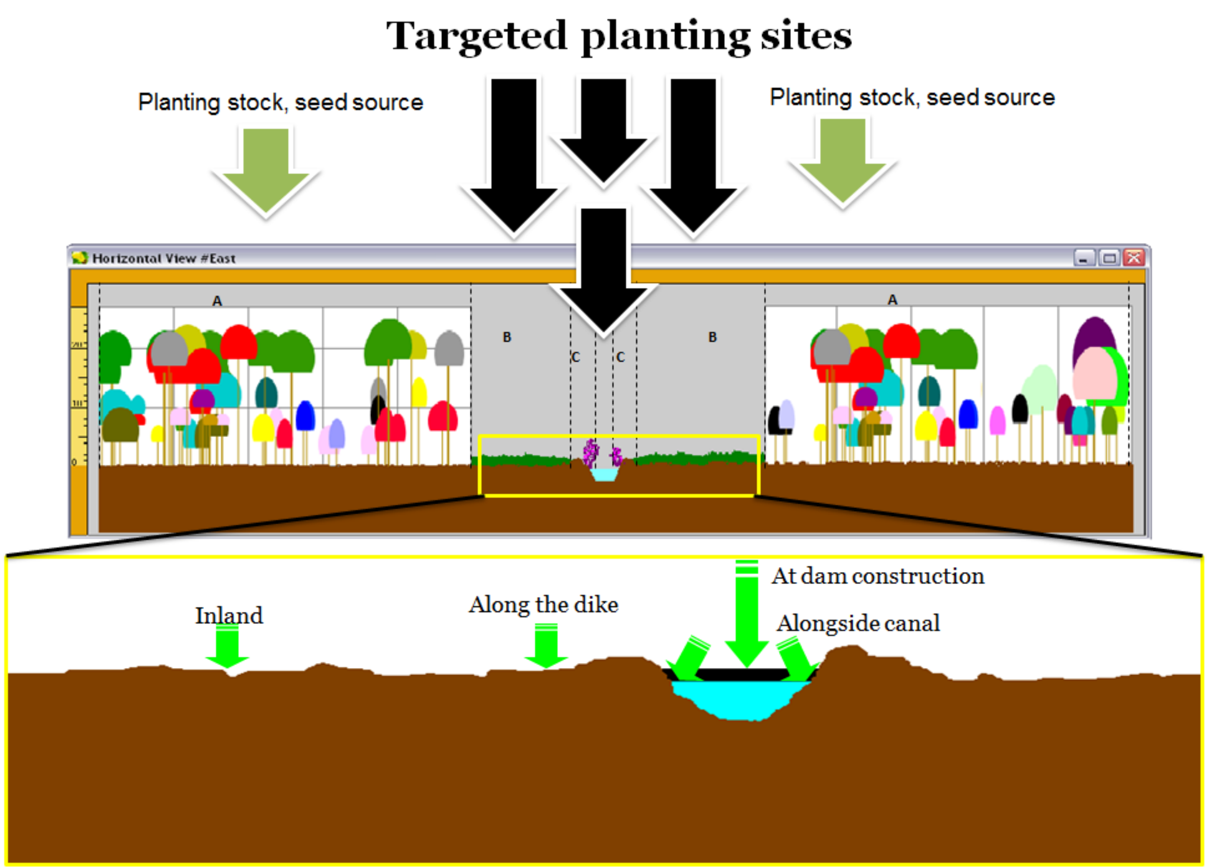

*Figure 4*. Planting method for the CCFPI Rehabilitation Programme

CKPP planting trial

The CKPP planting trial was a cooperative effort by WIIP and Palangkaraya University as a 6 month project from June to December 2008. The trial used three species (*Dyera lowii, S. balangeran, Stenomorus spp.*) and planted 100 of each. The results of the planting trial are presented in Figure 5.

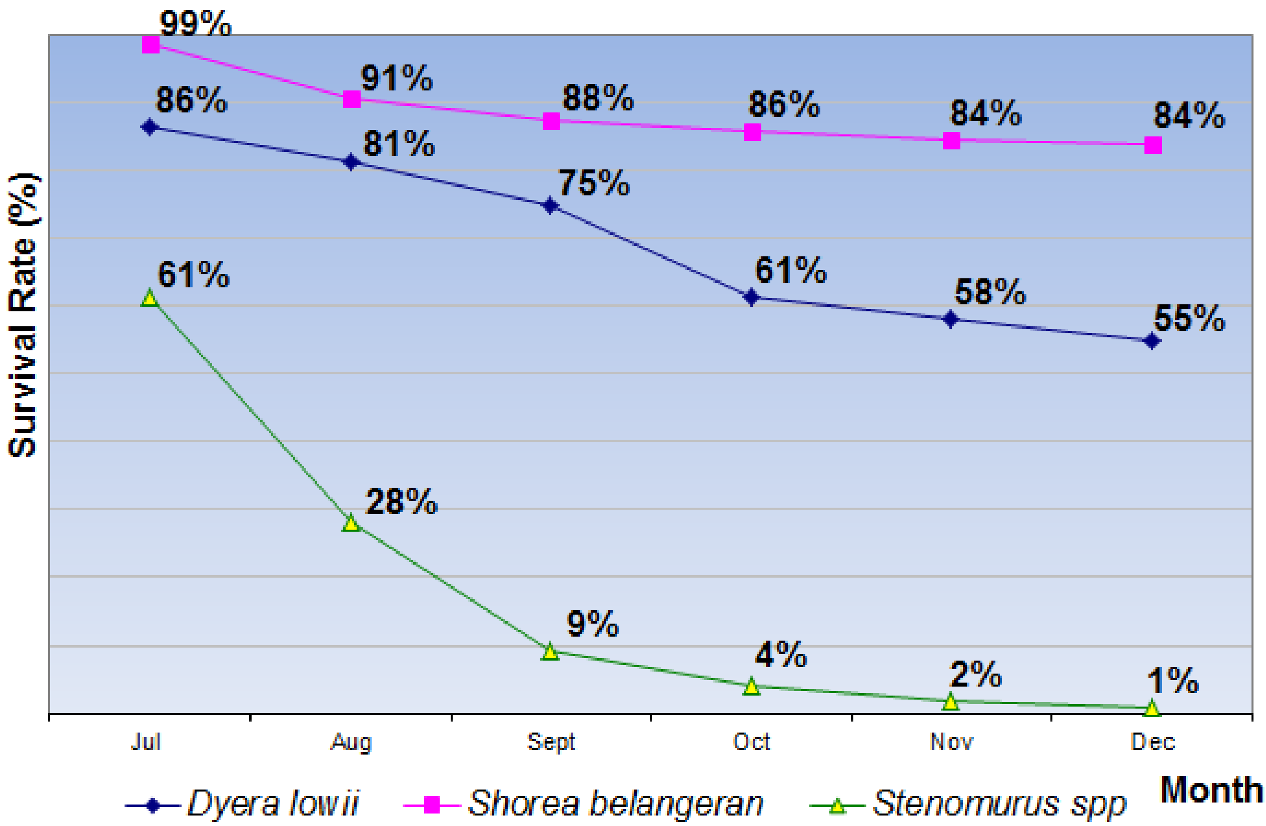


*Figure 5.* Results of the CKPP planting trial

**Lessons learned**

'Hardening' is very important to support survival of the seedlings. For drained peatlands, planting is more effective if integrated with hydrology restoration. There are still many promising species for rehabilitation but there is limited knowledge on propagation and planting techniques, and the artificial mound system is "relatively" effective but costly. Community involvement and training is important, primarily in sustaining rehabilitation, and should be a key part of all rehabilitation programmes.

From the trials it was found that there were some species preferences. In inland ex-burnt areas, species such as *Dyera lowii*, *Alstonia pneumatophora*, *Combretocarpus rotundatus* and *Shorea balangeran* did well. In wet areas (alongside canals, rivers, ditches), *Lophopetahum spp.*, *Campnosperma spp.*, *Shorea balangeran* and *Pandanus helicopus* did well.

In conclusion, fire prevention is the key factor for success. Understanding the hydrology of the area is also important to support the rehabilitation programmes.

# AGROFORESTRY OF JELUTONG ON PEATLAND: A LESSON LEARNED FROM CENTRAL KALIMANTAN

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## Abstract

Rehabilitation of degraded peatland has been facing challenges as peatland characteristics are unique and have serious damage when disturbed. Changes in peatland characteristics in terms of physical, chemical, biological and hydrological condition are sometimes irreversible. Several trials on peatland rehabilitation have been conducted in various sites. An agroforestry model on peatland rehabilitation using endemic species of Jelutong (*Dyera lowii*) came to be an alternative rehabilitation model. It was implemented as demonstration sites in several villages of the ex-mega rice project in Central Kalimantan. Jelutong trees were planted as mix-cropping with rambutan and pineapple or rubber trees, pineapple and paddy, and alley cropping with other crops such as corn, cassava, pepper, long bean, and mustard. These agroforestry models seem to improve productivity of degraded peatlands and peatland characteristics.

***Keywords:*** *rehabilitation, peatland, 'Jelutong', agroforestry, mix-cropping*

## INTRODUCTION

The peatland area in Central Kalimantan is about 3,472,000 ha and various stakeholders are concerned about the area. The peatlands seem to be under threat from ecological changes which lead to changes in the ecosystem. The most common example is the ex-mega rice project which has resulted in degraded peatland conditions. Degradation of the peatland area has reached more than 35% (Limin, 2004). The degraded peatland has been abandoned and is very vulnerable to fire in the dry season. Therefore, peatland rehabilitation is urgently needed to recover peatland functions which play an important role in balancing the ecosystem including ecological, sociocultural and economic functions.

One rehabilitation technology to solve the problem is *indigenous tree species*-based agroforestry system. The application of this system is expected to bridge the local farmer economy and the importance of peatland ecosystem sustainability. The selection of tree species needs to consider ecological, economic, and sociological aspects. One of the potential tree species is "Jelutong" (scientific name of *Dyera polyphylla* Miq. Steenis synonim with *Dyera lowii* Hook F.), which is an endemic species to peatland and is of high economic value. The species was found in Indonesia, especially in Sumatra and Kalimantan, and Malaysia. The wood has good potency for pencils and the sap is a good raw material for the chewing gum industry (Daryono, 2000). Development of Jelutong in the agroforestry system needs to be explored to recover degraded peatland.

The paper is aimed to analyse the feasibility of development of Jelutong in the agroforestry system based on technical and environmental aspects.

## MATERIAL AND METHODS

The study was conducted in four villages, namely:  Jabiren village, Mentaren II village, Tumbang Nusa village, which includes the Pulang Pisau District and Kalampangan village in Palangkaraya City, Central

Kalimantan. The four villages were selected because they have developed Jelutong in various agroforestry systems (Figure 1).

**Pulang Pisau District** **Palangkaraya city**

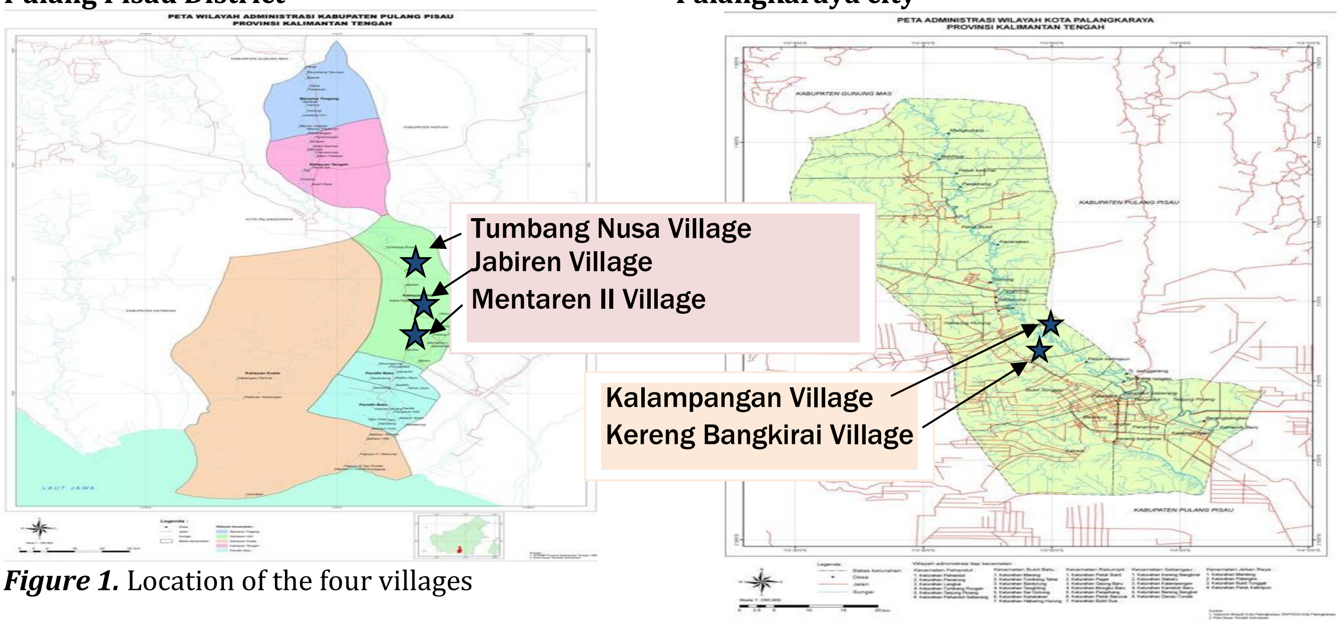


***Figure 1.*** Location of the four villages

*Focus Group Discussion* (FGD), interviews with key informants, soil analysis, measurements of Jelutong dimensions and micro-climate parameters were conducted to obtain the objective of the study.

## RESULTS AND DISCUSSIONS

### Seedling supply

Supply of Jelutong seedlings is managed by the local communities in Central Kalimantan using a generative technique. A Jelutong nursery was developed voluntarily by local communities in Tumbang Nusa, Taruna Jaya and Jabiren villages. The seed source came from an identified seed stand of mother trees in a natural forest maintained by communities and has been certified by the Forest Trees Seed Agency of Kalimantan. Tumbang Nusa is known as a center for Jelutong nurseries producing a ready stock of 1 – 3 milllion seedlings per year (Table 1).

***Table 1.*** Potential seed production in various identified seed source

| No. | Owner of seed source | Production per year (seed) |
|---|---|---|
| 1. | Hardianto | 115,200,000 |
| 2. | KUD Kahimat Desa Pilang | 1,440,000 |
| 3. | PT. Katingan Jaya Perkasa | 2,664,000 |
| 4. | KUD Kahimat Desa Tumbang Nusa | 5,616,000 |
| 5. | Ir. Soeyatno K. S. | 2,000,000 |
| **Total** | | **126,920,000** |

Potential seed supply from community cooperation and individuals in Central Kalimantan (assumption of seed viability of 80%) number about 101,536,000 seeds per year. Ready stock seedlings for planting (assumption of survival percentage of 80%) number about 81,228,800 seedlings per year. Seedlings used for degraded peatland (assumption of death in transportation of 20% and the successful planting in the field of 80% with planting spacing of 5 x 4m) means about 51,986,432 seedlings are available for 103,972.86 ha degraded peatland area per year.

#### Agroforestry pattern, growth performance, and environmental condition

Local communities have developed Jelutong in the agroforestry system with various unique patterns, which can be improved in the future. Basically, the agroforestry patterns of Jelutong are applied on shallow peat (Mentaren II and Jabiren villages) and deep peat (Tumbang Nusa and Kalampangan villages) as shown in Table 2 and Figure 2.

***Table 2.*** Agroforestry pattern in shallow and deep peat

| Agroforestry pattern | Short description | Main component |
|---|---|---|
| **Shallow peat** | | |
| *Alley cropping* with heap | Paddy planted on the alley, trees planted on the heap | Trees: rubber, Jelutong.<br>Seasonal crops: local paddy |
| *Alley cropping* with sunken beds | Paddy planted on the alley, trees planted on the raised beds | Trees: rubber, Jelutong.<br>Seasonal crops: local paddy |
| Agrosilvofishery | Fish pond, trees planted on the beds | Trees: rubber, Jelutong, gaharu, manggo, and durian.<br>Fruit plants: *salak pondoh*. Fish pond |
| **Deep peat** | | |
| Mixcropping with ditch | Cultivation area surrounded by ditch sized 50 cm – 100 cm width and depth. Trees planted on strip alternately, spacing 7m x7m. Seasonal crops planted surrounding ditch | Trees: Jelutong and rambutan<br>Seasonal crop: pinapple |
| Alley cropping with ditch | Land divided into blocks with ditch surrounding. Narrow blocks for trees, broader blocks for seasonal crops | Trees: Jelutong<br>Seasonal crops: vegetables (maize, long bean, brassica, leek, chilli) |

Table 3 shows the growth performance of Jelutong in various agroforesty patterns of which height increment ranged from 86,55 – 127,94cm per year and diameter increment ranged from 1,56 – 2,15cm per year. As comparison, diameter increment of natural Jelutong stands in Sumatera ranged from 1,5 – 2,0cm/year (Bastoni dan Riyanto, 1999), whereas semi-intensive Jelutong plantations in Sumatera has a diameter increment of 2,0 - 2,5cm/year (Bastoni, 2001). Furthermore, diameter increment of Jelutong planted in a monoculture system (Table 4) ranged from 0.72 – 1.21cm/year which indicates lower performance when it is compared to Jelutong agroforestry. Similarly, the height increment of monoculture Jelutong ranged from 107 – 170cm, which is higher than that of agroforestry Jelutong.

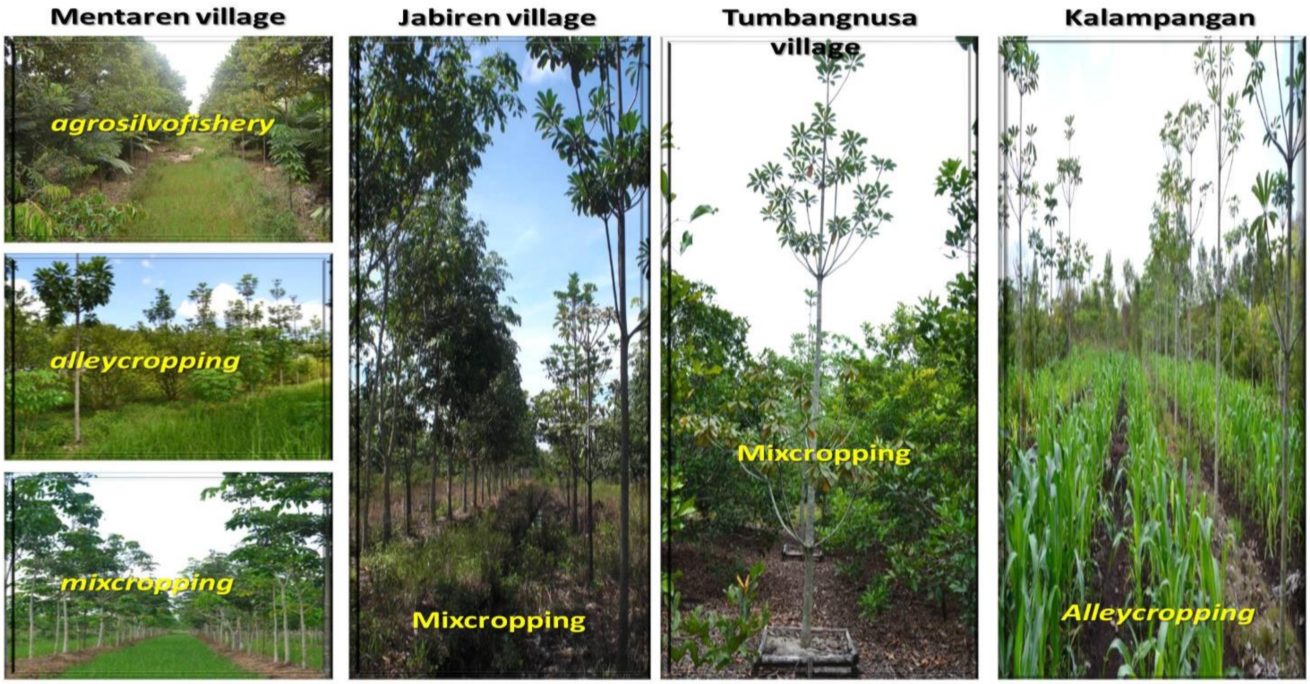


***Figure 2.*** Different types of cropping used in the 4 different villages

The study found differences in the microclimate condition of Jelutong agroforestry stands and Jelutong non-agroforestry stands. In general, the condition in agroforestry stands is better when compared to non-agroforestry stands. Similar trends were found in the three observation villages (Table 5). Lower value of temperature, soil temperature, and solar radiation intensity were found in agroforestry stands. In contrast, higher value of relative humidity was found in agroforestry stands. Therefore, the agroforestry system seems to provide better environmental conditions, which influence better growth performance of Jelutong.

***Table 3.*** Growth Performance of Jelutong in various types of peat and Agroforestry pattern

| Location, land typology, and Agroforestry pattern | Age (year) | Growth of Jelutong (cm) | | | |
|---|---|---|---|---|---|
| | | Mean diameter | Diameter increment/yr | Mean height | Height increment/yr |
| Kalampangan village, deep peat , alleycropping with ditch technique | 6.00 | 10.39 | 1.73 | 617.13 | 102.86 |
| Kalampangan village, deep peat, alleycropping with ditchtechnique | 5.25 | 8.69 | 1.66 | 454.38 | 86.55 |
| Tumbang Nusa village, deep peat, mixcropping with ditch technique | 5.30 | 10.11 | 1.96 | 626.70 | 116.03 |
| Jabiren village, shallow peat, mixcropping | 5.25 | 10.11 | 1.92 | 671.70 | 127.94 |
| Mentaren II village, shallow peat (sulphate acid), agrosilvofishery | 6.50 | 11.03 | 1.60 | 800.60 | 120.00 |
| Mentaren II village, shallow peat (sulphate acid), alleycropping | 6.50 | 13.98 | 2.15 | 716.18 | 110.18 |
| Mentaren II village, shallow peat (sulphate acid), mixcropping | 6.50 | 10.15 | 1.56 | 581.58 | 89.47 |
| **Average** | **5.90** | **10.64** | **1.80** | **638.32** | **107.58** |

***Table 4.*** Growth Performance of Jelutong in a monoculture system

| Parameter | Location | | | |
|---|---|---|---|---|
| | **Jabiren I** | **Jabiren II** | **Hampangin** | **Tumbang Nusa** |
| Age (year) | 8 | 20 | 10 | 6 |
| Mean Height (m) | 13.6 | 21.5 | 10.7 | 7.53 |
| Mean diameter (cm) | 5.6 | 20.5 | 12.1 | 11.82 |
| Diameter increment/year (cm) | 0.72 | 1.025 | 1.21 | 1.97 |
| Height increment/year (cm) | 170 | 107.5 | 107 | 125.48 |

***Table 5.*** Environmental condition of Jelutong agroforestry and Jelutong non agroforestry systems in various villages

| Micro climate parameters | Peatland vegetation coverage | | | | | |
|---|---|---|---|---|---|---|
| | **Jelutong agroforestry** | | | **Jelutong non agroforestry** | | |
| | **Observation period** | | | | | |
| | **Morning (08.00-09.00)** | **Noon (12.00-13.00)** | **Afternoon (16.00-17.00)** | **Morning (08.00-09.00)** | **Noon (12.00-13.00)** | **Afternoon (16.00-17.00)** |
| **Kalampangan village** | | | | | | |
| Temperature (max/min) $^oC$ | 33.7/33.1 | 35.6/35.4 | 33.2/32.8 | 37.3/29.6 | 39.4/39.0 | 35.8/35.3 |
| Relative Humidity (max/min) % | 79/58 | 54/49 | 58/55 | 49/43 | 52/48 | 55/49 |
| Soil temperature $^oC$ | 28 | 31 | 30 | 29 | 34 | 32 |
| Solar radiation intensity (x 100 lux) | 142 | 160 | 54 | 365 | 771 | 73 |
| **Tumbang Nusa village** | | | | | | |
| Temperature (max/min) $^oC$ | 29.1/28.9 | 33.6/33.4 | 32.4/32.1 | 33.1/32.5 | 39.5/37.6 | 34.9/34.8 |
| Relative Humidity (max/min) % | 81/80 | 65/64 | 72/71 | 74/73 | 60/59 | 71/69 |
| Soil temperature $^oC$ | 26 | 31 | 29 | 27 | 34 | 34 |
| Solar radiation intensity (x 100 lux) | 136 | 195 | 68 | 153 | 840 | 78 |
| **Mentaren II village** | | | | | | |
| Temperature (max/min) $^oC$ | 26.7/26.6 | 29.9/29.8 | 28.5/28.4 | 31.1/31 | 35.7/32.6 | 31.6/31.5 |
| Relative Humidity (max/min) % | 74/72 | 72/69 | 73/73 | 64/62 | 56/55 | 59/58 |
| Soil temperature $^oC$ | 25 | 28 | 27 | 28 | 33 | 31 |
| Solar radiation intensity (x 100 lux) | 18 | 63 | 23 | 321 | 563 | 486 |

## CONCLUSIONS

1. Development of Jelutong in an agroforestry system to recover degraded peatland is technically feasible, with an indicated seed supply ability of 126.920.000 seed/year and ready-planted seedling supply ability of 1 – 3 millions seedling/year.
2. There are various agroforestry system patterns of Jelutong developed by the local communities which could be a lesson learned.
3. Growth of Jelutong developed in an agroforestry system shows good performance and is comparable to that of natural Jelutong.
4. Microclimate of agroforestry Jelutong is better compared to non-agroforestry Jelutong (monoculture plantations).
5. Development of Jelutong in the agroforestry system in Central Kalimantan is technically and environmentally feasible.

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# PROPOSED RESTORATION OF RAMIN (*Gonystylus bancanus*) IN PEATLANDS IN SARAWAK, MALAYSIA

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## Abstract

Sarawak, one of the 13 States in Malaysia, is the largest state with 12.5 million hectares of land area. It has the largest peatland area of 1.2 million ha in the country. Peatland has always been regarded as unproductive for agriculture due to its infertile soil, strong acidity and waterlogged conditions. The most common species found in the peatland are Ramin (*Gonystylus bancanus*), Alan (*Shorea albida*), swamp Meranti (*Shorea spp.*), Jongkong (*Dactylocladus stenostachys*), Sepetir (*Copaifera palustris*) and a few others. Primarily, peatland forests in Sarawak were managed for timber extractions and had contributed significantly in terms of revenues collected from 1940 to 1980. Regeneration after logging in peatlands was not promising and had never been considered for reforestation or rehabilitation. After 1990, much of the peatland areas in the permanent forest estates (PFE) and statelands were excised for oil palm (*Elaeis guineensis*) plantation. Numerous proposals and conceptual plans were recommended in the joint Peatland Sustainability of Ramin Project conducted by Malaysia and the Netherlands in Sarawak. Similarly, in 2010, under the ITTO-CITIES Program, a consultancy report on the field assessment of Ramin in Sarawak was conducted. Experimental plans to rehabilitate and re-afforest the peatland forests were recommended. To carry out these experimental plans or proposals in the state, land management policy may need to be amended. To start with, the plans will need the relevant government authorities to support and lead, research institutions to provide expertise to assist corporate companies of oil palm estates in peatlands to cooperate, and local communities to participate.

***Keywords:*** *Ramin, peat swamp forest, trial planting, Sarawak*

**Abbreviations used in this paper**

| | |
|---|---|
| ANOVAR | = Statistical Analysis of Variance |
| Dbh | = Diameter at breast height (1.3m) |
| DIY | = Do It Yourself |
| ITTO | = International Tropical Timber Organisation |
| GPS | = Geographical Positioning System |
| MFMA | = Model Forest Management Area |
| PF | = Protected Forests |
| PFE | = Permanent Forest Estates |
| RM | = Ringgit Malaysia |
| SFD | = Sarawak Forest Department |
| SFC | = Sarawak Forestry Corporation |
| STA | = Sarawak Timber Association, Kuching, Sarawak |
| UNIMAS | = University of Sarawak, Malaysia |
| YP | = Yield Plots |

## 1. Introduction

Ramin (*Gonystylus bancanus*) has long been known and always been sought by overseas timber markets for the aesthetic value of its light creamy colour and its fine-looking texture for furniture and internal wall panelling. Ramin possesses easy wood-working properties. Since the late 1980s, the supply of Ramin had been severely depleted from Sarawak.

Sarawak and Sabah are located on Borneo Island and are two of the largest states in Malaysia. Both states share the same border with Kalimantan, Indonesia. The total land area of Sarawak is about 12.5 million ha. Of these, 1.2 million ha is peatlands or peat swamp forests (PSFs).

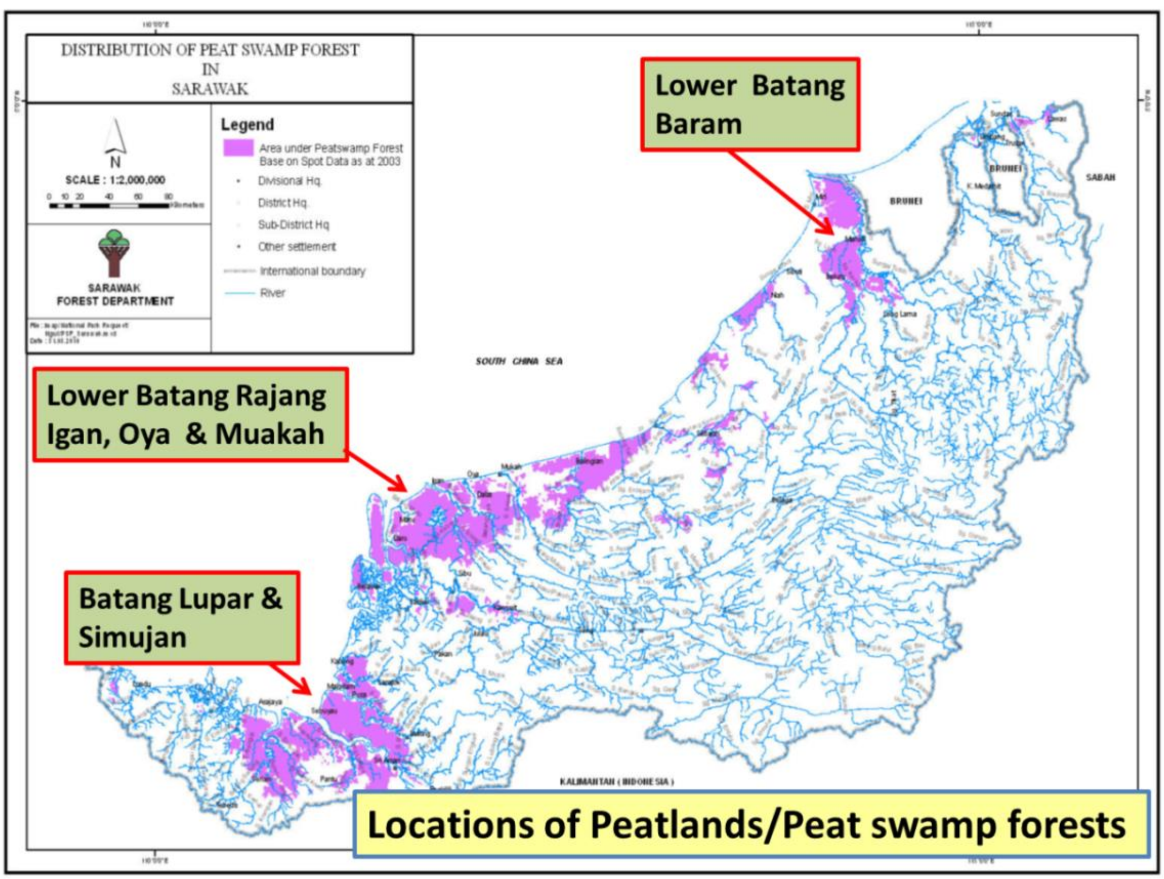
### 2. Forestry in Sarawak and Sabah are under the states' control

Both states, Sarawak and Sabah, have the absolute sovereign power on the control of forestry matters in their respective states. Each has its own mechanism on managing the state forests independently. The central government or the federal government in Kuala Lumpur has no authority intervening over these resources. However, certain regulatory and national policies are shared by both states.

### 3. Peatlands or PSFs in Sarawak

Of the 1.2 million ha of peatland forests or PSFs in Sarawak, over 770,000 ha were constituted as Permanent Forest Estates (PFE) by law and the rest are state lands (Lee, 2005). The Sarawak Forestry Department (SFD) has the overall control of the PFE, whereas state lands are administrated by the Sarawak Land and Survey Department. Nevertheless, regulation of the forest resources in the state lands is under the SFD's control. Most peatlands or PSFs in Sarawak are found along the coast-lines and at the lower parts of river mouths. They are located in three prominent parts in Sarawak: (1) southern parts around the Lupar and Simumjan Rivers, (2) central parts at the Mukah, Oya and Igan river estuaries, and (3) northern part of Sarawak along the Baram River. Please see Map 1 showing the locations of peatland / PSF distribution in Sarawak.

***Map 1***. Showing the distribution of peatlands or PSFs in Sarawak

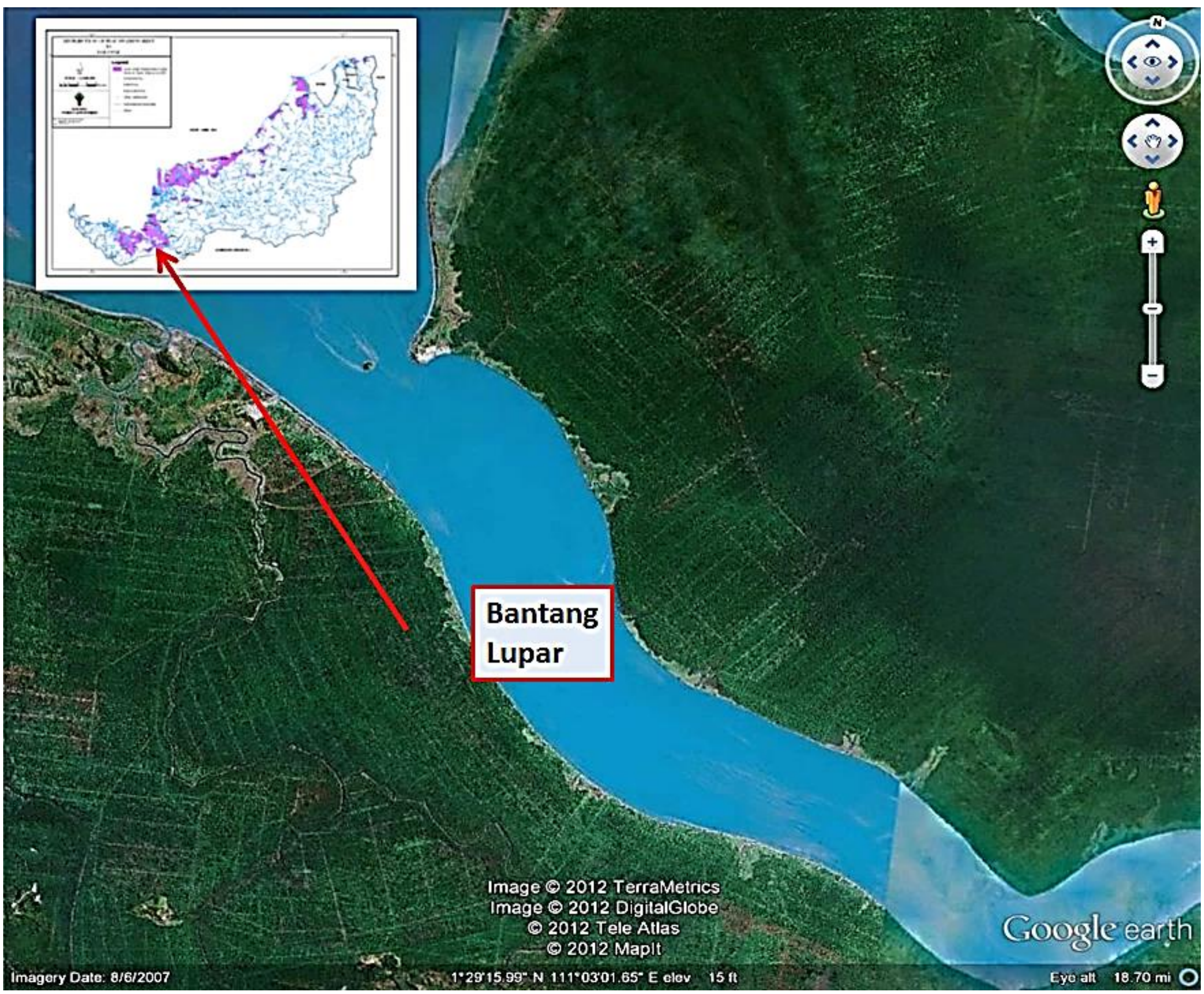


Peatlands in Sarawak were always flooded by brackish water year-round. The water level varies and depends on their location and monsoon seasons for the year. Peatlands have a strong acidity, as low as pH 4. For these reasons, peatlands in Sarawak are infertile and have never been considered for agricultural development.

### 4. Timber production from PSFs from 1950 to 1980s

From the 1950s to 1980s, timber production from PSFs had contributed significantly to state revenues. Due to these timber economic activities in those days, many coastal towns along the coast were flourishing (Lee, 2005). Most of the timber extracted from PSFs was Ramin (*Gonystylus bancanas*), Jongkong (*Dactylocladus stenostachya*), Sepitir (*Copaifera palustris*), Meranti (*Shorea spp.*), Alan (*Shorea albida*) and others. Timber extraction from PSFs was supported by a locomotive and railroad system. Felled logs were placed upon wooden sledges manually. Each sledge was dragged on ropes by a team of six to eight persons. The laden sledge was skidded on a wooden-rail network to the railways track. The log on the sledge was then transferred to the locomotive carriages. The locomotive rail track could be as long as more than 20km. Plate 1 shows the tiny hair-lines were locomotive railways traversing the PSFs at the southern part of Sarawak and Plate 2 shows a remnant Ramin tree found in Sarawak.

***Plate 1.*** Google Earth images show locomotive railway networks in the tiny hair-line formation in Sarawak



The logged-over PSFs in PFE were silviculturally treated by removing or poison-girdling all the undesirable species. Only undamaged and non-defective trees of a few 'desirable species' and '14 acceptable species' were reserved. The selection was based on 'The list of the Desirable and the Acceptable Species' that was developed for the PSFs at that time and as the future crop trees for the PFE. After silvicultural treatment, yield plots (YP) were established in the treated PFE. Each of the yield plots was one hectare in size. A diagnostic sampling followed at year-10 after silvicultural treatment. For details of silvicultural treatment of PSFs please refer to Lee and Lai (1977).

***Plate 2.*** A remnant Ramin tree left behind in the PSF

## 5. Findings and Current Status of PSFs

Observations showed that the logged-over PSFs were left with many seedlings below 1.0cm diameter at breast height (dbh) and saplings with dbh from 1.1cm to less than 9.9cm. However trees from 20cm dbh and above were very little. This posted a serious problem on the sustainability of the PSFs for the future harvestable crop trees (Chai, 2010; Lee, 1979; Lee and Chai, 1996; Sia, 2005).

The logging damages to these residual stands were severe and large numbers of undersized stands of no commercial value were felled. These significant numbers of undersized trees ranging from 10 to 20cm dbh were chain-sawed down for the construction of railway-sleeper networks and log-sledge skidding system.

Research results had highlighted that the regeneration of the logged-over PSFs was not promising and the growth rate was lower than those in the hill forests (Chai, 2010; Sia, 2005). The most recent report about the PSF in Sarawak would be the "Ramin Technical Report – Joint Working Group Malaysia – The Netherlands: Sustainable Management of Peats Swamp Forests of Sarawak with Special Reference to Ramin" implemented from 2001 to 2004. The Ramin Technical Report contains 17 individual technical reports (Peter *et al.*, 2005) and was published in 2005.

By the late 1980s, most of the peatland forests or the PSFs were logged. Due to the better economic returns from oil palm investments, most logged-over PSFs were excised for oil palm plantation developments. The PSFs in the PFE were reduced from 770,000 ha to about 330,000 ha in 2005 – a reduction of 50%. The details can be seen in Table 1 below.

## 6. Objectives

The objective of this paper is to propose Ramin restoration plans for the PFE in Sarawak:-

1. Peatland stakeholder – state government to initiate rehabilitation.
2. Restoration of suitable peatlands by local communities.
3. Trial planting of Ramin/others timber species in oil palm estates converted from peatlands.

***Table 1.*** Status of PFE (PSF) areas in Sarawak

| PSF function | Area (ha) | Percentage (%) |
|---|---|---|
| **Total area of PFE (PSF original)** | **771,732** | **100** |
| Area set for National Parks | 43,146 | 5.6 |
| Area set for other purposes | 18,942 | 2.5 |
| **Area excised for agricultural oil palm development** | **389,483** | **50.4** |
| Area constituted as communal forest | 1,483 | 0.2 |
| Area remaining as FR & PF | 318,678 | 41.3 |
| **Remaining PFE in PSF as of 2005** | **320,161** | **41.5** |

## 7. Proposed plans for the restoration of Ramin

### 7.1 The role of stakeholders to restore the PSFs

The main stakeholder of PSFs in Sarawak is the state government as mentioned earlier above. To restore the logged-over PSFs in Sarawak, the state government is definitely playing an important role as the lead driver. Without the state government's involvement, commitment and financial support, nothing much can happen.

Under the state government, past and present PSF or peatland research has been carried out till today by the Sarawak Forest Department (SFD) and Sarawak Forestry Corporation (SFC). Many of these research findings were reported, published and some were written as internal reports. Most of these reports can still be found in the libraries in SFD and SFC.

It is proposed that the state government should:-

1. Cease excising the remaining peatland or PSFs for any conversion whether it is from PFE or state lands.
2. Stop all logging activities and encroachment to the PSFs.
3. Identify and prioritise the proposals to be carried out as recommended in the Ramin Technical Report (Peter *et al.*, 2005).
4. Conduct a state-level forest inventory of the remaining PFE in the PSFs.
5. Identify suitable areas in the peatlands for restoration of Ramin and other common PSF timber species.
6. All oil palm plantations converted from PSFs must take responsibility to establish no less than 5% of plantable areas for restoration of Ramin and other peat swamp timber species.

### 7.2 Conversion of PSFs for oil palm plantations and illegal encroachment

The author visited the Lawas and Saribas PFE in the PSFs in Sarawak in 2010 (Chai, 2010). It was discovered that these PFEs in the PSFs were excised for oil palm plantation development. The remnant PSFs were left with no intermediate-sized trees and in some areas, canopy openings were large and extensive and colonized by weeds. The logged-over forests had become unproductive.

Encroachment in PSFs in Sarawak is still rampant. Logging operation in these forests had stopped for some time, but encroachments and illegal logging activities were rampant. Illegal loggers eyed the Alan logs which were felled 5 to 7 years earlier and left in the forests. These logs were not extracted due to its huge size and weight which is manually unmanageable. Stacked sawn timbers were sawn from *Shorea albida* logs and left in the forest. See Plates 3, 4, 5 and 6 below.

### 7.3 Ramin Technical Report

A committee should be formed to study the implications of the Ramin Technical Report (Peter *et al.*, 2005). The committee should identify research areas whereby some of the proposals and recommendations suggested in the Report should be considered to be carried out. This is for the purpose of restoring the PSFs into production forests again. Undoubtedly, there is a lot of invaluable research data and information available in the Report. The Report is the result of a joint collaboration of hard-work between Malaysia and the Netherlands with special emphasis on Ramin. A lot of effort, time, money, manpower and input was contributed by researchers and experts from local and overseas scientists into the Report. The project was carried out over a period of 5 years. Some of the findings and recommendations, if made used, surely will be beneficial to Sarawak.

### 7.4 PSFs inventory

SFD should carry out a forest inventory in the remaining peatlands in the PFE in Sarawak. Such a state level inventory has not been carried out before. The inventory will help to determine the exact status of the PFE in the PSFs. The inventory should take account of timber stands and stocking density, size class and species distribution. Another important factor to be borne in mind in the inventory is to identify areas suitable for the restoration of Ramin and other high value PSF species. Preferred sites for restoration will be areas encroached in the National Parks and fringe areas around PFE. Factors on accessibility and availability of manpower from the local communities for restoration should be considered.

Remnant Ramin and high value peat swamp timber species of superior forms should be selected, assessed, marked on maps and its GPS positioning taken for relocating the trees. These trees will remain the important stocks of genetic biodiversity resources for seed supplies for restoration.

***Plate 3.*** Illegal sawn timbers cut from *Shorea albida* (Alan) logs left behind in PSF

***Plate 4.*** The DIY bicycle converted from motor-bike's parts for transporting the sawn timbers

***Plate 5.*** The wooden track was used by illegal operators to transport the sawn timbers by a DIY bicycle

***Plate 6.*** Alan logs which were left behind 5 to 7 years ago in the forest due to its weight were converted into sawn timbers by illegal operators

### 7.5 Participation by the local communities

When suitable areas are being identified for the restoration of Ramin, the local communities must be consulted and not be neglected. Their participation will enhance on the success of the restoration project. The joint participation will involve the local communities, local elected committee, the stakeholder of the peatlands (SFD/SFC), local councils, and the timber company operating on the peatlands if the timber companies were legitimately licensed.

The author was engaged by ITTO from 1998 to 2000 to assist in the reforestation of shifting cultivation areas (SCA) in the Model Forest Management Areas (MFMA) Project in Sarawak. Experience showed that dissemination of proper information, the objective of the project and how the local communities can be involved in the restoration are imperative (Plate 7 and 8). Considerable successes were achieved by the local communities in restoring their SCA. Details can be found in Chai's reports (Chai, 2000).

Due to Sarawak's large land mass, most rural areas are less developed and lack proper infrastructure and basic amenities. The rural people have been living a less comfortable life than those living in towns. The impact of the disparity has caused lots of young people to migrate to towns looking for employment. Thus, the restoration project should be able to create employment and raise living standards for the local communities.

A project steering committee should be formed to look into the various aspects in the Ramin restoration project. This could include motivating local folks to get involved and be paid by carrying out a site survey, clearing, collection of planting materials and raising them in a nursery, which requires lining, planting and maintenance, etc. Some of the detailed planning can be found in the report on "Restoration of Ramin (Gonystylus bancanus) in The Peat Swamp Forests in Sarawak, Malaysia" (Chai 2005).

The duties of the project steering committee should include critically studying the financing of the project, site investigation on areas to be restored, recruitment of manpower, sourcing of planting materials, project duration and implementation of the project.

### 7.6 Trial planting experiment of Ramin in oil palm estates established in the PSFs

The author had in 2006 (Chai) proposed a trial planting project of Ramin in oil palm estates planted in PSFs. The proposed project was a joint venture with SFD, Sarawak Timber Association (STA), and two oil palm plantation companies. In addition, University of Sarawak Malaysia (UNIMAS) and Alterra, a research institute of Netherlands were both keen to participate in the project. As mentioned above, the Netherlands' Alterra research institute had from 2000 to 2004, jointly with SFD, collaborated and prepared the Ramin Technical Report (Peter *et al.*, 2005).

The main objective of the trial planting experiment is to investigate on the possibility to rehabilitate Ramin in oil palm estates converted from PSFs in Sarawak. The trial planting experiment will take advantage of the existing facilities in the oil palm estates in both PSF and lowland forests in Sarawak.

There were two oil palm plantation companies which were willing to provide financial support in the form of manpower input, providing sites and facilities for the proposed project. Unfortunately, due to some unforeseen reasons, the project was shelved as the Sarawak Timber Association was unable to fund the other half of the project's funding. The total funding estimated then was RM 1.2 million over a period of 4 years (equivalent US Dollar $ 1.00 = RM 3.10).

In this report, a similar proposal was recommended that Ramin trial plots be planted in two soil types namely – (1) PSFs and (2) lowland or mineral soils. The project will involve a total area of 150 ha and shall be monitored for a period of four years.

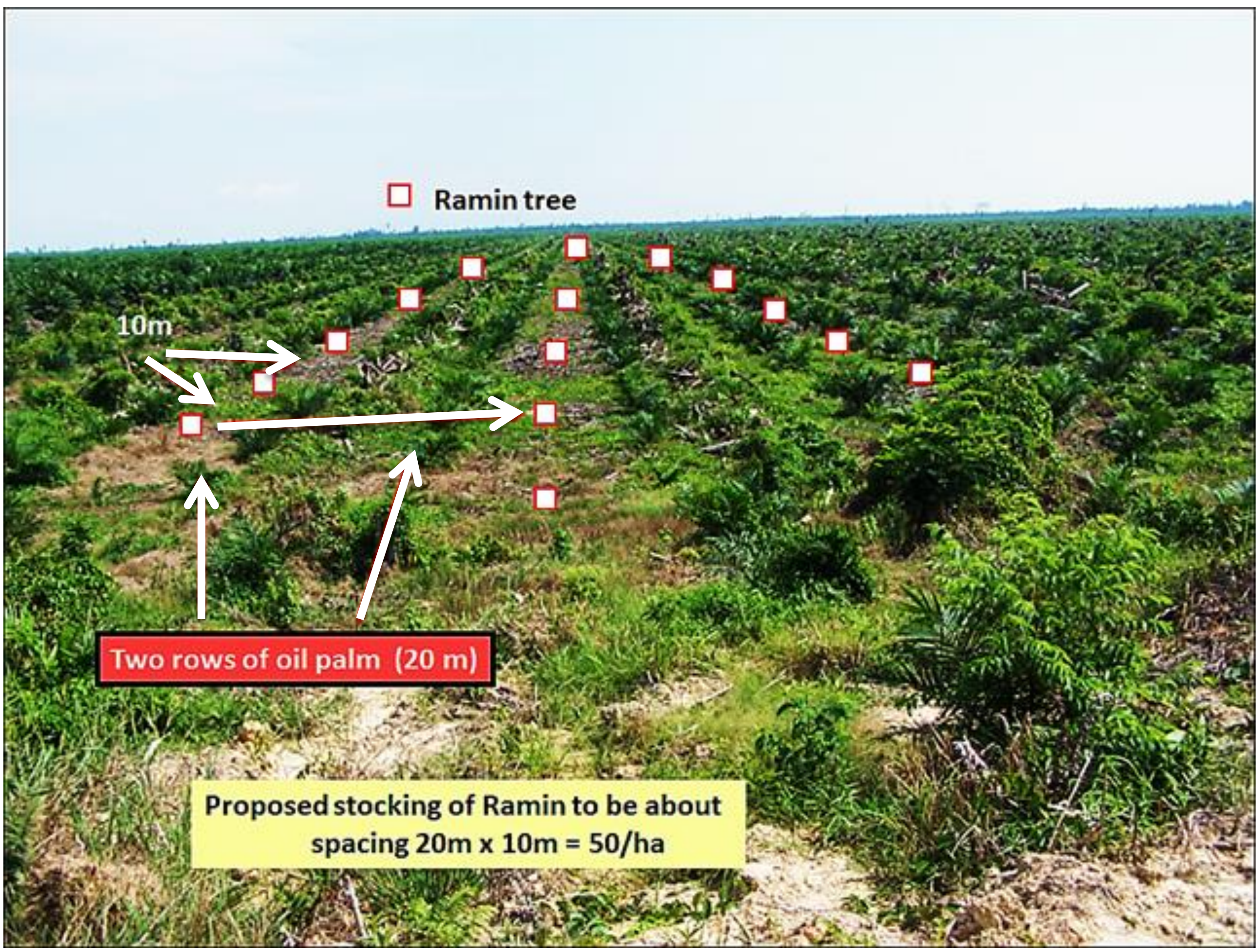
### 7.6.1 Experimental blocks in PSFs

The proposed Ramin trial blocks in the PSF will comprise of three planting blocks, each of 30 ha in size. The trial blocks consist of one control and two treatment blocks as follows:-

1. Control block: Ramin is planted in the block without any oil palm being planted
2. Treatment block 1: Ramin is inter-planted inbetween oil palm of 1.5 year-old oil palms
3. Treatment block 2: Ramin is inter-planted inbetween oil palm of more than 5 year-old oil palms

Ramin will be planted at 20m by 10m apart in-between two rows (20m) of oil palms. It is expected that 50 Ramin trees can be planted in one hectare (Plate 9).

***Plate 9.*** Ramin proposed to be planted for the trial planting experiment in oil palm plantations established from PSFs in Sarawak



### 7.6.2 Experimental blocks in mineral soils

The layout and spacing of Ramin planted in the mineral soils are exactly the same as in the PSFs. However, there will be only two trial blocks as follows:-

1. Control block: Ramin is planted without any oil palm being planted
2. Treatment block: Ramin is inter-planted in between oil palm of more than 5 year-old oil palms.

In each trial block (30 ha), 4 replicates/samples of one hectare each in size will be established to monitor the growth performance of Ramin. The series of Ramin growth data will be collected for statistical analysis on the assumption that there are no differences in the growth performance of Ramin being planted in the PSFs which are converted to oil palm plantation. It is proposed that a two-level ANOVAR statistical analysis be used for the comparative studies of Ramin planted in PSF and mineral soils.

There will be a total of 1,000 Ramin to be monitored from 20 replicates/samples each with 50 Ramin. A total of 7,500 Ramin will be planted in the trial planting experiment comprising 150 ha X 50 Ramin/ha.

The project should be monitored and assessed for a period of at least four years with at least 5 series of measurements.

## 8. Recommendations/Conclusion

The author wishes to propose the following:

- Carry out a state level PSF inventory in the remaining PFE
- Form a committee to study the findings reported in 'The Ramin Technical Report'
- The state government should cease excision of remaining PSFs for any conversion in the PFE
- The state government should continue to allocate sufficient funding in the support of PSF R&D and carrying out trial planting experiments of Ramin in oil palm estates converted from PSFs as proposed above
- If the trial planting project is proven to be viable, it is proposed that all the oil palm plantations converted from PSFs must reserve 5% of its total plantable area for restorations
- A guideline for the restoration should be formulated by the state government for planting Ramin and other timber species of PSFs in the reserved 5% areas
- All the planting costs in the restoration will be borne by the oil palm plantation company

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Google earth – for making use of the free satellite images.

The content of this report is solely the opinion of the author.

# FROM CARBON SOURCE TO CARBON STORE: REHABILITATION OF DEGRADED PEATLAND THROUGH COMMERCIAL PULPWOOD PLANTATION DEVELOPMENT IN OGAN KOMERING ILIR, SOUTH SUMATRA

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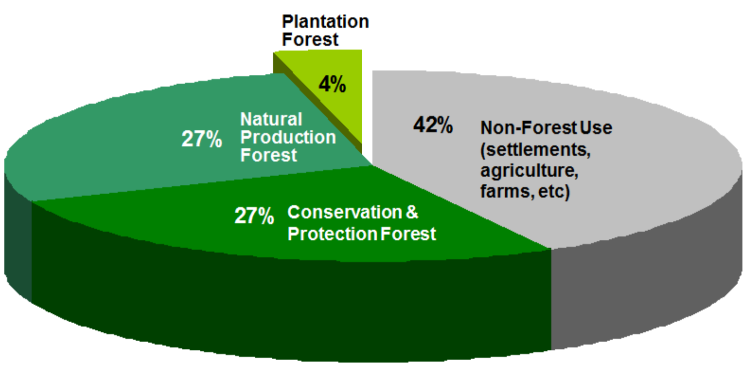
## Abstract

Indonesia has allocated some 110.9 million hectares or 51.9% of the country's land surface for forestry use, however, less than 4% is licensed for plantation development. During the 1997-98 El Niño period, there was widespread forest and land fires in Sumatra and Kalimantan, and a small region called Ogan Komering Ilir in the South Sumatra Province was hit the hardest. In 2004, the government offered over 580,000 ha of burnt and degraded land for plantation companies to develop. Three companies (SBA, BMH and BAP (Mitra Sinar Mas Forestry)) undertook the challenge to rehabilitate the area and invested a significant amount of effort and money to ensure that the rehabilitation program was successful. By implementing good water management practices and planting suitable timber species such as *Acacia crassicarpa*, the companies were successful in rehabilitating the area. The success has been supported and maintained by engaging and involving local communities in firefighting and educating them on alternative livelihood options.

***Keywords:*** *Acacia crassicarpa, carbon sequestration, rehabilitation, pulpwood plantation*

## Introduction

Indonesia has allocated some 110.9 million ha or 51.9% of the country's land surface for forestry use as Protection Forest, Conservation Forest and Production Forest. Alienable or convertible forest for non-forestry use is classified as none permanent forest land (Figure 1). Within the Production Forest area of 59.2 million ha, the forest management or silvicultural schemes authorised by the government include natural forest management or selective cutting, plantation forest management and community-based forest management schemes. Out of this, 88% is designated for natural forest management and 12% for plantation forest development (i.e. 3.7% of the country's total land surface).




| Use Allocation | Area (M ha) | % |
|---|---|---|
| **For settlements, agriculture, etc** | **80** | **42** |
| **For forestry use** | **111** | **58** |
| a. Conservation | 52 | 27 |
| b. Production Forest | | |
| - Natural Production Forest | 52 | 27 |
| - Plantation Forest | 7 | 4 |

***Figure 1.*** Allocation of land designated for forestry use in Indonesia
*(Source: Statistik Kehutanan Indonesia 2009; Kementerian Kehutanan, 2009)*

## The Ogan Komering Ilir rehabilitation site

Extreme dry weather and long drought hit the country in 1997 through to 1998 due to the El Niño weather phenomenon, which resulted in widespread forest and land fires in Sumatra and Kalimantan islands and transboundary haze problems especially in Malaysia and Singapore. Lowland forests were hit hard by the fires, especially in the Ogan Komering Ilir (OKI) region in South Sumatra Province. The area's economic and ecological values were destroyed by the fires and the local community had to leave to find alternative sources of livelihood.

In 2004, through an auction process, the Government of Indonesia offered plantation forest development licenses to the private sector for the rehabilitation of about 585,000 ha of badly degraded forestland in the OKI region (an area 9 times bigger than Singapore) (Figure 2). Three companies (i.e. SBA, BMH, and BAP (Mitra Sinar Mas Forestry)) took this offer and developed a rehabilitation program by investing in pulpwood plantation development for fiber production (Table 1).

***Table 1.*** Breakdown of the forest concession area by company

| Company | Area (ha) |
|---|---|
| **PT. Sebangun Bumi Andalas** | **142.355** |
| **PT. Bumi Mekar Hijau** | **250.370** |
| **PT. Bumi Andalas Permai** | **192.700** |
| **Total** | **585.425** |

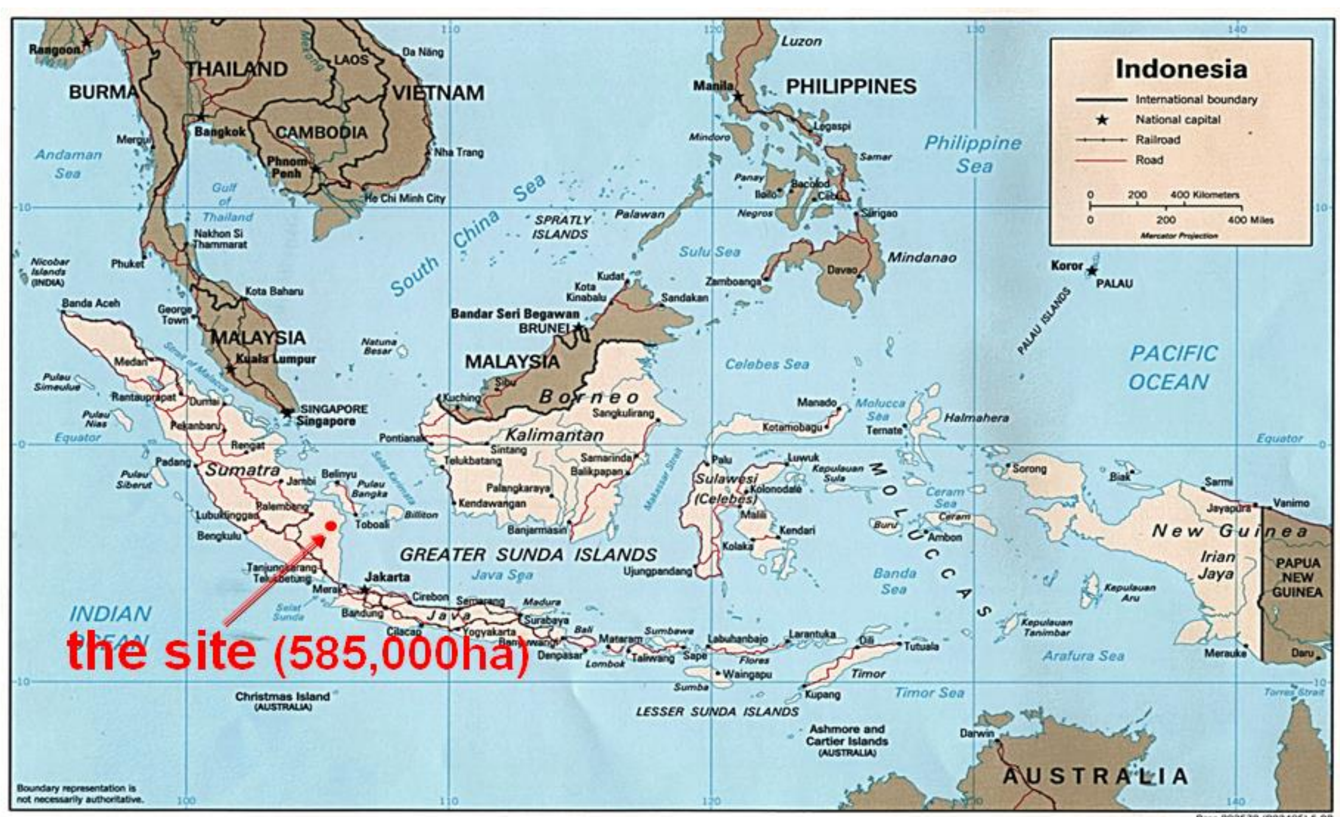



***Figure 2***. Location of the degraded forest concession area offered by the Government of Indonesia

For the companies, the undertaking was a huge challenge. The area was badly burnt and degraded, the peat had subsided by ±1m, and its location was remote and difficult to access since there was no infrastructure in place to support the development activities. There was also high land fire risk brought about by extreme weather conditions and recurring uncontrolled land fires from traditional farming practices, e.g. sonor, lebak lebung.

### Intervention with good plantation management practices

As of May 2012, 216,000 ha had been planted with *A. crassicarpa* for pulpwood production. The total investment put in was USD 324 million, which was equivalent to USD 1,500/ha. A huge investment was necessary to ensure sufficient return on investment and business sustainability. Good plantation management practices were implemented, such as the use of suitable timber species (*A. crassicarpa*) for establishing a timber plantation and water zoning for better eco-hydrological control (Figure 3). The trees were planted on a 4 to 6 year economic rotation and supported by appropriate infrastructure. Conservation areas of about 14 – 20% of the land area were set aside and local people were provided jobs and educated on fire management and alternative livelihoods to avoid unsustainable farming practices. Well-resourced firefighting teams were also established at the district level (20,000 – 30,000 ha) to ensure that fires could be suppressed before spreading to adjacent areas.

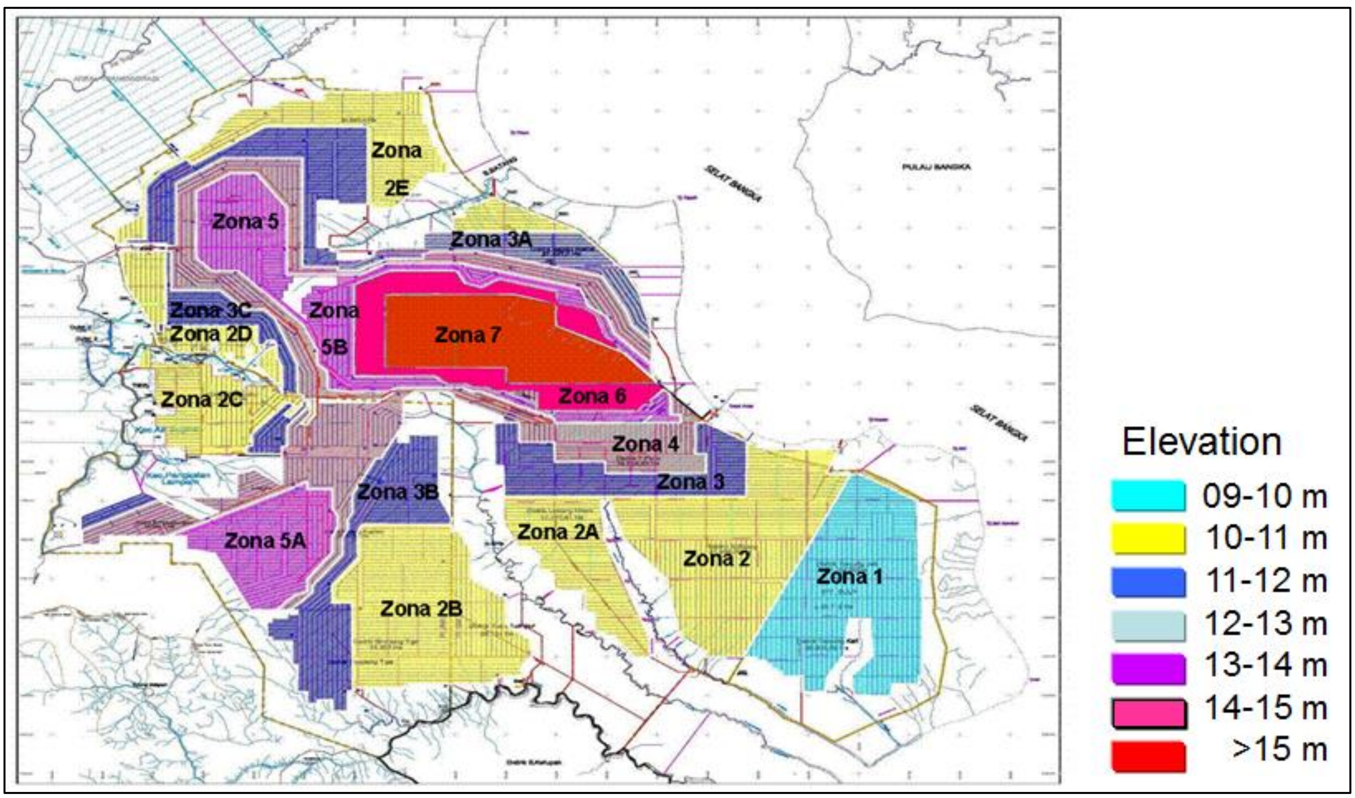



***Figure 3***. Map of the water zoning used for better eco-hydrological control

### Lessons learned

Establishing a successful timber plantation on the degraded area was not an easy job, and it has provided the opportunity to learn how it can be successful. Professional management inputs along with appropriate technology are key success factors to realizing the business goals.

The site is generally classified as wetland consisting of peat and mineral soils. Good water management is a key element providing sufficient moisture for optimum plant growth. If the water level is too high then it will kill the plants or retard their growth and yield, and if the water level is too low then it puts the crops under water stress and creates high fire risk condition. In a wide landscape such as the OKI area, water management zoning is important to maintain water at desired levels across the landscape. It was found that maintaining the water level between 50cm and 100cm supported good plant growth and good soil moisture. Additionally, the placement of canals played a key role in managing the water level. In OKI, 2,429 km of primary canals (width: 12m) and 6,300km of secondary canals were built within the plantation area.

*Acacia crassicarpa* is a leguminous plant and it grows best in peatland and in other areas of high moisture content. With tree improvement activities and appropriate silvicultural practices, growth and yield performance ranges from a mean annual increment of 25 to 35$m^3$/ha/yr over 6 years. The resulting carbon sequestration average in a well-stocked *A. crassicarpa* is about 30 tC/ha/yr at age 5 years.

Escaped fires from traditional slash-and-burn farming practices (e.g. sonor, lebak lembung) often develop into widespread fires and encroach into plantations, hence, it is also important to organise and equip ready firefighting teams to suppress fire occurrences before they become uncontrollable. Educating the local communities, providing them alternative livelihoods and related empowerment programs help ensure the protection of the crops.

### Concluding remarks

In conclusion, serious investment is required for implementing a forest rehabilitation program. A commercial pulpwood plantation development is an option to address economic, social, and environmental concerns. Implementation of sustainable plantation forest management practices is crucial to ensure that the program succeeds. This includes good water management that supports good plant growth and minimises environmental impacts and planting suitable timber species, like *A. crassicarpa*. It is also necessary to develop partnerships with local communities and establish well-resourced firefighting community organisations to ensure success in the rehabilitation of degraded forests.

# REHABILITATION OF PEAT SWAMP FOREST IN SELANGOR

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## Abstract

Peat swamp forests (PSFs) are very complex ecosystems in terms of their ecological processes, biodiversity, land and hydrological characteristics. Therefore, a landscape approach is required to assess all the relevant attributes including surface and subsurface water interactions. PSFs perform a wide range of services that are of value to society such as sediment control, flood storage, water purification and climate regulation.

PSFs in Selangor make up about one-third of the total permanent FR in Selangor, which is 250,129 ha. The PSFs are vital for many ecosystem functions and services. Despite the benefits, few areas remain in its pristine condition today. With rapid development and mounting population pressures on the natural resources, PSFs in Selangor are increasingly under threat. This scenario has resulted in the PSFs being drained and left dried, and oxidation of the desiccated top soil has produced tonnes of $CO_2$ emissions. A drained and degraded peatland is also more susceptible to forest fires. Smoke from peat fire has resulted in haze which has a huge impact on the economy and also on public health. This paper will highlight the progress made on managing and rehabilitating the degraded PSFs in Selangor with the support and collaboration of private sector, NGO and public. It will list the current efforts and programs undertaken to ensure its continuous survival for the well-being of the State.

***Keywords:*** *peat swamp forest, function, drained, degraded, fire, rehabilitation*

## Background

The North Selangor Peat Swamp Forests (NSPSF) is located in the north western part of the state of Selangor in Malaysia (Figure 1). It consists of the Raja Musa FR (RMFR) (23,486 ha) and Sungai Karang FR (50,106 ha). NSPSF has global importance for its role in maintaining endangered and endemic species (biodiversity conservation) and as a huge carbon sink. Locally, it plays an important role in supplying water for domestic and agricultural uses, plus supporting the local wood industry.

RMFR supports tree species with small to medium sized crowns, and typically 30m tall emergent trees are scattered throughout the area. The dominant tree species in the RMFR *are Koompassia malaccensis* (Kempas), *Shorea uliginosa* (Meranti Bakau), *Santiria spp.* (Kedondong), *Eugenia spp*. (Kelat) and *Durio carinatus* (Durian). *Gonystylus bancanus* (Ramin), which is a common species in peat swamp forests (PSFs), is now rarely found in this forest.

## History of RMFR

RMFR was intensively logged since the 1950s with very little control and supervision from the Selangor Forestry Department (SFD) and only gazetted as a FR in 1990. Pre-1990 it was considered as state land to be developed for other purposes at a later stage, allowing early logging operations to continue.

Between 1990 and 2000, it was observed that there were problems with the initial demarcation of the FR, which saw community activities (agriculture, etc.) within the reserve and intermittent forest fires.

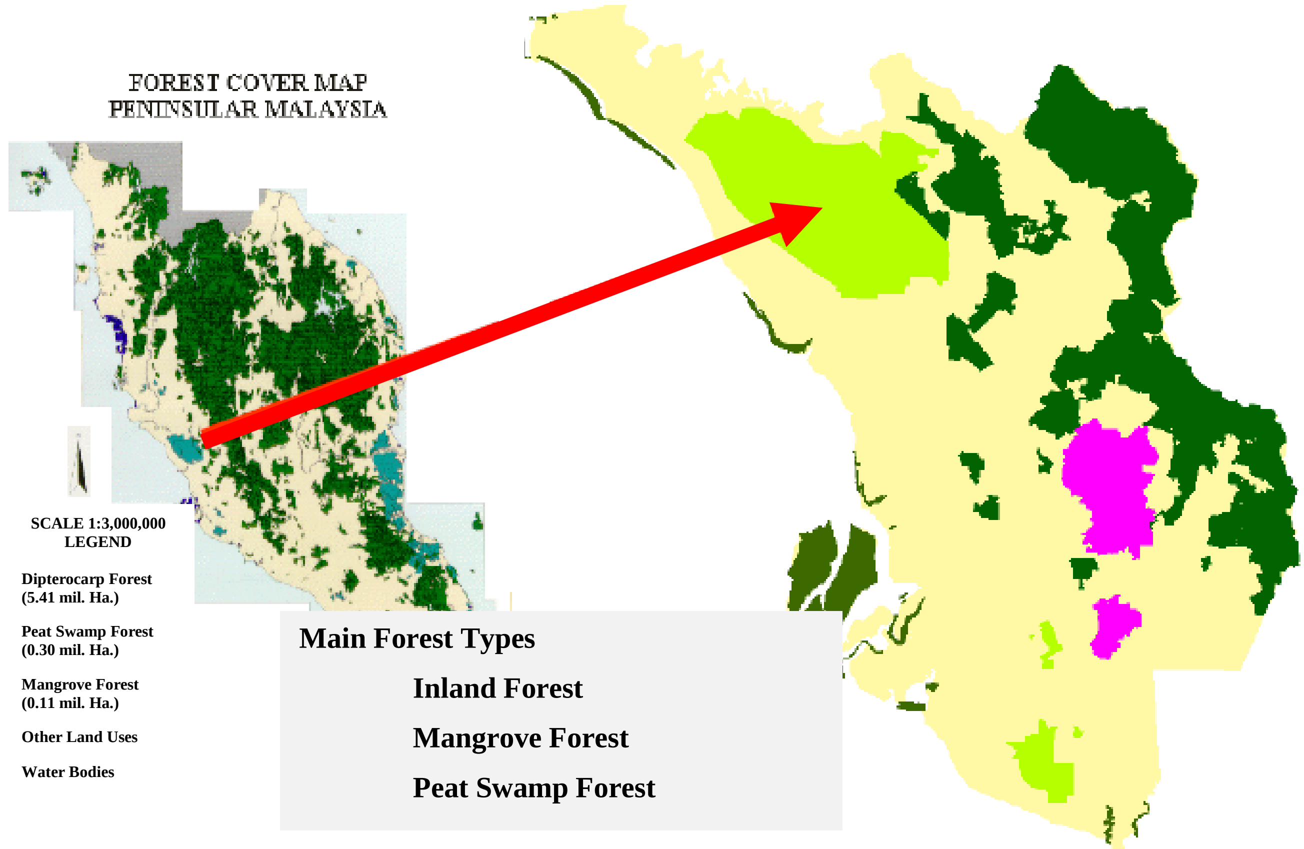


***Figure 1.*** Location of the North Selangor Peat Swamp Forests

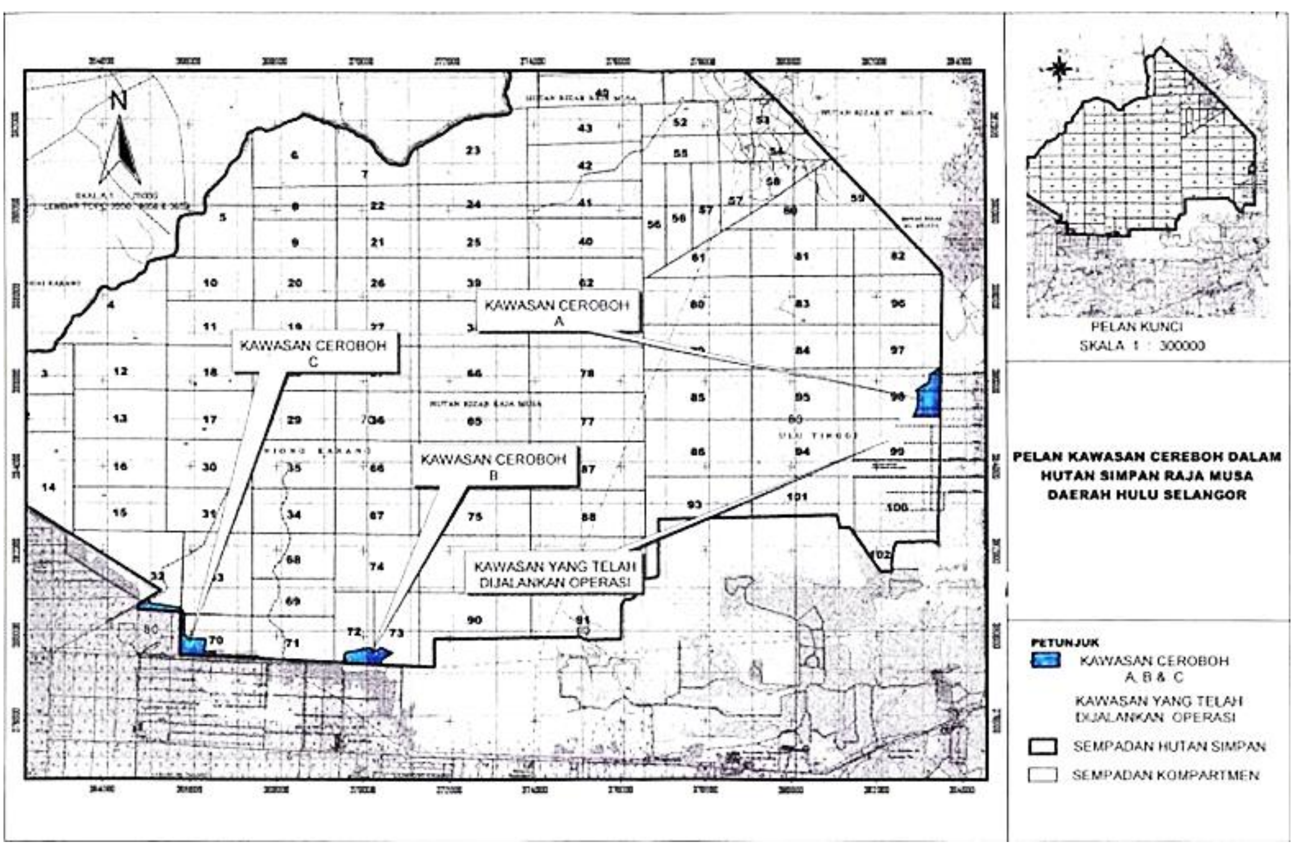


***Figure 2.*** Illegally encroached areas within the RMFR (in blue)

During 1997-98, there was a period of big forest fires where 630 ha of FR was affected, plus an equally-sized area outside of the FR. Between 2001 and 2010, there were problems with illegal encroachment into the FR, which was a result of illegal land clearing for settlement and agriculture in the previously burnt area outside of the FR (Figure 2). The problem escalated in 2008, even after a series of actions taken by the SFD, and only then did the Selangor State Government acknowledge the seriousness of the problem. Subsequently, 470 individuals were forcefully removed or evacuated from the affected site in June 2008 and these areas have now been subjected to forest rehabilitation activities.

### Issue and problems

There is a positive correlation between heavily drained and degraded forest areas and the incidence of fires within RMFR. Forest fires are common during prolonged dry spells in the months of February-March and June-August every year. The south-west side of RMFR is an especially fire prone area. It covers an area of about 6,500 ha and has been directly affected by drainage and hence succumbs to repeated forest fires, leaving it severely degraded and dominated by grassland. Since 2002, some 592 fires have been observed, affecting a total area of 592 ha (Table 1). These fires usually occur where settlements and villages border the FR and are caused by slash and burn agriculture practices.

***Table 1.*** Recorded fire incidences within RMFR

| Year | Area (ha) |
|---|---|
| 2002 | 161 |
| 2003 | - |
| 2004 | 10 |
| 2005 | 400 |
| 2006 | - |
| 2007 | 12 |
| 2008 | - |
| 2009 | 9 |
| 2010 | - |
| 2011 | - |
| **Total** | **592** |

### Remedial / mitigation actions

In 2008, to mitigate these problems, the state government authorised the SFD to evacuate the illegal settlers, dismantle their houses and destroy the agricultural crops. The SFD also blocked about 850 drainage canals / ditches and began attempts to reforest the degraded areas within the FR boundary (Figure 3). They increased patrolling and enforcement activities to at least 3 times a week with on the ground and aerial surveillance, and established clear signposts along the entire FR boundary.

In addition, Selangor Forestry Department (SFD) undertook a rehabilitation programme in partnership with a local NGO, Global Environment Centre (GEC) in November 2008. By the end of 2009, about 60 ha of degraded peatland area had been rehabilitated by planting more than 80,000 trees with the help of over 2,000 volunteers.

## Challenges and lessons learned

There is a need to decide between natural and artificial regeneration as both have their pros and cons. It is also important to select the right species for replanting and ensure that it is readily available. The area is also susceptible to weed infestation, especially by weeds like *Cylindrica imperata* (Lalang), so there is a need to manage this problem in a suitable way. Once the area has been surveyed well, it is not only important to block drainage canals, but also to maintain them properly to manage the water table. New encroachment should also be prevented to minimise further degradation. It is worth considering a community-based approach to rehabilitation programmes as the local community has proven to be a key ally and source of support. Most importantly, sufficient funding and trained human resources is the key to ensuring that the rehabilitation programme is successful.

## Next steps

There are three key activities that need to be, and will be, addressed in the coming years by the SFD:

<u>1. Procurement of planting stock</u>

Realising the need to procure a large number of planting stock, the department plans to aggressively raise them in the two existing nurseries. The facilities in these nurseries will be upgraded to increase their capacity.

<u>2. Enhancing collaboration with the private sector, NGOs and public NGOs</u>

They are important partners in the rehabilitation programmes. Besides helping in the promotion of public awareness on the importance of conserving PSFs, they also make available some amount of funds and human resources in terms of the volunteers. The department intends to further strengthen the existing collaboration by involving them in both the planning and implementation of the programmes.

<u>3. Prevention of new encroachment</u>

Encroachment of new areas and re-encroachment of the existing areas have to be prevented. Enforcement efforts will be increased. External boundaries of the permanent reserve forest will be clearly marked and more signage will be displayed.

## Conclusion

The forest rehabilitation conducted at RMFR is a success story mainly because the incidence of wild forest fire has been reduced. There have been no new cases of encroachment detected along the FR boundary and natural regeneration is taking place in areas where hydrological restoration was conducted. And finally, there has been an increase of above ground carbon content as a result of active tree planting and elimination of peat fires.

# PEATLAND MANAGEMENT: EXPERIENCE AND RESEARCH FINDINGS IN THE ASEAN PEATLAND FORESTS PROJECT (APFP) PILOT SITE AT BESTARI JAYA, SELANGOR, MALAYSIA

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## Abstract

Peat swamp forests (PSFs) are tropical moist forests where water logged soils prevent dead leaves and wood from fully decomposing, which over time creates a thick layer of acidic peat. Large quantities of carbon are stored in tropical peatlands due to the large amount of organic matter in their soils. These peatlands might also become significant sources of $CO_2$ resulting from human activities and forest fires. The changes in forest cover and percentage or amount of carbon stock annually could be differentiated or calculated using mathematical models. The use of satellite imagery has been reported to be a useful tool for peatland management. Results from remote sensing methods could provide local or global estimates of carbon stocks in forests. This technology can fill in the gaps where inventory information is unavailable. Consequently, this approach was used to estimate the changes in carbon stocks for a pilot site under the ASEAN Peatland Forests Project (APFP). The pilot site was located within the Raja Musa Forest Reserve (RMFR), Selangor, Malaysia. The APFP site covers an area of about 4,000 ha of which about half (2,000 ha) is used for agriculture and are state land, while the rest comprise a mixture of other land uses. In this project, satellite images of 1989, 2001 and 2010 were used to determine the changes in the extent of PSFs and aboveground carbon stocks. It was found that in 1989, the total PSFs of the APFP pilot site had lost about 342,756 tonnes of aboveground carbon stocks from the year 1989 (387,266.60 tonnes) to 2001 (44,510.42 tonnes) due to several episodes of forest fires. However, the above ground carbon stocks started to recover back due to natural regeneration as it increased about 57,337 tonnes (56%) from the year 2001 to 2010 (101,847.49 tonnes). Based on the results from this study, it was recommended that the recovery of the site be enhanced through rehabilitation or assisted regeneration. This paper elaborates further on changes in vegetation and carbon stocks from the year 1989 to 2010 and other related to aspects of protection.

***Keywords**: peatland, management, carbon stock, aboveground, remote sensing*

## Introduction

PSFs are tropical moist forests where water-logged soils prevent dead leaves and wood from fully decomposing, which over time creates a thick layer of acidic peat. These forests are normally located immediately behind the coastline and extends inland along the lower reaches of the main river systems. It is well recognised that PSFs are a significant carbon sink for the earth (ESA, 2003).

The recognition of PSFs as a carbon sink has gained an importance in recent years due to the implication that raised $CO_2$ levels contribute to global warming. Large quantities of carbon are stored in tropical peatlands due to large amounts of organic matter in its soils. It was estimated that 5,800 tonnes of carbon/ha can be stored in a 10m deep peat swamp compared to 300-500 tonnes/ha for other types of tropical forest (UNDP, 2006). Tropical peatlands, besides acting as stores of carbon, actively accumulate carbon in the form of peat. Because decomposition is incomplete, carbon is locked up in organic form in complex substances formed by incomplete decomposition. Drainage of peat swamps destroys this useful function and may contribute to global warming through the release of $CO_2$ into the atmosphere.

Currently, there is a tremendous amount and diversity of efforts being carried out related to forest and carbon accounting with a variety methods used for measurement. Remote sensing methods could provide local or global estimates of carbon stocks in forests. This technology can fill in gaps where inventory information is unavailable. Remote sensing applications could be very valuable in carrying out assessments of how climate change might be having an impact on forests by tracking major disturbances, changes in the growing season, and Net Primary Productivity (NPP). Carbon accounting is needed to support the objectives of international agreement to mitigate global climate change (UN, 1998). In conjunction with other spatial datasets such as climate, soil type, and tree height, forest coverage is important for the carbon cycle model (DeFries *et al.,* 2000).

Nonetheless, peatlands might also become significant sources of $CO_2$ resulting from human activities and forest fires. The occurrence of forest fires is not new in the ASEAN region and is still an important issue that relates to the environment and health. The devastation seems to be critical in drier periods of *El-Niño/Southern Oscillation* (ENSO) episodes. In Malaysia, forest fires pose a major threat to the management and conservation of peatlands, which at this stage has been very much reduced in extent and quality (Ismail *et al.,* 2011; Samsudin & Ismail, 2003). Forest fires have not only directly destroyed the flora and fauna of the peatland ecosystem, but their resulting haze is also detrimental to health and contributes to the accumulation of GHGs in the atmosphere. Records have shown that most of the forest fires occur during the prolonged annual dry spells between the months of January to March, and June to August. The fire occurs sporadically in the natural forests, particularly in the degraded PSFs. The root cause seemed to be human interventions, either as a result of their negligence or uncontrolled use of fire coupled with unplanned agricultural activities.

There is also a significant extent of PSFs found in Selangor. Out of a total of 250,129 ha of permanent FR (PFR) which is equivalent to 33.1% of the total land area of Selangor in the year 2010, PSFs cover an area of about 83,000 ha (Table 1). PSFs in Selangor are found in six FRs in the District Forest of Pantai Klang (South and North Kuala Langat FRs and Sungai Karang FR) and Hulu Selangor (Raja Musa FR). These PSFs are recognised as having important functions i.e. regulate sound environment such as flood and climate change control, supply water for domestic consumption and farming areas, and biodiversity conservation (Zulkifli *et al.,* 1999).

***Table 1.*** Different types of forest in Selangor for the year 2010

| **Forest types** | **Total (ha)** |
|---|---|
| Dryland | 136,859.45 |
| Peat swamp | 82,890.38 |
| Mangroves | 18,998.00 |
| Forest plantation | 11,381.00 |
| **Total (ha)** | **250,128.83** |

*(Source: Forestry Department Peninsular Malaysia (FDPM) 2011)*

## Project site

This project is in the peatland area of the ASEAN Peatland Forests Project (APFP) at the pilot site which partly covers Raja Musa FR (RMFR), Selangor, Malaysia. The APFP pilot site is located in the southern part of RMFR (Figure 1), covering an area of about 4,000 ha. The RMFR with an extent of 23,486 ha, is located in the North Selangor Peat Swamp Forests (NSPSF) in the north western part of Selangor. Prior to its gazettement as a permanent FR in 1990, RMFR was part of stateland forest and was intensively subjected to logging since the 1950s. The site is located inside the following corners of coordinates [Malaysian Rectified Skew Orthomorphic (MRSO) Projection]:

| | | | |
|---|---|---|---|
| Upper left | : | 371 813.1 | 382 944.3 |
| Upper right | : | 380 629.8 | 382 944.3 |
| Lower right | : | 380 614.4 | 378 383.2 |
| Lower left | : | 371 813.9 | 378 398.3 |

The forest is heavily disturbed and the forest stand has only low to medium density tree stocking. Under the "Integrated Management Plan of the NSPSF (2001 – 2010)", 70% of RMFR was classified as production forest, 27% as forest sanctuary for wildlife and the remaining 3% as research forest (JPNS 2000). In general, RMFR supports tree species with small to medium-sized crowns, typically reaching 30m in height. Emergent trees are scattered throughout the area. Kempas (*Koompassia malaccensis* ), Meranti bakau (*Shorea uliginosa*), Kedondong (*Santiria* spp.), Kelat (*Syzgium* spp.) and Ramin melawis (*Gonystylus bancanus)* are the dominant tree species within the forest. Part of the north-east corner of RMFR is known for its high water table as it is located near the peat dome in the central RMFR and dominated by palms and pandanus. Another 2,000 ha of the APFP pilot site is located outside the RMFR where the main landuses are agricultural areas and stateland PSFs.

The major issues with regards to the management and conservation of RMFR are forest fires and encroachment. The occurrence of forest fire is closely related to the heavily drained and degraded condition of the forest areas in RMFR. RMFR suffers from frequent fires almost every year particularly during prolonged dry spells in the months of February until March and June until August. The other issue related to RMFR is encroachment. Illegal occupation of government lands was rampant from the late 1990's up to mid 2000's. The degraded condition of the forest land due to burning provided an excuse for illegal settlers to encroach into the FR for settlement and agriculture. Nevertheless, these areas are outside from the APFP's pilot site. Efforts have been undertaken by the Selangor State Forestry Department to address the illegal encroachment problems. Consequently, several individuals forcefully evacuated from the affected sites within RMFR and these areas have now been allocated for forest rehabilitation activities.

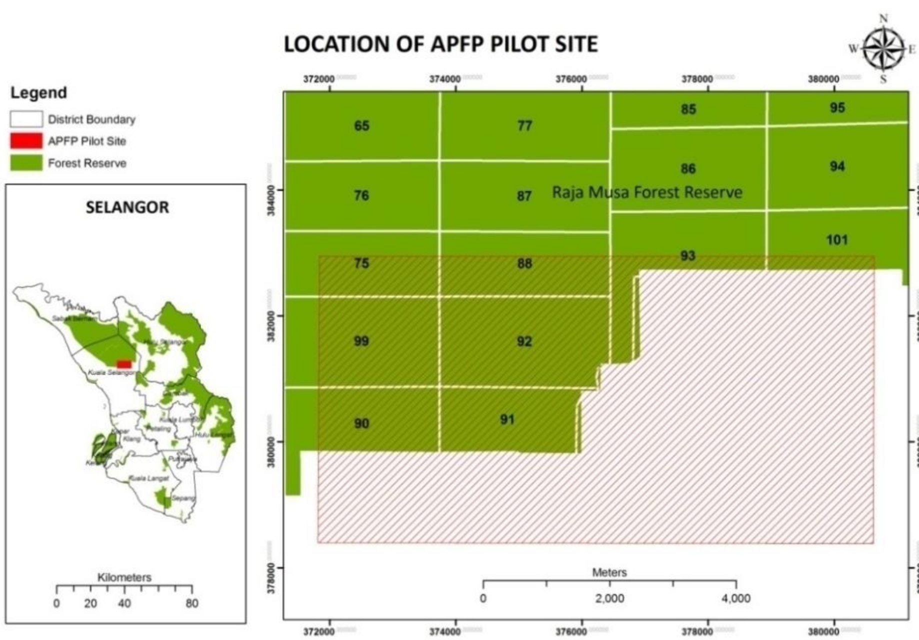



*__Figure 1.__* Location of APFP pilot site

### Data types

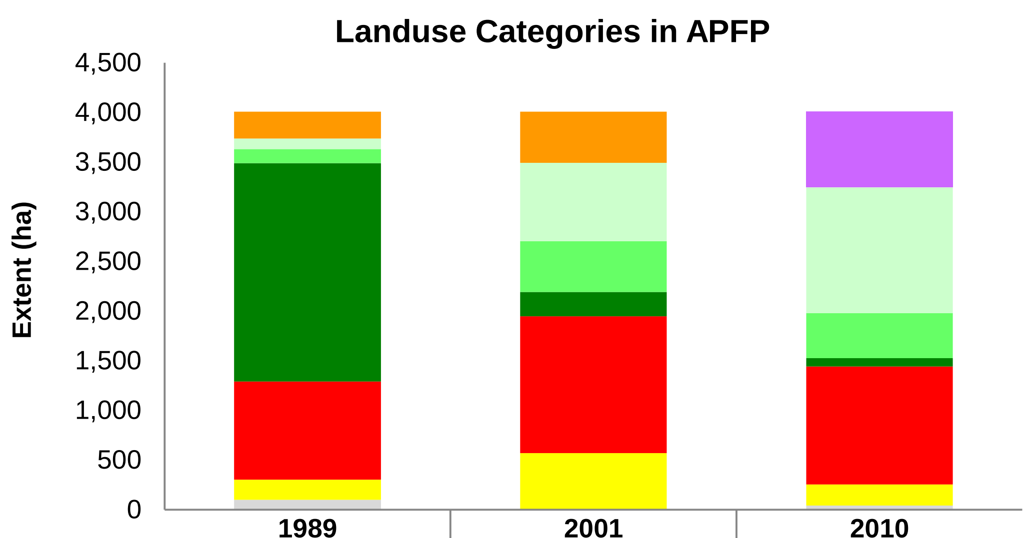
Two types of data were used in this study, namely secondary and satellite data. Secondary data comprised of the external FR boundary, compartment boundary and external APFP boundary based on existing forest data of 1999 (JPNS, 2000). These were all acquired from the Selangor State Forestry Department. In order to detect the changes in carbon stocks and the availability of satellite images, satellite data comprising Landsat-TM and SPOT-5 imageries over the years 1989, 2001 and 2010, were used as shown in Table 2.

***Table 2.*** Satellite data used in the study

| Year | Satellite | Date of image | Spatial resolution (m) |
|---|---|---|---|
| **1989** | Landsat-TM | 07/02/1989 | 30 |
| **2001** | Landsat-TM | 09/12/2001 | 30 |
| **2010** | SPOT | 24/01/2010 | 5 |

### Landuse classification in the APFP

Landuse classification was applied to the satellite images to identify and classify the extent of landuse/land cover classes in the study area. By using an appropriate classification algorithm, several classes of landuse of the 4,000 ha pilot site have been classified and the extent of each landuse category was quantified (Figure 2).




| | 1989 | 2001 | 2010 |
|---|---|---|---|
| Oil palm plantation | 0.00 | 0.00 | 760.35 |
| Shrubs | 269.82 | 513.36 | 0.00 |
| Tree Stands: Low | 105.24 | 788.70 | 1,266.97 |
| Tree Stands: Medium | 140.72 | 512.40 | 452.69 |
| Tree Stands: High | 2,200.61 | 244.22 | 83.74 |
| Mining sites | 986.72 | 1,378.84 | 1,188.95 |
| Grassland | 203.52 | 568.53 | 212.00 |
| Cleared land | 99.42 | 0.00 | 41.35 |

***Figure 2***. Landuse classes in the pilot site on different years (1989, 2001 & 2010)

In addition to the different landuse classes, the pilot area itself was categorised into three categories according to its tree density in NDVI (Normalised Difference Vegetation Index); namely low, medium and high tree stand. NDVI was found to range from 0.1-0.5 in the PSFs. This range was divided into three: (i) 0.1-0.2, (ii) 0.2-0.3 and (iii) 0.3-0.5, that represent low, medium and high, respectively. This categorisation was useful to provide information on tree and carbon stocking as well as the impact of the series of forest fires that occurred. The tree stand in the study area was considerably dense before the forest fire event as indicated on the satellite image for 1989. The classification results were spatially mapped as shown in Figures 3 – 5 for the years 1989, 2001 and 2010 respectively.

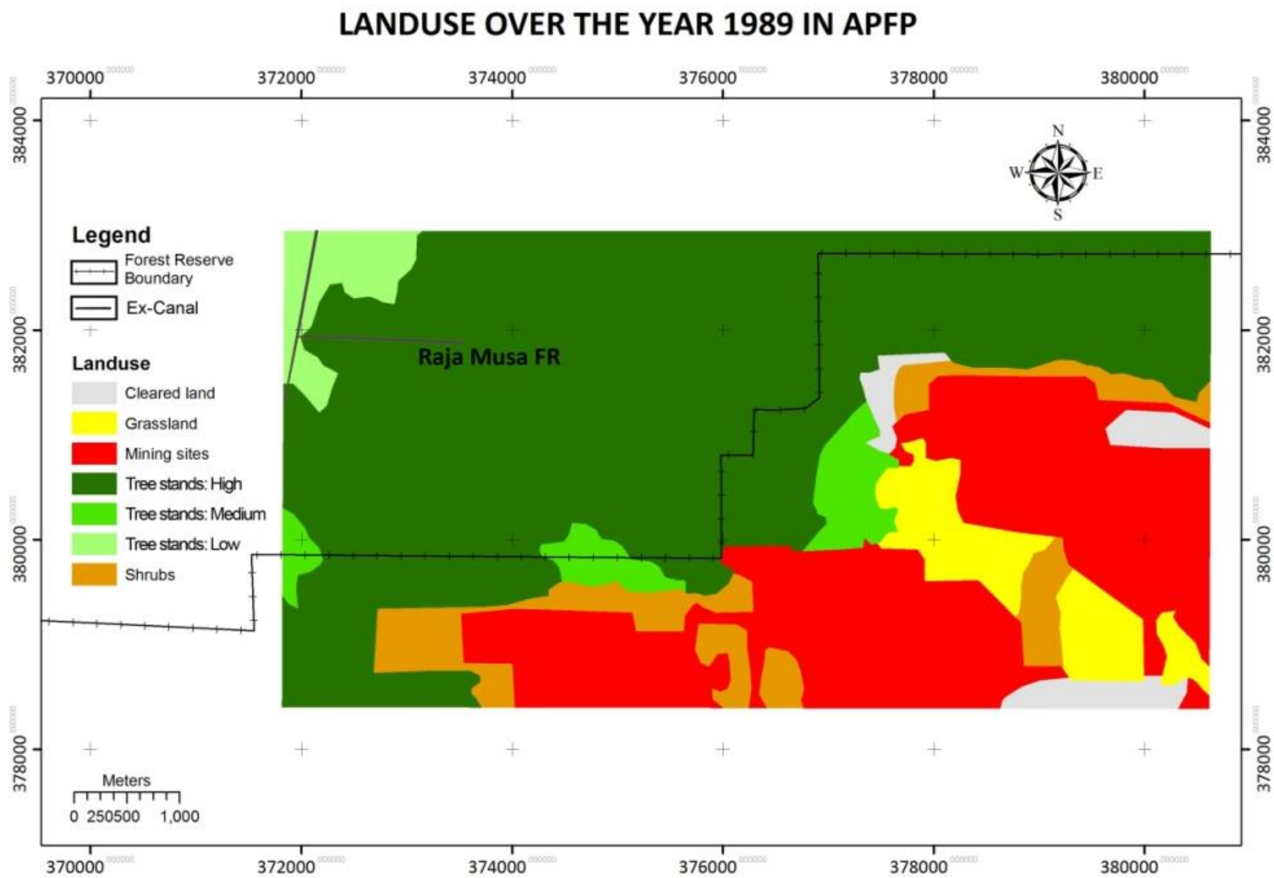



***Figure 3.*** Landuse classes in the year 1989

From the satellite data it was found that oil palm plantations only appeared on the satellite image in the year 2010. It occupied about 760 ha, fringing the central horizontal line of the APFP pilot site. Another landuse class that occupied a significant extent of pilot site is mining areas. These mining areas were probably PSFs sometime ago. However they were converted into water bodies and grassland areas after they were left abandoned following the completion of the mining activities. These mining sites are dominant in the southern part of the APFP pilot site.

The forest area that was pristine in the APFP pilot site occupied about 2,447 ha (61%) in the year 1989. However they were significantly reduced to 1,545 ha (39%) in the year 2001. This was due to a series of forest fires, which turned part of the forest areas into grassland and shrubs. However, some of these affected areas have regenerated back into PSFs thus increasing the total extent of forest area to 1,803 ha (45%) in 2010.

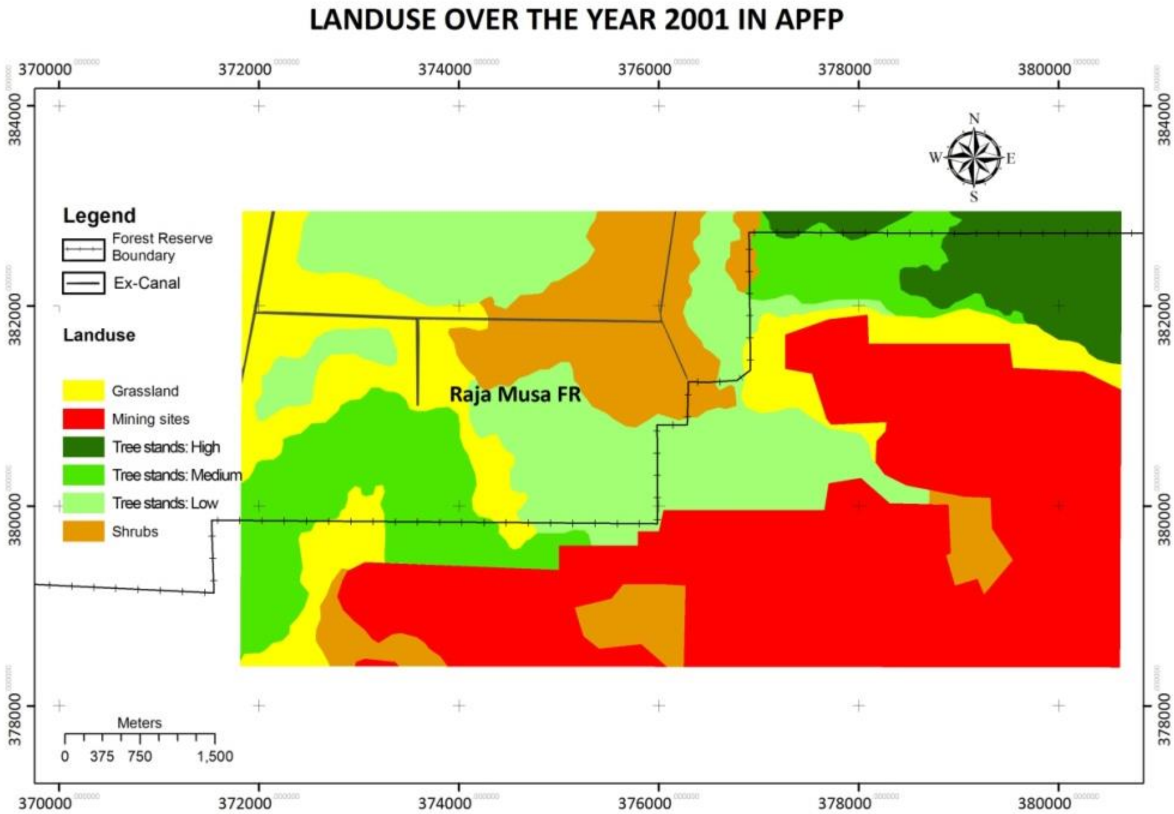



***Figure 4.*** Landuse classes in the year 2001

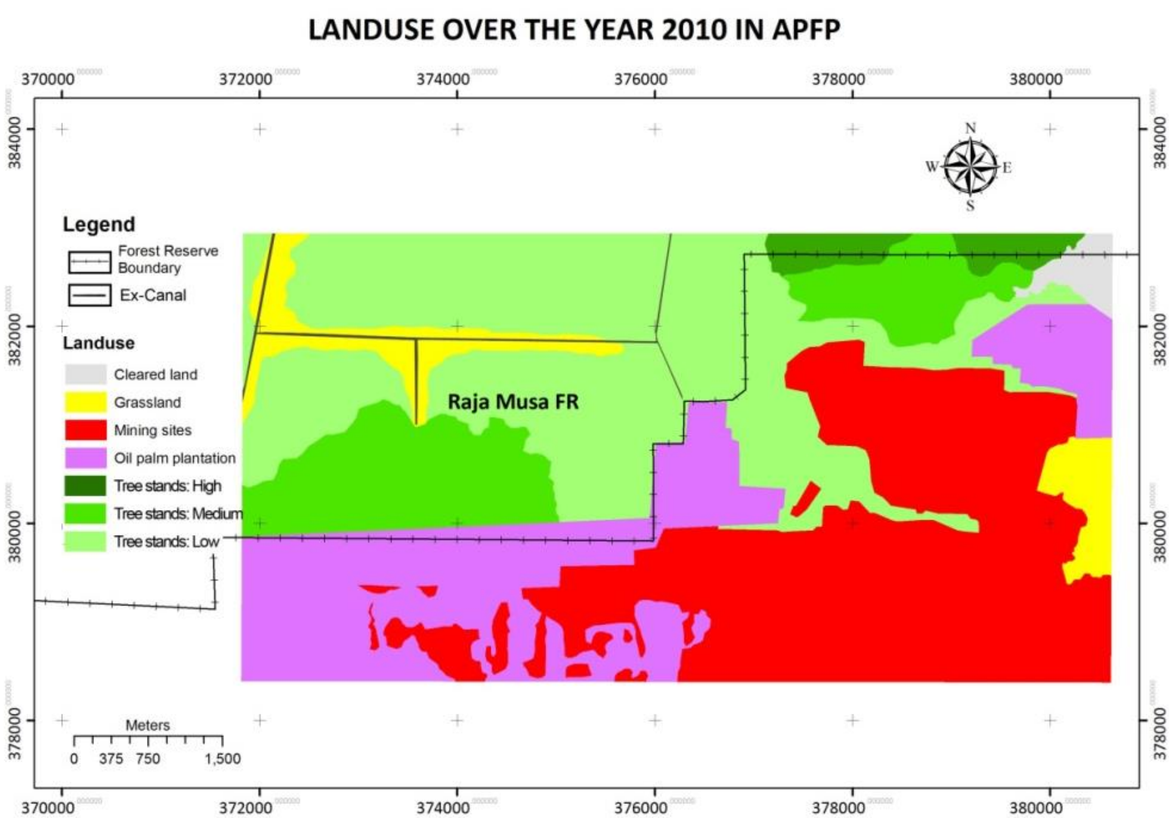



***Figure 5.*** Landuse classes in year 2010

### Aboveground carbon stocks in APFP

This project used secondary data to estimate aboveground carbon stock in the APFP pilot site due to limited resources available for field inventory. This was the optimum effort feasible within the short time frame of this project. A more detailed and precise calculation of the carbon stocks would require long-term measurements and detailed forest inventories. An additional uncertainty is that the resolution of the remote sensing data used (i.e. 30 x 30m) does not allow further detailed assessment.

A set of ground inventory data adopted from JPNS (2000) was used to generate an aboveground carbon stock prediction equation over the study area. Landsat-TM image over the year 2001 was used to perform this process. Since only standing volume ($m^3$ $ha^{-1}$) was given, the parameter has been converted to total carbon stock by using the following equation (simplified from IPCC, 2006):

**C = A x V x BCEF x CF**

Where,

C total carbon in carbon stock, in t
A area of land of certain land use class, in ha
V merchantable growing stock volume, in $m^3$/ha
BCEF biomass conversion and expansion factor
CF carbon fraction of dry matter [the carbon fraction (CF) of dry matter was chosen to be 50%, as recommended by IPCC]

The ground data set and the generated NDVI from the satellites images is listed in Table 3 and the correlation between these two parameters at corresponding locations is shown in Figure 6.

***Table 3.*** Ground inventory data and generated NDVI from satellite image

| Compartment | Estimated standing Volume ($m^3$ $ha^{-1}$)* | Aboveground C stock (t $ha^{-1}$) | Mean NDVI (Year 2001) |
|---|---|---|---|
| **75** | 79.36 | 66.27 | 0.2722 |
| **88** | 79.36 | 66.27 | 0.2357 |
| **90** | 60.89 | 50.84 | 0.1561 |
| **91** | 79.36 | 66.27 | 0.2585 |
| **92** | 0.00 | 0.00 | 0.0009 |
| **93** | 79.36 | 66.27 | 0.2936 |
| **99** | 0.00 | 0.00 | 0.0000 |
| **101** | 60.89 | 50.84 | 0.1959 |

**Note: Measurement was made in the year 1999 for the trees ≥ 15.0 cm DBH, JPNS (2000)*

The NDVI was used as the indicator/predictor for the aboveground carbon stocks in the study area. This index can be generated from both Landsat and SPOT image, which enabled the carbon stock estimation over the time series of satellite images. The aboveground carbon stock estimation that was calculated based on the satellite images have successfully shown the distribution over the certain years and further allowed carbon stock changes assessment in the APFP pilot site. However, these results include some level of uncertainty that need to be assessed. Therefore, a field survey was conducted in the study area to determine estimation error and accuracy of the estimated aboveground carbon stock for the purpose of validation and verification.

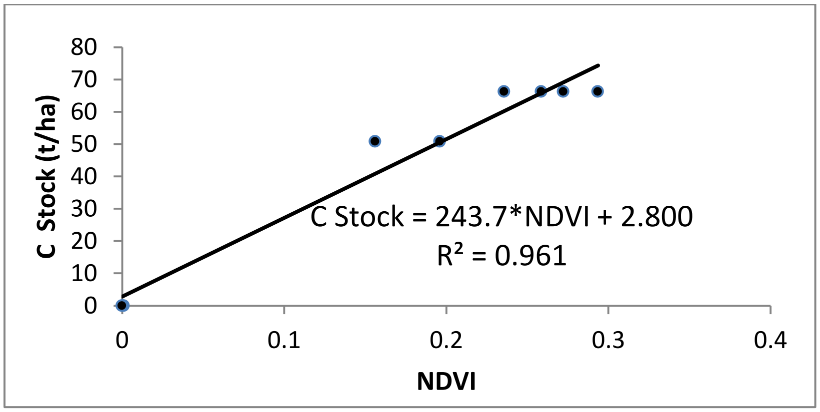



***Figure 6.*** Relationship between aboveground carbon stock and NDVI

### Causes of aboveground carbon changes

The NDVI images that were converted to aboveground carbon stock have allowed the calculation of total aboveground carbon stock in the study area over the three series of years. It was found that the total aboveground carbon stock in the APFP area has lost about 342,756 tonnes from the year 1989 to 2001 due to the series of forest fire. However the aboveground carbon stock started to recover back as it increased about 57,337 ha from the year 2001 to 2010. The distribution of carbon stocks in the APFP pilot site that ranged from 80 – 184 t $ha^{-1}$ in year 1989 decreased to 0 – 40 t $ha^{-1}$ in the year 2001 and increased back to a range of 20 – 40 t $ha^{-1}$. The statistics of assessed aboveground carbon stock in the APFP pilot site is shown in Table 4 and its trend of changes is shown in Figure 7.

***Table 4*****.** Basic statistics of assessed aboveground carbon stock in APFP

| Year | Minimum (t $ha^{-1}$) | Maximum (t $ha^{-1}$) | Mode (t $ha^{-1}$) | Average (t $ha^{-1}$) | Total (ton) |
|---|---|---|---|---|---|
| **1989** | 0.00 | 154.61 | 124.61 | 96.67 | 387,266.60 |
| **2001** | 0.00 | 61.11 | 37.38 | 11.11 | 44,510.42 |
| **2010** | 0.00 | 70.00 | 36.78 | 25.42 | 101,847.49 |

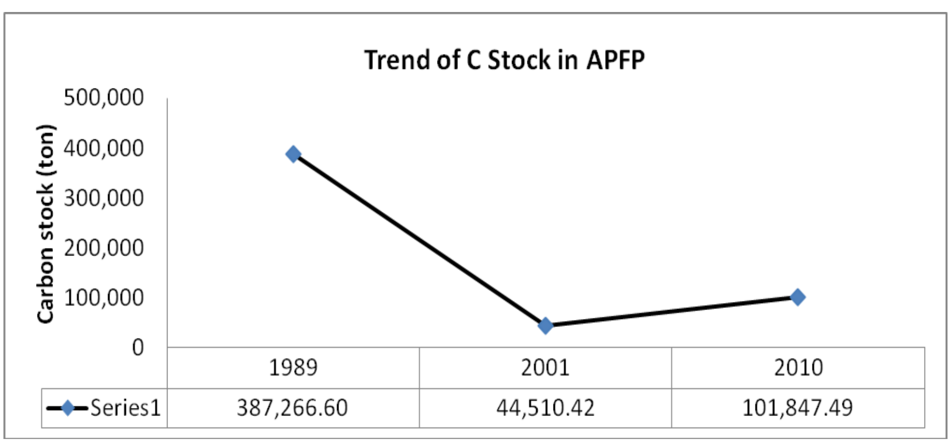



***Figure 7.*** Trend of changes in aboveground carbon stock in APFP from 1989 to 2010

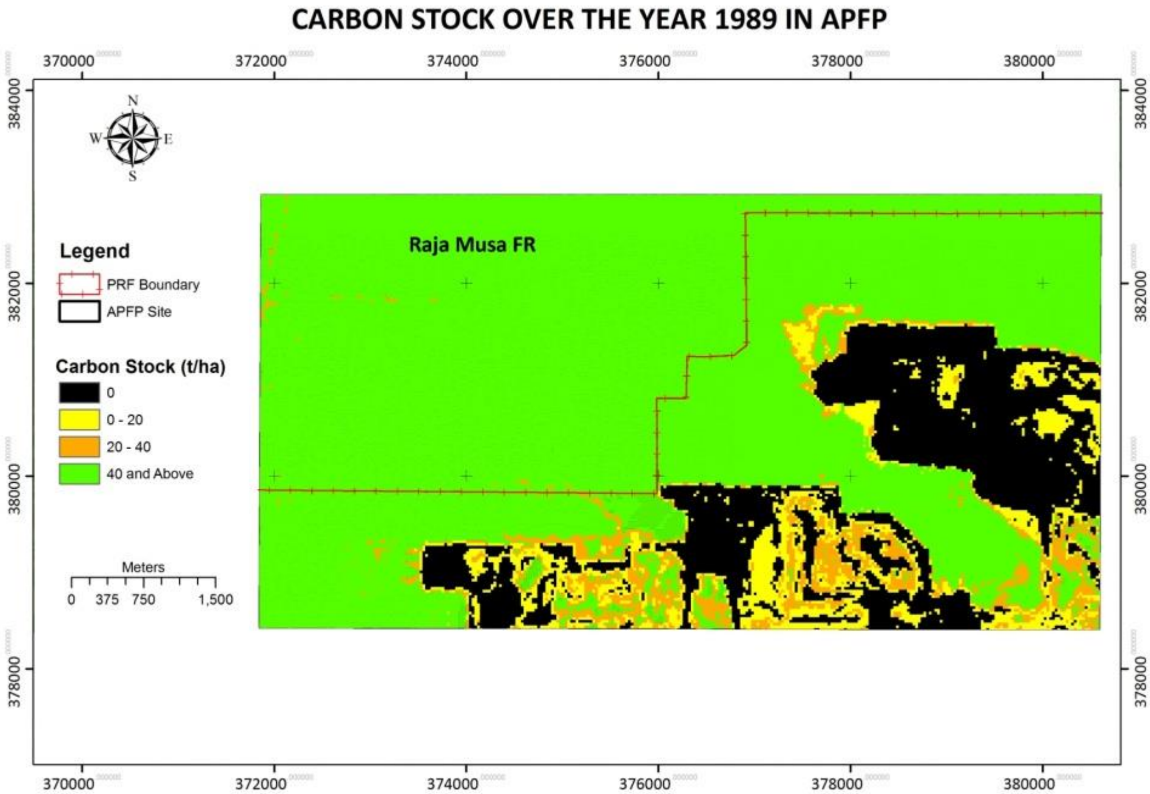



***Figure 8.*** Distribution of aboveground carbon stock in year 1989

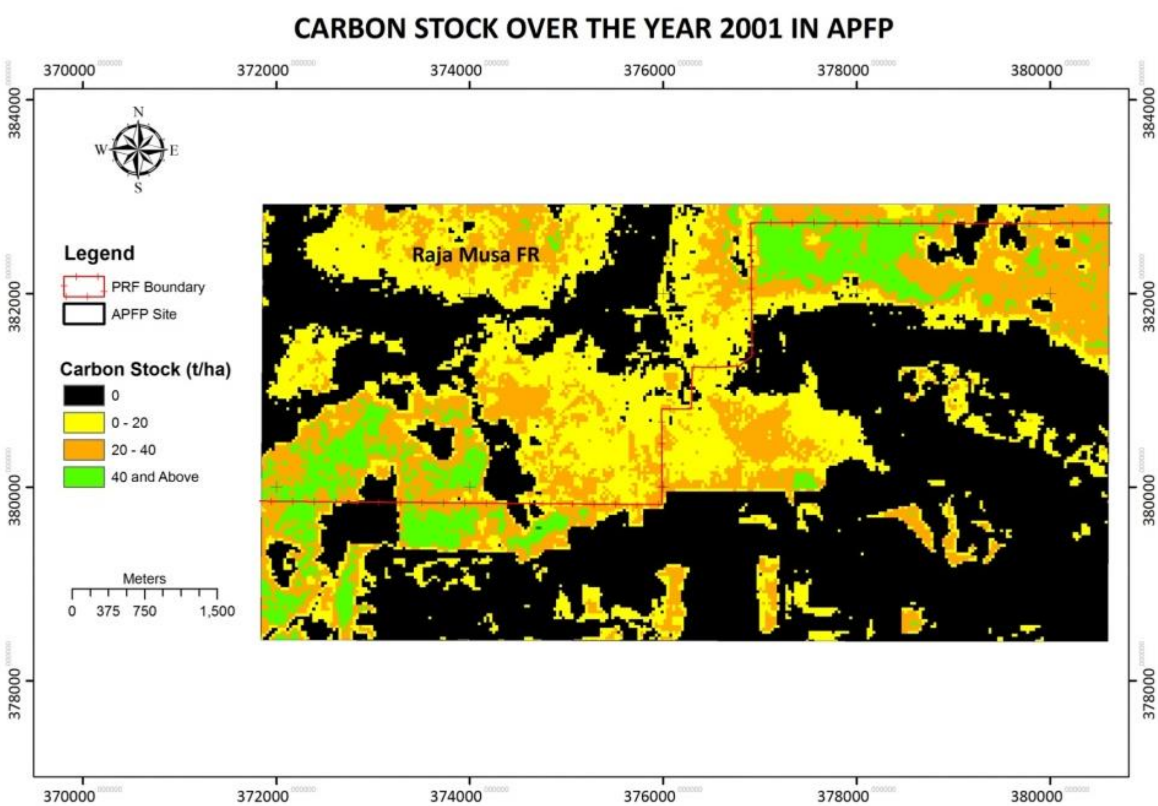



***Figure 9.*** Distribution of aboveground carbon stock in year 2001

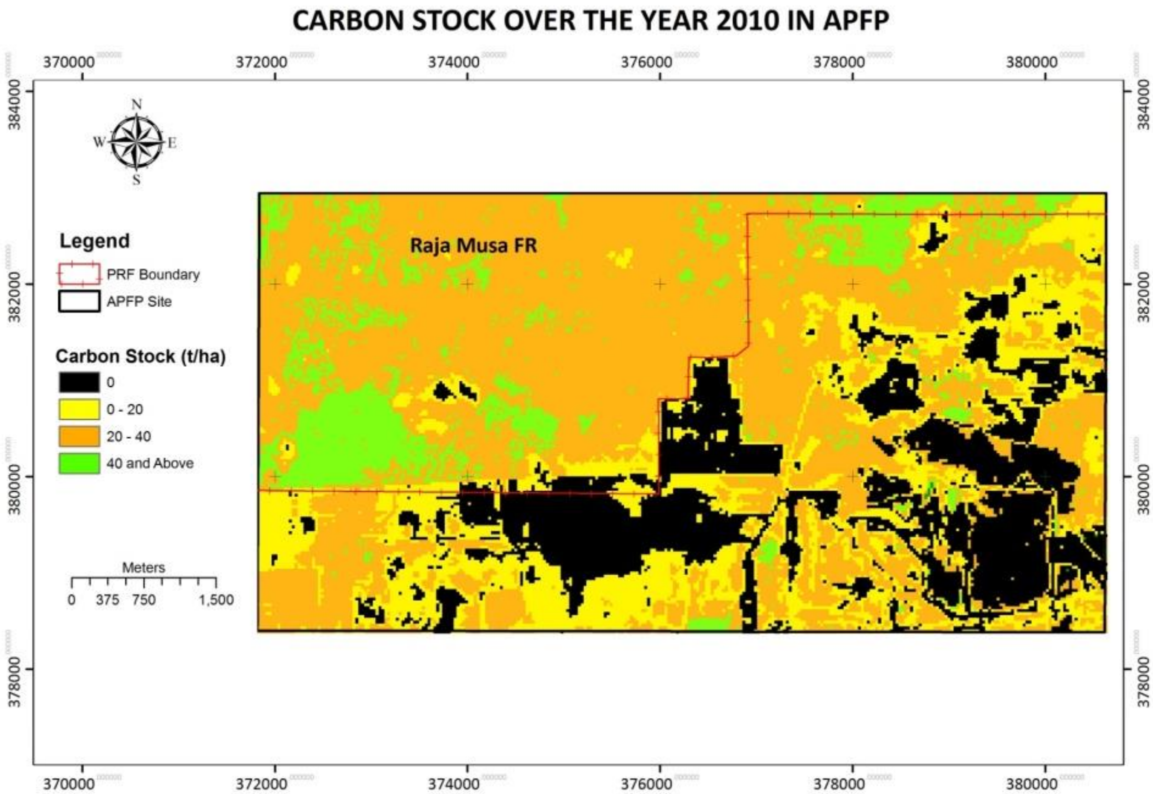



*Figure 10.* Distribution of aboveground carbon stock in year 2010

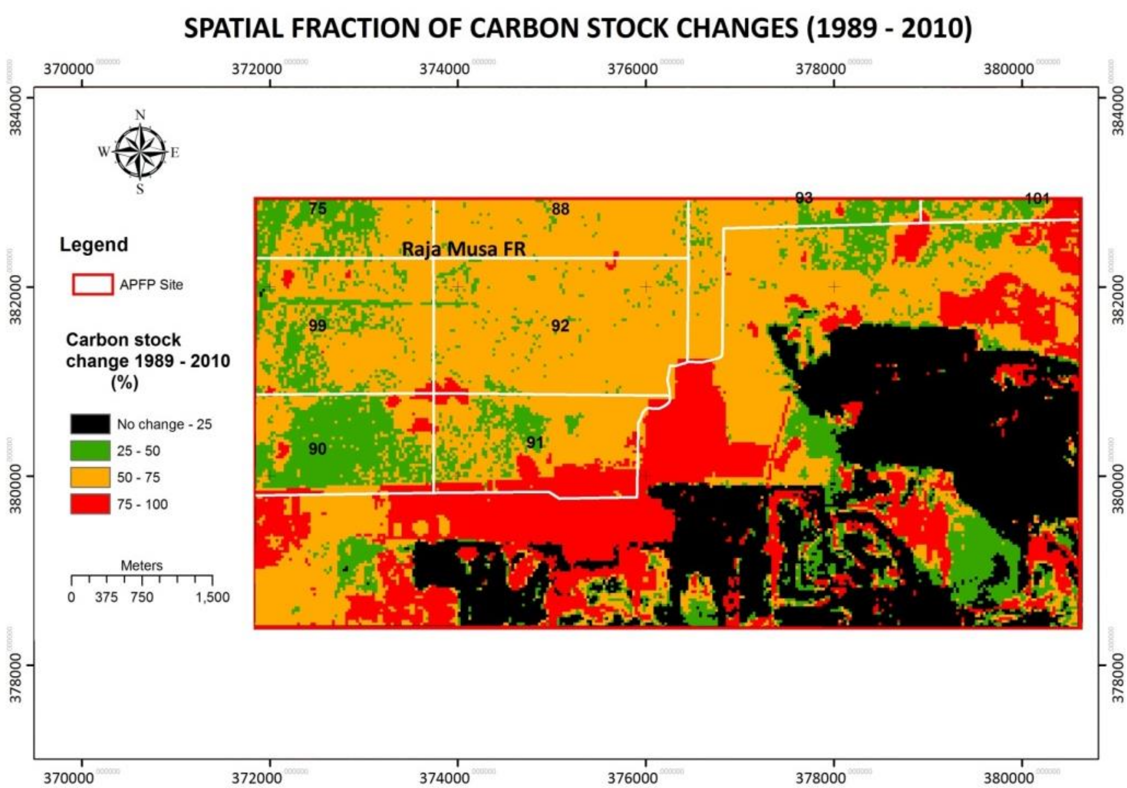



*Figure 11.* Fraction of aboveground carbon stock changes between year of 1989 and 2010

The study shows that the series of forest fire events that occurred in forest areas have caused a considerable amount of carbon loss. This carbon loss can occur within a short period of time during fire episodes, but the forest ecosystem has to take tens of years to recover the carbon storage. Figures 8 – 10 show the spatial distribution of aboveground carbon stock for the years 1989, 2001 and 2010. In addition, aboveground carbon stock changes of the APFP pilot site from the year 1989 to 2010 is shown in percentage in Figure 11. Most of the central and south west areas were totally (100%) changed due to the land conversion from forest area to oil palm plantation (outside the FR).

## Conclusions

Remote sensing technology has proven to be successful in a relatively short duration in estimating aboveground carbon stock over the years. The methodology was used to estimate the aboveground carbon stock changes in the PSFs areas of the APFP pilot site at RMFR, Selangor, Malaysia. Validation and verification results showed that estimation error and accuracy of the calculation are of acceptable levels. The method adopted in this study has been found to be a cost-effective way to estimate the aboveground carbon and its pattern of changes. Detailed field inventory in terms of ground vegetation is needed for more accurate estimation of the aboveground carbon, provided field inventory data for all investigated years are also available to compare their pattern. Field inventory in the APFP pilot site, if conducted, would only be able provide estimates of the current vegetation information to be used for estimating the current carbon stock.

Based on the project's findings, it was found that total aboveground carbon stock in PSF areas of the APFP pilot site has lost about 342,756 tonnes from the year 1989 (387,266.60 tonnes) to 2001 (44,510.42 tonnes) due the forest fires in this area. However the aboveground carbon stock started to recover back as it increased about 57,337 tonnes from the year 2001 to 2010 (101,847.49 tonnes). A study by Istomo (2006) found that about 20.1% of aboveground carbon in PSFs is belowground carbon. Therefore as for 2010, the total vegetation carbon of PSFs in the APFP site was about 122,318 tonnes (aboveground = 101,847 tonnes, belowground = 20,471 tonnes) or about 11.35 t $ha^{-1}$ (total area of PSFs for 2010 ~ 1,803 ha). The low stocking of vegetation carbon stock was because more than 70% of total PSF areas consisted of open areas with very little vegetation in the APFP pilot site in 2010. In comparison, an intact PSF in Pekan FR, Pahang could stock vegetation carbon at about 414.6 t $ha^{-1}$ (Khali Aziz *et al.,*2009).

## Recommendations

This study has provided useful information on the changes in C stocks in the study site for a 20 year period. Some useful lessons and experience were gained. Consequently the following recommendations are proposed:

i. Forest fire was found as the main threat to the PSFs areas in the APFP pilot site. Therefore, it is suggested that a permanent water level station be installed to measure water table and create a buffer zone of FR to prevent and control fires. It is suggested that the APFP project conduct a special study to develop a forest fire management plan that will have forest fire prevention measures.
ii. Implement fire prevention measures for the APFP pilot site, particularly good water management (canal blocking) strategies.
iii. Increase the number of regular monitoring by forestry department's personnel particularly during the dry season. It would be good to get the involvement of local community fire brigade.
iv. Conduct detailed carbon assessment for PSFs areas in the APFP pilot site including its soil via field inventory in order to determine total carbon stock of the area.
v. Conduct a comprehensive rehabilitation program particularly in open PSFs areas inside the RMFR to assist their regeneration, prevent fires and increase the carbon stock.

vi. Assign the APFP pilot site as a model for long-term management of peatlands in Malaysia. It is an ideal site to show good coordination and cooperation of stakeholders for integrated management of the peatlands. It also can be a suitable place for a Centre of Excellence for Peatland in Malaysia.
vii. Provide training to the staff of JPNS in the management of PSFs, including controlling and preventing forest fires in PSF.
viii. Conduct assessment of aboveground carbon stock for the whole RMFR or even all PSF forest reserves in Selangor by using the remote sensing technologies in order to estimate their contribution on stocking of carbon for environmental stability.

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# LESSONS LEARNED FROM FOREST MANAGEMENT CERTIFICATION ON PEATLAND

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## Abstract

Among peatland production forest, only a small amount of forest management units (FMUs) are eligible for certification. A report from Wetlands International (2011) stated that approximately 95% of Indonesia's peatlands are already degraded. Exsisting political and social dynamics in Indonesia show that certification will not significantly promote sustainable peatland management in the short term. Some lessons learned from Sustainable Forest Management (SFM) certification experiences show that certification could not work on forests without FMU having a clear management system and well-planned production. In addition, most of the existing Indonesian peatland FMUs are not eligible for SFM certification or do not have enough incentive to apply for certification.

To prevent continuing negative impacts on the climate and enhance the ecosystem service capacity, conversion of the remaining natural peatland forest ecosystem to plantation and other land uses should be stopped, followed by restoration and appropriate rewetting strategy.

***Keywords:*** *certification, sustainable peatland forest management*

## Overview of Indonesian forest land

The total forest land area in Indonesia in April 2011 was 130.68 million hectares. The total boundary length is 281,873 km of which 222,542 km are demarcated in the field. The total area gazetted is 14.24 million ha. Figure 2 and 3 provides a breakdown of the total forest area by forest function and type. In addition, Indonesia's National Forestry Plan (2011 – 2030) projects that 18.34 million ha of forest will be converted to other uses (Figure 4).

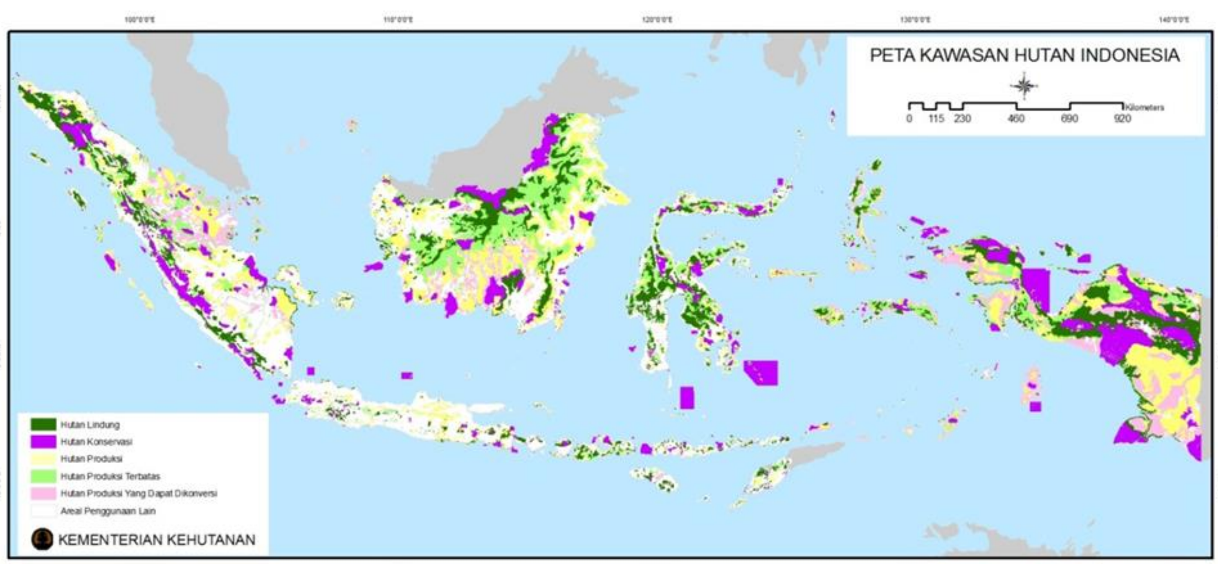
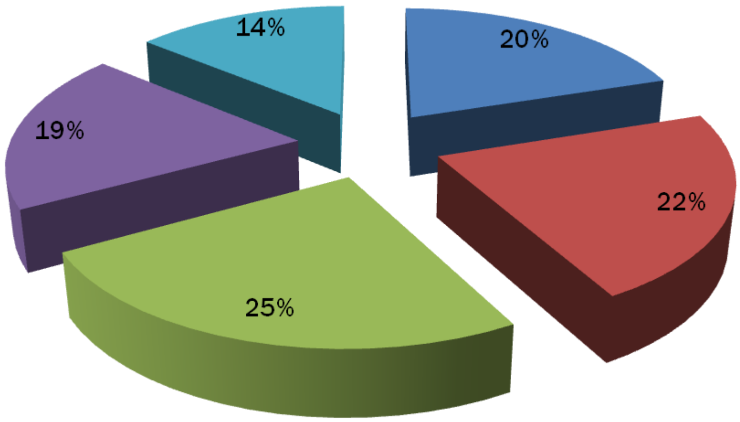
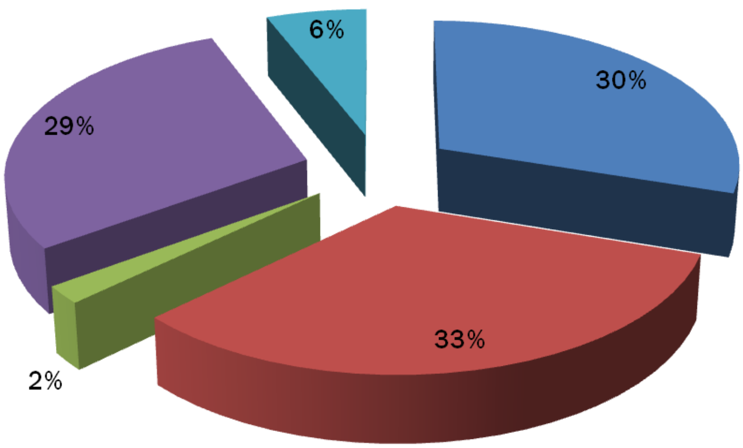


***Figure 1.*** Forest land area in Indonesia as of April 2011




| FOREST FUNCTION | Million Ha |
|---|---|
| CONSERVATION FOREST | 26,82 |
| PROTECTION FOREST | 28,86 |
| PRODUCTION FOREST | 32,60 |
| LIMITED PRODUCTION FOREST | 24,46 |
| CONVERSION FOREST | 17,94 |
| TOTAL FOREST LAND | 130,68 |

***Figure 2.*** Forest land by function (April 2011)




| FOREST COVER TYPE | Million Ha |
|---|---|
| Primary Forest | 41,26 |
| Secondary Forest | 45,55 |
| Plantation Forest | 2,62 |
| Non Forested Forest Land | 41,05 |
| Forested Non Forest Land | 8,07 |

***Figure 3.*** Forest cover by type

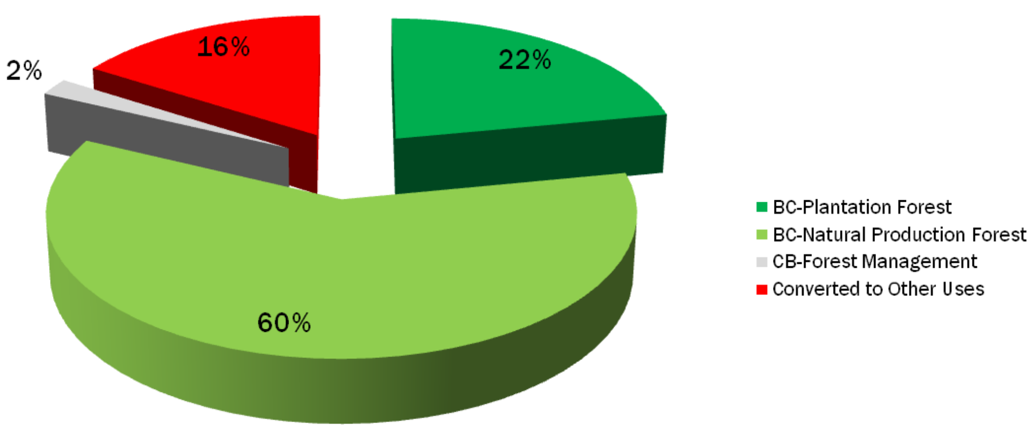



***Figure 4.*** Breakdown of Indonesia's production forest (NFP 2011 – 2030)

## Certification playground

As of June 2011, out of 284 FMUs (22.71 million ha) in natural production forests, less than half have cutting permits with probably less than 10% currently eligible for certification. Only 1 million ha is certified under LEI and FSC. In plantation forests, out of the 220 FMUs (9.68 million ha), only half has been planted on (4.92 million ha) and probably less than half of this is currently eligible for certification. Currently only 0.54 ha is certified under LEI. In community lands, approximately 3.59 million ha is mostly eligible for certification with technical assistance and improvement.

## Success stories

There is roughly 10.1 million ha of peatland in production and conversion forests. Companies that have obtained the LEI Certification on peatland are PT. Diamond Raya Timber (90,060 ha) from 1999 – 2011 and PT. Wira Karya Sakti (246,482 ha) from 2008 – 2012. The area managed by PT. WKS is comprised of approximately 46% peatland. These two areas represent success stories for FMU certification. Figure 5 and 6 show the location of the areas.

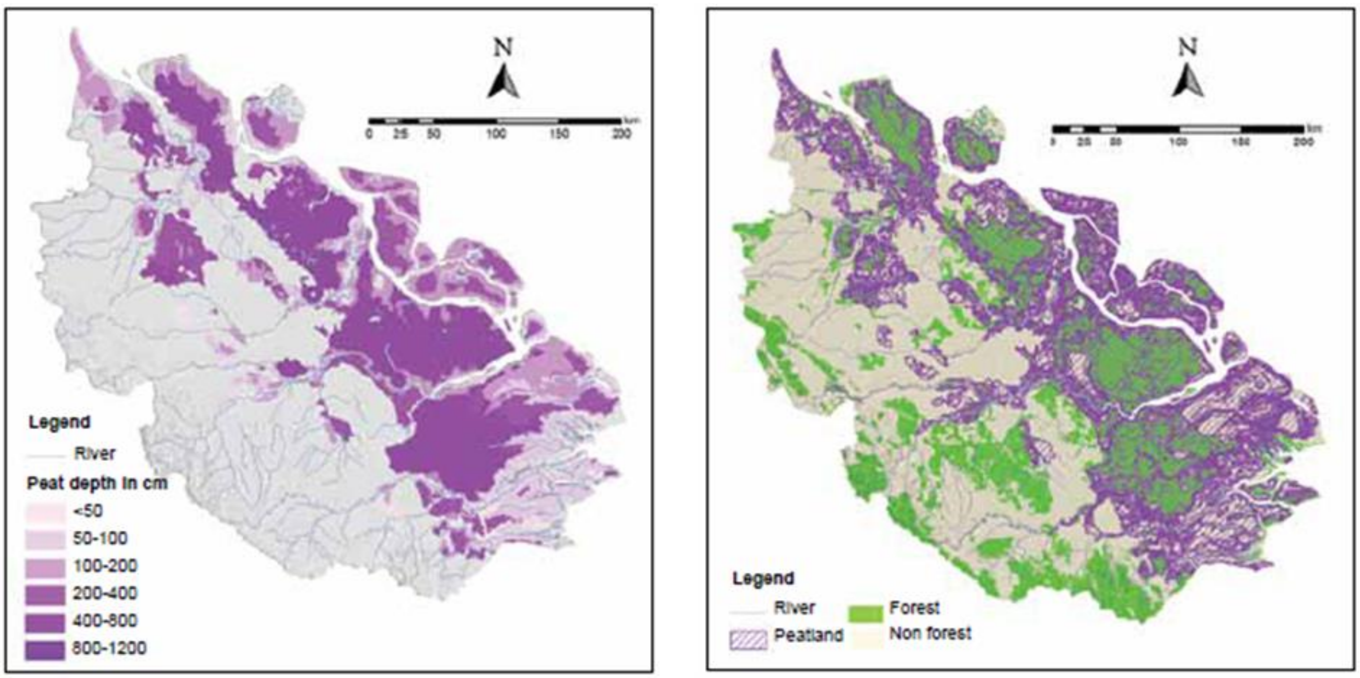



***Figure 5.*** Location of PT. DRT and PT. WKS success areas according to peat distribution (left) and forest cover (right) in Riau Province
*(Source: Murdiyarso, D. et al., 2011)*

## Lessons learned

The PT. DRT Certified Sustainable Forest Management System was a success due to a number of factors. There was a high commitment by the FMU to continuously improve the management system. They recognised the importance of the area as an important hydrological system and ensured it was maintained by practising minimum drainage of water. They also consistently implemented selective cutting and reduced-impact logging, such as using railroads and traditional skidding techniques (*kuda-kuda*) for timber transportation. There was also high local community support, resulting in minimum illegal activities.

In the Kampar Peninsula, landscape-scale planning was required as a single PSF ecosystem. It was a policy-driven trade-off based on identification of the core area important for the hydrological system and other

High Conservation Value (HCV) forests. A collaborative approach between KPH Tasik-Besar Serkap and BKSDA resulted in great management of the area where they improved water management based on a closed drainage system and "eco-hydrobuffer", restored all degraded natural forest in the core area as well as stopped further timber extraction in the core area. It soon became like a community-based managed forest where the core area was used for non-timber forest products, ecotourism and environmental services.

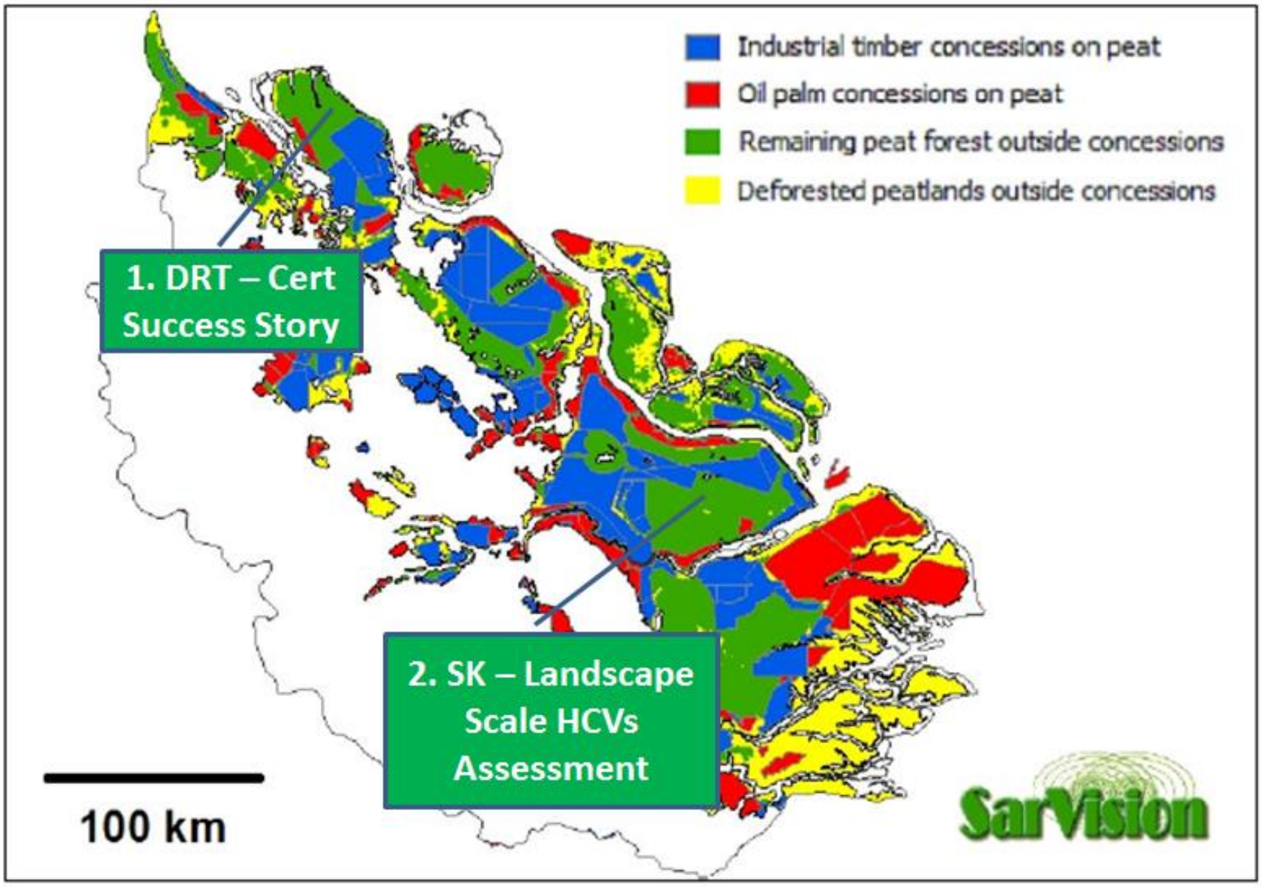



***Figure 6.*** The success areas are located in remaining peat forest outside concessions
*(Source: Hoiijer. A. et al., 2006)*

Based on certification experiences, certification on peatland will only work if the FMU is ready for performance assessment as most peatland FMUs are currently not eligible for certification. To counter this issue of non-certification, policy on peatland allocation and law enforcement is urgently needed to stop all forest conversion and illegal activities and create better conditions for improved forest management. The highest priority action should focus on: (1) restoration of degraded natural forest on peatland and (2) improvement of the water management system in plantation on peatland.

## Conclusion

There are several important factors that support best practices and SFM certification such as: (1) the right design of FMU relative to the water management regime; (2) implementation of low impact selective logging for natural forest; (3) implementation of a closed water management system supported by appropriate HCV management and eco-hydro buffer for plantation forest; (4) continual improvement of forest management system with emphasis on SIM development within FMUs; (5) active government role in coping with illegal activities, especially land encroachment and illegal logging; (6) local community recognition and support in forest management.

# FOREST MANAGEMENT CERTIFICATION UNDER THE MTCS WITH SPECIAL REFERENCE TO PEAT SWAMP FOREST

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**Abstract**

The paper describes briefly the developments leading to the proposal and adoption of forest certification as a market-linked tool to promote sustainable forest management at the international level, and the establishment of the Malaysian Timber Certification Council (MTCC) as an independent organisation to develop and operate a voluntary and independent Malaysian Timber Certification Scheme (MTCS).

The need for timber and timber products to be sourced from sustainably managed forests has to be addressed in view of the growing concern on the current state of the world's forests including peat swamp forests (PSFs) and their importance towards fulfilling societal needs and the well-being of the environment. This is also clearly reflected in the demand for the use of certified timber products in public and private sector timber procurement policies of many environmentally and socially sensitive markets such as in Europe.

The paper elaborates on the extent of PSFs certified under the MTCS and the role of forest certification in enhancing forest management practices in these forests.

***Keywords:*** *Malaysian Timber Certification Council, Malaysian Timber Certification Scheme, peat swamp forest*

## 1. INTRODUCTION

1.1 The late 1980s and early 1990s witnessed the growing concerns for deforestation and forest degradation particularly that of tropical forests, resulting in campaigns by some NGOs in certain developed countries, notably in Europe, calling for bans or boycotts on the use of tropical timber. However, it was subsequently realised that these measures are counter-productive since boycotts and bans not only conflict with international rules such as those of the World Trade Organisation (WTO) but also remove the economic value of the forests and thereby render them vulnerable for conversion to other competing land uses. It was then realised that efforts should be made to promote and encourage sustainable forest management (SFM) as the way forward instead.

1.2 The International Tropical Timber Organization (ITTO) was one of the first intergovernmental organisations to address the issues relating to SFM and forest certification. In 1992, it published a document entitled '*Criteria for the Measurement of Sustainable Tropical Forest Management*' which provided a set of criteria for assessing sustainability of tropical forests. This document has since been revised in 1998 as the "*ITTO's Criteria and Indicators for Sustainable Management of Natural Tropical Forests*" and further revised in 2005 as "*Revised ITTO Criteria and Indicators for the Sustainable Management of Tropical Forests including Reporting Format*."

1.3 The need to balance development with care for the environment was addressed by the United Nations Conference on Environment and Development (UNCED) in 1992 resulting in the formulation and adoption of Agenda 21 and the non legally-binding Forest Principles. In particular, Forest Principle 8(d) deals with the need to establish internationally agreed norms, criteria and indicators for the sustainable management, utilisation and development for all types of forests in the world.

1.4 Since UNCED, various initiatives on development of criteria and indicators for SFM in many ecological zones have been launched such as the ITTO C&I for humid tropical forests, the Helsinki Process for forests in Europe (boreal, temperate and Mediterranean-type), the Montreal Process for temperate and boreal forests outside Europe, and the Tarapoto Proposal for Amazon forest, etc.

1.5 However, merely having or adopting a set of C&Is would not be adequate to ensure the sustainability of the forest resources in the long term, as sustainable forest management needs to be demonstrated on the ground. The crucial questions that need to be answered are "*How can we be certain that such practices are implemented?*" and "*Are the assurances given by the forest managers adequate or good enough?*" It is in this context that forest or timber certification has been proposed as a market-linked tool to promote and encourage effective implementation of SFM, involving audits by independent third-part assessors.

1.6. This paper describes the implementation of the Malaysian Timber Certification Scheme (MTCS), which is operated by the Malaysian Timber Certification Council (MTCC), with special reference to the extent and management of PSFs certified under the MTCS, and the role of forest certification in enhancing forest management practices in these forests.

## 2. IMPLEMENTATION OF THE MTCS

2.1 In Malaysia, the implementation of the MTCS, following the establishment of the MTCC as an independent organisation in October 1998, can be considered as both a country as well as a market-driven initiative. It is country-driven as it is in the interest and well-being of Malaysia to ensure that its rich forest resources are sustainably managed to meet both the needs of the present and future generations. It is a market-driven initiative to take into consideration the growing demand for the use of certified timber products by the more environmentally and socially sensitive markets, many of which have specified this requirement in their public and private sector timber procurement policies.

2.2 MTCC started operating the MTCS in October 2001 using a phased approach. The initial forest management standard used for assessing Forest Management Units (FMUs) was the *Malaysian Criteria, Indicators, Activities and Standards of Performance for Forest Management Certification* [in short the MC&I(2001)] which was based on the 1998 ITTO *Criteria and Indicators for Sustainable Management of Natural Tropical Forests*. However, beginning 2005, MTCC started to use a new forest management standard, i.e. the *Malaysian Criteria and Indicators for Forest Management Certification* [referred to as the MC&I (2002)], that was developed using the Principles and Criteria of the Forest Stewardship Council (FSC) as the template. Based on the international norm on standard setting and the requirement under the MTCS that certification standards are to be reviewed once every five years, the MC&I (2002) was subjected to a review process which began in April 2009, and resulted in the finalisation of the MC&I (Natural Forest) by the multi-stakeholder Standards Review Committee in September 2011. The MC&I (Natural Forest) was subsequently adopted by the MTCC as the standard for forest management certification of natural forest under the MTCS in December 2011 and came into force in July 2012. Additionally, the MTCS has adopted the MC&I (Forest Plantations) in February 2009 as the standard for the certification of forest plantations in Malaysia.

2.3 As for the chain of custody certification standard, there has also been a change in the use of the standards since the operation of the MTCS; from initially the "*Requirements and Assessment Procedures for Chain-of-Custody Certification (RAP/CoC)*" in 2001, to the "*Requirements of Chain-of-Custody Certification*" in 2006, to "*PEFC Technical Document Annex 4: Chain of Custody of Forest Based Products – Requirements*" in July 2008, and the "PEFC ST 2002:2010 - *Chain of Custody of forest based products – requirements*" beginning November 2011.

2.4 Under the current institutional arrangement for the MTCS, MTCC is the National Governing Body (NGB) in Malaysia and is the overall operator of the scheme (Figure 1). As the NGB, MTCC is responsible for facilitating and coordinating the standard setting process, notification of certification bodies (CBs), and for setting rules related to the use of the logos and their related claims by holders of certificates issued by the notified CBs. The CBs, on the other hand, are responsible for receiving and processing applications for certification, conducting audits and making decisions for the MTCS award - *Certificate for Forest Management* or *Certificate for Chain of Custody* (CoC) to FMUs or timber product manufacturers or exporters which have complied with the requirements of the forest management or chain of custody standards, respectively. The CBs are required to be accredited to the Department of Standards Malaysia (STANDARDS MALAYSIA) and the national Accreditation Body (AB). The accredited CBs have to apply to MTCC to become PEFC-notified CBs to enable them to issue accredited certificates recognised by MTCC/PEFC.

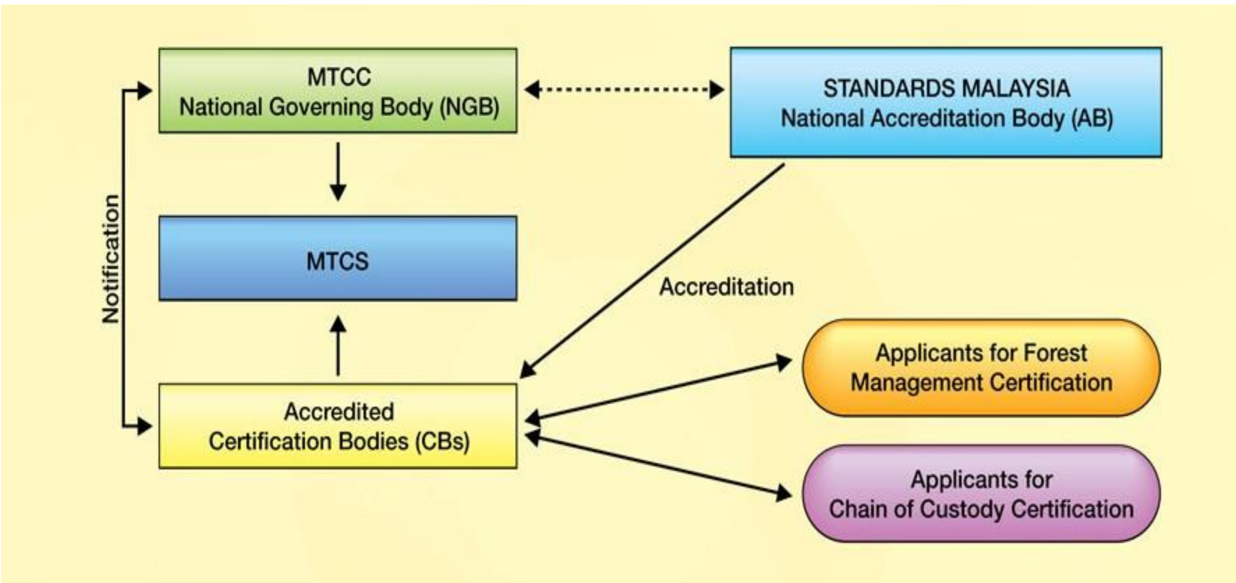


***Figure 1.*** Institutional arrangement of the MTCS

2.5 As of May 2012, nine FMUs covering a total of 4.65 million hectares of Permanent Reserved Forest (PRF), including 0.24 million ha of PSF have been awarded the *Certificate for Forest Management* based on the requirements of *MC&I*(2002) (Table 1). The certified area represents about 32% of the total PRF in Malaysia. Of the total, eight certified FMUs are located in Peninsular Malaysia (i.e. Johor, Kedah, Kelantan, Negeri Sembilan, Pahang, Perak, Selangor and Terengganu FMUs), while the remaining one (Segaliud Lokan FMU) is located in Sabah.

2.6 As of April 2012, a total of 173 timber companies have been issued with PEFC Chain of Custody Certificate (accredited certificate) under the MTCS. Of these companies, 94 of them have signed the PEFC Logo Usage Licence agreement which qualifies these companies to label their products with the PEFC logo.

## 3. MANAGEMENT OF PSFS IN CERTIFIED FOREST MANAGEMENT UNITS

3.1 PSFs constitute one of the major forest types in Malaysia, covering a total of 1.31 million ha in 2009. Besides PSFs, the other two major natural forest types are the inland forest and mangrove forest. Overall, PSFs are more extensive in Sarawak (0.95 million ha) than in Sabah (0.12 million ha) and Peninsular Malaysia (0.24 million ha).

***Table 1.*** Extent of PEFC-Certified FMUs in Malaysia

| No. | Name of FMU | Area certified (ha) | Extent of PSF (ha) |
|---|---|---|---|
| 1 | Segaliud Lokan, Sabah | 57,247 | - |
| 2 | Negeri Sembilan | 154,185 | - |
| 3 | Johor | 397,392 | 5,429 |
| 4 | Terengganu | 521,582 | 13,757 |
| 5 | Kedah | 307,046 | - |
| 6 | Pahang | 1,562,496 | 140,830 |
| 7 | Perak | 991,436 | - |
| 8 | Selangor | 230,187 | 82,890 |
| 9 | Kelantan | 424,497 | - |
| **Total Area Certified (% total)** | | **4,646,068** | **242,906 (5.2%)** |

3.2 PSFs are currently managed under a modified Selective Management System (SMS) with the prescription of different diameter cutting limits for the dipterocarp and non-dipterocarp species group. For example, in the case of Peninsular Malaysia, a minimum diameter cutting limit of 50cm has been prescribed for Ramin (*Gonystylus bancanus*) and 55cm for all other species. It is to be noted that Ramin is listed under Appendix II of the Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES). The listing in Appendix II of CITES requires a non-detrimental study be conducted and the imposition of an export quota for Ramin.

3.3 Being natural forest which is located in many Permanent Reserved Forests, PSFs are therefore covered under the scope of forest management certification under the MTCS. However, as shown in Table 1, the extent of PSFs in the nine certified FMUs is rather minimal, comprising only 5.2% of the total natural forests in these FMUs. In Peninsular Malaysia, PSFs are confined to four certified FMUs, with the largest extent (140,830 ha or 58%) located in Pahang FMU, followed by the Selangor FMU (82,890 ha), Terengganu FMU (13,757 ha) and Johor FMU (5,429 ha). Of these four FMUs, commercial logging of PSFs have been carried out in only two FMUs i.e. the Pahang and Selangor FMUs. Both these FMUs have an integrated Forest Management Plan (FMP) for PSFs prepared through collaboration with international donor agencies.

3.4 From the certification view point, forest management planning and operations in PSFs need to comply with requirements covering social, economic and environmental aspects as stipulated in the MC&I (2002). For example, Indicator 6.2.2 of the MC&I (2002) specifies the allocation of buffer strips of at least 5m in width on either side of rivers/streams in PSFs which are marked where the felling of trees is prohibited. This aspect will be inspected by the auditors of the CB during the field audit to ensure compliance. Additionally, as Ramin is the key species harvested in PSFs and is a species listed in Appendix II of the CITES, the FMU is also required to ensure that harvesting of this species in Peninsular Malaysia complies with the export quota of 10,000$m^3$ currently imposed for Peninsular Malaysia. Annual surveillance audits are conducted to ensure the continued compliance of the certified FMUs to the requirements of MC&I (2002). In this regard, it is without doubt that forest management certification helps to enhance forest management practices in PSFs.

## 4. EXPORT OF MTCS-CERTIFIED PRODUCTS AND RECOGNITION OF THE MTCS

4.1 The first shipment of MTCS-certified timber was exported to The Netherlands in July 2002. Since then, the export of MTCS-certified timber products has shown an increasing trend, both in terms of quantity of export, as well as the number of market destinations.

4.2 The export of MTCS-certified timber products increased steadily over the years from a mere 732m$^3$ in 2002 to 96,722m$^3$ in 2011 (Figure 2). By the end of May 2012, a cumulative total of 582,743m$^3$ of MTCS-certified sawn timber, mouldings, laminated timber, finger-jointed timber, door jambs and plywood have been exported to 27 countries, i.e. The Netherlands, Belgium, Denmark, France, Germany, Italy, Norway, Poland, the United Kingdom, Australia, Greece, Indonesia, Mauritius, South Africa, South Korea, USA, Japan, New Zealand, Singapore, Ireland, Albania, Philippines, UAE, Saudi Arabia, Pakistan, Jordan and Bahrain.

4.3 On recognition, the MTCS was endorsed by *Programme for the Endorsement of Forest Certification schemes (PEFC)* on 1 May 2009 for a period of 5 years. The PEFC is presently the largest forest certification organisation in the world. The PEFC endorsement enables the MTCS to be recognised internationally which allows for mutual recognition with 30 other PEFC endorsed schemes around the world. As an endorsed scheme, MTCS-certified products are allowed to use the PEFC Logo.

4.4 As a PEFC-endorsed scheme, the MTCS is accepted under the national timber procurement policies of Denmark, United Kingdom, Germany, Finland, Belgium, Switzerland and France.

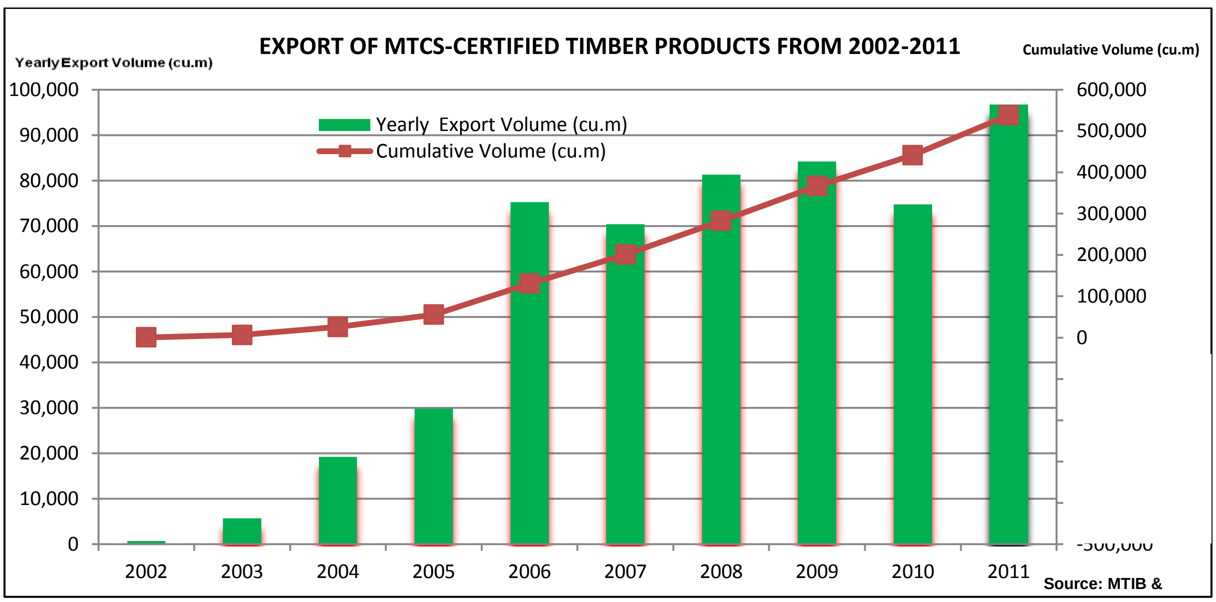


***Figure 2.*** Export of Certified Products under the MTCS

In addition, a number of authorities and organisations, particularly in key markets for Malaysia in timber products, have also accepted the MTCS as follows:

(i) The Ministry of Agriculture and Forestry, New Zealand has listed the MTCS as one of the seven certification schemes under the category "full certification" in the New Zealand Timber and Wood Products Policy (TWPP);

(ii) MTCS is listed as one of the certification schemes in the Guideline for Verification on Legality and Sustainability of Wood and Wood Products by the Forestry Agency, Ministry of Agriculture, Forestry and Fisheries, Japan;

(iii) The City of Hamburg in Germany has granted MTCS full acceptance in its procurement policy through the implementation of the MTCC-Hamburg Joint Project (December 2009);

(iv) The MTCS is accepted under *Keurhout Protocol for Sustainable Forest Management* (KH-SFM) in The Netherlands while the Dutch Ministry of Housing, Spatial Planning and Environment (VROM) has accepted the MTCS certificate as meeting the requirements for legal timber;

(v) As a PEFC-endorsed scheme, the MTCS is recognised under several green building schemes such as in Australia, Italy, Singapore, The Netherlands, UK, Canada, USA, Japan and Abu Dhabi, UAE; and

(vi) Green Building Index (GBI) in Malaysia recognises the MTCS under its Sustainable Timber criteria.

## 5. CONCLUSIONS

5.1 In operating the MTCS, MTCC's focus has been to promote the effective implementation of SFM nationally and increase the acceptance and recognition of MTCS internationally.

5.2 Just as with the other certification schemes, MTCC must continue to ensure that the MTCS keeps abreast of international and local developments related to SFM and timber certification, so that the MTCS remains credible and relevant to the interests of the different stakeholder groups as well as the market.

5.3 MTCC looks forward to continue working with all stakeholder groups towards further improvement of the MTCS, including the scientific communities on the use of new scientific and technical information pertinent to the better management of the natural forest including PSFs in Malaysia.

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# ISSUES AND OBSERVATIONS OF FORESTRY PRACTICES ON PEATLANDS: CASE ON INDONESIA'S MANDATORY CERTIFICATION

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## Abstract

Timber License Assurance System (TLAS)/Standar Verifikasi Legalitas Kayu (SVLK) is a mandatory certification mechanism, developed by the Indonesian government, to ensure that wood in Indonesia and its products come from legal sources and can be verified. There is a positive correlation between peatlands being increasingly threatened and the implementation of the mandatory certification (SVLK) by the Ministry of Forestry, Indonesia. In addition, it is important to note that the monitoring process is being done by Independent Forest Monitoring (IFM/JPIK). Therefore, it is possible that we can expect the SVLK to provide a good way to rescue PSFs.

***Keywords***: *certification, TLAS, peatland, forest monitoring*

## Background

The purpose of the Timber License Assurance System/Standar Verifikasi Legalitas Kayu (TLAS/SVLK) is to provide a reliable means to distinguish between legal and illegally produced forest products. It was developed through the European Union's (EU) Forest Law Enforcement, Governance and Trade (FLEGT) Voluntary Partnership Agreement (VPA), which is a bilateral agreement between EU and timber exporting countries, such as Indonesia, aimed at improving forest sector governance.

Although Indonesia entered into VPA negotiations with the EU in 2007, Indonesia had already started developing a legality assurance system since 2003 where stakeholders began working on a legality definition to be used to audit the forest industry. Indonesia was keen to tackle the problem of illegal logging and improve market opportunities for their timber products in response to new market regulations in the US, EU and other consumer markets. However, it was not until July 2009 that the TLAS/SVLK was completed. Indonesia only began implementing its TLAS/SVLK in September 2010 when it started a programme of audits and capacity building across the industry.

## About the TLAS

Under Voluntary Partnership Agreements (VPAs), partner countries have to develop control systems to verify the legality of their timber exports to the EU. The EU provides support to establish or improve these control systems, and once ratified and implemented the VPA is legally binding on both parties, committing them to trading only in verified legal timber products.

There are five instruments to achieve this:

1. A definition of legally-produced timber;
2. Control of the supply chain;
3. Verification;
4. Issuance of licenses; and
5. Independent monitoring of the systems.

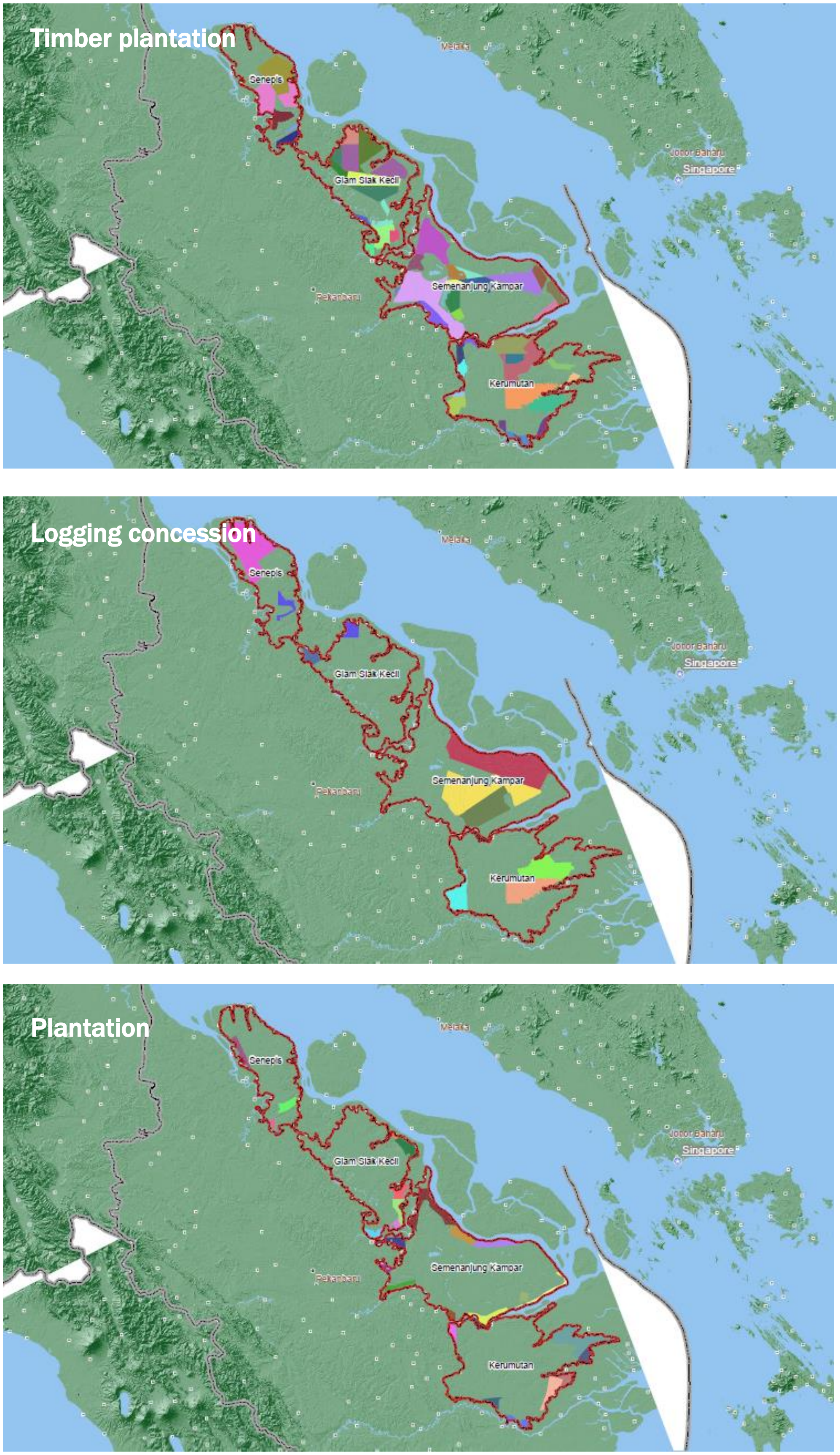


***Figure 1.*** Map of the 4 corridors of peat in Riau (outlined in red) and corresponding land use in the area

The TLAS is comprised of two main components – the Timber Legality Verification (VLK) and Sustainable Forest Management (PHPL). Through these two components, TLAS provides:

a. Assurance: legality and sustainable management
b. Improvement of forestry governance: forest destruction/illegal logging, transparency, multi-stakeholder participation, attacking corruption
c. Consumer/market responsibility to satisfy both supply and demand

### TLAS and peatlands

Peatlands are fragile and endangered ecosystems. It is vulnerable because improper use will interfere with its function, making it hard to restore, and the trend of peatland utilisation due to the expansion of logging and conversion has degraded many such ecosystems.

In the Riau Province, there are 4 million hectares of peatlands (Wetlands International, 2002) spread over 4 corridors. There are 51 timber plantation concessions covering 824,099 ha, 17 logging concessions covering 707,244 ha, and 36 palm oil concessions covering 243,611 ha (Jikalahari, 2010) (Figure 1).

### Challenges and issues

Many stakeholders are relying heavily on the TLAS to improve forest management in Indonesia. However, there are a few issues that have been observed by MIF. Firstly, obtaining a permit is a major problem and there is limited access to information, processes, and location. There are not enough procedures and communication standards for the assessment and certification process and most importantly, for peatlands, there is no peatland categorisation in certain indicators of Criterion 3 on Ecology of the Standards and Guidelines on Assessment of Performance in Sustainable Forest Management within State-owned Forests. The indicators that do not accommodate for peatlands are 3.1, 3.3 and 3.4 and these indicators are a key part of the assessment standards as this section is the only part that deals with assessing the main ecological aspects of the area. The indicators relate to:

- 3.1: Existence, stability and condition of protected areas in each forest type on the assessment indicator
- 3.2: Management and monitoring of the impact on soil and water due to forest utilisation
- 3.3: Species identification of protected and/or endangered, rare, threatened and endemic flora and fauna

### Conclusion

As a mandatory mechanism, many stakeholders are really hoping that the efforts will improve forest management in Indonesia. SVLK can potentially guarantee good forest management as well as the legal aspects of the product.

# Annexes

# Annex 1: Workshop Organising Committee

**ASEAN Secretariat**

Nathalia Marthaleta

**Global Environment Centre**

Faizal Parish
Chee Tong Yiew
Chin Sing Yun
Noor Azura Ahmad
Serena Lew Siew Yan
Drika Punud
Julia Lo Fui San
Shafinaz binti Shahabudin

**Ministry of Environment Malaysia**

Hermono Sigit
Rajimun Muslihudin
Lailan Syaufina
Huda Achsani
Sri Hastuti
Derta Yan Wijaya
Eko Pujoriyanto

# Annex 2: Workshop Programme

| Day One<br>Wednesday, 27th June 2012 | |
|---|---|
| | **Registation and Opening** |
| 0815 | Registration of participants and invited guests |
| 0850 | Arrival of guest of honor, Mr. Ir. Arief Yuwono, *M.A.*<br>Deputy Minister of Environmental Degradation Control and Climate Change, Ministry of Environment Indonesia |
| 0900 | Welcome remarks by Mr. Faizal Parish, Global Environment Centre (GEC) as Regional Project Executing Agency (RPEA) of ASEAN Peatland Forests Project (APFP) and SEApeat Project |
| 0905 | Opening address by Mr. Ir. Arief Yuwono, KLH, Indonesia and official launching of the photography competition "Our Precious Peatlands".<br>Presentation of Souvenir to the Guest of Honour |
| 0925 | Introduction to the regional efforts of Peatland Management in Peat Swamp Forests and Existing Forest Plantations on peatlands – status and trend of peatlands in Southeast Asia<br>*Mr. Faizal Parish, GEC/RPEA* |
| 0945 | Refreshments / Press conference |
| | **Session 1 : Forest Management**<br>**Moderator: Mr. Hoetomo** |
| 1015 | The current policy and status for forestry and plantations on peatlands in Indonesia<br>*Mr. Ruandha Agung Sugardiman, Ministry of Forestry, Indonesia* |
| 1035 | Policy on Protection and Management of Peatland Ecosystem in Indonesia<br>*Mr. Hermono Sigit, Ministry of Environment, Indonesia* |
| 1055 | Sustainable Forestry And Reduced Impact Logging Practices of Peat Swamp Forests In Malaysia<br>*Dr. Ismail Parlan et al., Forest Research Institute of Malaysia (FRIM)* |
| 1115 | Assessing the Success of Tropical Peatlands Restoration: A Review<br>*Mr. Alue Dohong et al., University of Palangka Raya* |
| 1135 | Giam Siak Kecil – Bukit Batu Biosphere Reserve: A public-private sector initiative for merging biodiversity conservation and sustainable use of tropical peat swamp forest<br>*Mr. Canecio P. Munoz & Mr. Haris Surono, Sinar Mas Forestry* |
| 1155 | Q & A |
| 1230 | Lunch |
| | **Session 2: Best Management Practices and Case Studies – Forest Plantation**<br>**Moderator: Mr. Ernest Chai Oi Khun** |
| 1400 | Development Of Silvicultural Techniques For Native Tree Species of Peat Swamp Forests In Indonesia<br>*Dr. Cahyo Wibowo, IPB Darmaga Bogor* |
| 1420 | Conservation and sustainable use of *Melaleuca* forests on peatlands and marsh areas in Ca Mau, Viet Nam<br>*Mr. Pham Trung Thanh, Dept of Agriculture & Rural Development, Viet Nam* |
| 1440 | Responsibly Managed Plantations On Peatland – A Positive Story<br>*Mr. Tony Wenas, APRIL Indonesia* |
| 1500 | Refreshments |

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|---|---|
| 1520 | Paper 9: Peatland Development Challenges – A Case Study from Kampar Peninsula, Riau, Indonesia<br>*Dr. John Bathgate, APRIL Group* |
| 1540 | Paper 10: Carbon budget in *A. crassicarpa* pulpwood plantations in peatland<br>*Dr. Basuki Sumawinata et al., Bogor Agricultural University* |
| 1600 | Paper 11: Plantation Forest Fire Management and Community Participative Approach<br>*Mr. Slamet Irianto, Sinar Mas Forestry* |
| 1620 | Q & A/ Discussion |
| 1900 | Welcome dinner (all participants) |

## Day Two
## Thursday, 28th June 2012

**Session 3: Best Management Practices and Case Studies – Rehabilitation**
**Moderator: Mr. Alue Dohong**

| | |
|---|---|
| 0830 | Paper 12: Peatlands Rehabilitation; constraints, limitation factors and lessons learnt<br>*Mr. Iwan Tri Cahyo Wibisono, Wetlands International Indonesia Programme* |
| 0850 | Paper 13: Agroforestry of Jelutong on Peatlands: A Lesson Learned from Central Kalimantan<br>*Dr. Lailan Syaufina, IPB Bogor* |
| 0910 | Paper 14: Proposed Restoration of Ramin (*Gonystylusbancanus*) in Peatlands in Sarawak, Malaysia<br>*Mr. Ernest Chai Oi Khun, Tropical Evergreen Enterprise* |
| 0930 | Paper 15: From carbon source to carbon sink: Large-scale rehabilitation of severely degraded peat forest in South Sumatra<br>*Mr. Sambusir Yusuf et al., Sinar Mas Forestry and Mitra-FMUs* |
| 0950 | Refreshments |
| 1010 | Paper 16: Rehabilitation of Peat Swamp Forest – Selangor Experience<br>*Mr. Badrol Hisam Abd Rahman, et al., Selangor Forestry Department Malaysia* |
| 1030 | Paper 17: Peatland Management – Experience And Research Findings in APFP Pilot Site at Bestari Jaya, Selangor, Malaysia<br>*Ms. Azian et al., Forest Research Institute Malaysia (FRIM)* |

**Session 4: Certification and Monitoring**
**Moderator: Mr. Chee Tong Yiew**

| | |
|---|---|
| 1100 | Paper 18: Lesson Learned from Forest Management Certification on Peat Land<br>*Mr. Haryanto R. Putro, IPB Bogor* |
| 1120 | Paper 19: Forest Management Certification under the MTCS with special reference to peat swamp forests<br>*Mr. Yong Teng Koon, Malaysian Timber Certification Council (MTCC)* |
| 1140 | Paper 20: Issues and observations of Forestry Practices on Peatlands – Case on Indonesia's Mandatory Certification Independent Monitoring<br>*Mr. Mohd Zainuri Hasyim, Independent Forest Monitoring Network* |
| 1200 | Q&A session |
| 1220 | Lunch |

**Break out group discussion**

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|---|---|
| 1330 | Discussion on measures to strengthen management of peat swamp forest and existing plantations on peat<br>**Break-out Group**<br>Room 1: Peat Swamp Forest Management/Rehabilitation<br>Facilitator: *Dr. Lailan Syaufina and Dr. Hendrik Segah*<br>Room 2: Existing Forest Plantations on Peat<br>Facilitator: *Mr. Faizal Parish and Mr. Chai Ah Sung* |

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|---|---|---|
| 1510 | **Tea break** | |
| 1530 | **Plenary Session**<br>Presentation Group 1<br>Presentation Group 2<br>Discussion | |
| 1630 | **Closing Remarks** | |

## Day Three
## Friday, 29th June 2012

| | |
|---|---|
| 0800 | **Visit to Bogor Botanical Garden & Palace** (optional) |
| 1100 | **End** |

# Annex 3: Participants List and Contacts

| | Name | Organisation | Email |
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