



ASEAN Peatland Forests Project | www.aseanpeat.net



Draft (30 June 2014)Rev2.4

Integrated Management Plan for North Selangor Peat Swamp Forest 2014-2023

for

Selangor State Forestry Department



Prepared by



(blank page)

PREFACE

North Selangor Peat Swamp Forest comprises of Raja Musa Forest Reserve, Sungai Karang Forest Reserve, Sungai Dusun Forest/Wildlife Reserve and part of Bukit Belata Forest Reserve Extension. It covers an area of 81,304 hectares. The Integrated Management Plan has prepared from Dec 2013 to June 2014 supported by Malaysian component of the ASEAN Peatland Forest Project (APFP) which is implemented under the framework of the ASEAN Peatland Management Strategy 2006-2020 (APMS).

This Plan significantly updates an earlier Integrated Management Plan (IMP) previously prepared with support from DANCED in 1999. The current plan will cover the next 10 years from 2014 – 2023 and incorporates the findings from a number of studies and activities undertaken through the Smart Partnership programme of the APFP Malaysia (involving the Forestry Department of Peninsular Malaysia and other partners including Forestry Department Selangor, Department of Agriculture, Department of Irrigation and Drainage, Malaysian Metereology Department, Forest Research Institute of Malaysia, University Putra Malaysia, Malaysian Nature Society, Sahabat Hutan Gambut Selangor Utara and the Global Environment Centre) between 2011 – 2014.

We wish to extent our appreciation to the members of Smart Partnership programme, staff of Selangor State Forestry Department and state government agencies and other stakeholders who give out their inputs and advice to the development of the IMP. In addition we thank the National Coordinator of APFP facilitated the various related studies and activities.

A special acknowledgement to the financial assistance given by the Global Environment Facility through the International Fund For Agriculture Development (IFAD) Cofinancing was provided by the Selangor State government and the SEApeat project funded by the European Union. Carbon assessment and hydrological surveys were supported by USAID-LEAF project. Special thanks are made to the ASEAN Secretariat for facilitating the APFP.

Faizal Parish
Director
GEC (RPEA – APFP)

Dr. Mohd Puat Bin Dahalan
Director
Selangor State Forestry Department

Dato' Prof Dr Hj Abd Rahman b. Hj. Abd Rahim
Director General, Forestry Department of Peninsular Malaysia

EXECUTIVE SUMMARY

Introduction

This document is a ten-year Integrated Management Plan for North Selangor Peat Swamp Forest for the period 2014-2023. The IMP updates an earlier plan for the period 2000-2010. It has been necessary to update the plan to reflect current conditions on the ground as several parameters/variables such as strengthened laws and a moratorium on logging have been put into place over the years. It also draws on significant studies and other activities undertaken under the Malaysian component of the ASEAN Peatland Forests Project (APFP) within the NSPSF between 2011-2014.

North Selangor Peat Swamp Forest (NSPSF) is made up of four forest reserves - Raja Musa, Sungai Dusun, Part of Bukit Belata Extension and Sungai Karang Forest Reserves. A summary on total area of NSPSF is as in Table 1.

Table 1: Total area of North Selangor Peat Swamp Forest as included in formal gazettelement documents.

No.	Forest Reserve	Size (ha)
1.	Raja Musa Forest Reserve	36,938
2.	Sungai Karang Forest Reserve	36,654
3.	Part of Bukit Belata (Extension) Forest Reserve	2,821
4.	Sungai Dusun Wildlife Reserve / Sungai Dusun Forest Reserve	4,891
	Total	81,304

NSPSF is located within the administrative Districts of Kuala Selangor, Sabak Bernam and Hulu Selangor in the northern part of Selangor State.

Management Aim and Objectives

The proposed overall management objective for the ten-year planning period is as follows:

“To maintain the geographical extent and integrity of the North Selangor Peatland Forest to sustain and rehabilitate the functions of the ecosystem as provider of goods and services for the benefit of the local and global communities.”

Specific Management Plan Objectives:

The Specific Management Plan Objectives are:

1. Re-establish the hydrological functions and the natural water balance of the NSPSF.
2. Prevent all fire occurrence and associated haze in and adjacent to NSPSF
3. Restore the Forest ecosystem of NSPSF by encouraging natural forest regeneration and where necessary supplement with planting in severely degraded sites
4. Establish a buffer zone of at least 500m width along the entire outer boundaries of the NSPSF to minimize impacts of activities in adjacent areas.
5. Develop and promote sustainable use of NSPSF including eco-tourism, harvesting of NTFP, recreation and environmental awareness, education and research
6. Promote conservation of peatland biodiversity and ecosystem functions
7. Maintain and enhance carbon stock, minimize GHG emission and develop options for carbon financing
8. Promote multi- stakeholder participation in the implementation of the IMP

Management Zones

An analysis of data and studies conducted during the project showed that some parts of the forest are degraded and need intensive work for rehabilitation whereas others have important values for conservation, ecotourism or water resources management. Thus, the area is divided into specific forest management zone each with different objectives and management prescriptions as follows:

1. Potential Production Forest

2. Rehabilitation Zone
3. Recreation/Eco-tourism and Education/Research
4. Biodiversity Conservation
5. Community Forest
6. Agroforestry Zone

The distribution between the various areas are shown in Table 2.

Table 2: Summary of overall Management Zones, NSPSF

Management Zone	Area (ha)	
	Ha	Percent
A. Potential production/water catchment forest	22,595	27.7
B. Rehabilitation zone	19,397	23.8
C. Recreation/ eco-tourism and Education/ Research	8,398	10.3
D. Biodiversity Conservation	29,141	35.7
E. Community Forestry	226	0.2
F. Agroforestry zone	1,765	2.2
Total	81,522	100

Management Approach

To maintain the water management functions and promote the natural regeneration in the forest the natural hydrological regime of the NSPSF needs to be restored by blocking up to 500km of abandoned logging canals in the forest. This will support the regeneration of the forest, reduce the emission of Greenhouse Gasses as well as the risk of fires. It will also enhance the value of the NSPSF in water supply and flood control for adjacent areas.

In order to maintain the integrity of the NSPSF it is necessary to actively control and manage activities in the adjacent areas. Activities such as mining, agriculture and plantations in adjacent land can lead to significant negative impacts on the NSPSF including overdrainage and fires. As a result, land in a zone one kilometer wide along the entire

outer boundary of the forest reserves covering an area of 15,000 ha has been prescribed as a formal buffer zone in line with the Malaysian National Physical plan and the Selangor State Structure Plan (2020). A separate but complementary Buffer Zone Management Plan has been developed to guide the management of this zone.

A major threat to the NSPSF is fire which has impacted more than 5000 ha of the forest over the past 10-15 years. Fires lead to loss of forest resources, biodiversity and generate GHG emissions and smoke which affect the health of local communities. The fires also lead to economic losses costing of tens of millions of RM. Fires can only be prevented by working in an integrated manner in partnership with government agencies, local communities and the private sector. A separate Cooperative Fire Management Plan has been developed as a key part of the IMP to guide activities by a range of partners to prevent and control fires both within and adjacent to the NSPSF.

With estimated population of more 10,000 people living in more than 10 villages adjacent to the NSPSF engagement of local communities will be an important component in the management of the IMP. One of the objectives of the Buffer Zone Management is to integrate the community into the forest management activities carried out in NSPSF, foster goodwill and understanding amongst the community. Communities should also play a key role in the Cooperative Fire Management Plan.

The state government needs to review and approve this plan and to allocate or generate adequate resources to support its implementation. Sources of funds to support implementation include State budgets, Federal funding as well as grants from international sources such as ASEAN, GEF and the European Union. Funds can also be developed through development of Carbon financing projects as well as generating private sector support through CSR and partnership activities.

RINGKASAN EKSEKUTIF

Pengenalan

Dokumen ini adalah Pelan Pengurusan Bersepadu (IMP) sepuluh tahun bagi Hutan Paya Gambut Selangor Utara bagi tempoh 2014-2023. IMP ini mengemaskini pelan awal bagi tempoh 2000-2010. Adalah perlu untuk mengemaskinikan pelan itu bagi mencerminkan keadaan semasa di lapangan dimana beberapa parameter / pembolehubah seperti pengukuhan undang-undang dan moratorium pembalakan yang telah dijalankan. Ia juga mengambilkira kajian-kajian penting dan aktiviti-aktiviti lain yang dijalankan di bawah Projek APFP komponen Malaysia di NSPSF dari 2011-2014.

Hutan Paya Gambut Selangor Utara (NSPSF) terdiri daripada empat hutan simpan - Hutan Simpan Raja Musa, Hutan Simpan Sungai Karang, Hutan Simpan Bukit Belata Tambahan (sebahagian) dan Hutan Simpan Sungai Dusun. Ringkasan jumlah kawasan NSPSF adalah seperti di Jadual 1.

Jadual 1: Jumlah kawasan Hutan Paya Gambut Selangor Utara seperti yang diwartakan:

No.	Forest Reserve	Size (ha)
1.	Hutan Simpan Raja Musa	36,938
2.	Sungai Karang Forest Reserve	36,654
3.	Hutan Simpan Bukit Belata Tambahan (sebahagian)	2,821
4.	Hutan Simpan Sungai Dusun	4,891
	Total	81,304

NSPSF terletak dibawah pentadbiran 3 daerah iaitu Dearah Kuala Selangor, Dearah Sabak Bernam dan Dearah Hulu Selangor.

Matlamat dan Objektif Pengurusan

Objektif keseluruhan pengurusan yang dicadangkan bagi tempoh perancangan sepuluh tahun adalah seperti berikut:

"Untuk mengekalkan kawasan geografi dan integriti Hutan Paya Gambut Selangor Utara untuk mengekalkan dan memulihkan fungsi ekosistem sebagai pembekal sumber dan perkhidmatan bagi manfaat masyarakat tempatan dan global."

Objektif Khusus Pelan Pengurusan:

Objektif Khusus Pelan Pengurusan adalah:

1. mewujudkan semula fungsi hidrologi dan keseimbangan air semula jadi di NSPSF
2. Elakkan semua kejadian kebakaran dan jerebu yang berkaitan di dalam dan di kawasan yang bersebelahan dengan NSPSF
3. Memulihkan ekosistem hutan NSPSF dengan menggalakkan pertumbuhan semula hutan semula jadi dan jikalau perlu menanam pokok di kawasan yang terosot.
4. Mewujudkan zon penampan sekurang-kurangnya 500 meter lebar di sepanjang sempadan luar NSPSF untuk mengurangkan impak aktiviti di kawasan bersebelahan
5. Membangun dan menggalakkan penggunaan lestari NSPSF termasuk eko-pelancongan, pengambilan hasil hutan tidak berkayu, rekreasi dan kesedaran alam sekitar, pendidikan dan penyelidikan
6. Menggalakkan pemuliharaan biodiversiti tanah gambut dan fungsi ekosistem
7. Mengekalkan dan meningkatkan stok karbon, mengurangkan pelepasan GHG dan membangunkan pilihan pembiayaan karbon
8. Menggalakkan penyertaan pelbagai pihak berkepentingan dalam pelaksanaan IMP

Zon Pengurusan

Analisa data dan kajian yang dijalankan semasa projek menunjukkan bahawa beberapa bahagian hutan telah terosot dan memerlukan kerja pemulihan yang intensif manakala kawasan yang lain mempunyai nilai-nilai penting bagi pemuliharaan, eko-pelancongan atau pengurusan sumber air. Oleh itu, kawasan ini dibahagikan kepada zon-zon pengurusan tertentu dan masing-masing dengan tujuan dan kaedah pengurusan yang berbeza seperti berikut:

1. Hutan Produksi yang berpotensi
2. Zon Pemuliharaan
3. Rekreasi/Eco-pelancongan dan Pendidikan/ Penyelidikan
4. Pemeliharaan Biodiversiti
5. Hutan Komuniti
6. Zone Perhutani

Pengagihan zon –zon adalah seperti di jadual 2.

Jadual 2: Ringkasan Pengurusan Zon keseluruhan, NSPSF

Zon Pengurusan	Keluasan (ha)	
	Ha	Percent
A. Hutan Produksi yang berpotensi /hutan tadahan air	22,595	27.7
B. Zon Pemuliharaan	19,397	23.8
C. Rekreasi/Eco-pelancongan dan Pendidikan/ Penyelidikan	8,398	10.3
D. Pemeliharaan Biodiversiti	29,141	35.7
E. Hutan Komuniti	226	0.2
F. Zone Perhutani	1,765	2.2
Total	81,522	100

Pendekatan Pengurusan

Untuk mengekalkan fungsi pengurusan air dan menggalakkan pertumbuhan semula semula jadi di hutan, regim hidrologi semula jadi NSPSF perlu dipulihkan dengan menyekat sehingga 500km terusan pembalakan yang ada di dalam hutan. Ini akan menyokong pertumbuhan semula hutan, mengurangkan pelepasan gas rumah hijau serta mengurangkan risiko kebakaran. Ia juga akan meningkatkan nilai NSPSF dalam bekalan air dan kawalan banjir bagi kawasan bersebelahan.

Dalam usaha untuk mengekalkan integriti NSPSF ini, adalah perlu untuk mengawal dan menguruskan secara aktif aktiviti-aktiviti di kawasan bersebelahan. Aktiviti-aktiviti seperti perlombongan, pertanian dan perladangan di tanah bersebelahan boleh membawa kepada kesan yang ketara pada NSPSF termasuk saluran yang berlebihan dan kebakaran. Oleh itu kegunaan tanah dalam zon 1km dari sempadan hutan simpan di sekeliling NSPSF yang meliputi kawasan seluas 15,000 ha telah dinilai dan zon penampakan sekurang-kurangnya 1000 meter telah ditetapkan selaras dengan Rancangan Fizikal Negara Malaysia dan Rancangan Struktur Negeri Selangor (2020). Pelan pengurusan Zon Penampakan berasingan tetapi saling melengkapi telah dibangunkan untuk membimbing pengurusan zon ini

Ancaman utama kepada NSPSF adalah kebakaran hutan yang telah memberi kesan kepada lebih daripada 5000 hektar hutan dalam tempoh 10-15 tahun yang lalu. Kebakaran menyebabkan kehilangan sumber hutan, kepelbagaian biologi dan menjana pelepasan GHG dan asap yang memberi kesan buruk kepada masyarakat tempatan. Kebakaran juga membawa kepada kerugian ekonomi sebanyak RM 10-juta. Kebakaran hanya boleh dicegah dengan bekerja secara bersepadu dengan agensi-agensinya kerajaan, masyarakat setempat dan sektor swasta. Satu plan yang berasingan iaitu Pelan Pengurusan Bersama Kebakaran telah dibangunkan sebagai satu bahagian penting dalam IMP untuk membimbing aktiviti-aktiviti dari pelbagai rakan kongsi bagi mencegah dan mengawal kebakaran di dalam dan di kawasan bersebelahan dengan NSPSF.

Dengan penduduk yang dianggarkan berjumlah lebih 10,000 orang yang tinggal di lebih daripada 10 kampung bersebelahan dengan NSPSF, penglibatan komuniti tempatan akan menjadi satu komponen penting dalam pengurusan IMP. Salah satu objektif Pengurusan Zon Penampian adalah untuk mengintegrasikan masyarakat ke dalam aktiviti-aktiviti pengurusan hutan yang dijalankan di NSPSF, mumupuk muhibah dan pemahaman di kalangan masyarakat. Komuniti juga perlu memainkan peranan utama dalam Rancangan Pengurusan Kebakaran Bersama.

Kerajaan negeri perlu mengkaji semula dan meluluskan pelan ini dan memperuntukan atau menjana sumber yang mencukupi untuk menyokong pelaksanaannya. Sumber dana untuk menyokong pelaksanaan termasuklah belanjawan Negeri, peruntukan dari Persekutuan, dan juga geran daripada sumber antarabangsa seperti ASEAN, GEF dan Kesatuan Eropah. Dana juga boleh dibangunkan melalui pembangunan projek-projek pembiayaan Karbon serta menjana sokongan sektor swasta melalui aktiviti-aktiviti CSR.

Table of Contents

PREFACE	iii
EXECUTIVE SUMMARY	iv
RINGKASAN EKSEKUTIF	viii
List of Tables	xviii
List of Figures	xix
List of Abbreviations.....	xx
1 Introduction	1
1.1 Background	1
1.2 Purpose	2
1.3 Scope, Methodology and Approach	2
1.4 Structure	4
2. Legal and Administrative Framework	5
2.1 Legislation	5
2.1.1 Federal and State Jurisdiction	5
2.1.2 Legislation of Relevance to Management of Peat Swamp Forests	6
2.2 Administrative Framework	9
2.2.1 Federal Level	9
2.2.2 State Level	11
2.3 International Conventions & Agreements.....	15
a) ASEAN Agreement on Transboundary Haze Pollution.....	15
b) ASEAN Peatland Management Strategy, APMS	15
c) Convention of Biological Diversity (CBD)	16
d) Convention on Wetlands of International Importance or Ramsar Convention.....	16
2.4 National Policies and Strategies	17
a) National Action Plan for Peatlands, NAPP 2011	17
b) National Policy on Climate Change, NPCC 2010	17
c) Common Vision on Biodiversity 2009.....	17
c) National Physical Plan, NPP 2010	18
d) National Wetland Policy 2004	19
e) National Agriculture Policy	19
f) National Policy on the Environment 2002.....	19
g) National Policy on Biological Diversity 1998.....	20

h)	National Forest Policy 1978, Amended 1992	20
2.5	State Policies.....	21
a)	Selangor Forestry Management Plan 2011-2020 with specific reference to peat swamp forest management	21
b)	Malaysia Criteria, Indicators, Activities and Standards of Performance (MC&I) for Forest Management Certification (MC&I)	21
2.6	Vision, Mission and Goal of Selangor State Forestry Department.....	21
3.	Biophysical Description of The North Selangor Peat Swamp Forest	23
3.1	Site description	23
3.1.1	Location and Geographical Extent	23
3.1.2	Climate.....	24
3.1.3	Geology:	27
3.1.4	Peat Characteristics	27
3.2.1	Drainage canal of NSPSF	30
a)	Water table:	31
3.2.2	Water balance.....	37
3.2.3	Water quality	38
3.3	Vegetation	39
3.4	Fauna	43
3.4.1	Mammals	43
3.4.2	Birds.....	45
3.4.3	Fish.....	46
3.5	Forest Classification Based on Remote sensing.....	48
3.6	Forest Management Inventory	51
	Results of the Forest Management Inventory in 1999	51
	Stand Composition.....	51
	Summary of Findings from the Forest management inventory	54
4	The Socio- Survey On Importance Of Peat Swamforest Ecosystem To Local Communities Adjacent To Raja Musa Forest Reserve.....	55
4.1	Introduction of North Selangor Peat Swamp Forest & Utilization.....	55
4.2	Introduction of the socio-economic study	56
4.3	Historical utilization of NSPSF (including RMFR)	56
4.4	Methodology	57
4.3.1	Techniques of Data Collection	57

4.3.2 Selection of Study Area.....	58
4.4 Result and Discussions.....	62
4.4.1 Section A	62
4.4.2 Section B (perception & views).....	63
4.4.3 Section C (Investigation on proposed future development in PSF)	68
4.4.3 Section D (Respondents option in General)	70
5. Past and Present Management.....	73
5.1 Historic Overview of Land Uses.....	73
5.1.1 Logging.....	73
5.1.2 Land Clearing for Farming	74
5.1.3 Tin Mining	75
5.2 Present Uses.....	75
5.2.1 Forest reserve.....	76
5.2.2 Adjacent area.....	77
5.3 From State Land to Permanent Forest Estate	80
5.3.1 Environmental Action Plan for North Selangor Peat Swamp Forest	80
5.3.2 Selangor State Action Plan for Peatlands (SAPP)	82
5.4 Implications for Future Management.....	83
5.4.1 Legal and Administrative Requirements.....	83
5.4.2 Biophysical Context.....	84
5.4.3 Socio-Economic Context	84
5.4.4 <i>Sustainability Permanent Forest Reserve (Moratorium)</i>	85
6 Forest Management Plan 2014- 2023	86
6.1 Objectives and Strategies.....	86
6.1.1 National Level	86
6.1.2 Overall Management Plan Objective	87
6.1.3 Specific Management Plan Objectives	89
6.1.4 Summary of Objectives and Strategies	95
6.2 Forest Zoning.....	100
6.2.1 Management Zones	100
6.2.2 Criteria for Location of Management Zones	102
6.2.3 Specific Location of Management Zones	103
6.3 Management Prescriptions Applicable to All Management Zones.....	112

6.3.1 Peat Hydrological Management	112
6.3.2 Cooperative Fire Management Plan for NSPSF	116
a) Fire Prevention	121
b) FIRE PREPAREDNESS STRATEGIES	123
c) FIRE RESPONSE STRATEGIES	125
d) POST FIRE RECOVERY STRATEGIES.....	127
6.3.3 The Rehabilitation Plan of Severely Degraded Areas in NSPSF	133
6.4 Buffer Zone Management Plan for NSPSF	136
6.4.1 Proposed management strategies for buffer zone management adjacent to NSPSF	137
6.5 Boundary Demarcation	144
External Boundaries:.....	144
6.6 Management prescription applicable to specific zones	145
A. Potential Production Forest/Water Catchment Forest	145
B. Rehabilitation Zone.....	145
C. Biodiversity Conservation	146
D. Recreation/Eco-tourism , Education, and Research.....	147
E. Community Forestry	150
7. Implementation	152
7.1 Administrative and Organisational Measures.....	152
7.1.1 Organisation and Staffing.....	152
7.1.2 Inter-Agency Co-Operation	157
7.1.2 Stakeholder Engagement.....	158
7.1.3 Human Resources Development.....	159
7.2 Operational Measures	160
7.2.1 Protection.....	160
7.2.2 Blocking of Old Logging Canals	161
7.2.3 Recreation, Eco-tourism, Education and Research	161
7.2.4 Conservation.....	162
7.2.5 Buffer Zone Management Plan.....	163
7.2.6 Cooperative Fire Management Plan.....	164
7.2.7 Rehabilitation Plan	167
7.2.8 Carbon Project	167

7.3 Management Planning.....	168
7.3.1 Monitoring and Record Keeping	168
7.3.2 Annual Operation Plans (AOP).....	168
7.3.3 Annual Report	169
7.3.4 Mid-Term Review of The Ten-Year Management Plan.....	169
8. References	170

List of Tables

Table 2-1: Federal, State, and Concurrent Lists of the Malaysian Constitution of relevance to the management of Peat Swamp Forest.....	6
Table 2-2: Functional classes in Permanent Forest Estates, as prescribed in the National Forestry Act	7
Table 2-3: prescribed activities of special relevance for Peat Swamp Forests from the Environmental Quality (prescribed activities) (environmental impact assessment) order 1987 ...	7
Table 2-4: Key agencies at state level.....	11
Table 2-5: Rank and Criteria under ESA (From National physical Plan 2010)	19
Table 2-6: Classification of Permanent Forest Estate to major functions, as stipulated in the National Forest Policy	20
Table 2-7: Vision, Mission, and Objectives for Selangor State Forestry Department	22
Table 3-1: Forest Reserves and area in the NSPSF	23
Table 3-2: Details of the piezometer established in NSPSF in 2013-14.....	31
Table 3-3: Water Balance of NSPSF	38
Table 3-4: mean value/ concentration and standard deviation (in brackets) of water quality in NSPSF.....	38
Table 3-5: Finding from flora survey during the scientific expedition.....	39
Table 3-6: Findings of species composition/diversity of peat swamp forests in Peninsular Malaysia.....	39
Table 3-7: Tree species found in NSPSF (Modifeid from Appanah et al, 1999, Salleh et al., 2013, Lo, 2013 and Chew et al., 2013)	40
Table 3-8: Mammals found in NSPSF(based on PERHILITAN 2004 and survey during scientific expedition)	44
Table 3-9: Fish species recorded from ditches along the roadsides on the northern boundary of NSPSF.....	46
Table 3-10: Forest Type comparison for 1998and 2014 for Sungai Karang FR dan Raja Musa FR.....	48
Table 3-11: Tree Distribution per ha by Size Classes within Forest Classes	51
Table 3-12: Basal area in square metres per ha.....	52
Table 3-13: Dominant tree species in the seven Forest Classes.....	53
Table 4-1: Breakdown of respondents.....	57
Table 4-2: Categories of total population of Bestari Jaya Village	58
Table 4-3: Economic activities of Bestari Jaya Village.....	59
Table 4-4: Categories of total population of Raja Musa Village	59
Table 4-5: Economic activities of Raja Musa Village	59
Table 4-6: Categories of total population of Ampangan Village	60
Table 4-7: Economic activities of Ampangan Village	60
Table 4-8: Categories of total population of Sri Tiram Jaya Village.....	60
Table 4-9: Economic activities of Sri Tiram Jaya Village	60
Table 4-10: Other villagers that were also interviewed at the vicinity of the Raja Musa Forest Reserve	61
Table 4-11: Goods & Services Valued at Raja Musa Forest Reserve.....	65

Table 5-1: Landuse type in 1km buffer zone	79
Table 5-2: List of recommended future actions to be taken in the NSPSF (Prentice, 1990).....	81
<i>Table 6-1: Summary of Objectives and Strategies</i>	95
Table 6-2: Forest Management Zones, Specific and General Objectives of each ZoneManagement Zone:	100
Table 6-3: Forest Management Zones, Functions and Functional Classes	102
Table 6-4: Criteria for selection of sites for the Six Management Zones in the NSPSF.....	103
Table 6-5: Summary of specific Management Zones for NSPSF.....	105
Table 6-6: proposed management measures for the different zones.....	108
Table 6-7: Summary of overall Management Zones, NSPSF	111
Table 6-8: Detailed description of each high fire risk area	128
Table 7-1: Organisation and staffing requirement within the administration and management of the NSPSF	153
Table 7-2: Buildings and Equipment required within the implementation of IMP	156
Table 7-3: Proposed member of the NSPSF IMP sub-committee.....	158
Table 7-4: Proposed responsibilities for range/ sub-range office	160
Table 7-5: Proposed Nature of Buffer Zone.....	163

List of Figures

Figure 3-1: Map of NSPSF showing four forest reserves and landuse adjacent to forest reserve	24
Figure 3-2: Annual rainfall at Raja Musa Estate Station (a)(MMD, 2013) and Annual precipitation for the NSPSF area determined from bias corrected TRMM satellite precipitation for 2003-2013 (b) (Vernimmen, 2014)	25
Figure 3-3: Average monthly rainfall at Raja Musa Estate Station(a) (MMD, 2013) and Average monthly precipitation for the NSPSF area determined from bias corrected TRMM satellite precipitation for 2003-2013, (b) (Vernimmen, 2014)	26
Figure 3-4: Peat depth map of NSPSF	28
Figure 3-5: Map of NSPSF showing the canals network and 6 locations of the piezometer.....	30
Figure 3-6: water table depth at JSP from Dec 2013 to June 2014	32
Figure 3-7: water table depth at TSD from Dec 2013 to June 2014.....	32
Figure 3-8: water table depth at P4R_S from Dec 2013 to June 2014.....	33
Figure 3-9: water table depth at P4R_S from Dec 2013 to Feb 2014	33
Figure 3-10: water table depth at TC_W from Dec 2013 to June 2014	34
Figure 3-11: water table depth at TC_E from Dec 2013 to June 2014	34
Figure 3-12: water table depth at KASB from Dec 2013 to June 2014.....	35
Figure 3-13: water table depth at JHD from Dec 2013 to June 2014	36
Figure 3-14: Forest Type map of NSPSF, 1999 and 2014.....	50
Figure 4-1: Location of the four villages studied (Source from Kuala Selangor District Office)...	58
Figure 4-2: Percentage of occupation by respondents in the four villages	62

Figure 4-3: Percentage of Goods & Services of the Raja Musa Forest Reserve (RMFR) by local communities (respondents) in the four villages.....	63
Figure 4-4: Problems identified by community affecting Raja Musa Forest Reserve	66
Figure 4-5: The respondent's views different future uses of the peat swamp forest.....	68
Figure 6-1: Map of Forest Management Zones of NSPSF	104
Figure 6-2: Map of NSPSF showing networks of drainage canals	112
Figure 6-3: Map of fire risk area for NSPSF	118
NSPSF is divided into 10 fire management zones (refer to Figure 6-4) based upon the following:	120
Figure 6-5: Map of Landuse of Buffer zone for NSPSF	143
Figure 7-1: Map showing the proposed locations of the sub-range office forest, guard post, watch tower, pump house and eco-tourism entry point.....	156
Figure 7-2: Diagram of forest fire management organisation chart for NSPSF	166

List of Abbreviations

AOP	Annual Operation Plans
APFP	ASEAN Peatland Forest Project
APMS	ASEAN Peatland Management Strategy
BMP	Best Management Practices
CBD	Convention of Biological Diversity
CFMP	Cooperative Fire Management Plan
CITES	International Trade Convention for Endangered Animal Species and Wild Plants
CSR	Corporate Social Responsibility
DANCED	Danish Cooperation for Environment and Development
DFO	District Forest Officer
DID	Department of Irrigation and Drainage
DLP	District Local Plans
DOA	Department of Agriculture
DOE	Department of Environment
DOH	Department of Health
DOHS	District Office of Hulu Selangor
DOKS	District Office of Kuala Selangor
DOSB	District Office of Sabak Bernam
DTCP	Department of Town and Country Planning
EIA	Environmental Impact Assessment
EPU	Economic Planning Unit
ESA	Environmentally Sensitive Area
EXCO	Executive Council
FDPM	Forestry Department of Peninsular Malaysia
FDRS	Fire Danger Rating System
FMU	Forest Management Unit

FR	Forest Reserve
FRIM	Forest Research Institute of Malaysia
GAPP	Guidelines for Global Action on Peatlands
GEC	Global Environment Centre
GEF	Global Environment Facility
GHG	Greenhouse Gas
HORAS	Hybrid of River Augmentation System
IADA Baratlaut	Integrated Agriculture Development Area of Northwest Selangor Project
ICM	Integrated Coastal Management
ICS	Incident Command System
IFAD	International Fund for Agricultural Development
IMP	Integrated Management Plan
IRBM	Integrated River Basin Management
KDEB	Kumpulan Darul Ehsan Berhad
KeTTHA	Ministry of Energy, Green Technology and Water
LDO	Land and District Office
LPA	Local Planning Authority
LUAS	Selangor Water Management Authority
MBI	Menteri Besar Incorporation
MC&I	Malaysia Criteria, Indicators, Activities and Standards of Performance
MDHS	Majlis Daerah Hulu Selangor (District Council)
MDKS	Majlis Daerah Kuala Selangor (District Council)
MDSB	Majlis Daerah Sabak Bernam (District Council)
MES	Merakyatkan Ekonomi Selangor
MMD	Malaysian Meteorological Department
NAPP	National Action Plan for Peatlands
NPCC	National Policy on Climate Change
MPIC	Ministry of Plantation Industries and Commodities
NPP	National Physical Plan
NRE	Ministry of Natural Resources and the Environment
NSPSF	North Selangor Peat Swamp Forest
NWFP	Non Wood Forest Products
PA	Protected Area
PERHILITAN/DWNP	Department of Wildlife and National Parks
PKPS	Selangor Agricultural Development Corporation
PRF	Permanent Reserved Forests
PSF	Peat Swamp Forest
REDD+	Reduced Emissions from Deforestation and Forest Degradation
RMFR	Raja Musa Forest Reserve
SAPP	Selangor State Action Plan for Peatlands
SDWR	Sungai Dusun Wildlife Reserve
SHGSU	Sahabat Hutan Gambut Selangor Utara
SEMESTA	Kumpulan SEMESTA Sendirian Berhad

SKFR	Sungai Karang Forest Reserve
SOP	Standard Operating Procedure
SSFD	Selangor State Forestry Department
SSFRD	Selangor State Fire and Rescue Department
SSSP	Selangor State Structure Plan
UM	University of Malaya
UNISEL	University of Selangor
UPEN	Selangor State Economic Planning Unit
UPM	Universiti Putra Malaysia
WWF	World Wide Fund For Nature

1 Introduction

1.1 Background

This updated Integrated Management Plan (IMP) for the North Selangor Peat Swamp Forest (NSPSF) 2014-2023 expands on the 2001-2010 IMP which was developed with support of the Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forests in 2000.

The existing IMP has provided the Selangor State Forest Department with a framework for managing the North Selangor Peat Swamp Forest for more than 10 years. During this time, several changes have taken place.

In 2010, Malaysia became part of a regional initiative to enhance conservation and sustainable management of peatland forests in Southeast Asia, called the ASEAN Peatland Forest Project or APFP. Countries involved in this project are Indonesia, Malaysia, Philippines and Vietnam. The project was funded by the Global Environment Facility (GEF) through the International Fund for Agricultural Development (IFAD). The Malaysian component is led by the Forestry Department of Peninsular Malaysia (FDPM). The North Selangor Peat Swamp Forest is the main pilot site, managed by the Selangor State Forestry Department (SSFD).

In 2011, the project on the Sustainable Management of Peatland Forests in Southeast Asia (SEApeat), funded by the European Union (EU) and led by GEC was initiated. This project supports activities in all 10 ASEAN member states. In Malaysia, it supports work on NSPSF in partnership with APFP, but with a focus on community involvement and development.

Through these 2 projects, many positive developments have been achieved in enhancing the sustainable management of the NSPSF area. Therefore, an updated IMP was in order.

In December 2013, Global Environment Centre (GEC), a Malaysian environmental NGO, which is also the Regional Project Executing agency for APFP and SEApeat projects, was appointed by the Forestry Department of Peninsular Malaysia (FDPM) to review and update the existing IMP for NSPSF. The objective of this review is to enable preparation of an updated Integrated Management Plan for North Selangor Peat Swamp Forest for the period 2014-2023 with special consideration of rehabilitation of degraded areas; fire prevention and control as well as buffer zone management.

1.2 Purpose

The updating of the NSPSF Integrated Management Plan (IMP) has been made necessary due to several factors. One is the end of the timeframe for the existing document; and the other is changes that have happened over the years, creating a need for an updated management plan. For example, an indefinite moratorium was put into place in 2010 to stop all logging activities in Selangor State. In addition the prevalence of forest fires within and adjacent to NSPSF has increased linked to increasing pressure for development of adjacent lands. Significant experience has also been gained over the past 10 years on the options for rehabilitation of degraded portions of the forest. Furthermore, the cooperation with several governmental agencies and local communities had been strengthened, which should be incorporated into the management plan

The definition of North Selangor Peat Swamp Forest area has also been expanded in this IMP to include Bukit Belata extension and Sg Dusun Forest Reserve -so as to create a complete and more effective management unit (refer details in Chapter 3).

The National Physical Plan (NPP) adopted in 2005 and the Selangor State Structure Plan (SSSP) adopted in 2007 have both specified the need for a 1km wide buffer zone around the NSPSF where development activities are restricted. This important requirement needs to be incorporated in to the management plan.

1.3 Scope, Methodology and Approach

The scope of the review was as follows:-

Review and update the Integrated Management Plan for North Selangor Peat Swamp Forest (2001-2010) as a guide for the preparation of the Integrated Management Plan for North Selangor Peat Swamp Forest (2014-2023) .

- i. Gather information on the impact of socio-economic activities in the buffer zone area and develop management strategies; including
 - The designated buffer zone area 1 km beyond the outer boundary of Permanent Forest Reserve;
 - Identify patterns of economic livelihood activities (agriculture, urban development, farming, etc.) along the outer border of peatlands and propose mitigation measures to reduce impact in the buffer zone (forest recovery, better agricultural management, eco-zone to reduce peat fires, etc.);
 - Provide strategic buffer zone management plans as well as address land use conflicts and assist in the implementation of relevant activities.

- ii. Evaluation of fire prone areas and propose preventive and remedial measures;
 - Identify fire-prone areas to confirm the signs of fire and identify new hotspots;
 - Recommend fire prevention plan and fire control procedures (SOPs) for each fire prone area;
 - Provide an updated fire management plan which includes a fire hazard map;
- iii. Preparing a rehabilitation plan for North Selangor Peat Swamp Forest, including buffer zones, especially for degraded areas (encroached and fire prone areas);
- iv. Integrate the results of other studies or the latest information related to the North Selangor Peat Swamp Forest implemented under APFP including the following activities;
 - Report on the best management practices for peatlands;
 - Report on the inventory of North Selangor Peat Swamp Forests under the 5th National Forest Inventory (2012-2014) by Peninsular Malaysia Forest Department;
 - Report on the trends and changes in peatland use in Selangor through satellite/ remote sensing;
 - Report on the North Selangor Peat Swamp Forest Scientific and Bio-D Expedition; and
 - Report on the involvement of community and local land owners in rehabilitation programmes;
- v. Gather relevant secondary data from 2011 to 2013 for the preparation of the Integrated Management Plan for North Selangor Peat Swamp Forest (2014-2023)

The IMP was prepared using a participatory approach. The plan preparation was guided by the Selangor State Forestry Department and Forestry Department of Peninsular Malaysia with specific inputs from a number of agencies working under the APFP Smart Partnership Programme including Department of Agriculture, Department of Irrigation and Drainage, Malaysian Meteorology Department, Forest Research Institute of Malaysia, University Putra Malaysia, Malaysian Nature Society, Sahabat Hutan Gambut Selangor Utara and the Global Environment Centre. Five stakeholder consultations were organized at state and district level between November 2013 and June 2014 to enable inputs to be provided by a broad range of state and local stakeholders. Stakeholder participating in the meetings included Respective District Offices and District Township Councils (Kuala Selangor, Hulu Selangor and Sabak Bernam), Department of Wildlife and National Park, Malaysia, Economic Planning Unit, Federal Department of Town and Country Planning Peninsular Malaysia, Fire and Rescue Department, Minerals and Geoscience Department, Malaysian Palm Oil Board, Public Work Department, Department of Environment, Department of Veterinary and Services, Selangor Agriculture Development Corporation, FELDA, LUAS, IADA, Kumpulan Darul Ehsan Bhd, Kumpulan Semesta Sdn Bhd., Sime Darby Plantation and Peers Consult (M) Sdn Bhd

1.4 Structure

The structure of this updated document broadly follows the original IMP.

Chapter 2 provides the legal and administrative framework for the Management plan at local, state, national and international level. Chapter 3 gives a biophysical description of the North Selangor Peat Swamp Forest. Chapter 4 describes the social and economic context, and Chapter 5 is a record of past and present management practices in the peat swamp forest.

Based on the status provided in chapters 2 to 5, Chapter 6 and 7 constitute the operational part of the Management Plan. Chapter 6 contains the management objectives for the next ten-year period and descriptions of interventions related to all aspects of forest management are provided. Chapter 7 gives the details of the measures required to implement the plan, and a schedule for the different actions to be taken. Finally, the framework for monitoring and control of the implementation is described.

All sections of the plan have been updated based on the latest available information.

Chapter 2 Legal and Administrative Framework

2. Legal and Administrative Framework

Any proposed forest management plan must fit into the legal and administrative framework of Malaysia to be of practical relevance. Chapter 2 describes selected laws, institution and bodies and their work, as well as local and international policies and strategies that are of relevance for management of peat swamp forest.

2.1 Legislation

2.1.1 Federal and State Jurisdiction

The Malaysian Constitution and Federal and State Government policies provide the framework for Malaysia's legislation. The Constitution divides legislative responsibilities between the Federal and State Governments. Government policies determine if existing legislation should be retained or new legislation introduced.

The Ninth Schedule of the Malaysian Constitution contains three lists that correspond to Federal, State, and Concurrent level. The Federal Government can make laws related to subjects on the Federal and Concurrent lists. State Governments may legislate on subjects included on the State and Concurrent lists. However, the Federal Parliament may make laws on subjects included on the State List in order to promote uniformity of the laws between two or more states. To become effective, respective State Legislatures must adopt and gazette such legislation

Table 2-1: Federal, State, and Concurrent Lists of the Malaysian Constitution of relevance to the management of Peat Swamp Forest

List	Legislative powers related to:
Federal List	Trade, commerce and industry Communication and transport
State List	Land Agriculture and Forestry Local Government Mining
Concurrent List	National parks Water supplies and services, preservation of heritage Protection of wild animals and birds

The North Selangor Peat Swamp Forest is under the jurisdiction of Selangor State Forestry Department, and is as such under the control of the State Government of Selangor. However, as demonstrated in Table 2.1, Federal laws may apply certain aspects of the management of the area. Hence, from a legal perspective, the State of Selangor must make sure that planned intervention are within the limits of and along the lines of relevant Federal Legislation.

2.1.2 Legislation of Relevance to Management of Peat Swamp Forests

Several Acts and Codes are relevant to development of management plans for Peat Swamp Forests. Of particular relevance are the National Forestry Act of 1984 and the Environmental Quality Act of 1974.

Other relevant Codes and Acts are The National Land Code of 1965; the Town and Country Planing Act of 1976; and the Local Government Act of 1976. Together, the three Acts and Codes form the basis of land laws and administration in Peninsular Malaysia.

a) The National Forestry Act

The National Forestry Act of 1984 was formulated to update and standardize the various State Forest Enactments already in place, and to facilitate the implementation of the National Forest Policy. The Act was amended in 1993 to strengthen its provisions to curb illegal encroachment of forests and theft of timber, and the State Governments later adopted the amended Act.

Under Section 10 of the National Forestry Act, the states may decide to classify existing Permanent Forest Estate into different functional classes. The State Forestry Department is responsible for drafting the classification, and to become effective the State must gazette the classes. The 11 functional classes are shown in Table 2.2 below.

Table 2-2: Functional classes in Permanent Forest Estates, as prescribed in the National Forestry Act

Class Number	Description of Type and Function of Forest Class:
1	Timber Production Forest, Sustained Yield
2	Soil Protection Forest
3	Soil Reclamation Forest
4	Flood Control
5	Water Catchment Forest
6	Forest Sanctuary for Wildlife
7	Virgin Jungle Reserve Forest
8	Amenity/Recreational Forest
9	Education Forest
10	Research Forest
11	Forest for Federal Purposes

b) The Environmental Quality Act

The Environmental Quality Act of 1974, together with the Waters Act of 1920, deals with regulations for pollution of inland waters and wetland areas. Orders passed pursuant the act contain provisions for Environmental Impact Assessments (EIA). The Environmental Quality (prescribed activities) (environmental impact assessment) order 1987 makes an Environmental Impact Assessment (EIA) mandatory for 19 prescribed activities.

Prescribed activities of special relevance for Peat Swamp Forests are schedule 3b, 6b, and 6C. A description of the prescribed activities is provided in Table 2.3 below:

Table 2-3: prescribed activities of special relevance for Peat Swamp Forests from the Environmental Quality (prescribed activities) (environmental impact assessment) order 1987

Order	Instruction:
Schedule 3b	Drainage and Irrigation: An EIA is mandatory for drainage of wetlands, wildlife habitats or virgin jungle forest covering an area of 100 hectares or more
Schedule 6b	Forestry: An EIA must be carried out when forest land is logged or converted into other land use within the catchment area of reservoirs used for municipal water supply, irrigation, or hydro power generation, or in areas adjacent to state, or national parks and national marine parks
Schedule 6c	Forestry: Logging covering an area of 500 hectares or more requires that an EIA is conducted

The EIA requirements deal with specific projects, and do not take an overall view of the complex role of a particular site in the overall ecosystem. While the requirements can be used to regulate individual project (such as logging or mining concessions), they cannot be used to prevent fragmentation of a habitat.

Outside the permanent reserve forest or NSPSF, however, there is a total ban on all forms of opening burning except for religious and cremation purposes as stipulated under Section 29A of the Environmental Quality Act, 1974. Any person starting fires may be charged under such law which on conviction carries a RM500,000 (Ringgit Malaysia: Five Hundred Thousand) fine or maximum prison term of five years or both. Therefore, farmers and planters must refrain from open burning.

c) The National Land Code

The National Land Code of 1965 divides land areas into four categories in accordance with the intended main use of the area. The main uses are agriculture, commercial, residential and industry.

The National Land Code is Federal Legislation. However, land management is legally and administratively under the jurisdiction of the State Governments. Hence, State Governments can acquire alienated land for development purposes.

d) The Town and Country Planning Act

The Town and Country Planning Act of 1976 was amended in 1996, and it recognises conservation as an essential element of land use planning. The Act gives certain powers at both state and local level to protect specific areas. The Act instructs the establishment of a State Planning Committee to oversee the general policy related to planning of all land areas within the local authority in the state. It also calls for local planning authorities to regulate and control planning in their area and to prepare development and structure plans. The National Physical Plan was first adopted in 2005 and an updated plan adopted in 2010. The Selangor State structure plan 2020 was gazetted in 2007; a revised plan to 2035 is in preparation. District local plans for Kuala Selangor and Sabak Bernam Districts were gazetted in 2007 for the period up to 2015. The district local plan for Hulu Selangor was gazetted in 2011 for the period up to 2020. The Kuala Selangor & Sabak Bernam District Local Plan 2025 are in the process of finalization.

2.2 Administrative Framework

2.2.1 Federal Level

All aspects of planning, management, and administration of natural resources are organised on a sector basis. At least four key ministries and several agencies within these ministries are involved in management of forest, land, agriculture, water and wildlife resources; i.e., of; Ministry Natural Resources and Environment (NRE); Ministry of Agriculture and Agrobased Industry (MOA); Ministry of Plantation Industries and Commodities (MPIC) ; Ministry of Energy, Green Technology and Water (KeTTHA) and Ministry of Urban Wellbeing, Housing and Local Government. Hence, liaison and co-ordination between ministries and their departments are critical elements of integrated management planning for the use of natural resources.

Key federal ministries and agencies are:

a) The Economic Planning Unit (EPU)

EPU is responsible for the economic planning of Malaysia with mission to manage the country's socio-economic development in strategic and sustainable manner. Environment and Natural Economic Section is a section established and effective in June, 2003, under the Macro Planning Division. This section is responsible in leading and coordinating the national environment and natural resources stability, with better efficiency and effectiveness.

b) Ministry of Nature Resources (NRE)

NRE responsible in leading the country in sustainable management of natural resources and conservation of environment towards achieving national vision. NRE is responsible for the natural resources management of forest management, irrigation and drainage management, wildlife management and minerals management. It is also responsible for the conservation and management of environmental and shelters such as environmental conservation.

b) Ministry of Plantation Industries and commodities (MPIC)

MPIC is responsible for the commodities that contribute to economy of the country such as rubber, oil palm, forestry etc. It's vision is to make Malaysia the centre of excellence of the - commodity sector and as a major producer of higher value-added commodity- based products in the global markets

c) Ministry of Energy, Green Technology and Water (KeTTHA)

KeTTHA responsible for planning, formulating policies and programs that shows a strong green technology, it also lead a new initiative addressing global issues such as environmental pollution, ozone depletion, 'global warming' and issues related thereto.

d) Forestry Department Peninsular Malaysia (FDPM)

FDPM is under the Ministry of Natural Resources and Environment and comprises of Forest Department Headquarters Peninsular Malaysia, 11 State Forestry Departments and 33 District Forest Offices located throughout Peninsular Malaysia. FDPM is responsible for the management, planning, protection and development of the Permanent Reserved Forests (PRF) in accordance with the National Forestry Policy, 1992 and the National Forestry Act, 1984. However, forest management at state level is under the control of State Governments through their State Forestry Departments.

e) Malaysia Meteorological Department (MMD)

Apart from weather related forecast, Malaysia Meteorological Department is also the focal point for Fire Danger Rating System (FDRS). The main objective of FDRS is to provide an early warning of the potential of land and forest fires. Early warning generated from FDRS can assist management in implementing operations to prevent fires and effectively control fires before they spread.. Currently MMD maintain the FDRS for Peninsular Malaysia, Sabah and Sarawak as well as for the ASEAN region.

f) Department of Environment (DOE)

DOE's mission is to promote, enhance, and sustain sound environmental management in the process of nation building. A key activity is to study and assess development projects subject to the Environmental Impact Assessment Order. DOE also provides environmental input to Federal and State Agencies to ensure that use of land and other natural resources is carried out in a manner that complies with the concept of sustainable development. DOE is also for monitoring of open burning and enforcing regulations on open burning.

g) Department of Agriculture (DOA)

DOA provides service to farmers and the private sector on crop technology, agro-based industries. and regulatory services to increase national agricultural productivity. Of special relevance is the Information Technology Unit that produces maps covering: Soil Survey; Land Use; and Agro-climatic zoning for each State of Peninsular Malaysia.

2.2.2 State Level

Also at State level, there are several bodies that may be directly or indirectly involved in management of land, forest, and peat swamp forests.

The State Executive Council (EXCO)

EXCO is the highest administrative authority on any matters related to land administration. The EXCO is answerable to the State Legislative Assembly. The EXCO has absolute power to decide on any land matters, provided that the decisions do not contravene Federal or State Laws, or Policies agreed to by the National Land Council.

Key State Agencies are shown in the table below 2-4 below.

Table 2-4: Key agencies at state level

No.	Agency	Functions
I.	Selangor State Economic Planning Unit (UPEN)	<ul style="list-style-type: none">Responsible for economic planning at state level. To be effective, the planned activities in the NSPFR must be coordinated with development proposals and plan, for example for land development in the state land.
II.	Selangor State Forestry Department (SSFD)	<ul style="list-style-type: none">Administer and manage the state's forest resources for State Forest Management concept in order to benefit the social, economic and environment to the people.Act as the implementing agency policies and enforcement of laws and forestry regulations.Act as the implementing agency's development efforts, rehabilitation and reforestation through proper silvicultural practices for optimum production of forest products and sustainable.
III.	Selangor State Fire and Rescue Department (SSFRD)	<ul style="list-style-type: none">SSFRD is responsible for suppress fire and provide training for the small holder famer on the firefighting operation on peatland.
IV.	Department of Agriculture of Selangor (DOA)	<ul style="list-style-type: none">Provide consultation services and technical support in a package format to entrepreneurs, private organizations and agriculture development agencies.Development of trained and skilled workforce to cater to the needs of the agriculture industry.Develop Agriculture Food and Soil Information Centres for planning purposes and implement development programmes for the agriculture sector.

		<ul style="list-style-type: none"> • Conduct training at the agriculture Institute and Training Centre to fulfill the requirements for skilled workforce within the agriculture sector. • Monitor and control the quality of the country's agriculture resource and seedlings.
V.	District Offices (Kuala Selangor/ Hulu Selangor & Sababk Bernam)	<ul style="list-style-type: none"> • Management development and disposal of land. • Provides technical services and enforcement. • Management of land title registration. • Management of land revenue. • Management Services include administration, human resources, finance and information technology. • Management of socio-economic development and the implementation of small-scale rural infrastructure projects. • Implement the new Government Policy namely <i>Merakyatkan Ekonomi Selangor (MES)</i>.
VI.	Local district councils: Majlis Daerah Kuala Selangor (MDKS) Majlis Daerah Sabak Bernam (MDSB) Majlis Daerah Hulu Selangor (MDHS)	<ul style="list-style-type: none"> • Their functions are as local government of respective areas including provision of services such as waste disposal.
VII.	Selangor Water Management Authority (LUAS)	<ul style="list-style-type: none"> • Responsible to ensure the state's water resources, including river basin, groundwater and surface water, lakes and coastal area is protected. • These functions and responsibility are executed through Integrated River Basin Management (IRBM) and Integrated Coastal Management (ICM) approaches.
VIII.	Integrated Agriculture Development Area of Northwest Selangor Project (IADA)	<ul style="list-style-type: none"> • Increase agricultural infrastructure, particularly irrigation and drainage system for certain agricultural • Strengthen and expand support services for agriculture and agricultural management. • Coordinate the activities of advisory and extension services to target groups through human development/ training.
IX.	Department of Irrigation and Drainage of Selangor (DID)	<ul style="list-style-type: none"> • Conserve, manage and develop water resources, land and related resources across all sectors within a river basin. • Implement erosion control plans across the country. • Integrated River Basin Development and Integrated Flood Management for flood management plans. • Provide Standards and Procedure for Urban Drainage Design for Peninsular Malaysia.
X.	Department of Environment of Selangor (DOE)	<ul style="list-style-type: none"> • To administer and enforce the Environmental

		<p>Quality Act, 1974 including section 29(A), and Section IV of the Exclusive Economic Zone Act, 1984.</p> <ul style="list-style-type: none"> • To ensure and sustain sound environmental management in the process of nation building. • A key activity is to study and assess development projects subject to the Environmental Impact Assessment order. • DOE also provides environmental inputs to state agencies to ensure that use of land and other natural resources is carried out in a manner that complies with the concept of sustainable development.
XI.	Department of Town and Country Planning of Selangor (DTCP)	<ul style="list-style-type: none"> • Act as the principal adviser to the State Government on all matters of planning, including the preservation of land use and development. • Act as advisors to local authorities on town and country planning, and development and land use. • Implement and coordinate the standardization of the full implementation of the Town and Country Planning Act 1976 (Act 172) in all local planning authorities in Selangor. • Coordinate the preparation of the development plan of the State Structure Plan, Local Plan and Special Area Plan and research / special projects either ordered or on the initiative of the department based on ESA component adoption. • Provide advice to departments / agencies of the town and country planning.
XII.	Department of Mineral and Geoscience of Selangor	<ul style="list-style-type: none"> • To undertake systematic investigations in various geoscience disciplines such as geological mapping, groundwater resources, engineering geology, geological hazards, environmental geology, marine geology, geophysics, and others. • To collect, analyse and disseminate data and information pertaining to mineral exploration, mining and related activities. • To provide technical advisory and expertise services in the fields of mineral, geoscience, mining and quarrying. • To ensure that mining of minerals and related activities are carried out safely, efficiently and systematically.
XIII.	Department of Wildlife and National Parks of Selangor (PERHILITAN)	<ul style="list-style-type: none"> • DWNP is responsible for the management of the Sungai Dusun Wildlife Reserve. Conservation measures and monitoring of wildlife in the NSPSF should be co-ordinated with the activities and plans of DWNP in Sungai Dusun Wildlife Reserve and elsewhere. • Coordinate the enforcement of wildlife protection in Selangor State.

		<ul style="list-style-type: none"> • Objectives of department: <ul style="list-style-type: none"> ✓ Protection, management and preservation of biodiversity for production benefits. ✓ Protection and development of protected areas for the purpose of research, education, economic, aesthetic, recreation and ecological purposes. ✓ Enhancement of knowledge, awareness and public support on the importance of biodiversity conservation.
XIV.	Department of Veterinary Services of Selangor	<ul style="list-style-type: none"> • Control, prevent and eradicate animal and zoonotic diseases. • Production of livestock, livestock produce and animal feed. • Training for the livestock and domestic animal industries. • Expand livestock production and animal health as well as general veterinary health.
XV.	Department of Health (DOH)	<ul style="list-style-type: none"> • DOH is responsible for a healthy community through:- <ul style="list-style-type: none"> ✓ Provision of high quality, affordable and accessible healthcare service ✓ Prevention and control disease ✓ Protection of health of the population ✓ Sustainable and continual health promotion in smart partnership with various agencies, organizations and the community
XVI.	Selangor State Government linked corporation <ol style="list-style-type: none"> I. Mentei Besar Incorporated (MBI) II. Selangor Agricultural Development Corporation (PKPS) III. Kumpulan Darul Ehsan Berhad (KDEB) IV. Kumpulan SEMESTA 	<ul style="list-style-type: none"> • Responsible for the development of farming and agro-based industry to improve the socio-economic and development. • Involved with commercial agricultural projects, palm plantation development and mining (clay & sand) for the State of Selangor.
XVII.	National Government-linked companies SIME Darby Plantation Sdn Bhd & FELDA Plantation Sdn Bhd	<ul style="list-style-type: none"> • Involved in oil palm plantation management cultivation and downstream activities, agribusiness and food, as well as R&D. • Have extensive plantations adjacent to NSPSF
XVIII.	Other relevant authorities	<p>Interested parties (NGOs, JKK kampung, Head of Village, CBOs)</p> <ul style="list-style-type: none"> • Work together with government and others agencies to protect and support the government in conserving the forest reserved. • Land owners, local community involvement and

		<p>support is important for a successful management programme that will involve the protection, monitoring, development, conservation and promotion in the buffer zone adjacent to NSPSF.</p>
--	--	---

2.3 International Conventions & Agreements

Malaysia is a party to several international convention and agreements related to forestry and environment, and is by its signature committed to pursue certain policies and practises. The ones most relevant to peat swamp forest management are briefly described below:

a) ASEAN Agreement on Transboundary Haze Pollution

The ASEAN Agreement on Transboundary was signed by ten ASEAN Member States on 10 June 2002 in Kuala Lumpur, Malaysia and came into force on 25 Nov 2003. The agreement contains provision on monitoring, assessment and prevention, technical cooperation and scientific research, mechanism for coordination, lines of communication and simplified customs and immigration procedures for disaster relief.

b) ASEAN Peatland Management Strategy, APMS

The APMS was endorsed by the 10th ASEAN Ministerial Meeting on Environment in 2006. The goal of the strategy is to promote sustainable management of peatlands in ASEAN region through collective actions and enhanced cooperation to support and sustain livelihoods, reduce risks of fire associated haze and contribute to global environment management. It has 4 general objectives and 13 focal areas.

Objectives:

- Enhance awareness and capacity building
- Address transboundary haze pollution and environmental degradation
- Promote sustainable management of peatlands
- Promote Regional cooperation

c) Convention of Biological Diversity (CBD)

In 1992, 154 nations at the United Nations Conference on Environment and Development in Rio de Janeiro signed the Convention on Biological Diversity. Malaysia ratified the convention in 1994, and a National Biodiversity Committee was set up the same year to protect and manage Malaysia biological resources.

The objective of the CBD is to conserve biological diversity, promote the sustainable use of its components, and encourage equitable sharing of the benefits arising out of the utilization of genetic resources. Equitable sharing includes appropriate access to genetic resources, as well as appropriate transfer of technology, taking into account existing rights over such resources and technology.

d) Convention on Wetlands of International Importance or Ramsar Convention

The Convention on Wetlands was adopted in 1971 in the Iranian City of Ramsar, The Convention was ratified by Malaysia in 1987. Malaysia now have 6 Ramsar sites, namely: Tasek Bera, Tanjong Piai State Park, Pulau Kukup State Park, Sungai Pulai Wetlands, Kuching Wetland National Park and the Lower Kinabatangan-Segama Wetlands.

Recognising that wetlands are ecosystems of high importance for biodiversity conservation and human communities, the convention has over the years broadened its scope to cover all aspects of wetland conservation. The convention requires parties to wisely manage all of the wetlands in their territories.

Guidelines for Global Action on Peatlands was adopted by Ramsar member states at the 8th Conference of the Contracting Parties to the Ramsar Convention (COP8, Valencia, 2002). These Guidelines recommend a series of priority approaches to address the issues of concern and to enhance the integrated management planning of peatland forests in SE Asia under seven themes:

- Knowledge of peatland forest resources
- Education and public awareness on the importance of peatland forests
- Policy and legislative instruments that support the integrated management of peatland forests
- Wise use of peatland forests
- Research networks, regional centres of expertise, and institutional capacity
- Regional and International cooperation Implementation and support

2.4 National Policies and Strategies

National policies and strategies related to conservation, forestry, and land use have been developed to inform authorities and other stakeholders how the Government of Malaysia would want legislation and international conventions to be put into practice. For management of swamp forest, the policies listed below are the most relevant ones.

a) National Action Plan for Peatlands, NAPP 2011

The goal of the NAPP is to sustainably manage peatlands in Malaysia in an integrated and sustainable manner to conserve resources, prevent degradation and fire and generate benefits for current and future generations. The four objectives of NAPP:

- a) Enhance knowledge, awareness and capacity for sustainable peatlands management and development
- b) Conserve peatlands resources and reduce peatlands degradation and fire
- c) Promote sustainable and integrated management of peatlands
- d) Ensure effective multi- stakeholders cooperation

b) National Policy on Climate Change, NPCC 2010

Objective of NPCC

- a) Mainstreaming climate change through wise management of resources and enhanced environmental conservation resulting in strengthened economic competitiveness and improved quality of life
- b) Integration of responses into national policies, plans and programmes to strengthen the resilience of development from arising and potential impacts of climate change; and
- c) Strengthening of institutional and implementation capacity to better harness opportunities to reduce negative impacts of climate change

c) Common Vision on Biodiversity 2009

The Common Vision on Biodiversity was adopted by the National Biodiversity and Biotechnology Council in 2009. The Vision aims at explaining what biodiversity is, why it is important and which measures are required to ensure a constant provision of ecosystem services essential for human livelihood. The Common Vision promotes a three-prolonged implementation approach and outreach strategy as follows:

- a) Strengthening the protected area system,
- b) Land/seascape management of biodiversity; and
- c) Mainstreaming biodiversity

c) National Physical Plan, NPP 2010

National Physical Plan emphasized on the protection of Environment Sensitive Area (ESA)- refer to areas that are of critical importance in terms of the goods, services and life-support systems they provide such as water purification, pest control and erosion regulation. In addition, they also refer to areas that harbour the wealth of the nation's biodiversity. Natural wetlands with high conservation value and wetlands outside protected areas are classified as ESA rank 1 and rank 2.

ESA Level (Rank 1) : No development, agriculture or logging shall be permitted, except for eco-tourism, research and education.

ESA Level (Rank 2) : No development or agriculture. Sustainable logging and eco- tourism may permitted subject to local constraints.

ESA Level (Rank 3) : Controlled development where the type and intensity of the development shall be strictly controlled depending on the nature of the constraints.

A composite analysis is used to derive the ESA Categories, based on three broad ESA criteria such as areas important for biodiversity; areas important for life support (although it should be noted that areas important for biodiversity are almost always also important for life support); and areas vulnerable to hazards.

Table 2-5: Rank and Criteria under ESA (From National physical Plan 2010)

Rank	Criteria
Protection of Biodiversity	
1	<ul style="list-style-type: none"> Existing and proposed Protected Areas (PA) Important small habitats outside the PA system: Turtle landing sites, salt licks, important plant areas, limestone outcrops and natural wetlands of high conservation value
2	<ul style="list-style-type: none"> All other forests and wetlands outside of Protected Areas 500m buffer zone around rank 1 areas
3	<ul style="list-style-type: none"> Marine Park islands 500m buffer zone around rank 2 areas
Life Support System	
1	<ul style="list-style-type: none"> Catchments of existing and proposed dams
3	<ul style="list-style-type: none"> Catchments of water intake and groundwater recharge zones
Hazard Risk Area	
1	<ul style="list-style-type: none"> Areas above 1,000m contour
2	<ul style="list-style-type: none"> Areas between 300m -1,000m contour
3	<ul style="list-style-type: none"> Areas between 150m -300m contour Areas with erosion risk above 150 ton/ha/yr. Areas experiencing critical or significant coastal erosion

d) National Wetland Policy 2004

Peatlands which constitute more than 50% of the area of wetlands in Malaysia are encompassed by this policy calling for sustainable and wise use of wetlands with respect to their ecological characteristics.

e) National Agriculture Policy

The main objective of the policy is to maximize income through optimum resource usage. It also emphasizes the conservation and sustainable use of the natural resources.

f) National Policy on the Environment 2002

The National Policy on the Environment aims at continued economic, social and cultural progress of Malaysia and enhancement of the quality of life of its people , through environmentally sound and sustainable development.

g) National Policy on Biological Diversity 1998

The National Policy on Biological Diversity aims to conserve Malaysia's biological diversity and to ensure that its components are utilized in sustainable manner for the continued progress and social economic development of the nation.

h) National Forest Policy 1978, Amended 1992

In 1977 the National Forest Council accepted a National Forest Policy. In 1978 the National Land Council endorsed the policy, and later all the State Governments in Peninsular Malaysia accepted the National Forest Policy. The scope of the National Forest Policy is to ensure uniform implementation of forest management, conservation and development strategies. To enhance the implementation of the policy, the National Forest Act 1984 and the Wood-Based Industries Act 1984 were prepared to harmonise laws _with regard to administration, management, conservation, and development of forests within the different States.

In 1992 the policy was revised as a consequence of the growing concern about the importance of conservation of biological diversity and sustainable use of genetic resources, and the role of local communities in forest development. The objectives of the National Forest Policy are:

To conserve and manage the nation's forests, based on the principles of sustainable management;
To protect the environment as well as to conserve biological diversity, genetic resources, and to enhance research and education.

The policy establishes that Permanent Forest Estate should comprise sufficient areas, strategically located throughout the country and designated in accordance with the concept of rational land use. The Permanent Forest Estate is managed and classified under four major functions: Protection Forest; Production Forest; Amenity Forest; Research and Education Forest. The forest types and their major functions are shown in Table 2.6 below:

Table 2-6: Classification of Permanent Forest Estate to major functions, as stipulated in the National Forest Policy

Forest Class	Major Functions
Protection Forest	To ensure favourable climatic and physical conditions of the country, safeguard water resources, soil fertility, environment quality, conservation of biological diversity and the minimization of damage by flood and erosion to rivers and agricultural lands
Production Forest	To supply, in perpetuity at reasonable rates, all forms of forest produce that can be economically produced within the country and are required for agricultural, domestic and industrial

	purposes or export
Amenity Forest	For conservation of sufficient forest areas for recreation, eco-tourism and promotion of public awareness of forestry
Research and Education Forest	For research, education and conservation of biological diversity

2.5 State Policies

The state policy is to conserve forest resources by imposing moratorium for logging for 25 years since 2010.

a) Selangor Forestry Management Plan 2011-2020 with specific reference to peat swamp forest management

Peat Swamp Conservation Area

The plan allocates 14,360 ha of peat swamp area in Sg Karang FR and Raja Musa FR as peat swamp conservation area. This is to ensure the long term stability of the ecosystem.

b) Malaysia Criteria, Indicators, Activities and Standards of Performance (MC&I) for Forest Management Certification (MC&I)

Following adequate compliance to the Malaysia Criteria, Indicators, Activities and Standards of Performance (MC&I) for Forest Management Certification, The Selangor Forest Management Unit (FMU) has been issued with the MTCC Certificate for Forest Management Since 2002.

2.6 Vision, Mission and Goal of Selangor State Forestry Department

Selangor State Forestry Department (SSFD) is responsible for the implementation of management plan and field operations within the Permanent Forest Estate in the State of Selangor. In practical terms this means that at operational level, SSFD is charged with the responsibility of enforcing forestry and environment legislation, for implementation of government green policies and for Malaysia fulfillment of international environmental conventions. To guide it works, SSFD has adopted the aims and objectives defined by the federal forestry department, Peninsular Malaysia and as presented in Table 2.7

Table 2-7: Vision, Mission, and Objectives for Selangor State Forestry Department

Level	Description of Management Target
Vision	To be recognized as the agency of excellence in sustainable management of tropical forest
Mission	To sustainable manage and develop the forest resources and optimize their contributions the national socio-economic development
Objectives	<p>To manage the forest resource sustainable for the continuous production of forest goods and services and their optimum utilization, compatible with environment requirement</p> <p>To increase the supply of forest goods and services through appropriate forestry activities that enhance the quality, productivity and utilization of the forest resource</p> <p>To further develop appropriate environmentally sound technology for the conservation, management and utilization of the forest resource</p> <p>To conserve and protect the forests' biological diversity, water and soil, and their sustainable utilization</p> <p>To increase the quality and the efficiency of the forest based processing mills and enhance higher value downstream activities</p> <p>To strengthen human resource development to support forestry sector</p> <p>To improve public awareness on the environment and conservation roles forests through educations and dissemination of information</p> <p>To increase the forestry sectors contribution to national income, foreign ex-change and employment opportunities</p>

Table 2.7 shows the management targets, that SSFD tries to accomplish by its operations at different level. Table 2.7 demonstrates that the operations of SSFD are guided by principles, that are in accordance with Malaysia's national priorities and Malaysia's international commitment to global conservation and sustainability – a commitment Malaysia has declared by signing international conventions listed in this chapter. The management targets also show the intention and willingness of SSFD to promote multiple purpose forestry.

Chapter 3: Biophysical Description of The North Selangor Peat Swamp Forest

3. Biophysical Description of The North Selangor Peat Swamp Forest

3.1 Site description

3.1.1 Location and Geographical Extent

The North Selangor Peat Swamp Forest or NSPSF is located on a flat coastal plain in the northern part of the State of Selangor.. It consists of 4 Forest Reserve; Raja Musa Forest Reserve, Sungai Karang Forest Reserves and Bukit Belata Extension Forest Reserve (partial) and Sungai Dusun Forest Reserve/ Sungai Dusun Wildlife Reserve with a combination total of 81,304 hectares.

Table 3-1: Forest Reserves and area in the NSPSF

No.	Forest Reserve	Size (ha)
1.	Raja Musa Forest Reserve	36,938
2.	Sungai Karang Forest Reserve	36,654
3.	Bukit Belata extension Forest Reserve (partial) (1635 ha –peat area)	2,821
4.	Sungai Dusun Forest Reserve/ Sunagai Dusun Wildlife Reserve (45% of the land is peat)	4,891
	Total	81,304

During the review process, it was found that the legal boundary of the two main forest reserves- Raja Musa and Sg Karang Forest Reserve is not Sg. Tengi as specified in the previous IMP - but the district boundary as indicated in the map below. Changes are made to the compartment numbering due to the changes in the forest reserve boundary. In this document, new numbering will be used, however, for record purposes, old numbering will be provided as Annex.

Since Sg Dusun Forest reserve is also gazetted as Sg Dusun Wildlife Reserve and is managed by PERHILITAN with its own management plan- Sungai Dusun Wildlife Reserve Development and Management Plan, it is recommended that Sungai Dusun Wildlife Reserve maintain their Management Plan and the area will be considered as a separate management sub-unit which will be discussed in detail in Chapter 6

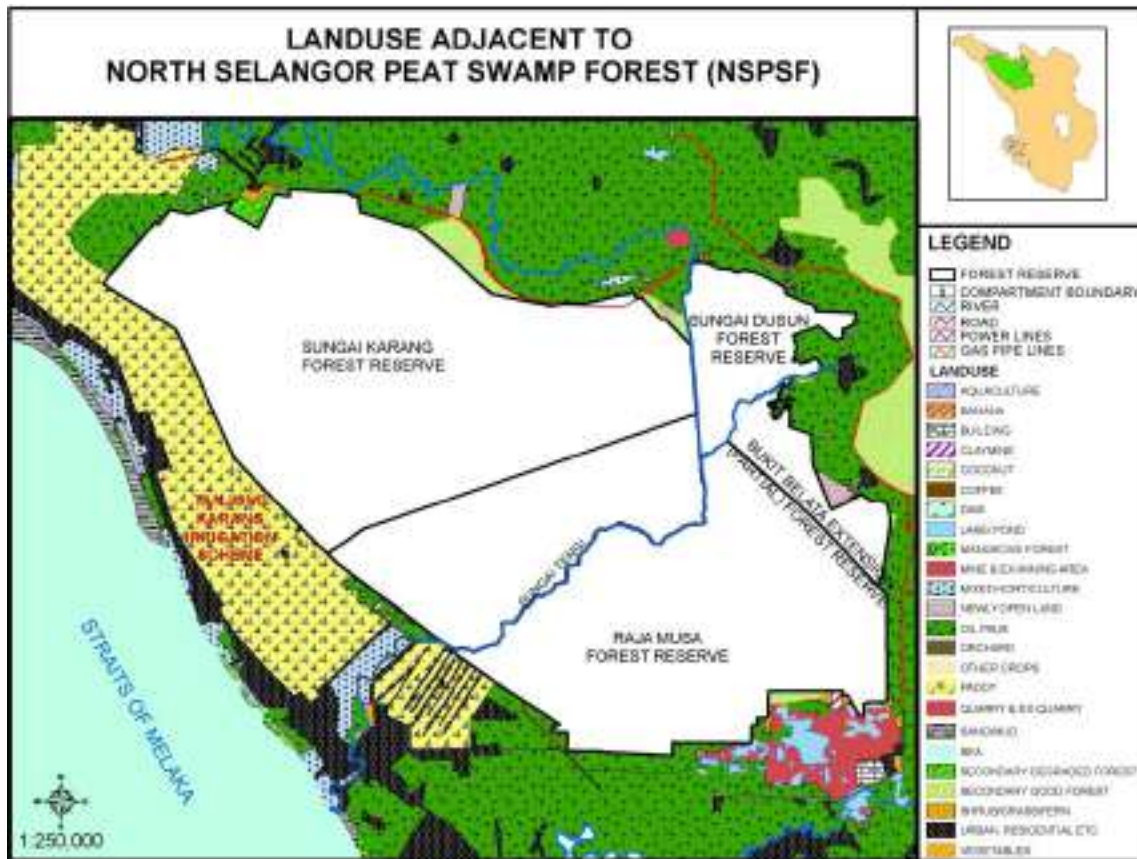


Figure 3-1: Map of NSPSF showing four forest reserves and landuse adjacent to forest reserve

The landuse on the land adjoining the forest reserve are Tanjong Karang Irrigation Scheme to the south-west and west, oil palm plantation owned by small holders to the north, north- west, southeast and sand and clay mining to the southeast.

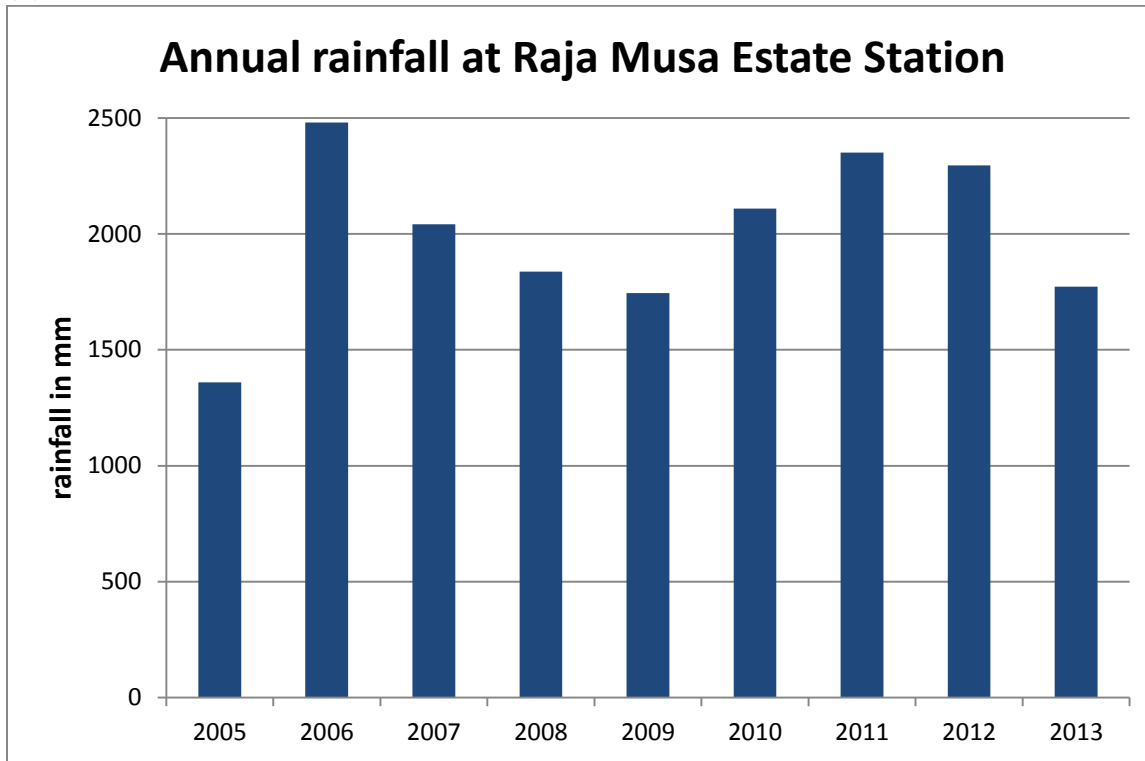
3.1.2 Climate

North Selangor Peat Swamp Forest is located in a humid tropical zone, and the climate is characterized by heavy rainfall and high humidity and temperature

From 2005 to 2013, the mean annual rainfall varies and range from 1359mm to 2480mm. There are 2 distinct peak; March to April and October to November. The months of January- February and May-Sept are generally the dry months.

The mean temperature is 27 degree Celsius. The mean relative humidity is 79.3%.

(a)



(b)

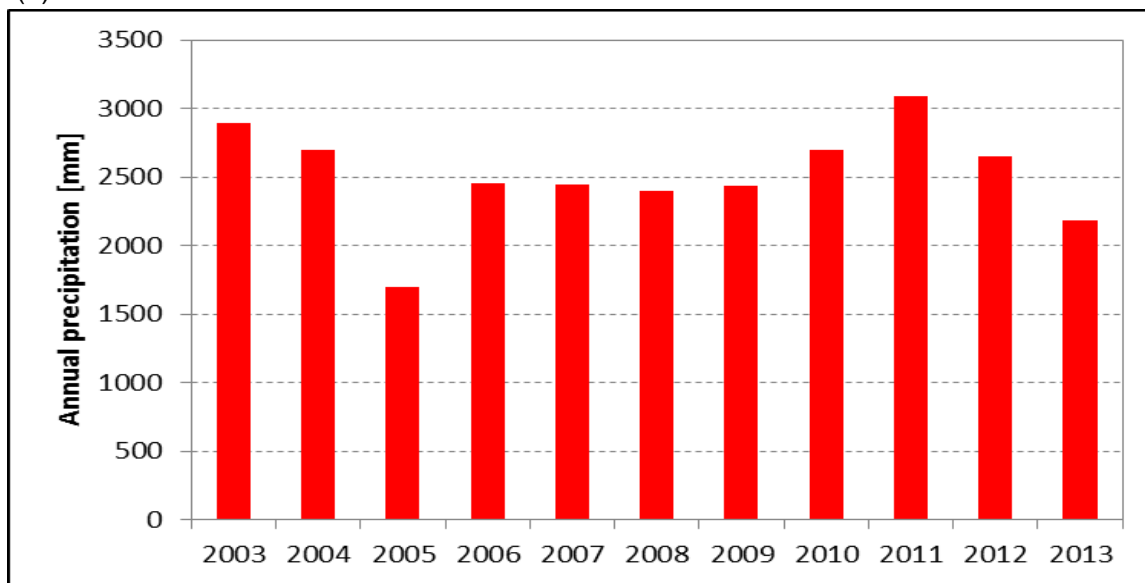
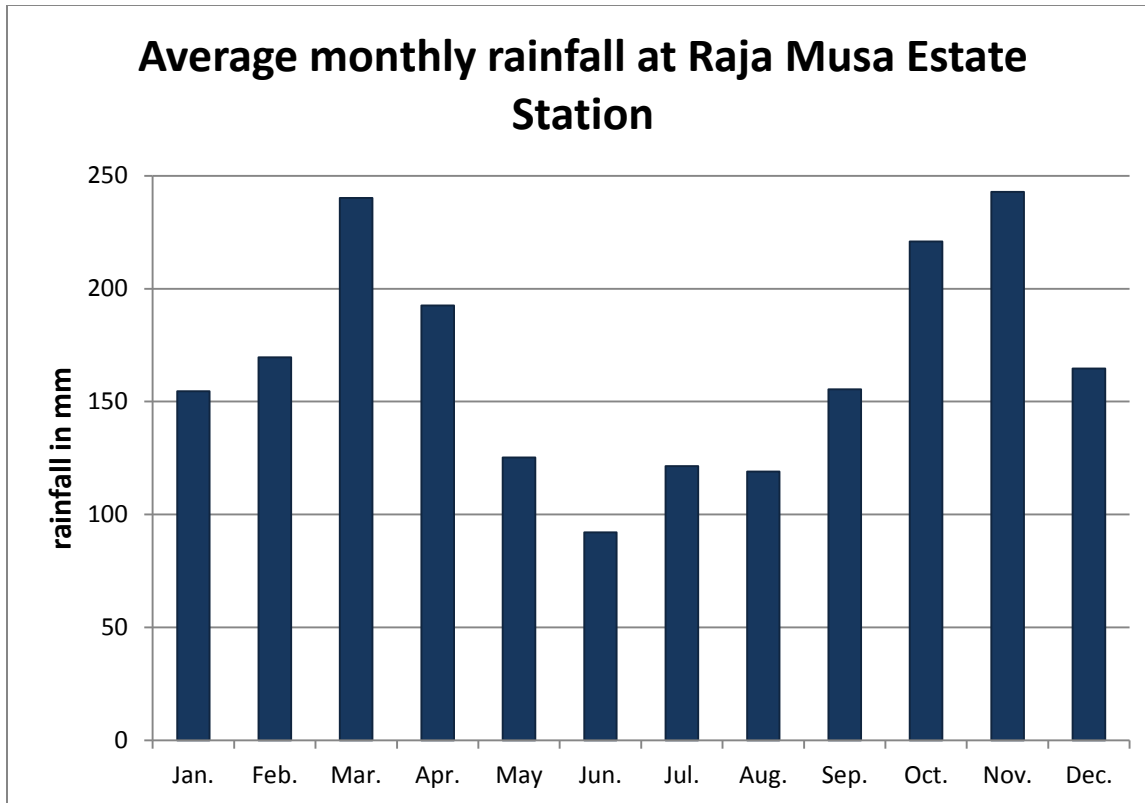


Figure 3-2: Annual rainfall at Raja Musa Estate Station (a)(MMD, 2013) and Annual precipitation for the NSPSF area determined from bias corrected TRMM satellite precipitation for 2003-2013 (b) (Vernimmen, 2014)

(a)



(b)

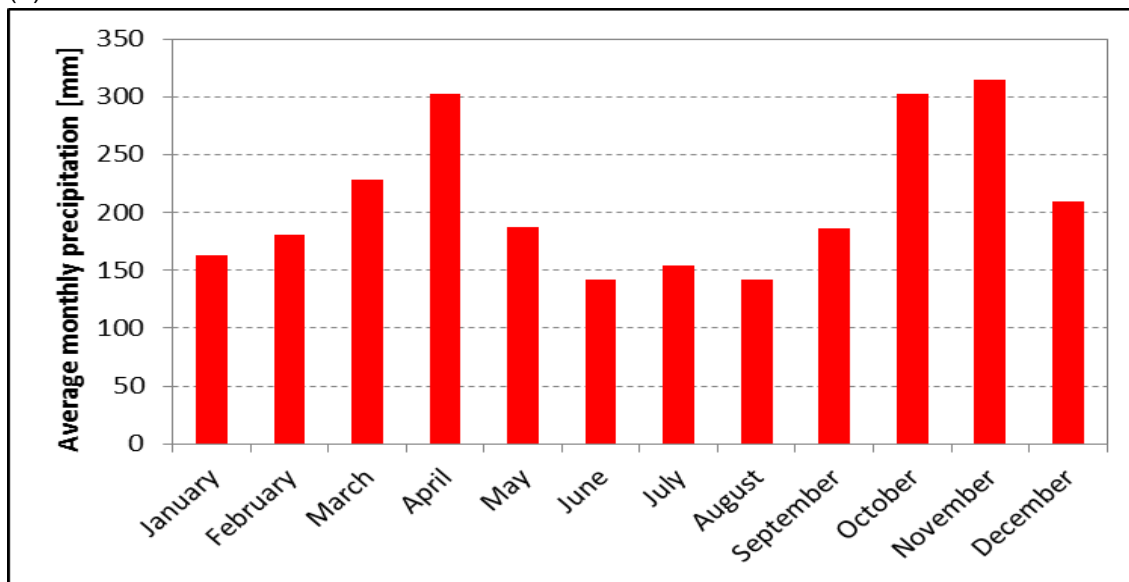


Figure 3-3: Average monthly rainfall at Raja Musa Estate Station(a) (MMD, 2013) and Average monthly precipitation for the NSPSF area determined from bias corrected TRMM satellite precipitation for 2003-2013, (b) (Vernimmen, 2014)

3.1.3 Geology:

Peat swamps in Malaysia are typically found in former coastal lagoons and deltas, that were created by the rising sea level following the last ice age about 10,000 years ago (FDHQ & DANCED, 1997). The actual formation of the peat probably started about 5,000 -7000 years ago.

The peat swamps of Peninsular Malaysia have developed on different deposits of sedimentary origin. Along the sheltered West Coast, where the NSPSF is located, peat swamps are generally found on clay deposits formed by fine sedimentation of clay materials.

3.1.4 Peat Characteristics

a) Morphology

In South East Asia, peat swamp forests are usually found located between adjacent rivers system. It is often found to be dome-shaped. Although they are domed shaped, the domes are not visible to the naked eye as the gradient is very shallow. NSPSF comprises of two peat domes, with Sg Tenggi as the natural divider for the two units. Peat depth survey result had clearly shown this finding: one peat dome to the south of Sg Tenggi and another to the north of Sg Tenggi. However, more detailed studies would be recommended for a complete peat depth map of NSPSF.

b) Peat depth

The two surveys carried out by Hahn- Schilling (1994) and Zulkifli et al. (1999) had found the deepest peat depth to be 7m in a 17km transect in Sg Karang Forest Reserve. In 2013 peat depth surveys were conducted at various places in and around NSPSF. The deepest depth recorded for RMFR is 6.23m and the deepest peat depth recorded for SKFR is 10.15m (GEC, 2013). Figure 3-4 below shows the location of the peat depth survey as well as its depths.

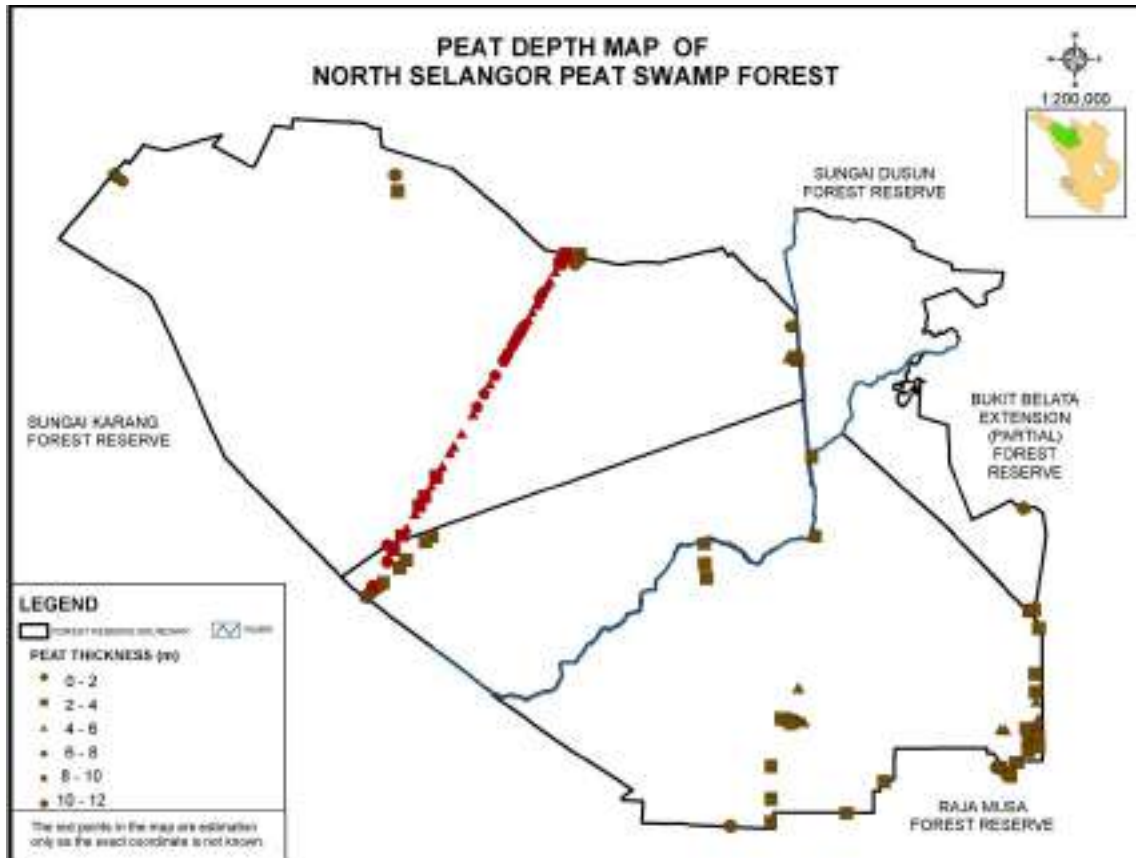


Figure 3-4: Peat depth map of NSPSF

c) Composition

Peat soil has high content of organic material in various stages of decomposition. In the tropics such soils are especially rich in woody materials, including tree trunks, branches and roots.

Chemically, peat soils are normally very acidic with pH levels as low as 3.5, and the peat soils only contain limited amounts of nutrients although the C/N ratio is high.

d) Carbon storage

Peat soil contains high organic materials and thus high carbon content, and over thousands of years accumulate thousand tonnes of carbon during its formation. As the peat layer accumulates, large amounts of carbon were locked and stored in the peat soil and prevented from releasing to the atmosphere. Apart from carbon stored in peat soil, peat swamp forest also contributes in term of aboveground biomass. Kumari (1995) estimated that unlogged forest contains 150tC/ ha. . A more recent study estimated that the aboveground biomass for relatively undisturbed forest at a range of 132 – 199 tC/ ha (Verwer, 2010). However most of NSPSF is considered as disturbed ofrest so the carbon stock would be significantly lower.

For peat soil carbon stock, assuming the bulk density of 0.09g/cm³ and carbon content of 56% (Page et al., 2011) carbon stock of 1 hectare peat soil is 504tC/ha for each metre in depth. Based on the 83 peat depth points, the average peat depth of the NSPSF is 3.6m, and multiplied by 73000 hectares (about 90% of NSPSF is peat), peat soil carbon stock for NSPSF is estimated at 132million tonnes of carbon equivalent to 473 million tonnes of carbon dioxide.

Once disturbed, this carbon sink could become a carbon sources. A recent estimate (Walker et al., 2014) on the potential emission from NSPSF as a result of drainage and fires are 2 million tonnes of CO₂ e/year. If the cvalue of lost CO₂ is estimated conservatively at US\$3 or RM10/tonne. The loss of stored carbon from drainage and fires is currently about RM20 million per year.

3.2 Hydrology

Peat swamp forests are generally viewed as affecting the hydrology of an area positively. During wet seasons, undisturbed peat swamp forests act as natural flood control structure, protecting lower areas by temporarily storing excess water runoff and lowering the peak discharge. The excess water is then released slowly, hence sustaining the base flow. Like other wetlands, peat swamp forest could play important role in supplying water for domestic and agricultural uses. Besides provision and maintenance of surface water, peat swamp forests also recharge ground water aquifers.

The above general statements apply to undisturbed peat swamp forest as logging and establishment of canals affect the hydrology of a peat swamp forests. Zulkifli et al (1999) carried out a hydrology study in NSPSF. Further study was conducted in 2013-2014 as part of the review of the IMP. The purpose of the studies were to test if the above general characters apply to the heavily disturbed NSPSF, and to quantify the hydrological system in NSPSF. Also the study should propose practical measures to alleviate negative impacts from logging and other activities. The main finding of the study are presented in the following paragraph.

3.2.1 Drainage canal of NSPSF

There are estimated 500km of drainage canals existed in NSPSF. Map below shows the extensive networks of the canals across both the Sungai Karang FR and Raja Musa FR.

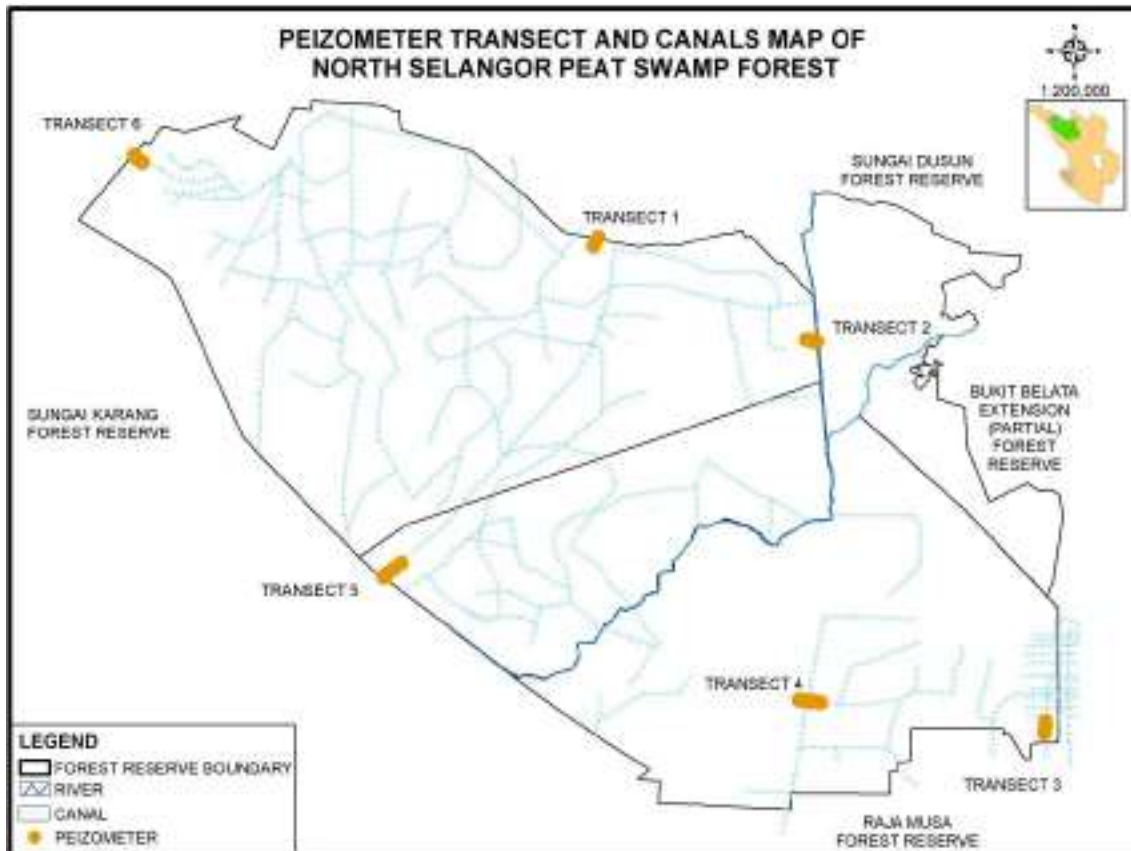


Figure 3-5: Map of NSPSF showing the canals network and 6 locations of the piezometer

a) Water table:

In 1997-98, piezometers were positioned in 2 transects perpendicular to a canal to measure the impacts of canals on water levels. In 2014, more piezometers were established to look at the same impacts but from different areas around NSPSF. Altogether, a total of 38 piezometers were placed along 6 transects, all perpendicular to a canal. The results below show the measurements taken over the period from Dec 2013 to May 2014. There are 2 transects where piezometers are placed on both side of the canal, in 1 transect, one side of the piezometers were destroyed by fire in February 2014.

Generally, water tables fluctuate in sync with the wet and dry seasons. Water tables are higher in December and January and then drop significantly in February and March (where Malaysia as a whole experienced an unprecedented drought), then it gradually moved up in April and May when rain is more frequent. The water level in May is lower compare to the level in December/ January. The lowest water table was recorded at an oil palm plantation.

Table 3-2 and Figure 3-4 provide more details for each transects.

Table 3-2: Details of the piezometer established in NSPSF in 2013-14

Transect	Name	No of piezometer	Farthest distance from the canal (m)	Vegetation
1	Jalan Sungai Panjang/ JSP	5	500	Logged over/secondary forest
2	Terusan Sg Dusun/ TSD	5	500	Logged over / secondary forest
3	Parit 4 Raja Musa North/ P4R_N	4	250	Shrub/ lallang grass
3*	Parit 4 Raja Musa South/ P4R_S	3	250	Lallang grass
4	Tokong Cina West/ TC_W	5	500	Logged over/ secondary forest
4	Tokong Cina East/ TC_E	4	500	Ferns/ shrubs
5	Kunci Air Sungai Burung/ KASB	7	1000	Ferns/secondary forest/logged over forest
6	Jalan Hj Dorani/ JHD	5	500	Oil palm

Figures below shows the fluctuation of the water level for all the six locations. The data were taken once a month starting from December 2013 to June 2014.

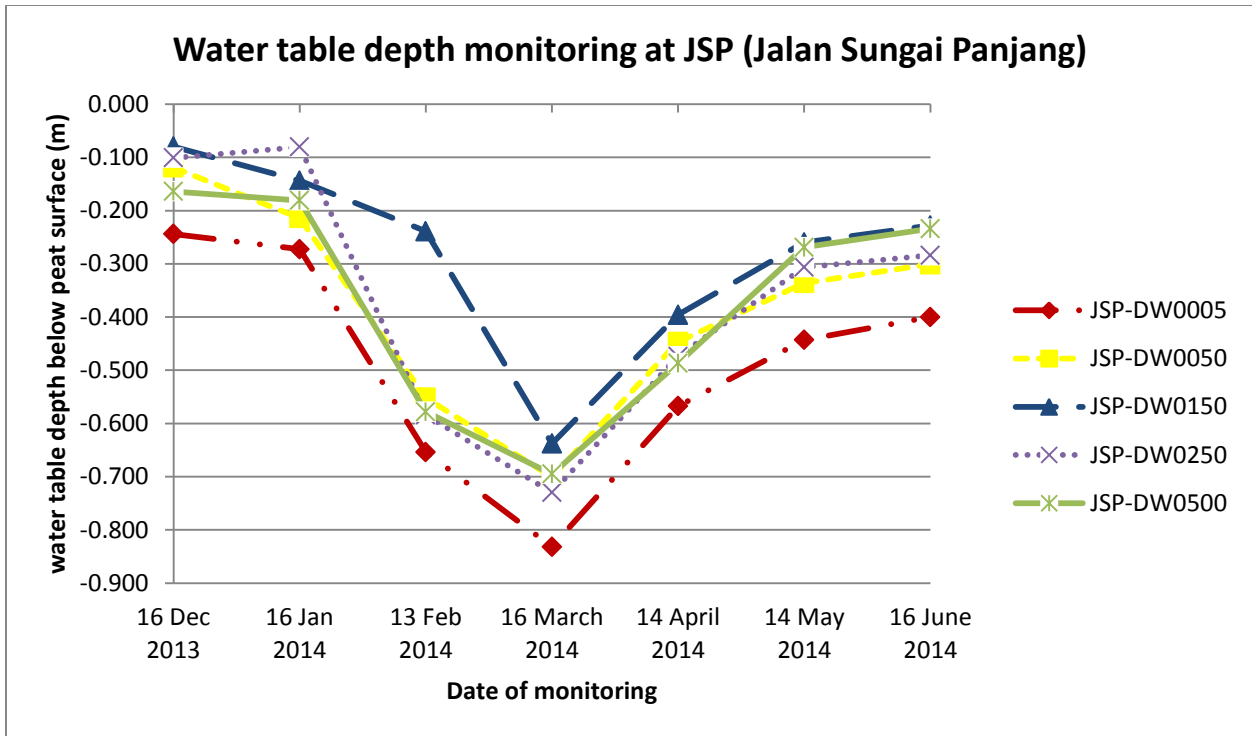


Figure 3-6: water table depth at JSP from Dec 2013 to June 2014

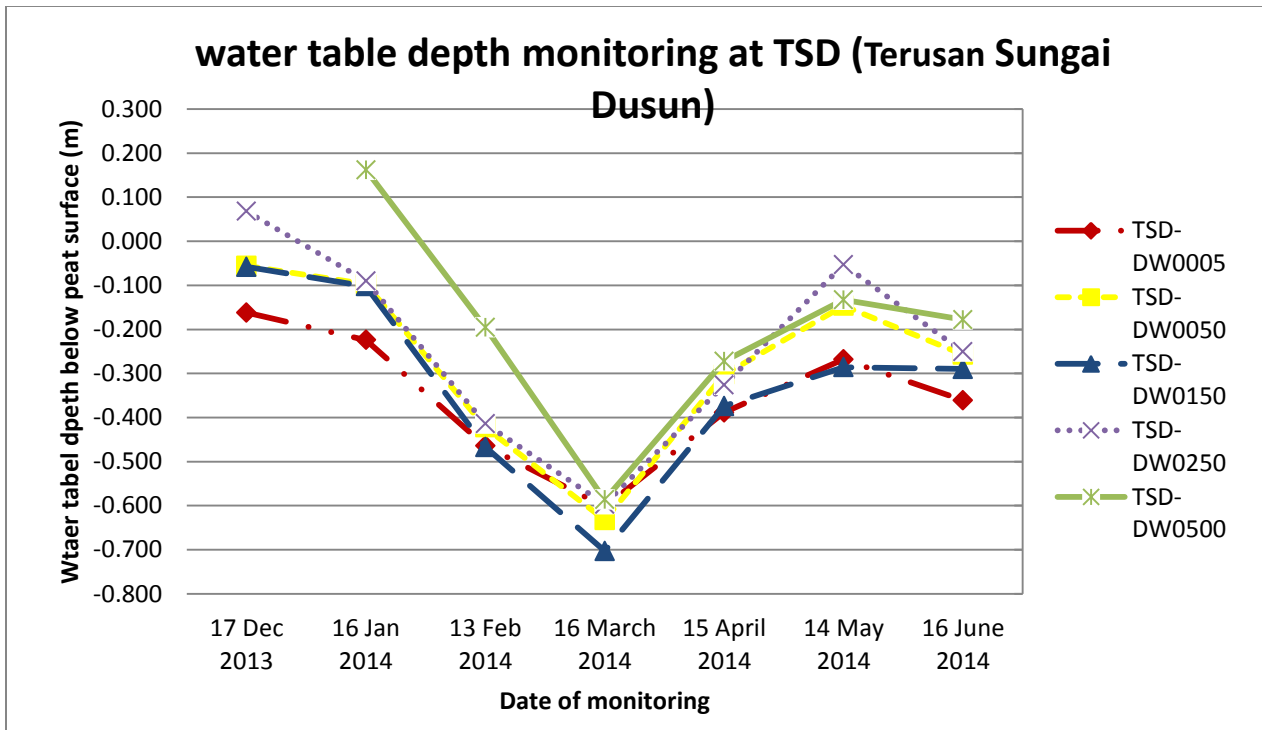


Figure 3-7: water table depth at TSD from Dec 2013 to June 2014

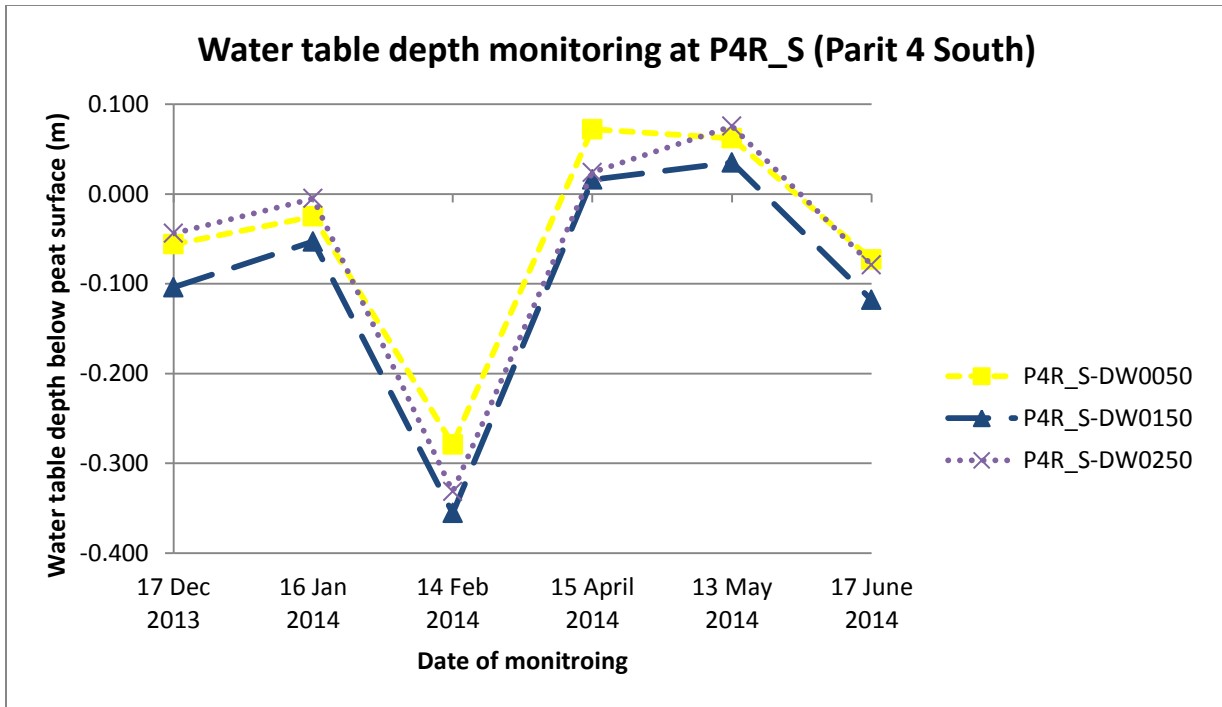


Figure 3-8: water table depth at P4R_S from Dec 2013 to June 2014

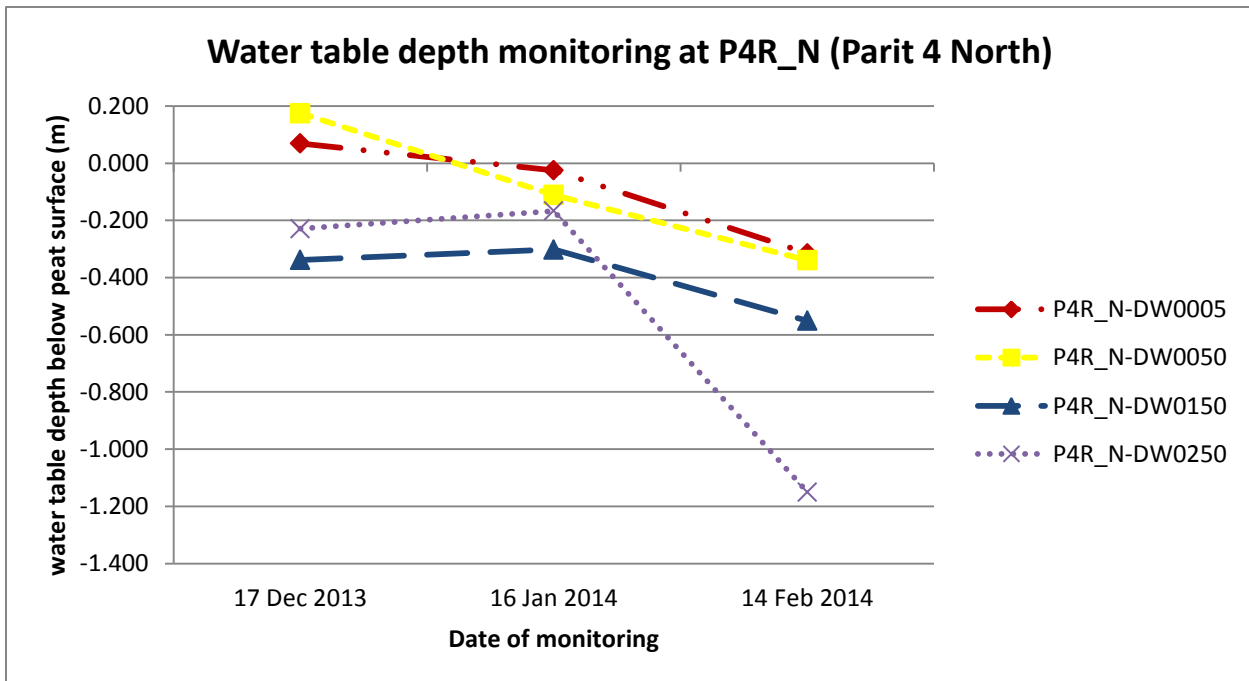


Figure 3-9: water table depth at P4R_S from Dec 2013 to Feb 2014

Note: All the piezometers at Parit 4 Raja Musa South were destroyed during a fire in March 2014.

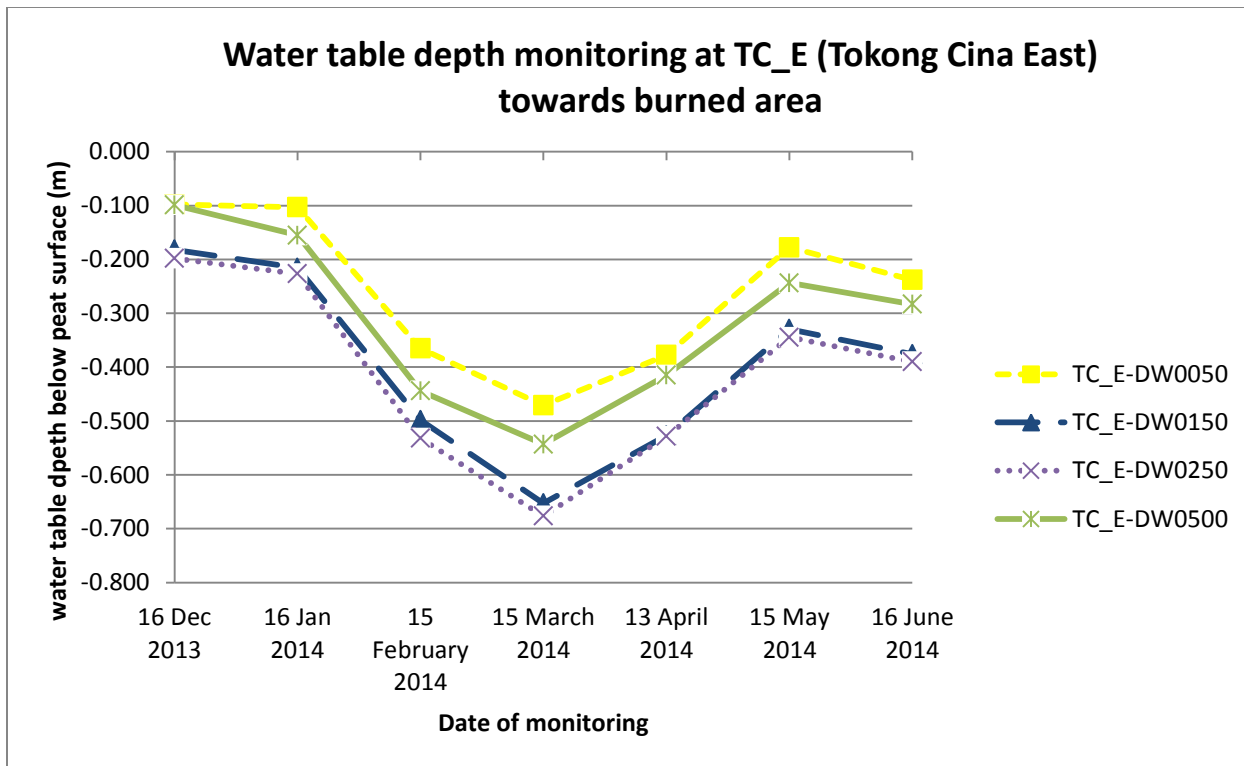


Figure 3-10: water table depth at TC_W from Dec 2013 to June 2014

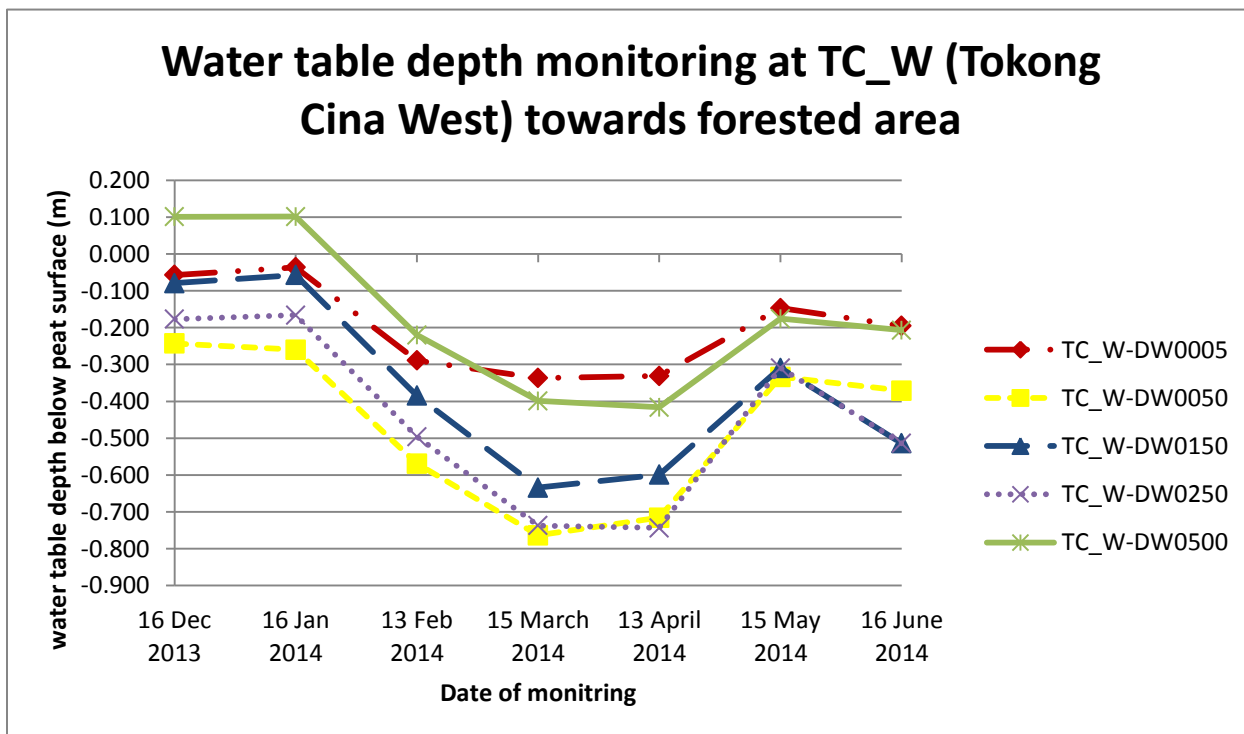


Figure 3-11: water table depth at TC_E from Dec 2013 to June 2014

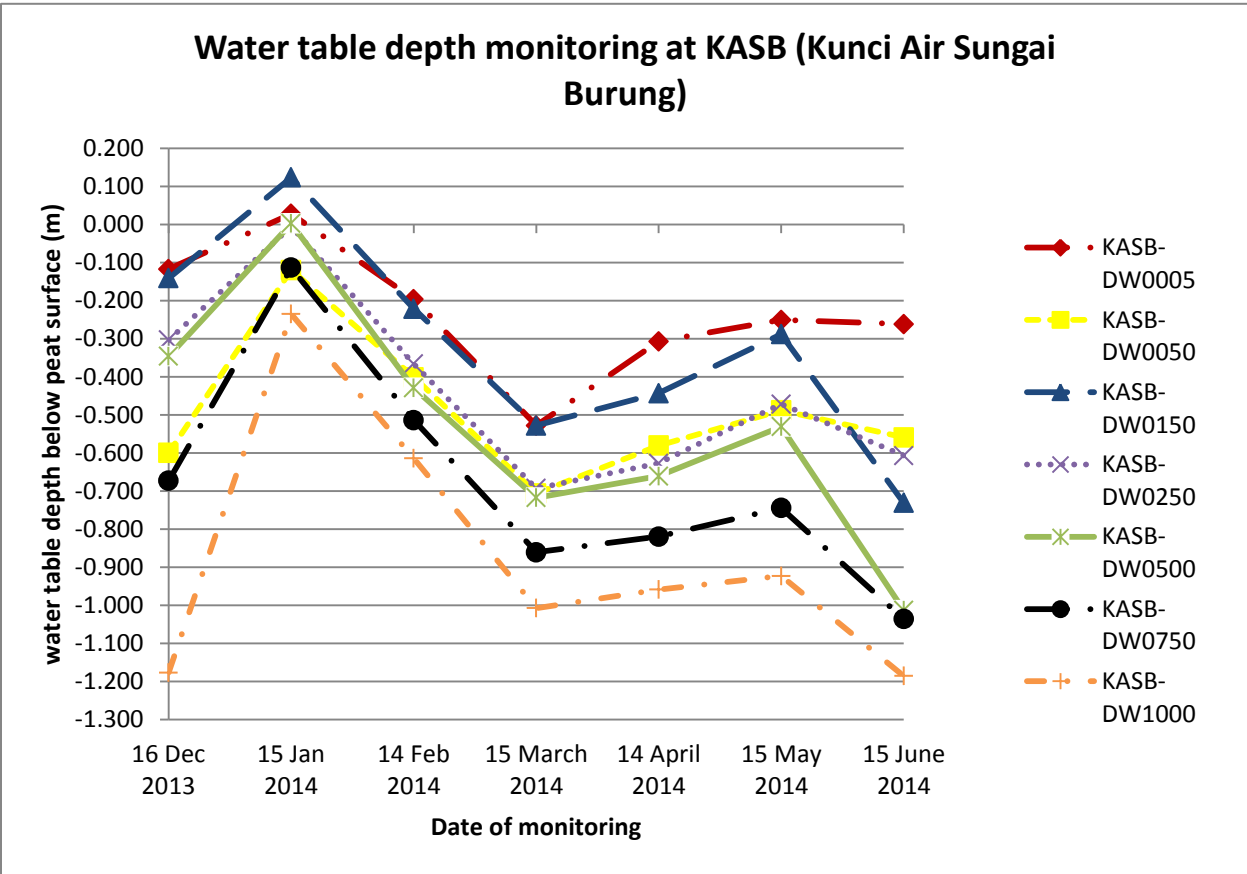


Figure 3-12: water table depth at KASB from Dec 2013 to June 2014

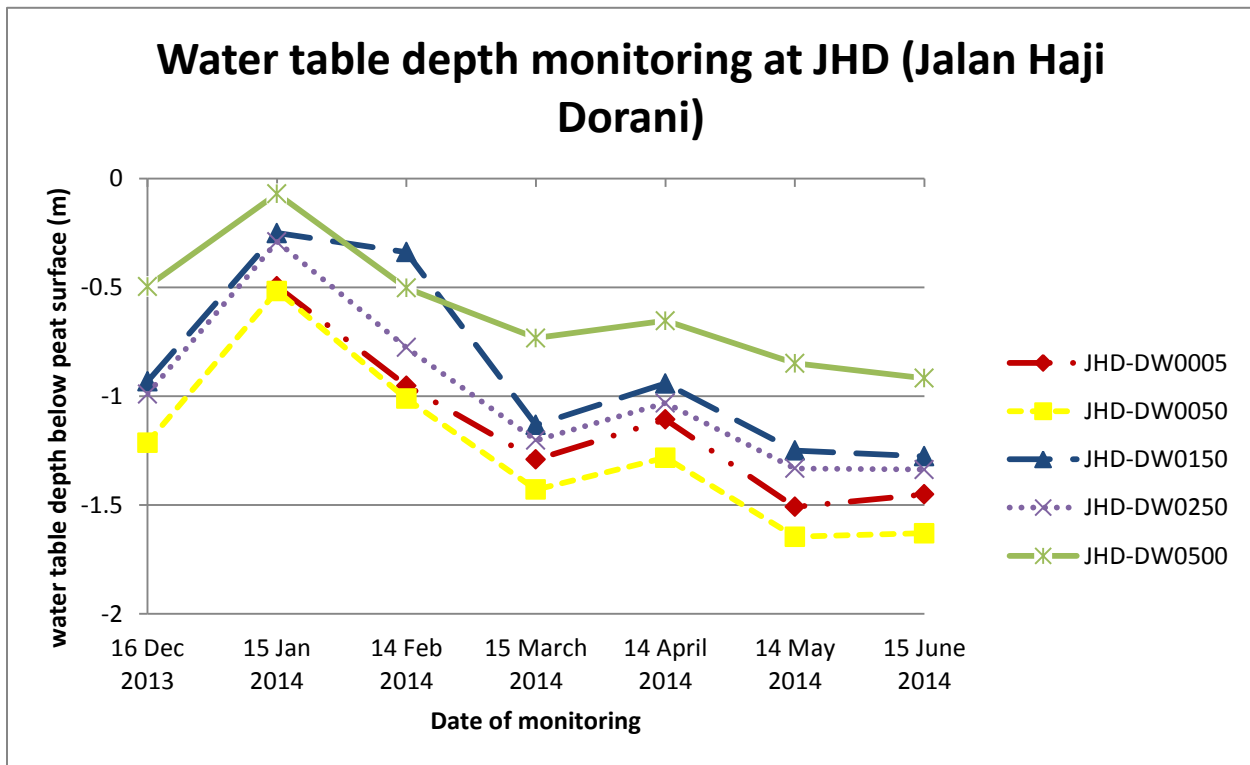


Figure 3-13: water table depth at JHD from Dec 2013 to June 2014

Based on the graphs above, generally the drawdown effects of a canal is at least 500m, as only a few of the of the piezometer showing water level above surface during the wet season (Vernimmen, 2014). It is apparent that drainages canal had significant effects on the water level of the area. Piezometer located at transect JHD recorded the lowest water table during the period, as most of the measuring showed the range from 50cm to 2m. Even during the wet season the only two peizometers showed reading less than 30cm below the surface. As all the piezometers are located inside oil palm estate, this clearly shows that oil palm estate did not have good water management (as the optimal water levels for oil plam is 40-50cm below the surface.

3.2.2 Water balance

Water inflow:

The main sources of water entering the NSPSF are rainfall and occasional overflow from the Bernam River. It is estimated that the average annual rainfall over the area is 2300mm/year. Occasionally, the Bernam River floods large parts of the forest. In terms of quantity, the water inflow to the peat from flooding is considered marginal. However, it is believed that the floods are significant for maintaining the ecosystem, as the river water contains more nutrients than rainwater.

Water outflow:

The out flow from NSPSF was estimated by measuring the proportion of water in the main irrigation canal from the Bernam River and from peat swamp forest, using the Hydrogen Mixing Technique. For details on the Hydrogen Mixing Technique, see Zulkifli et al (1999).

The measurements that took place from March 1998 to November 1998, showed that during periods with high precipitation, about 20% of the water in the main irrigation canal came from the peat swamp forest. The equivalent figure for dry periods came to about 5% only.

These measurements contradict the general observation applicable for undisturbed peat swamp forest that the peat functions as a sponge, that retains water in periods with heavy rain and release it in dry periods. It is believed that the much larger outflow during periods with heavy rain is associated with the extensive network of unblocked canals in the forest that severely diminishes the capacity of the swamp to retain water.

Run-off and Recharge of ground water:

Zulkifli et al (1999) used Hydrogen Mixing Measurements, records of rainfall, and estimate of evapotranspiration from comparable forest areas to establish the water balance of the NSPSF, see Table 3.1. A simplified model was used, in that it is assumed the net inflow of water to the peat swamp forest comes from rainfall. This water then leaves as:

- Evapotranspiration;
- Contribution to the main canal; and
- Ground water recharge

Table 3-3: Water Balance of NSPSF

Description	Water source/ contribution	Equiv. Rain. (mm/year)	Percent
In flow	Annual precipitation	2300	100%
Outflow	a) Evapotranspiration	1500	65%
	b) Contribution to the main irrigation canal;	146	6%
	c) Ground water recharge	654	29%

Table 3.3 shows that about two third of the water entering the peat swamp is lost through evapotranspiration. The contribution to ground water recharge amounts to just below 1/3 of the rainfall over the areas, while the annual contribution to the neighboring irrigation scheme under the present conditions of the peat swamp forest is 6%.

3.2.3 Water quality

Zulkifli et al (1999) took water samples at different locations to establish the water quality of the peat swamp forest. The results are summarized in Table 3-4. Table 3-4 shows that the quality of the peat swamp forest is significant different from the quality of water from Feeder Canal. The quality of water in the Main Irrigation Canal confirm that the main source of water for Tanjong Karang Irrigation Project is the Bernam River via the Feeder Canal.

Table 3-4: mean value/ concentration and standard deviation (in brackets) of water quality in NSPSF

Parameters/ Sites	Peat Swamp Site					Feeder Canal			
	S2	S3	S4	S5	S8	S6	S7	S1	S14
PH	3.72 (0.08)	3.84 (0.12)	3.73 (0.08)	3.70 (0.09)	3.76 (0.13)	6.06 (0.26)	5.98 (0.13)	5.93 (0.55)	5.83 (0.22)
Electrical conductivity (mS/cm)	96.70 (21.60)	73.50 (6.50)	83.20 (3.10)	92.40 (13.10)	74.80 (4.20)	33.90 (16.40)	30.00 (3.90)	33.80 (7.10)	35.90 (11.60)
Colour (Hazen)	>500	>500	>500	>500	>500	102.40 (60.90)	93.20	237.50 (170.50)	150.80 (28.10)
Dissolved Oxygen (mg/l)	1.77 (0.57)	2.89 (1.57)	3.91 (0.33)	1.58 (0.73)	4.35 (2.62)	4.73 (0.43)	4.45 (0.52)	5.61 (0.87)	3.96 (0.66)
Nitrate-N (mg/l)	0.12 (0.13)	0.15 (0.13)	0.09 (0.13)	0.08 (0.13)	0.12 (0.11)	0.07 (0.04)	0.12 (0.11)	0.13 (0.11)	0.12 (0.08)
Ammoniacal-N (mg/l)	0.07 (0.07)	0.14 (0.07)	0.10 (0.09)	0.09 (0.03)	0.09 (0.07)	0.02 (0.01)	0.07 (0.07)	0.05 (0.05)	0.09 (0.08)
Potassium	0.49	1.03	0.45	2.63	0.07	1.31	1.58	1.41	1.53

(mg/l)	(0.50)	(0.60)	(0.27)	(1.88)	(0.08)	(0.16)	(0.39)	(0.63)	(0.17)
Calcium (mg/l)	0.38 (0.33)	1.24 (0.57)	0.50 (0.26)	1.04 (0.78)	0.30 (0.19)	0.82 (0.40)	0.80 (0.59)	1.12 (0.66)	1.13 (0.70)
Magnesium (mg/l)	0.17 (0.19)	0.59 (0.20)	0.18 (0.23)	1.11 (0.76)	0.24 (0.38)	0.16 (0.26)	0.07 (0.08)	0.46 (0.69)	0.55 (0.93)

3.3 Vegetation

The special features of peat swamp forest such as the low levels of pH and nutrients constitute severe constraints to growth and reproduction of plants, and only the most tolerant species are able to survive. Hence, the diversity of plants in the peat swamp forests is low when compared with dry land forest types in the tropics.

Of non-tree species, Hahn-Schilling (1994) found 26 species in logged-over forest in the North Selangor Peat Swamp Forest, including 11 woody climbers, 4 herbs, 3 non-woody climbers 4 ferns, 3 palms, and one grass species.

In 2013, a Scientific Expedition on the Biodiversity of NSPSF was carried out. During the course of expedition, 5 agencies had conducted study on flora survey which includes tree species, herbs, mosses and orchids.

The following table summarized the findings:

Table 3-5: Finding from flora survey during the scientific expedition

Agencies	Flora type	Family	Genus	Species
Forestry Dept	Tree only	27	56	78
FRIM	All plants	67	115	142
GEC	Tree only	22	32	48
UPM	Orchids	2 subfamilies	22	32
UM	Mosses	5	14	24

Table 3-6: Findings of species composition/diversity of peat swamp forests in Peninsular Malaysia.

Site	Findings/Results	Source
Bebar F. R. Pekan	84 tree species (> 10cm dbh; 2 ha.)	Appanah et al (1989)
Bebar F. R. Pekan	119 tree species from 39 different families (> 1cm dbh; 4 ha)	Shamsudin (1997)
K. Langat VJR, Selangor	54 tree species from 27 different families (> 5cm dbh)	Shamsudin & Chong (1992)
NSPSF	107 tree species from 27 different families (> 5cm dbh: 25 1 ha plots)	Hahn-Shilling (1994)
NSPSF	48 tree species from 25 families (17 sampling plots diff. Dbh classes)	Appanah et al (1999)

Tree Species

Peat swamp forests support tree species with small to medium sized crowns, and crowns are normally open and irregular. Typically 30 meter tall emergent trees are scattered throughout the area. *Koompassia malaccensis* (Kempas), *Shorea uliginosa* (Meranti bakau), *Xylopiya fusca* (Jangkang paya), *Santiria* sp. (Kedondong) *Syzygium* sp. (Kelat), and are the dominant tree species in natural peat swamps. *Gonystylus bancanus* (Ramin) is now a rare sight in peat swamp forest due to over exploitation

Table 3-7 and shows the result of flora survey in 1999 and 2013. In 1999, only 48 tree species were found but in 2013, 78 tree species were recorded.

Table 3-7: Tree species found in NSPSF (Modifeid from Appanah et al, 1999, Salleh et al., 2013, Lo, 2013 and Chew et al., 2013)

Family	Species	Local Name
1.Anacardiaceae	1. <i>Buchanania arborescens</i>	Otak udang daun tumpul
	2. <i>Camptosperma coriaceum</i>	Terentang Simpoh
	3. <i>Camptosperma auriculatum</i>	Terentang daun besar
	4. <i>Dracontomelon dao</i>	Sengkuang
	5. <i>Gluta</i> sp.	Rengas
2.Anisopteraeae	6. <i>Anisoptera marginata</i>	
3.Anonaceae	7. <i>Polyalthia hypoleuca</i>	Mempisang
	8. <i>Xylopiya fusca</i>	Jangkang Paya
	9. <i>Polyalthia glauca</i>	Mempisang
	10. <i>Monocarpia marginalis</i>	Mempisang
	11. <i>Polyalthia</i> sp.	Mempisang
	12. <i>Polyalthia sclerophylla</i>	
4.Apocynaceae	13. <i>Alstonia angustiloba</i>	Pulai
	14. <i>Alstonia scholaris</i>	Pulai
	15. <i>Alstonia pneumatophora</i>	Pulai basong
5.Aquifoliaceae	16. <i>Ilex macrophylla</i>	Mensirah
	17. <i>Ilex cymosa</i>	
6.Burseraceae	18. <i>Dacryodes rostrata</i>	Kedondong Kerut
	19. <i>Dacryodes macrocarpa</i>	Kedondong
	20. <i>Santiria laevigata</i>	Kedondong kerantai licin
	21. <i>Santiria rubiginosa</i>	Kedondong
7.Chrysobalanaceae	22. <i>Parastemonurophyllous</i>	
8.Clusiaceae	23. <i>Calophyllum ferrugineum</i>	Bintangor
	24. <i>Calophyllum</i> sp.	
	25. <i>Dialium patens</i>	Keranji paya
	26. <i>Garcinia</i> sp.	Kandis
	27. <i>Garcinia eugeniaefolia</i>	Kandis
	28. <i>Cratoxylum arborescens</i>	
	29. <i>Garcinia miqueli</i>	
9.Combretaceae	30. <i>Terminalia phellocarpa</i>	Jelawai mempelam babi
10.Ctenolophaceae	31. <i>Ctenolophon parvifolius</i>	Mertas
11.Dipterocarpaceae	32. <i>Shorea uliginosa</i>	Meranti Bakau
	33. <i>Anisoptera marginata</i>	Mersawa Paya
	34. <i>Vatica</i> sp.	Resak

	35. <i>Shorea platycarpa</i>	Meranti paya
	36. <i>Vatica pauciflora</i>	Resak laru
	37. <i>Stemonurus secundiflorus</i>	
12.Ebenaceae	38. <i>Diospyros lanceifolia</i>	Kayu arang
	39. <i>Diospyros siamang</i>	Kayu arang paya
	40. <i>Diospyros maingayi</i>	
13.Elaeocarpaceae	41. <i>Elaeocarpus floribundus</i>	Mendong
	42. <i>Elaeocarpus petiolatus</i>	Mendong
	43. <i>Elaeocarpus</i> sp.	
	44. <i>Elaeocarpus griffithii</i>	
14.Euphorbiaceae	45. <i>Macaranga puncticulata</i>	Mahang
	46. <i>Macaranga pruinosa</i>	Mahang
	47. <i>Antidesma cociaceum</i>	
	48. <i>Neoscortechinia forbesii</i>	
	49. <i>Glochidion rubrum</i>	Ubah
	50. <i>Glochidion wallichianum</i>	Ubah
	51. <i>Antidesma cuspidatum</i>	Beruni
	52. <i>Baccaurea racemosa</i>	Tampoi
	53. <i>Blumeodendron tokbrai</i>	Gaham badak
	54. <i>Glochidion arborescens</i>	Ubah-ubah
	55. <i>Macaranga gigantea</i>	Mahang gajah
	56. <i>Mallotus macrostachyus</i>	Balik angin
	57. <i>Austrobuxus nitidus</i>	
15.Fabaceae	58. <i>Koompassia malaccensis</i>	Kempas
	59. <i>Adenanthera pavonina</i>	Saga daun tumpul
	60. <i>Archidendron clypearia</i>	Jering monyet
	61. <i>Callerya atropurpurea</i>	Tulang daing
	62. <i>Dialium indum</i>	Keranji paya
	63. <i>Dialium patens</i>	
16.Fagaceae	64. <i>Lithocarpus</i> sp.	Mempening
	65. <i>Lithocarpus leptogayne</i>	Mempening
17.Guttiferae	66. <i>Calophyllum ferrugineum</i>	Bintangor gambut
	67. <i>Calophyllum sclerophyllum</i>	Bintangor paya
	68. <i>Cratoxylum arborescens</i>	Geronggang-geronggang
	69. <i>Cratoxylum formosum</i>	Geronggang
	70. <i>Garcinia nigrolineata</i>	Kandis
	71. <i>Garcinia parvifolia</i>	Kandis
	72. <i>Mesua lepidota</i>	Penaga sabut
18.Hypericaceae	73. <i>Cratoxylum arborescens</i>	Geronggang
19. Icacinaceae	74. <i>Stemonurus secundiflorus</i>	Kayu Pasir
	75. <i>Stemonurus malaccensis</i>	Sampul keris
20. Juglandaceae	76. <i>Engelhardtia serrata</i>	Dunggu Paya
21. Lauraceae	77. <i>Litsea gracilipes</i>	Medang
	78. <i>Litsea grandis</i>	Medang Daun Lebar
	79. <i>Cinnamomum altissimum</i>	Medang teja
	80. <i>Litsea</i> sp.	Medang
	81. <i>Litsea crassifolia</i>	
	82. <i>Lagerstroemia speciosa</i>	Bungor

22. Melastomataceae	83. <i>Memecylon</i> sp.	Nipis kulit
23. Meliaceae	84. <i>Aglaia rubiginosa</i>	Bekak
	85. <i>Chisocheton amabilis</i>	Pasak lingga
	86. <i>Sandoricum beccarianum</i>	Sentol paya
24. Moraceae	87. <i>Artocarpus elasticus</i>	Terap nasi
	88. <i>Ficus variegata</i>	Ara lempong
	89. <i>Ficus</i> sp.	Ara
	90. <i>Paratocarpus venenosus</i>	Ara bertih
25. Myristicaceae	91. <i>Knema intermedia</i>	Penarahan
	92. <i>Knema uliginosa</i>	Penarahan
	93. <i>Horsfieldia crassifolia</i>	Penarahan
	94. <i>Gymnacrahera eugeniifolia</i>	Penarahan
	95. <i>Horsfieldia irya</i>	Penarahan pianggu
	96. <i>Knema plumulosa</i>	Penarahan
	97. <i>Myristica lowiana</i>	Penarahan arang gambut
26. Myrtaceae	98. <i>Syzygium</i> sp. (<i>Eugenia</i> sp.)	Kelat
	99. <i>Syzygium politum</i> (<i>Eugenia polita</i>)	Kelat
	100. <i>Syzygium setosum</i> (<i>Eugenia setose</i>)	Kelat
	101. <i>Syzygium zeylanicum</i> (<i>Eugenia spicata</i>)	Kelat
	102. <i>Syzygium cerinum</i>	Kelat
	103. <i>Syzygium subdecussatum</i>	Kelat
	104. <i>Tristania merguensis</i>	Pelawan
27. Ochnaceae	105. <i>Campylospermum serratum</i>	Lemak ketam
	106. <i>Bracken ridgea palustri</i>	
28. Polygalaceae	107. <i>Xanthophyllum</i> sp.	Minyak Beruk
29. Rhizophoraceae	108. <i>Carallia brachiata</i>	Meransi
	109. <i>Gynotroches axillaris</i>	Mata keli
30. Rosaceae	110. <i>Prunus arborea</i>	Pepijat
31. Rubiaceae	111. <i>Gardenia tubifera</i>	Mentiong
	112. <i>Mitragyna speciosa</i>	Ketum /Biak
	113. <i>Neonauclea</i> sp.	Mengkal
	114. <i>Timonius flavescens</i>	
32. Rutaceae	115. <i>Acronychia porteri</i>	
	116. <i>Acronychia laurifolia</i>	
	117. <i>Melicope glabra</i>	Pepauh
	118. <i>Melicope lunu-ankenda</i>	Pepauh /Tenggek burung
	119. <i>Maclurodendron porteri</i>	Limau hutan
	120. <i>Euodia roxburgiana</i>	Tenggek Burung
33. Sapindaceae	121. <i>Nephelium lappaceum</i>	Rambutan hutan
34. Sapotaceae	122. <i>Madhuca motleyana</i>	Nyatoh Ketiau
	123. <i>Palaquium</i> sp.	Nyatoh
	124. <i>Pouteria maingayi</i>	
35. Sterculiaceae	125. <i>Sterculia rubiginosa</i>	Kelumpang
36. Thymelaeaceae	126. <i>Gonystylus bancanus</i>	Ramin

3.4 Fauna

Sg Dusun wildlife sanctuary with an area of 4330ha is managed by the Department Of Wildlife And National Park (PERHILITAN) and is called Rezab Hidupan Liar Sungai Dusun or Sungai Dusun Wildlife Reserve (SDWR). It is highly possible for the wildlife to move from the Reserve into NSPSF. PERHILITAN has produced a Development and Management Plan for SDWR in 2004 and have conducted many wildlife surveys and the latest one was conducted in 2009 to help them to better understand and manage the Reserve.

The below information is drawn from the Perhilitan survey supplemented by information from the 2013 expedition.

3.4.1 Mammals

It is important to note that the Reserve, which was established in June 11, 1964, to specifically protect and conserve the Sumatran Rhinoceros (*Dicerorhinus sumatrensis*) that were found in the Reserve. Studies on the ecology of the Sumatran Rhinoceros in the late 1960's confirmed the existence of three individuals (Strickland, 1967). In the early 80's, another study on their ecology estimated a population of five rhinoceros (Mohd Zuber, 1983). In 1985, due to land conversion activities, a number of Rhinoceros were relocated. From 1989 to 1993, one Rhinoceros was killed by poachers and another five were relocated into captivity within the Reserve by PERHILITAN. In 1993, the last Rhinoceros was displaced and in the last decade, the population in Malay Peninsular is believed to have become extinct. Even in the latest survey done by PERHILITAN in 2009 has not recorded any presence or signs of presence of the species.

The second largest mammal (PERHILITAN, 2009) which is the Tapir (*Tapirus indicus*) can still be seen within the reserve area and elsewhere in the NSPSF. Sun Bear (*Helarctos malayanus*) was also observed during the 2009 survey and was recorded with young in Raja Musa Forest reserve during the 2013 expedition. The most common mammal observed during the survey was Wild Boar (*Sus scrofa*). No sightings or sign of presence of Malayan Tiger (*Panthera tigris*) have been recorded in SDWR or NSPSF. From primates Order, the most species observed during the 2009 survey was White-handed Gibbon (*Hylobates lar*) followed by Long-tailed Macaque (*Macaca fascicularis*), followed by Dusky-Leaf Monkey (*Presbytis obscurus*) and Banded-Leaf Monkey (*Presbytis melalophos*).

Base on the Development and Management Plan for SDWR (2004), the largest diversity of mammals recorded in the Reserve, were bats and rodents. The three main families from the Order Rodentia are Sciuridae, Muridae and Hystricidae. Bats are divided into two suborders, the Megachiroptera and Microchiroptera. Species from both suborders are found in SDWR, consisting of four families; Pteropodidae from suborder Megachiroptera, and families Emballonuridae, Rhinolophidae and Vespertilionidae from suborder Microchiroptera.

All in all, 46 species of mammals consisting of 10 orders and 22 families have been recorded in SDWR (Perhilitan, 2004).

Table 3-8: Mammals found in NSPSF(based on PERHILITAN 2004 and survey during scientific expedition)

Order	Family	Species	Common Name
Insectivora	Erinaceidae	<i>Echinoerix gymnurus</i>	Moonrat
Dermoptera	Cynocephalidae	<i>Cynocephalus variegatus</i>	Malayan Flying Fox
Chiroptera	Pteropodidae	<i>Rousetlus amplexicaudatus</i>	Geoffry's Rousetle
	Pteropodidae	<i>Cynopterus brachyotis</i>	Lesser Dog-faced Bat
	Pteropodidae	<i>Megaerops ecaudatus</i>	Tailess Bat
	Emballonuridae	<i>Emballonura monticola</i>	Lesser Sheath-tailed Bat
	Rhinolophidae	<i>Rhinolophus trifoliatus</i>	Trefoil Horseshoe Bat
	Vespertilionidae	<i>Myotis mystacinus</i>	Whiskered Bat
	Vespertilionidae	<i>Tylonycteris pachypus</i>	Lesser Flat-headed Bat
Vespertilionidae	<i>Tylonycteris robustula</i>	Greater Flat-headed Bat	
Scandentia	Tupaiaidae	<i>Tupaia glis</i>	Common Tree Shrew
Primates	Lorisidae	<i>Nycticebus caucang</i>	Slow Loris
	Cercopithecidae	<i>Macaca fascicularis</i>	Long-tailed Macaque
	Cercopithecidae	<i>Macaca nemestera</i>	Pig-tailed Macaque
	Cercopithecidae	<i>Presbytis obscurus</i>	Dusky-leaf Monkey
	Cercopithecidae	<i>Presbytis melalopus</i>	Banded-leaf Monkey
	Hylobatidae	<i>Hylobates lar</i>	White-handed Gibbon
	Hylobatidae	<i>Symphalangus syndactylus</i>	Siamang
Rodentia	Sciuridae	<i>Ratufa bicolor</i>	Black Giant Squirrel
	Sciuridae	<i>Ratufa affinis</i>	Cream-colored Giant Squirrel
	Sciuridae	<i>Callosciurus nonatus</i>	Plantain Squirrel
	Sciuridae	<i>Callosciurus caniceps</i>	Grey-bellied Squirrel
	Sciuridae	<i>Callosciurus nigrovittatus</i>	Black-banded Squirrel
	Sciuridae	<i>Sundasciurus tenuis</i>	Slender Squirrel
	Sciuridae	<i>Sundasciurus lowii</i>	Low's Squirrel
	Muridae	<i>Ratus tiomanicus</i>	Wood Rat
	Muridae	<i>Maxomys rajah</i>	Brown Spiny Rat
	Muridae	<i>Maxomys surifer</i>	Red Spiny Rat
	Muridae	<i>Leopoldamys sabanus</i>	Long-tailed Tree Rat
	Hystricidae	<i>Hystrix brachyura</i>	Common Porcupine
	Hystricidae	<i>Trichys lipura</i>	Long-tailed Porcupine
Carnivora	Ursidae	<i>Helarctos malayanus</i>	Malayan Sun Bear
	Mustelidae	<i>Lutra perspicillata</i>	Smooth Otter
	Mustelidae	<i>Amblonyx cinerea</i>	Oriental Small-clawed Otter
	Viverridae	<i>Paradoxurus hermaphroditus</i>	Common Palm Civet
	Viverridae	<i>Arctogalidia trivirgata</i>	Small-toothed Palm Civet
	Viverridae	<i>Viveria tangalunga</i>	Malay Civet (Tenggalong)
	Viverridae	<i>Herpestes javanicus</i>	Small Indian Mongoose
	Felidae	<i>Prionailurus bengalensis</i>	Leopard Cat
	Felidae	<i>Panther pardus</i>	Black Panther
Pholidota	Manidae	<i>Manis javanicus</i>	Scally Anteater

			(Pangolin)
Perissodactyla	Tapiridae	<i>Tapirus indicus</i>	Malayan Tapir
Artiodactyla	Suidae	<i>Sus scrofa</i>	Wild Pig
	Tragulidae	<i>Tragulus javanicus</i>	Lesser Mouse-deer
	Tragulidae	<i>Tragulus napo</i>	Napuh
	Cervidae	<i>Muntiacus muntjak</i>	Barking Deer

3.4.2 Birds

Prentice and Aikanathan (1989) recorded 173 species of birds in NSPSF which included 145 species were breeding residents, 21 species non-breeding migrants, 6 were resident and migratory population, and 1 was a breeding migrant.

In 1997, PERHILITAN conducted an avifauna survey in SDWR and recorded, 109 species and a survey in 2009 recorded 85 species. It is not known whether the apparent decline is due to the survey approach or the presence or absence of birds. . The most recorded species in the 2009 survey was the Red Jungle Fowl (*Gallus gallus*), followed by White-rumped Shama (*Copsychus malabaricus*) and Hill Myna (*Gracula religiosa*). Rhinoceros Hornbill (*Buceros rhinoceros*) and Great Argus (*Argusianus argus*) have also been observed in abundance within the SDWR.

In 2013, another survey has been conducted as part of the biological expedition which recorded 92 species of bird including species from 44 families, 85 residents, 14 Near threatened species. Out of this 92 species, 21 species were additional to the existing list.

The NSPSF will sustain the presence of large birds species because of the availability of food especially from the wild fruit trees and this abundant food source available will also attract birds from other places to feed within the forest.

An important nesting area for hornbills has been found along the northern boundary of the Sg Karang Forest reserve which has been developed as an ecotourism site.

3.4.3 Fish

The water quality of peat swamp forest is quite unique. The number of fish species that are able to survive and breed in the black water environment, is limited and many species found in the peat swamp forest are not found in other habitats. Many of these species are colourful and are collected for its ornamental value and use while others are attractive fish for consumption and sports (Zakaria, 1999).

During an intense study in NSPSF, Ng et al (1994) found 47 species of fish living in this black water. Out of this, 14 species were stenotopic to acidic black waters, meaning that they are confined to only black water habitat. Buch-Anderson and Cold in 1999 have carried out an inventory of fish species in the NSPSF during the dry season and 28 species were have recorded.

In 2013, a scientific expedition in NSPSF was conducted and the study on fishes recorded a total of 30 species of freshwater fishes in small roadside ditches of the NSPSF, between Sg. Besar and Tanjung Malim. Fishes recorded were mostly from the family Osphornimidae, followed by Cyprinidae and Channidae with 10, six and three species, respectively. Nine families were represented by a single species and the other (Family Siluridae) with two species.

Six unique fish species have been recorded at NSPSF. These species were first recorded in 1989 (Ng et al 1994). These species were new to science and most of them have only been recorded at NSPSF.

Table 3-9: Fish species recorded from ditches along the roadsides on the northern boundary of NSPSF

No.	Family	Species	Status	Recorded by
1.	Cyprinidae	<i>Desmopuntius hexazona</i>	A	Ng (1994) & MNS (2013)
2.		<i>Desmopuntius johorensis</i>	A	Ng (1994) & MNS (2013)
3.		<i>Rasbora cephalotaenia</i>	A	Ng (1994) & MNS (2013)
4.		<i>Rasbora einthovenii</i>	A	Ng (1994) & MNS (2013)
5.		<i>Rasbora kalochroma</i>	A	Ng (1994) & MNS (2013)
6.		<i>Trigonopoma pauciperforatum</i>	A	Ng (1994) & MNS (2013)
7.		<i>Rasbora gracilis</i>	A	Ng (1994)
8.		<i>Rasbora dorsiotellata</i>	A	Ng (194)

9.	Cobitidae	<i>Lepidocephalichthys tomaculum (En)</i>	A	Ng (1994) & MNS (2013)
10.		<i>Lepidocephalichthys pristis</i>	A	Ng (1994)
11.	Balitoridae	<i>Neohomaloptera johorensis</i>	S	Ng (1994) & MNS (2013)
12.	Siluridae	<i>Kryptoterus macrocephalus</i>	A	Ng (1994) & MNS (2013)
13.		<i>Silurichthys indragiriensis</i>	A	MNS (2013)
14.		<i>Ompok leiacanthus</i>	S	Ng (1994)
15.		<i>Silurichthys hasseltii</i>	A	Ng (1994)
16.	Clariidae	<i>Clarias cf. leiacanthus</i>	A	Ng (1994) & MNS (2013)
17.		<i>Clarias meladerma</i>	E	Ng (1994)
18.		<i>Clarias teijsmanni</i>	A	Ng (1994)
19.		<i>Encheloclarias curtisoma(En)</i>	S	Ng (1994)
20.	Bagridae	<i>Mystus bimaculatus</i>	S	Ng (1994) & MNS (2013)
21.		<i>Leiocassis micropogon</i>	A	Ng (1994)
22.		<i>Mystus nemurus</i>	E	Ng (1994)
23.	Zenarchopteridae	<i>Hemirhamphodon pogonognathus</i>	A	MNS (2013)
24.	Parakysidae	<i>Parakysis verrucosa</i>	A	Ng(1994)
25.	Chaudhuriidae	<i>Genus nova Sp nova (En)</i>	S	Ng (1994)
26.	Synbranchidae	<i>Monopterus alba</i>	E	Ng (1994)
27.	Pristolepidae	<i>Pristolepis grootii</i>	A	Ng (1994)
28.	Mastacembelidae	<i>Mastacembelus cf. circumcinctus</i>	A	Ng (1994) & MNS (2013)
29.	Nandidae	<i>Nandus nebulosus</i>	A	Ng (1994) & MNS (2013)
30.	Anabantidae	<i>Anabas testudineus</i>	E	Ng (1994) & MNS (2013)
31.	Helostomatidae	<i>Helostoma temminckii</i>	A	Ng (1994) & MNS (2013)
32.	Osphronemidae	<i>Belontia hasselti</i>	A	Ng (1994) & MNS (2013)
33.		<i>Betta hipposideros</i>	S	MNS (2013)
34.		<i>Betta bellica</i>	A	Ng (1994) & MNS (2013)
35.		<i>Betta livida (En)</i>	S	Ng (1994) & MNS (2013)
36.		<i>Betta sp nova (En)</i>	S	Ng (1994)
37.		<i>Luciocephalus pulcher</i>	A	MNS (2013)
38.		<i>Parosphromenus harveyi</i>	S	Ng (1994) & MNS (2013)
39.		<i>Sphaerichthys osphromenoides</i>	S	Ng (1994) & MNS (2013)
40.		<i>Trichopodus leeri</i>	A	Ng (1994) & MNS (2013)
41.		<i>Trichopodus pectoralis</i>		Ng (1994)
42.		<i>Trichopodus trichopterus</i>	E	Ng (1994) & MNS (2013)
43.		<i>Trichopsis vittatus</i>	E	Ng (1994) & MNS (2013)
44.		Channidae	<i>Channa bankanensis</i>	S

45.		<i>Channa lucius</i>	A	Ng (1994) & MNS (2013)
46.		<i>Channa striatus</i>	E	MNS (2013)
47.		<i>Channa gachua</i>	A	Ng (1994)
48.		<i>Channa melasoma</i>	A	Ng (1994)

Remarks: A. Stenotopic to acid waters,
E. Eurytopic (acid to neutral or slightly alkaline),
S. Stenotopic to acid blackwaters

According to PERHILITAN survey conducted in 2009, 17 species of amphibians from Family Bufonidae, Raniidae, Microhylidae, Megophrydae and Rhacophoridae have been recorded. Poisonous Rock Frog (*Rana hosii*) from Raniidae Family has also been recorded in the peat swamp forest area. As for reptiles, 16 species have been recorded from Agamidae, Gekkonidae, Scincidae, Varanidae, Elapidae, Boidae and Colubridae Families.

In the 2013 scientific expedition, 17 species of spiders were recorded from 7 families - with the most recorded family being Araneidae with 5 species followed by Salticidae with 4 species, Tetragnathidae with 3 species and Family Lycosidae, Oxyopidae and Theridiidae with 1 species respectively.

47 species from nine families of dragonflies and damselflies (Order: Odonata) were also recorded during the scientific expedition.. Of these, 28 species were in family Libellulidae, nine were in family Coenagrionidae, two each were in families Platycnemididae and Protoneuridae and Chlorocyphidae, and one each was in families Gomphidae, Lestidae, Argiolestidae and Corduliidae. A good number of species recorded in NSPFS were peat swamp specialists. The number of Odonata species recorded during the scientific expedition was high, representing 19% of the species found in Peninsular Malaysia indicating NSPFS is particularly rich in Odonata fauna.

3.5 Forest Classification Based on Remote sensing

A classification was made of the forest types in Sg karang and Raja Musa Forest reserves in 1999 based on aerial photographs from 1998 (Forestry department PM and Forest maps G Gleason 1999) and this was repeated in 2014 using Landsat 8 images from April 2014 (Alias 2014). The results are shown in Table 3-9 and Fig 3-14

Table 3-10: Forest Type comparison for 1998 and 2014 for Sungai Karang FR dan Raja Musa FR

Forest Types	Sungai Karang FR and Raja Musa FR			
	1998	2014	changes	
	(ha)	(ha)	(ha)	(%)
Tall-High Density Forest	776	786	10	1.3%
Tall-Medium Density Forest	9,806	9,669	-137	-1.4%
Tall-Low Density Forest	8,599	7,891	-708	-8.2%
Medium-High Density Forest	1,791	1,074	-717	-40.0%
Medium-Medium Density Forest	21,109	20,547	-562	-2.7%

Medium-Low Density Forest	23,720	24,130	410	1.7%
Low Forest (<15 meter)	3,816	2,028	-1,788	-46.9%
Grassland/scrub/burnt area	3,561	5,755	2,194	61.6%
Agriculture Plantation	377	1,282	905	240.1%
TOTAL	73,555	73,162		

Notes :

Tall-High Density Forest = High Forest (>25 meter), High Density (>80% Crown Coverage)

Tall-Medium Density Forest = High Forest (>25 meter), Medium Density (50 - 80% Crown Coverage)

Tall-Low Density Forest = High Forest (>25 meter), Low Density (<50% Crown Coverage)

Medium-High Density Forest = Medium High Forest (>25 meter), High Density (>80% Crown Coverage)

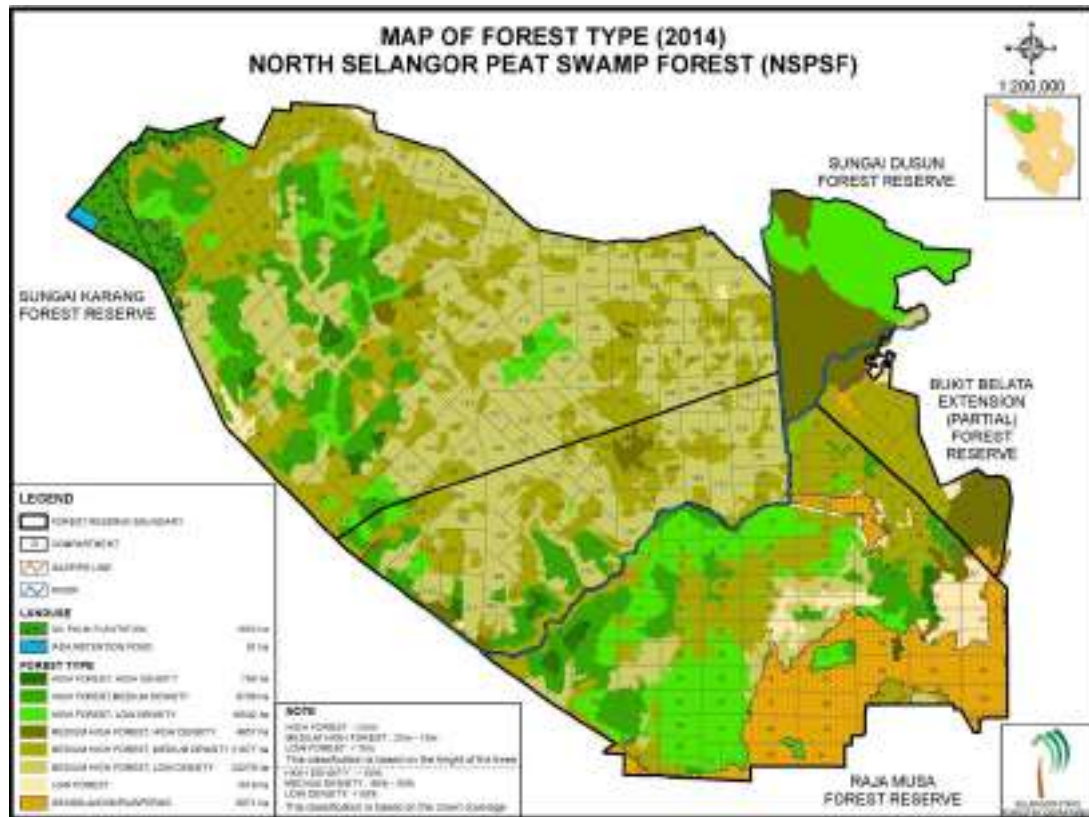
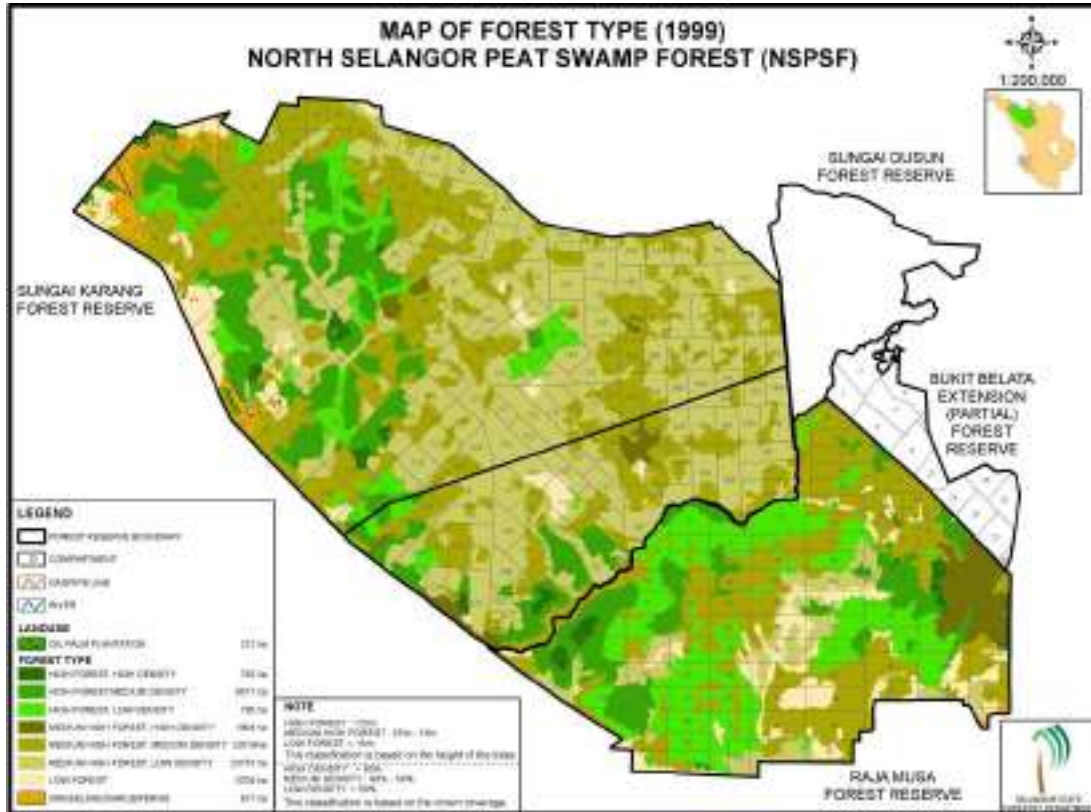
Medium-Medium Density Forest = Medium High Forest (>25 meter), Medium Density (50 - 80% Crown Coverage)

Medium-Low Density Forest = Medium High Forest (>25 meter), High Density (>80% Crown Coverage)

Low Forest = Low Forest (<15 meter)

Based on the analysis, there is not a significant change for the forested site in Sg Karang, showing slight increase in the area. However, for Raja Musa Forest Reserve, the decrease in forested area is very significant especially for Medium-High Density Forest which shows reduction of 717ha or 40%. There are also significant increases in the grassland/open land, which had increased by 2194ha (61.6%) and plantations which had increased to 1282ha (240% increase). The main difference is caused by the burning of medium -High density forest in the southern portion of raja musa and its conversion to grassland by frequent fires. The expansion of the oil plam plantations has taken place mainly in the northwest corner of the Sg Karang Forest Reserve – mainly through planting of grasslands and degraded areas.

Figure 3-14: Forest Type map of NSPSF, 1999 and 2014



3.6 Forest Management Inventory

Results of the Forest Management Inventory in 1999

A management inventory was undertaken in 2000 (RCFM and EMS, 2000). The overall picture of the management inventory is as follows:

In total, 3,734 trees with dbh > 15.0cm were identified and measured in 550 plots of 250 m² each, covering a total sampling area of 13.75 ha. This gives an overall average density of trees with dbh > 15.0cm of 272 trees per ha.

A total of 4,125 tree saplings in the dbh size class from 5.0cm to 14.9cm were identified and measured in 550 plots of 78.54 m² each, covering a total sampling areas of 4.32 ha. This gives an overall average sapling density of 955 saplings per ha.

A total of 7,401 seedlings were identified and counted in 550 plots of 12.57 m² each, covering a total area of 0.69 ha. This gives an overall average seedling density of 10,708 seedlings per ha.

The total area of the seven Forest Classes, that were covered by the inventory, is 69,799 ha. The total area of the 550 main plots is 13.75 ha. Thus, the inventory covered 0.02% of the area covered with trees in the NSPSF.

Stand Composition

Trees, dbh > 15cm:

The diameter of all trees with a dbh above 15.0cm was measured in the main plots. The average number of trees per ha, found within each size class, is presented in Table 3-11.

Table 3-11: Tree Distribution per ha by Size Classes within Forest Classes

Forest class	Size Classes, dbh in cm					Total >15
	15.0-29.9	30.0-44.9	45.0-59.9	60.0-74.9	>75	
1.a High Forest high density	229	39	13	5	2	288
1.b High Forest, Medium density	214	45	11	1	2	274
1.c High Forest, Low density	151	32	6	3	0	192
2.a Medium High Forest, High density	228	44	7	2	2	283
2.b Medium High Forest, Medium density	257	48	8	2	1	315
2.c Medium	212	37	5	1	0	255

High Forest, Low density						
3 Low Forest	235	49	11	1	0	303

Table 3-11 reveals that the forest contains very few timber-sized trees (dbh >45cm). The highest number of timber-sized trees per ha is found in Forest Class 1.a (High Forest. High Density) that contains an average of 20 trees of timber-size per ha only. The low frequency of large trees implies that practically every large trees were removed during previous logging activities. A closer examination of the few remaining very large trees with dbh > 75cm showed that they are mostly senile individuals of poor shape, that were probably left out during past logging operations.

Table 3-11 also shows that small trees (dbh 45cm) are dominant in all Forest Classes. The average number of trees per ha with dbh 45 ranges 183 in Forest Class 1.c. to 305 in Forest Class 2.b, and in total the Small trees make up 97-99% of the total tree population with dbh 15cm.

Another measure of forest stand density is the basal area per ha. Table 3-12 shows the basal area of different size classes in the NSPSF:

Table 3-12: Basal area in square metres per ha

Forest class	Size Classes, cm dbh					Total
	15.0-29.9	30.0-44.9	45.0-59.9	60.0-74.9	>75	>15
1.a High Forest high density	7.77	3.98	2.85	1.72	1.07	17.38
1.b High Forest, Medium density	7.47	5.68	2.19	0.19	0.81	16.34
1.c High Forest, Low density	5.24	3.09	1.28	1.08	0.00	10.69
2.a Medium High Forest, High density	7.51	4.35	1.34	0.73	1.23	15.16
2.b Medium High Forest, Medium density	9.70	4.79	1.61	0.57	0.91	17.59
2.c Medium High Forest, Low density	7.39	6.49	1.07	0.23	0.34	15.52
3 Low Forest	8.07	4.80	2.30	0.47	0.00	15.64

The overall picture is that results from Table 3-12, is similar to findings from Table 3-11-- trees from the lower dbh classes dominate the forest, and such small trees take up most of the space in the forest.

It should be noted that the figures presented in Table 3-11 and 3-12 are average figures and that considerable variation was observed in tree density and basal area between both clusters and plots within the same Forest Class. The Forest Classes are not homogenous entities, as illustrated in the discussion on species composition below.

To qualify the stand composition, an analysis of the species composition of the seven Forest Classes was carried out. A summary of this analysis is provided in Table 3-13.

Table 3.-13 shows that there is a correlation between the degree of disturbance and species composition. Secondary forest species are dominant in Forest Classes 1.a, 1.b, 1.c, and 2.a, and the forest appears to be developing towards a species composition, that is similar to the composition, that is found in an undisturbed peat swamp forest. In the more heavily disturbed Forest Classes (Forest Class 2.b, 2.c, and 3), pioneer species are, as expected, more frequently found.

Although the seven Forest Classes may appear uniform from Table 3-11, and the Forest Class Map presented in Figure 3-14, it should be noted that each Forest Class in effect cover more than one ecological and hydrological zone. Accordingly, there is significant variation in the species composition, stand structure, and density within the Forest Classes. The variation was most clearly observed during the helicopter survey carried out before the field measurement, that revealed the following:

The area covered with Forest Class 2.a forest along the south-west border of Sungai Karang (e.g. Compartment 118) is dominated by Kedondong, whereas Forest Class 2.a areas in Raja Musa (Compartment 84) has a much lower coverage of Kedondong and a higher coverage of Pandanus.

The areas of Forest Class 1.c in the north-east corner of Raja Musa (compartment 96-98) is dominated by palms and appeared to have a high water table at the time of the survey. In contrast, the Forest Class 1.c area in the centre of Sungai Karang (Compartment 228) has no palms and the forest floor appeared to be dry.

Table 3-13: Dominant tree species in the seven Forest Classes.

Forest Class	Dominant species in the order of abundance	Comments
1.a	Meranti Bakau, Nyatoh, Kelat, Medang, Mahang	Secondary forest species have successfully established themselves, and are beginning to outperform pioneer species.
1.b	Kelat, Medang, Mahang, Nyatoh, Meranti Bakau	
1.c	Medang, Kelat, Mahang, Jangkang, Kedondong	In the process, pioneer species are being replaced by long-living timber tree species.
2.a	Kelat, Meranti Bakau, Terentang, Simpoh, Medang, Resak	

2.b	Medang, Mahang, Kelat, Nyatoh, Geronggang	There is a high number of Mahang, Pulai and other pioneer tree species. This implies that the stands are in the early stages of recovery
2.c	Mehang, Kelat, Medang, Nyatoh, Geronggang	
3	Pulai, Mahang, Geronggang, Kelat	
2.b	Medang, Mahang, Kelat, Nyatoh	There is a high number of Mahang, Geronggang Pulai and other pioneer tree species. This implies that the stands are in the early stages of recovery
2.c	Mehang, Kelat, Medang, Nyatoh	
3	Pulai, Mahang, Geronggang, Kelat	

The tree regrowth within Forest Classes is unevenly distributed. Areas that have in the past have been completely open, such as heavily logged areas along old rail lines and canals, tend to be covered almost exclusively by homogenous even-aged stands of pioneer species such as Mahang.

The picture presented in Table 3.11 to 3.13 is therefore general and due note should be taken of the considerable ecological and hydrological differences within each Forest Class, that result in significant variation in the tree composition and density within Forest Classes.

Summary of Findings from the Forest management inventory

A total of 13.75 ha of the NSPSF was inventoried in 550 plots organised in 110 clusters located within seven Forest Classes covering the forested areas of the Forest Reserve. Significant variation was observed between clusters and plots within the same Forest Class and so the numeric findings of the inventory gives an indication of the level of measured parameters rather than exact estimates.

Overall, the inventory showed that the NSPSF is severely degraded as a consequence of previous intensive logging and drainage from logging canals. The average stock of trees of with a dbh > 45cm is at the level of 15-30 m³ per ha in most parts of the forest.

An analysis of the species composition of trees, saplings, and seedlings showed that the forest is in the process of recuperating and is moving towards a forest structure that is dominated by secondary peat swamp forest species and where pioneers are subdued. The major factors threatening the recuperation process include drainage of the ecosystem, unsustainable logging practices, and conversion of the forest to other land uses.

CHAPTER 4

4 The Socio- Survey On Importance Of Peat Swamforest Ecosystem To Local Communities Adjacent To Raja Musa Forest Reserve

The study of the social-economic impacts of Raja Musa Forest Reserve utilisation by local communities in the vicinity was carried out in 2012. From these studies have recognized the social and economic aspects of the uses of the NSPSF and assesses the economic value of the most important benefits derived from it. Such benefits and their values are closely linked to the way the forest is managed. Chapter 4 should therefore be seen in conjunction with Chapter 5 that provides a description of past and present uses of the forest and management practices in place to regulate the uses.

4.1 Introduction of North Selangor Peat Swamp Forest & Utilization

Peat swamp forest development and management has attracted much attention at both national and international levels. The location of peat swamps forest relatively near to human settlements has often resulted in its utilization and development by the state or the local villagers. The case of Raja Musa Forest Reserve (RMFR or North Selangor Peat Swamp Forest/ NSPSF) is a typical example of utilization of peat swamp forest for various purposes. Forest utilization often affects the local livelihood of residents in the vicinity. While much study has focused on the forestry aspects of NSPSF, their general lack of research on the socioeconomic impacts of its utilization.

Local communities make use of resources in Raja Musa Forest Reserve for various purposes, i.e (a) settlement, (b) agricultural cultivation, (c) fishing, and (d) harvesting of non-timber forest products (NTFP). A study is needed to provide better understanding of local uses of peat swamp forest resources and resulting socioeconomic impacts. The output of this study could be used for sustainable management of peat swamp forest.

4.2 Introduction of the socio-economic study

A socio-economic survey was carried out for three months (October to December 2012) in four villages located in the vicinity of RMFR (see Figure 4.1). The purpose of this survey is to find out how people in the local villages surrounding Raja Musa Forest Reserve (RMFR) use the forest and how they view the threats and opportunities in it.

The aims of the socioeconomic survey were:

- To determine and document the use of natural resources and forests by local communities
- To assess the relationship of socioeconomic impact of people living in the surrounding peat swamp forests, and
- To understand local responses and perceptions about the wise use of peat swamp

4.3 Historical utilization of NSPSF (including RMFR)

The NSPSF has had a long history of development since the 1930s until its status change in the 1980s. The majority of these areas have also been drained for timber harvesting and agriculture development etc. The lack of proper management of this area would result in repeated and further degradation and burning of the forest. Before 1990/1991, apparently there was little planning in the timber harvesting from NSPSF. It was only after the gazettement of NSPSF as forest reserve in 1990/91 that proper management planning on timber harvesting was introduced and implemented.

Areas destroyed by forest fire were subsequently encroaching especially by people inhabiting the nearby villages and settlements mainly for agricultural purposes. The encroachment activities were first detected in 1998. Since then, some portions of the FR areas that have been encroached. The area encroached were planted with oil palm and perennial crops such as banana, pineapple, yam, tapioca and vegetables. Small scale livestock rearing was also found. There were also houses and dwelling huts. On 2008, the Selangor State Government decided to rehabilitate the encroached areas and the Forestry Department was given the task to move the people out of the area, dismantle the houses/dwelling huts and destroy the agriculture crops in the FR. Since then the Selangor State Forestry Department (SFD) has been kept busy blocking old logging and drainage canals to prevent water leakage and subsequent drying of the peat swamp forest, which have led to several forest fire incidence. Since December 2008 and until to date, many series of tree planting programmes had been carried out in collaboration with NGOs, local interest groups, other government agencies, private sector, students from schools and higher learning institutions (mostly from Klang Valley), and involving the local communities from nearby villages surrounding the RMFR.

4.4 Methodology

4.3.1 Techniques of Data Collection

Two main techniques were used to gather primary data, namely rapid rural appraisal and survey research. The rapid rural appraisal technique enables a quick assessment of the existing environment and the possible impacts of forest resource utilisation on the local socioeconomic livelihood. The method used included group discussion, mapping, stories & taking -note. It provides a general overview on the extent of local dependence on the forest resources and boundaries for livelihood. These techniques helped much in questionnaire preparation. Based on the questionnaire, the survey research was carried out. With regard to survey on rural villagers, a face to face interview survey was undertaken. In addition, survey research provide better understanding of the socioeconomic conditions and activities of villagers such as paddy farming, oil palm plantation (small holders), recreational activities (fishing, ecotourism, & etc.) and harvesting of non-wood forest products (NWFP) of RMFR.

The total numbers of respondents interviewed was 393 people in four villages. Out of these respondents, 250 were male and 142 were female. Table below shown the number of respondents interviewed.

Table 4-1: Breakdown of respondents

Gender Total	Target respondents	Villages					Total
		Bestari Jaya	Raja Musa	Ampangan	Sri Tiram	Others	
Male	70	73	71	51	45	11	250
Female	30	31	31	48	32	0	142
Total	100	104	102	99	77	11	393

4.3.2 Selection of Study Area

The socioeconomic survey was carried in four villages which are Bestari Jaya, Raja Musa, Ampangan and Sri Tiram Jaya. These villages are located in the vicinity of RMFR. Surveys were carried out for three months starting from Bestari Jaya and ends at Sri Tiram. Most of respondents have heard of RMFR and its location. The main economic activity in these villages is involved with agricultural. So, most of them have a farm and oil palm.

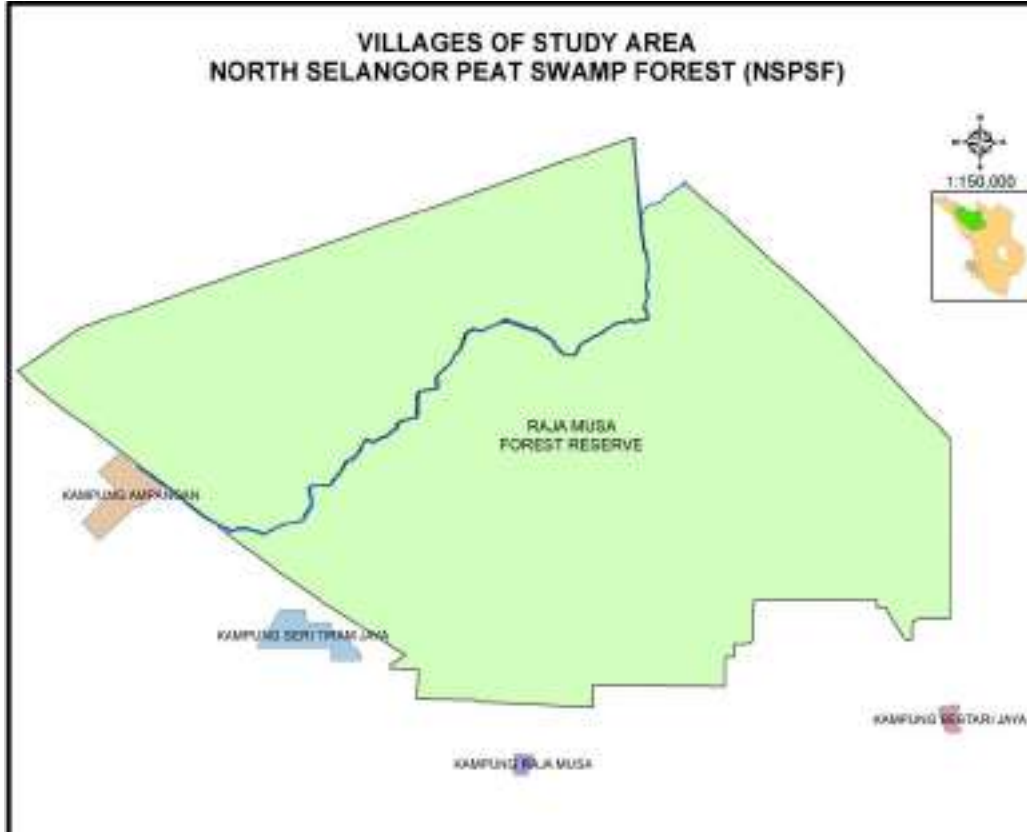


Figure 4-1: Location of the four villages studied (Source from Kuala Selangor District Office)

Section below show the profile about each of village selected for this study, 2012;

Bestari Jaya Village's Profile

Village' name : Bestari Jaya
Mukim : Bestari Jaya
Parliament : Kuala Selangor
Dun : Ijok
Total Population : 3172 people

Table 4-2: Categories of total population of Bestari Jaya Village

No.	Categories	Total Population (%)
1	Senior citizens Senior Citizens (60 Years and Over)	25%
2	Adult (41 Yr, 59 Yr)	34%
3	Youth (15 Yr, 40 Yr)	26%

Table 4-3: Economic activities of Bestari Jaya Village

No.	Economic activities	Type of economic activities
1	Services	Teachers, civil employees (Unisel), working at provide companies (Segi Niaga)
2	Business	Food stall, retail and others
3	Agricultural	Cassava, palm oil, banana and vegetables
4	Livestock	goat
5	Aquacultures	Cat fish and fresh water prawns
6	Non-Timber Forest Products	Fishing, harvesting of lotus flower and others

i) Raja Musa Village' Profile of Raja Musa Village

Village' name	: Raja Musa
Mukim	: Pasangan
Parliament	: Tanjong Karang
Dun	: Permatang
Total Population	: 886 people

Table 4-4: Categories of total population of Raja Musa Village

No.	Categories	Total Population (%)
1	Senior citizens Senior Citizens (60 Years and Over)	10%
2	Adult (41 Yr, 59 Yr)	17%
3	Youth (15 Yr, 40 Yr)	43%

Table 4-5: Economic activities of Raja Musa Village

No.	Economic activities	Type of economic activities
1	Agricultural	Vegetables, pineapple and yam
2	Livestock	Cattle, goat, chicken and "burung walit"
3	Services	Teachers, civil servant and others
4	Business	Food stall, retail and others
5	Non-Timber Forest Products	Fishing and others

- ii) Ampangan Village Profile
- Village' name : Ampangan
 Mukim : Tanjong Karang 1
 Parliament : Tanjong Karang
 Dun : Sungai Burong
 Total Population : 1625 people

Table 4-6: Categories of total population of Ampangan Village

No.	Categories	Total Population (%)
1	Senior citizens Senior Citizens (60 Years and Over)	10%
2	Adult (41 Yr, 59 Yr)	40%
3	Youth (15 Yr, 40 Yr)	35%

Table 4-7: Economic activities of Ampangan Village

No.	Economic activities	Type of economic activities
1	Agricultural	Paddy and coconut
2	Services	Teachers, civil employee and others
3	Business	Food stall, retail, homestay programme and others
4	Non-Timber Forest Products	Fishing, and others
5	Livestock	Cattle along the IADA bund

- iii) Sri Tiram Jaya Village's Profile
- Village' name : Sri Tiram Jaya
 Mukim : Tanjung Karang 2
 Parliament : Kuala Selangor
 Dun : Permatang
 Total Population : 2808 people

Table 4-8: Categories of total population of Sri Tiram Jaya Village

No.	Categories	Total Population (%)
1	Senior citizens Senior Citizens (60 Years and Over)	10%
2	Adult (41 Yr, 59 Yr)	23%
3	Youth (15 Yr, 40 Yr)	32%

Table 4-9: Economic activities of Sri Tiram Jaya Village

No.	Economic activities	Type of economic activities
1	Agricultural	Paddy and palm oil
2	Livestock	Cattle and goats
3	Services	Teachers, civil servant and others

4	Business	Food stall, retail and others
5	Non-Timber Forest Products	Fishing, and others

Table 4-10: Other villagers that were also interviewed at the vicinity of the Raja Musa Forest Reserve

No.	Village
1	Ijok Village
2	Rawang Village
3	Sri Gambut Village
4	Rantau Panjang Village

4.4 Result and Discussions

4.4.1 Section A

Respondents Details

a) Occupation

Respondents have engaged in various types of jobs, which are not related to the Raja Musa Forest Reserve such as farmers, civil servant, business and employment in private sector and others. More than 55% of the respondents are farmers who Such as growing oil palms, orchards, and farming outside the forest reserve.

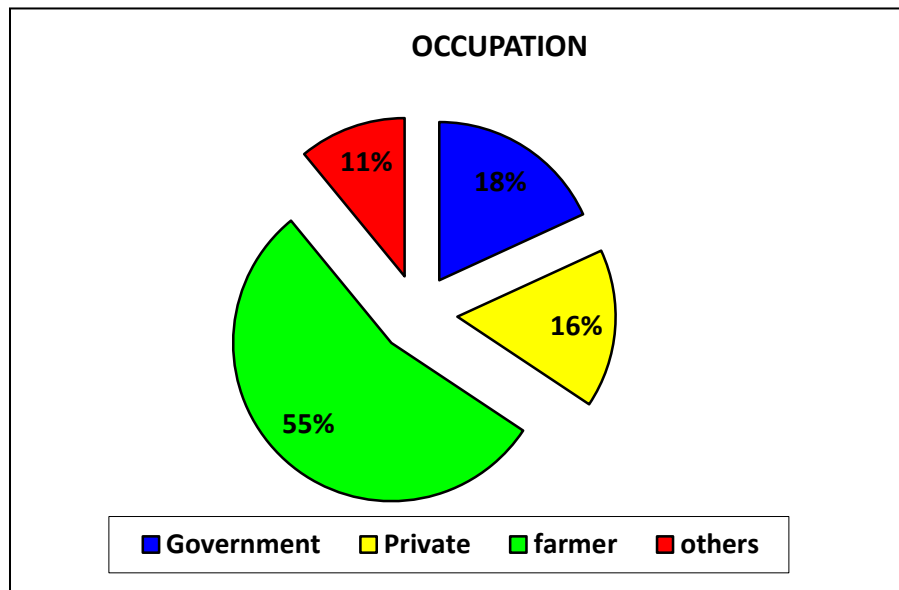


Figure 4-2: Percentage of occupation by respondents in the four villages

4.4.2 Section B (perception & views)

The survey also looked into the type problems respondents perceive in relation to the peat swamp forest, and how the forest in their view could be used in the future.

Introduction and peat swamp forest use

Local communities use and benefit from the peat swamp forest in different ways. Some of the uses take place in the forest, while other activities are carried out outside the forest, using non-timber forest products from the peat swamp forest.

A summary of the most important goods & services of the RMFR is presented in Figure 4.3.

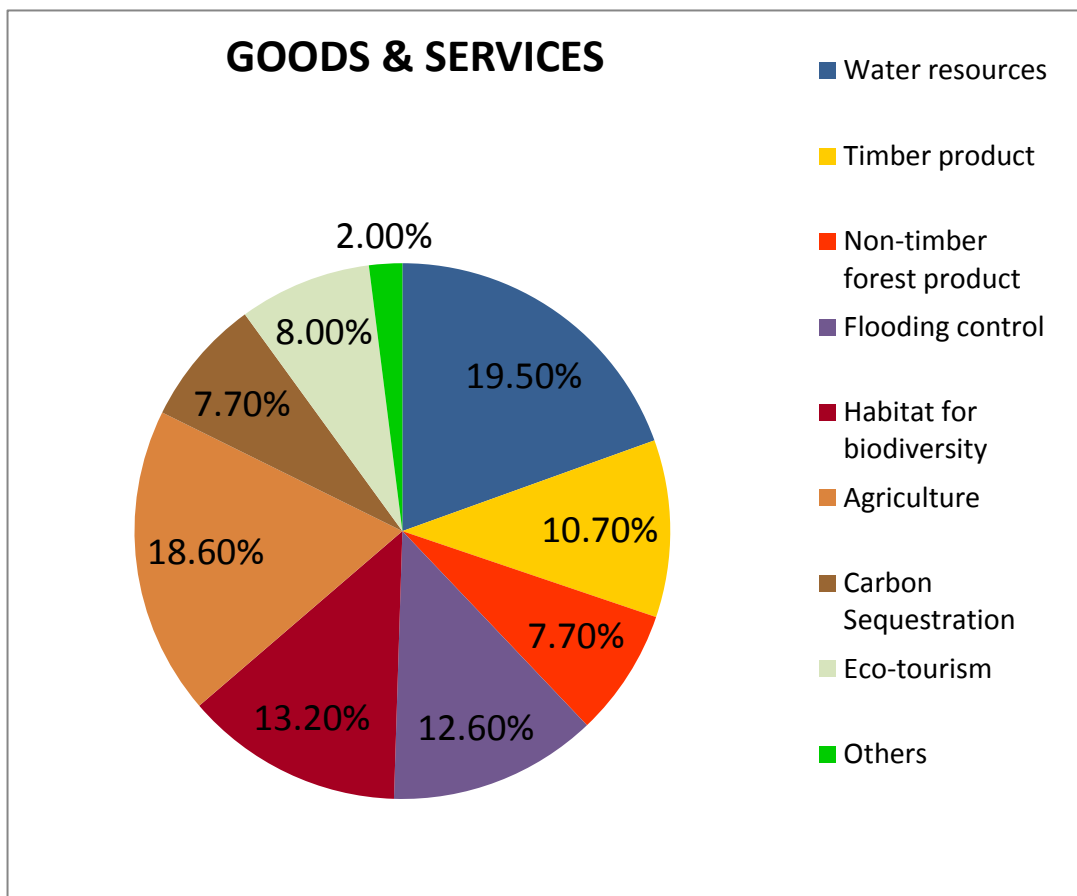


Figure 4-3: Percentage of Goods & Services of the Raja Musa Forest Reserve (RMFR) by local communities (respondents) in the four villages.

Most of the respondents agreed that RMFR contribute substantially to the agricultural activities and domestic water supply through its influence on the hydrological function.

The hydrological services provided by the RMFR are in the form of:

- Irrigation water to paddy and oil palm cultivation
- Domestic water supply for residential
- Flood control

a) Habitat for biodiversity

Peat swamp forests are found to have a high biodiversity value for the both plant and animal species. Peat swamp forest also provides a habitat for several rare and endangered species, and it is in the interest of the local community that such species are not extinguished.

b) Timber product

RMFR are designated production forest and available for logging in the 1990 to 2006. Then, the forest harvesting operations have been discontinued in 2007.

c) Non-timber forest product (NTFP)

Non-timber forest products that were harvested by villagers in the vicinity RMFR are fishing, collection of fruit, 'Palas' leave, rattan, and 'ulam-ulaman'. According to the villagers, Tapah fish have high market value. Some of the fruit and 'Palas' leave were sell in the market beside own consumption. 'Palas' leave was used as warapping for "ketupat" a traditional malay food.

d) Eco-Tourism / Recreation

According to respondents, Eco-tourism can be used as a good proxy to assess the potential value of the RMFR. RMFR is rich with many nature elements where it can become a major tourist attraction. . RMFR can be access mainly by rivers and canals, therefore visitors will have to use boats as a mean of transportation. Thus, kayaking can be introduced as a recreation activity besides recreational fishing. Bird watching could be other attractions as the area is located along the route of the migratory birds and these birds stopover here to rest before proceeding on their annual journey. . In addition to that, traditional house of villagers that are located in the vicinity of RMFR can be introduced into homestay programme, which in turn can support the socio-economic of the local communities.

e) Carbon Sequestration

Large quantities of organic matter are accumulated in the peat swamp forest, and so the RMFR functions as carbon storage. Above ground, carbon is primarily stored in the tree trunks, while below ground carbon is fixated in the peat. If the peat swamp forest is converted to other uses; that entail clearing the forest and depleting the peat, by burning, mining or natural decomposition, this carbon will be released into the atmosphere. Hence, the global environment and the global community benefit from keeping the peat swamp forest in a condition, where the level of stored carbon is maintained

f) Others goods and services,

Some plants of the peat swamp forest are sources of some natural chemical compounds with potential to be developed into modern medicine. But much of these compounds have not proceeded into the bio-prospecting stage. There are some respondents known to collect plants parts for use as traditional medicines or food (salad or ulam-ulam).

Table 4-11: Goods & Services Valued at Raja Musa Forest Reserve

Types of good & services	Product / function	Types of values
Hydrological	Domestic water supply (residential & industrial uses)	Direct
	Agricultural	Effect on production
	Flood mitigation	Indirect
	Fire prevention (haze or loss forest elements)	Direct
Timber	Wood	Direct
Non-Timber Forest Products	Palas leaves, Fish, rattan, bamboo, ornamental plants, asam kelubi, medicinal plants, etc.	Direct
Carbon Sequestration	Carbon sink	Indirect
Biodiversity habitats	Wildlife, fishes, birds, flora, etc.	Direct / Endangered

- **Direct Use values**

These are values that accrue from the direct human use of peat swamp forest

- **Indirect use values**

Peat swamp forest has an important role in the maintenance of ecological and environmental function. Humans do not have obtained any direct use in this capacity. But with these functions uninterrupted, various related uses and services can continuously be supplied such as regulated water flow into farmland. These benefits that accrued, as a result of the ecological and environmental functions are termed indirect use values

The major benefit and services derived from the RMFR are shown in Table . Of these, water resources and agricultural aspects are considered to the most important benefits derived from the RMFR. Potential of eco-tourism are fast becoming important socio-economic activities in North Selangor (especially in Raja Musa Forest Reserve).

Problems Identified

According to Figure 3, the main problems identified by respondents in relation peat swamp forest were forest encroachment (forest reserve), peatland encroachment (state land), forest fire & haze, water problems, and others.

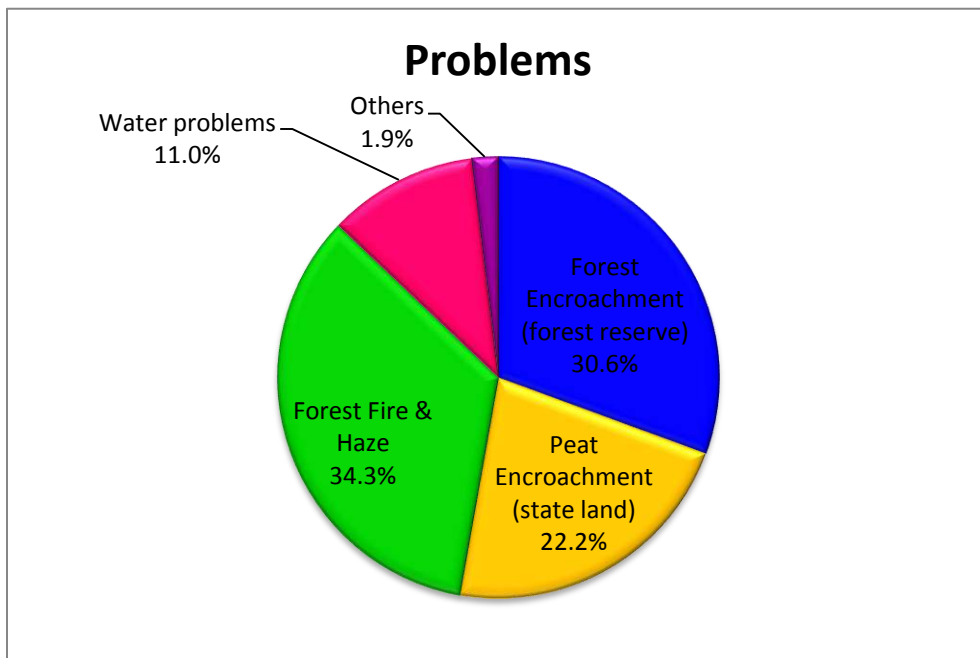


Figure 4-4: Problems identified by community affecting Raja Musa Forest Reserve

Based on the four village respondents, the forest and state land encroachments (land clearing) are carried out at the vicinity of forest reserve. However this encroachment causes several negative impacts to local communities and environmental services (natural benefits) including:

- Forest Fire and associated haze
- Flooding
- Water problems
- Other - Loss of environmental services (subsidence, water supply & non-timber forest product).

a) Forest Fires & Associated haze

Drainage of the peat swamp forest will lead to draining out of the peat and increased fire risk. Most of these fires were deliberately started as part of legal or illegal land development activities – primarily for oil palm. Fires were able to spread as a result of the development of drainage systems which drained out water from the forest reserves during dry season.

b) Flooding

Uncontrolled encroachment or land clearance partly contributed to local flooding after heavy rain down pour, especially in the months of November & December. According to the respondents that oil palm over there, it is flooded even in the January to February 2013, the relatively dry period. There is no way for them to harvest the fruit because of the relatively high water level of about one metre. The trees are surviving but no growing well.

c) Water problems

In recent years the rice scheme has faced some water shortage periodically. Diverting all the water from the 70,000ha PSF into the sea will necessarily reduce the water supply further and may cause severe water shortage problem to the farmers during the drought seasons – when there is insufficient flow in the Sg Bernam. Other than that, declining water quality such as high sedimentation in river channels, water treatment, recreational services, fishing and domestic water use. Unsupervised canal construction may drain water from the peat swamp forest affecting ground water level and regulation of water supply

d) Others

Peat swamp forest may provide sustainable timber & non-timber forest products to local communities and environmental services to other natural systems. Converting peat swamp forest into agricultural farming generally produces impacts which are:

- Loss or alteration to the productivity of the peat swamp forest resources at the site such as quantitative and qualitative decline in stocking of timber and non-timber forest products. This may contribute to decline opportunities for future bio-prospecting.
- Loss of peat swamp forest resource in turn may affect environmental function.

4.4.3 Section C (Investigation on proposed future development in PSF)

Investigation on proposed future development in PSF

The survey also investigated how respondents' views different future uses of the peat swamp forest. The uses examined were encroachment, agricultural, mining, highway development, water supply, eco-tourism and preservation of Raja Musa Forest Reserve. The survey also looked into the type of problems respondents perceive in relation to the peat swamp forest, and how the forest in their view could be used in the future. Figure 4-5 below shows the result of the survey.

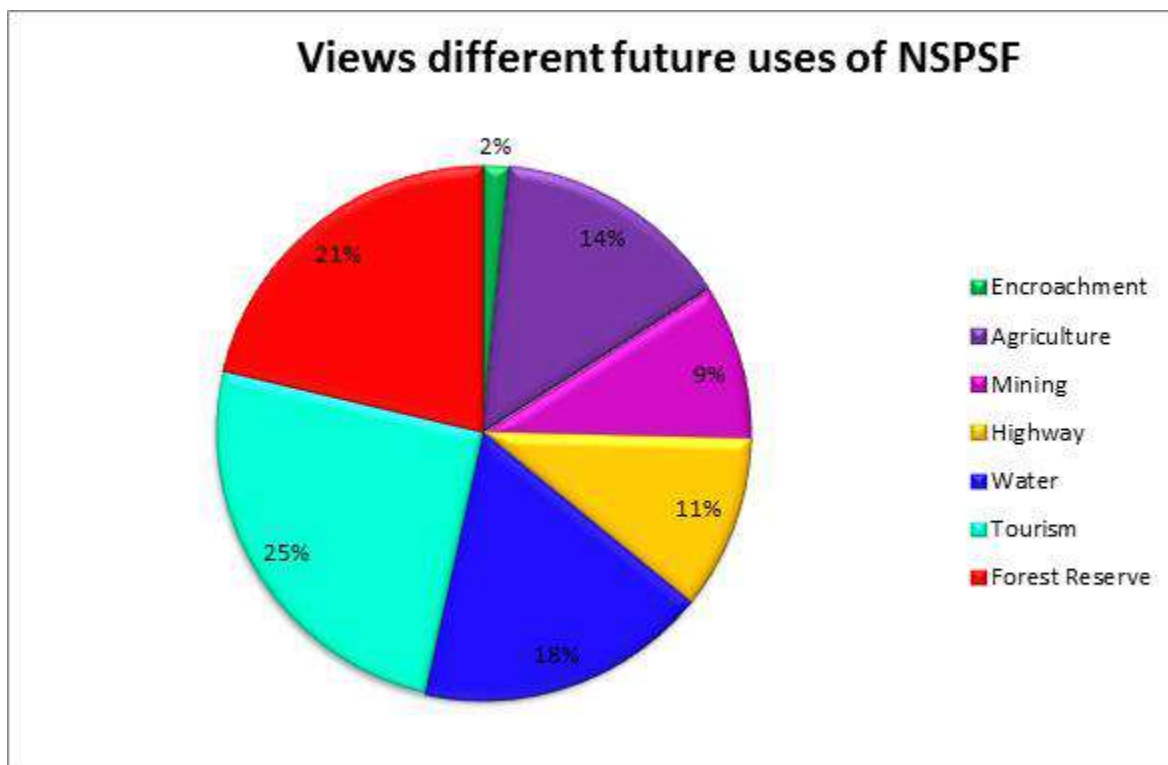


Figure 4-5: The respondent's views different future uses of the peat swamp forest

Preservation of Raja Musa Forest Reserve (RMFR/ Forest Reserve)

The respondents were asked if they would agree to totally preserve the RMFR, meaning that the forest area should be kept intact with minimum disturbance. Almost all of the respondents agreed to this. The main reasons for agreeing were to ensure adequate supply of irrigation for rice scheme project and to continue existing oil palm cultivation and farming activities.

Eco-tourism

Kuala Selangor is famous as an eco-tourism destination. The respondents were asked if development of eco-tourism should be promoted in the RMFR. Most of the respondents responded positively, mainly because they expect eco-tourism to boost local employment and income.

Water supply

RMFR is adjacent to the Tanjung Karang irrigation project. The peat swamp forest functions as buffer for the water supply for this scheme, and it was recognised that to sustain this function, the current land use practices, especially encroachment, had to stop. The yield in the paddy fields under the irrigation scheme is significantly higher than that is achievable without irrigation. Paddy is cultivated 5 times per 2 years and harvests of more than 5 tonnes per ha is common

Mining

The respondents were asked if mining should be allowed in the forest reserve. More than 70% of the respondents disagreed with allowing mining in or out of the forest reserve. The opposition was greatest among farmers, again because of their interest in protecting the forest as a source of irrigation water.

Encroachment

The respondents were asked if they agree to use of RMFR for encroachment. More than 85% of the respondents disagreeing to that they expect that further conversions of the peat swamp forest would worsen the forest fire and shortage of irrigation water.

4.4.3 Section D (Respondents option in General)

a) Best Management Practices/ BMPs

Best management practices (BMPs) is a basic guide for the sustainable use of peatland soils for vegetable production while at the same time reducing the environmental impacts especially GHG emissions and subsidence (Lim *et. al.* 2012).

This guide examines:

- the management practices used in oil palm production on peat soils, including the management of water, soil, crops, fertility, and pests; and
- the conservation practices available to peatland oil palm producers to ensure agronomic, economic and environmental sustainability including the conservation of adjacent peat swamp forest areas.

In addition, most of the respondents having problem with their agricultural practices (0.303, $P < 0.05$). They also were looking forward some training for optimizing sustainably the oil palm yield production.

b) Multi sectorial participation and co-operation

The socio-economic survey showed that the RMFR is affected by plans and interventions carried out on the land surrounding it, under the supervision and control of other government bodies. To ensure that prescriptions to achieve the objective protection of the RMFR are not undermined or offset by actions and events beyond the forest reserve boundaries and vice versa, plans and interventions in the RMFR should be co-ordinated with those of relevant authorities. It is especially important that activities are co-ordinated with SFD, DOE, DOA, DID, F&RD (Bomba), DLO, DOH and other relevant authorities (UPEN, DWNP and others). *(See Chapter 2 for the suggested government bodies and respective responsibilities and roles)*

c) Proposed Immediate Measures Should Be Taken By The Concerned Agencies (action plan)

Apart from the relevant government agencies, local community involvement and support is important for a successful management programme that will involve the protection, monitoring, development, conservation and the promotion of the RMFR. Below are listed some of the respondents proposed immediate measures should be taken by the concerned agencies to protect RMFR from external threats. Figure 4.6 have shown the percentage of proposed immediate measures that were suggested and agreed by respondents during the survey.

i) Monitoring

According to the respondents, there have some weakness in the monitoring of the state land & forestry land. Lack of this monitoring, directly contributing to the illegal activities. Respondents have proposed the relevant government agencies have to play an important role to monitor their own respective area from further encroachment (such as DOKS, DOHS, SSFD, DOE, and others). Therefore, the respondents have suggested for frequency of field inspections varies between sites. To maintain the geographical extent of the RMFR and to prevent encroachment and other illegal activities, external & internal boundaries must be stable. The measures required for maintaining external & internal boundaries are too clearly to mark the boundaries with signboards at regular intervals and filed inspections. The specific activities needed for boundary control depend on the nature of the boundary and the land use and ownership of neighbouring land. However, boundaries and demarcation should be inspected in connection with Forestry Department supervision and monitoring of field operation such as agricultural activities.

ii) Awareness campaign

The education and public awareness programmes should also be encouraged to attract community participation in the protection and conservation of the RMFR. Organised recreation and outdoor activities, such as tree planting, fishing activities, involving local community will provide opportunities for local residents to understand the importance of this forest reserve. Public education and awareness programmes can also be implemented by the dissemination of information through mass media, the website, seminars, local magazine (publications), posters, and brochures related to the preservation and importance of the RMFR.

During the survey, a specific question has been discussed with the respondents on public education and fire awareness campaigns to decrease fire risk at RMFR. Below are listed some of the answers:-

- Signs and warning boards (fire index risk) should be erected along the roads and on places with high fire risk (bridges, rubbish belts, fishing points, concession roads, main transport canals, popular fishing places)
- At beginning of the dry season, fire awareness campaign should be organised to motivate the local stakeholder and communities to take care with use of fire

iii) Law enforcement

The agro-industrial companies or land owners often do not comply with the basic legal regulations by inappropriately employing cost effective yet environmentally inefficient deforestation methods such as forest fires to clear the land for agricultural purposes. Preparation of rules and regulations to be followed by groups using the forest, including the development of signboards explaining the rules and regulations to be placed at strategic locations. Those areas break the rules and regulations must impose with serious legal action according to the government legislation and regulation.

iv) Conservation

The forest encroachment should not be allowed in the Raja Musa Forest Reserve and focus on conservation. An important task of the management is, therefore, to ensure that the conservation areas are protected from external threats. Block selected drainage canals in and adjacent to RMFR and enhance water management in the forest and adjacent farmlands and plantations to reduce fire risk. Rehabilitation of degraded peat swamp forest in RMFR in partnership with local communities and other stakeholders.

Chapter 5: Past and Present Management

5. Past and Present Management

5.1 Historic Overview of Land Uses

The section below gives a summary of the history of land use in and adjacent to the NSPSF.

5.1.1 Logging

At the turn of the century, there was little utilisation of the peat swamp forests in the northern part of Selangor. The population was relatively small, and most people lived along the coast. The pressure on the land from villagers and the state was therefore small.

However, in the 1930s logging activities began. A license for a sawmill site in Mukim Batang was issued to a local Chinese businessman in 1938, and more areas were logged in subsequent years.

The logging intensified, and several canals were constructed for log extraction. Because of the status of as state land, the logging activities were not subject to stringent rules and controls. Consequently, most areas in Sungai Karang and Raja Musa Forest Reserves have been logged several times since the 1960s.

Management System

Prior to the gazettelement of NSPSF as Permanent Forest Estate, logging operations were carried out more or less without management restriction. However, since 1990/91, the Selective Management System (SMS) has officially been used.

Logging Concessions

There were 10 main agreements areas in the NSPSF; with 8 in Sungai Karang (licenses approved 1966-1997) and 2 in Raja Musa (approved in 1960). The size of the agreement areas varied from 2,274 ha to 9,091 ha. By 1997, 11,859 ha or 42 % of these 10 agreement areas had been harvested, and annual coupe was ranging from 47 to 197 ha (Razani, 1997). Another 19,466 ha of small agreement areas was distributed to several minor concessionaires that are all located in Sungai Karang.

Logging Methods Used in the NSPSF:

Historically, the first logging operations in peat swamp forest were carried out manually using the *Kuda-Kuda* system. The system is very environmentally friendly, and requires logs to be hauled manually from the stump to small narrow gauge railways.

However, gradually timber harvesting became more mechanised, and in the early 1980s the traxcavator and canal system was introduced. The system was originally used in peat swamp forests that were earmarked for conversion (state land). Hence, it became the system most frequently used in the NSPSF, although narrow gauge railways continued to be used in combination with traxcavators.

The traxcavator and canal system entails digging a grid of canals measuring about 3 metres wide and 4 metres deep. The canals were used for hauling logs from the forest to a river or a road, from where the logs can be taken to a sawmill. The traxcavators are used for digging the canals, and a corridor, typically 5 to 10 m wide, is cleared along the canals. The corridors cleared for railway construction are sometimes up to 20 meters wide. Although the corridors cleared for canal construction are relatively narrow, canals are considered more damaging to the environment than narrow gauge railways, due to their disturbance of the natural PSF hydrology; see Section 3.2 on hydrology.

Felling was done by chainsaw. Directional felling was not commonly practised, and the damage to remaining trees and canopy was significant. After felling, logs were hauled to nearest canal or railway by traxcavator. Most commonly, traxcavators were allowed to move around freely in the logging area to extract timber without proper planning of secondary skid trails and roads. The damage to the trees and regeneration was very high.

The NSPSF has suffered severely from the past commercial forestry operation. The surveys and inventories presented in Chapter 3 revealed that the NSPSF is severely depleted in terms of hydrology, vegetation, wildlife, and timber. The practices described above in combination with the frequency of that they have been carried out are the underlying causes behind the present poor status of the forest.

5.1.2 Land Clearing for Farming

Paddy Cultivation

The logging activities also brought other land uses to the peat swamp forest. The building of roads leading to the forest area meant that villagers would now have access to the forest, and the British colonial government encouraged villagers in the vicinity of the forest to clear land with peat swamp forest for paddy cultivation. By 1940, many villagers had cleared forest, and established paddy fields. However, the production is reported to have been low due to poor soil fertility, grass infestation, and irregular water supply.

During the Japanese Occupation 1941-1945, more peat swamp forest was cultivated to meet food demands. The Japanese occupants forced villagers to establish and tend paddy fields, and the paddy fields were relatively clear of weeds compared to in the past. With increased yield, more people migrated from nearby regions and established themselves as paddy farmers.

After the Japanese Occupation ended in 1945, the paddy cultivation was further developed. The government improved the irrigation system, and a main canal and a feeder canal transporting water from Sungai Bernam and Sungai Tengi were established.

Oil Palm

The first oil palm plantation in Malaysia was established in Tennamaram (to the immediate south of NSPSF). Oil palm has also been developed in the eastern and northern edges of the NSPSF. About 1,500 ha had been established within the boundaries of the NSPSF. Between 2008-2010 about 400ha of oil palm cultivated inside the forest reserve was cleared and the area rehabilitated back to forest.

5.1.3 Tin Mining

Tin mining started in the 1950s in the southern part of Raja Musa. Tin mining declined after the international tin crisis in 1985, and by 1998 it had become an insignificant activity. Ex- tin mining land cover about 2,700ha to the southeast of NSPSF.

5.2 Present Uses

Prior to their status as Forest Reserves, the forests were classified as Stateland forests, and had been subject to intensive timber harvesting for more than 30 years. Timber harvesting in Stateland forests is not subject to the stringent rules which apply to reserved forests, and consequently the forests are very degraded. World Bank assessment recognized the NSPSF as being vital to the rice producing scheme in their role of storing and supplying water and as a result the forests were granted Forest Reserve status in 1990 (Kumari, 1996). Forest Reserve status has led to more managed timber harvesting operation in these forests.

In year 2008, the Selangor State Government acknowledged the severity of damage that had been done to the NSPSF, thus the State Government declared a 25 – year moratorium on timber harvesting, not only in NSPSF but for entire State of Selangor.

In the following sections, most important present uses and management practices are described.

5.2.1 Forest reserve

a) Logging

All logging was stopped 2007 and in 2010, a state wide moratorium was imposed in Selangor. No current timber harvesting is taking place in the forest reserve due to the moratorium.

b) Water supply

The most significant economic resources coming from the forest reserve is water, for irrigation and domestic supply. The peat forests of NSPSF have been managed to control flooding and as a source for irrigation during the dry season. The peat forests help to regulate the water table, thereby protecting against salinity intrusions (Kumari 1996) and the peat water from the peat forests contribute to the domestic water supply for Tanjong Karang.

c) Fishing and Hunting

Fishing is common along the main canal and along the River Tengi. Villagers from nearby communities and some come from as far as Kuala Lumpur fish on a part time basis for subsistence, while others for hobby. Among the fishes collected are ikan baung, tapah, lampam Sungai, haruan, and other black water fishes. At the moment, the fishing is not subject to management regulations, however, there are some informal agreement among villagers on the zoning of fishing activities along the JPS diversion canal and part of Sg. Tengi.

There is small scale hunting at the fringe of the forest.

d) Retention ponds

A 90 ha retention pond is currently in the proices of being constructed on 90ha within the northwest corner of the NSPSF,. The retention pond main functions is to supply water for the paddy irrigation to the Sg Pangjang area.

e) Non-Timber Forest Products (NTFPs)

The collection of NTFPs in NSPSF is mostly carried out by the local communities and it contributes significantly to their socio-economic livelihood. The NTFPs that are being collected are:

- fish
- animals
- mengkuang leavess
- palas leaves
- fruits
- medicinal plants

On a small scale, some villagers collect fruit in Raja Musa on a part time basis during the fruiting season. The fruit collection is for home consumption and sale through middlemen. Palas leaf and mengkuang leaf harvesting is an important activity in NSPSF. The *Pallas* leaf harvested for preparation of Malay traditional food which is Ketupat. While, *Mengkuang* leaf are used to make mats. Fruit collection is not subject to management regulations.

Rattan is found in the forest. However, the amount is so low that it is not harvested.

f) Ecotourism

Several ecotourism programmes has been conducted outside the Sungai Karang Forest Reserve. The most active ecotourism programme is carried out by Agro-tourism Homestay Sungai Sireh. Their activities however are based mainly on agriculture, where they bring the visitors to the paddy field, oil palm plantation, cash crop land and etc. to promote the lifestyle of farmers. The activity involving Forest Reserve is still at minimum level, only during the jungle trekking programme, with permission from SSFD.

5.2.2 Adjacent area

a) Former tin mine area

Bestari Jaya, former tin mining catchment is located in Kuala Selangor District, and covers an area of 2656 hectares comprised of four hundred and forty-two different-size lakes and ponds which is located immediately south of the forest boundary. The catchment flows downstream to Ayer Hitam River and Udang River which ultimately ends up with Selangor River at 5 Km upstream of Batang Berjunti Water Treatment Plants (SSP1 and SSP2) which are major water distributors to federal territory (Kuala Lumpur and Putrajaya) and Selangor state as well. (Muhammad Aqeel Ashraf et al, 2011).

This area has been proposed for protection as a water supply under the HORAS project under jurisdiction of LUAS.

b) Sand & Clay Mining

Sand and clay mining are continuing in portion of the former tin mining area.

The main problems caused by existing mining operation (such as sand & clay mining) are the destruction of natural habitats and formation of wasteland, as well as damage to natural drainage and water pollution. The main source of pollution occurs when tailings from tin mines or water from the mines enters a river. The mining activities experienced some operational problems with local flooding from adjacent reclaimed peat swamp land, which is expensive to alleviate through drainage works. This was an indication of the need for integrated water management for this peat swamp. Appropriate management is critical to maintain the water purification, flood control and water supply functions of peatlands.

c) Oil palm estate

Oil palm estate is arguably the biggest land use of the land adjacent to NSPSF, covering an area of about 8559 ha in the 1km buffer zone. Most of these estates are mainly owned by big corporations such as PKPS, Sime Darby, FELDA etc., whereas smallholders also plant small scale oil palm at the fringe of the forest reserve.

d) Paddy

IADA scheme is still functioning and covers area of 18980ha and is one of the primary rice granary areas in Malaysia.

River water is channeled through the NSPSF from the Bernam and Tenggi Rivers to the irrigation scheme to the south-west of the forest, and the peat swamp forest is also itself contributing to the supply of water. Peat swamp forests of NSPSF act as a sponge soaking in monsoon rains and thus delaying discharge downstream via the Tenggi River. The stored waters are released during the dry season to irrigate crops, especially to the large paddy field. The yield in the paddy fields under the irrigation scheme is significantly higher than that is achievable without irrigation. Paddy is cultivated 5 times per 2 years, and harvest of 7-10 tonnes per ha/year is common.

e) Mixed horticulture

Mixed horticulture usually carried out by communities or smallholders. Usually this land is cultivated with vegetables, yam, corn, tapioca and banana.

Table 5-1: Landuse type in 1km buffer zone

No	TYPE OF LANDUSE	AREA (ha)
	Agriculture/ Aquaculture	
1	Paddy	2714
2	Oil Palm	9025
3	Mixed Horticulture	205
4	Banana/ coconut/ coffee/vegetables/ orchard	60
5	Aquaculture	17
	Mine	
6	Mine & Ex-Mining/clay mine	923
7	Quarry & Ex-Quarry	13
	Forested land	
12	Secondary Degraded Forest	374
13	Shrub/Grass/Fern	477
14	Secondary Good Forest	802
13	Urban, Residential etc.	58
14	Newly Open Land	272
15	Other Crops	23
TOTAL AREA		14958

5.3 From State Land to Permanent Forest Estate

Before 1990, the status of the NSPSF was as state land. However in the 1980s it was realised that this status had to be changed to ensure sustainable use of the area, and in 1990/ 1991 the area was gazetted as Forest Reserve. The main reasons to gazette the area as Forest Reserve were:

NSPSF is adjacent to the Tanjong Karang Irrigation Project. The peat swamp forest functions as buffer for the water supply for this scheme, and it was recognised that to sustain this function, the current land use practices, especially logging, had to stop.

The government examined the possibility of converting the land for agriculture. However, it was found that the land was not suitable for agriculture.

The government wished to discourage further cultivation of forest into farming.

5.3.1 Environmental Action Plan for North Selangor Peat Swamp Forest

The Environmental Action Plan for the NSPSF was prepared by the Asian Wetland Bureau prepared the action plan in conjunction with University of Malaya and FRIM with funding from WWF Malaysia.. The purpose of the environmental action plan was to provide a basis for environmentally sound management of the area, for the use of concerned government and non-government agencies.

The plan was based on separate short studies on hydrology (Low & Balamurugan, 1989), forestry (Chan, 1989), fish fauna (Davies & Abdullah, 1989), and other fauna (Prentice & Aikanathan, 1989). Several government agencies, including Selangor State Forestry Department, were also involved in the preparation of the plan. The different bodies involved in or affected by the administration of the NSPSF, and their interactions were analysed in Prentice & Faizal (1990), and an integrated approach to land use management was recommended.

A summary of the recommended actions to be taken is presented in Table 5.4. Most of the recommendations presented in the environmental action plan of 1990 are still relevant and valid.

Table 5-2: List of recommended future actions to be taken in the NSPSF (Prentice, 1990)

Aspect/area of action to be taken	Recommended action
General	<ul style="list-style-type: none"> • Establish a multi-agency working group under the Planning and Development Unit of Selangor for management of the peat swamp forest • Sufficient financial resources should be available for: <ol style="list-style-type: none"> a) Research on water and forest resources; b) Monitoring; and c) Active management and administration • Stop/control negative impacts such as burning or draining and maximize sustainable utilization/conservation aspects
Hydrology	<ul style="list-style-type: none"> • Return swamp to natural condition by controlling drainage, and minimizing impacts on future activities • Develop water management plan to maximize flood mitigation/ water supply functions of peat swamp
Forestry	<ul style="list-style-type: none"> • Develop management plan for PSF, including zoning to different use zones such as tourism, wildlife, flood control • Improve ability of Forestry Department in managing area by provision of required staff, equipment, funds, etc. • Introduce minimum impact logging methods and initiate regeneration efforts
Conservation	<ul style="list-style-type: none"> • A sanctuary gazetted as “Forest Reserve for Wildlife” under the 1984 Forestry Act should be created on the eastern side of the forest to act as buffer/extension of the Sungai Dusun Game Reserve • Sungai Dusun Wildlife Reserve should be extended to include the forests along the Sungai Dusun/Bernam outside the present forest reserves • Black-water pools and other important areas for fish should be protected • Recreational and subsistence fishing should be encouraged on a sustainable basis.
Other Uses	<ul style="list-style-type: none"> • Tin and peat mining should be controlled and their effects on the hydrology of the swamp should be minimized • Further land clearance for agriculture should not be permitted. Agro-forestry with sago or rattan could be considered for marginal areas • Burning should be stopped to prevent loss of the forest and minimize air traffic hazard • Recreation and tourism should be encouraged but managed

An integrated management plan was prepared in 2000 for the period 2000-2010 (which is updated by this current document).

5.3.2 Selangor State Action Plan for Peatlands (SAPP)

Selangor State Action Plan for Peatlands (SAPP) is being prepared in line with the National Action Plan (NAPP) for Peatlands developed by Ministry Natural Resources and Environment, Malaysia (NRE) and adopted by the Malaysian Cabinet in 2011. The latter guides peatland management in this country, while, the former is important for Selangor in managing the peatlands at local level.

The objective of the SAPP is to set down a vision, values and principles which will guide Government policy in relation to all peatlands in Selangor. These will be applied through their incorporation into the more detailed sectoral plans, policies and actions adopted and undertaken for each policy area. The SAPP is aimed at peatland owners, users and the broader community which benefits from the services that peatlands provide. It is also aimed at policy and decision makers.

The SAPP is required to give direction to Selangor's approach to peatland management and how to optimise the benefits derived from our vast peatland resource over the coming decades. The term ecosystem services are used to describe the range of benefits that peatlands provide for human well-being. Gaining a sense of the true value and potential of Selangor peatlands requires consideration of a wide range of issues including current and possible land uses and the implications of such uses.

The SAPP recognises that Selangor's peatlands will continue to contribute to a wide variety of human needs and to be put to many uses. It aims to ensure that Selangor's peatlands are sustainably managed so that their benefits can be enjoyed responsibly. It aims to inform appropriate regulatory systems to facilitate good decision making in support of responsible use. It also aims to inform the provision of appropriate incentives, financial supports and disincentives where required.

The direction Selangor takes in managing its peatland resource will be informed by best scientific knowledge. Extensive research on the role and functioning of peatlands has been undertaken and further work is ongoing. Further areas of research have been identified as part of this SAPP.

Responsible management of peatlands will require collaboration and partnership between land-owners, communities, public authorities, commercial organisations and non-governmental organisations. This SAPP will ensure that appropriate supports, structures, funding mechanisms and regulatory frameworks are in place to allow such partnerships to develop.

The importance of responsible peatlands management and how it can impact on the wider community is not widely understood or appreciated by the general public. This SAPP would be aimed for increase awareness and understanding by the public, by land owners and by decision makers of the value of peatlands and the implications of good and bad management practices.

5.4 Implications for Future Management

The section below summarises how future management of the NSPSF is affected by past management and the administrative, the biophysical, the socio-economic environment and the sustainability permanent forest reserve (Moratorium).

Restrict further conversion of forested peatlands to agriculture

The conversion of peatlands into agricultural or plantation schemes will result in loss of the peat swamp forest, total drainage of peat water and subsidence of peat soil. When this happens, this will have serious effects on the hydrology of peatland and increase the risk of peatland fires. Development with inadequate understanding of peat swamp and peat soil characteristics poses a threat to the integrity of a peatlands and its associated uses. In addition, inadequate environmental management consideration on the use of agro-chemicals, over-drainage and subsidence, use of fires for land preparation will bring negative impacts in the long term. The State should stop further conversion of peat swamp forests and provide protection status to remaining peatland forests on state land such as gazetting them as forest reserves. A buffer zone map is prepared that divide forest and buffer zones area.

5.4.1 Legal and Administrative Requirements

The Integrated Management Plan aims at meeting the requirements of national forestry and environmental strategies and policies, and complying with Malaysia's international commitments as agreed in relevant international conventions. Consequently, the management plan is a multiple purpose land use plan, aiming at reconciling local and national needs for commercial forest utilisation with local, national, and global environmental and social needs. A key element of the management plan is to divide the Forest Reserve into zones in accordance with the main functions of specific areas.

To become operational, the Management Plan should be presented and approved by the Selangor State Government.

5.4.2 Biophysical Context

The aerial survey and the management inventory showed that the timber resource base of the NSPSF is severely depleted. The present stocking level of commercial timber insufficient to support commercial logging activities in the foreseeable future without compromising the requirements applicable to sustainable forestry.

The hydrological study revealed that the many canals established in connection with past and present logging operations affect the hydrology of the NSPSF. The canals drain the peat and reduce the function of the peat swamp forest to act as a natural flood control structure during wet periods and as a water store during dry seasons.

The studies on flora, fauna, and fish showed that the bio-diversity of the peat swamp forest is depleted and disturbed. Still, the forest holds significant bio-diversity conservation values, as it provides habitats for several species of local and international importance. In addition, the NSPSF is the last remaining large area with peat swamp forest on the West Coast of Peninsular Malaysia.

5.4.3 Socio-Economic Context

The villagers living in the vicinity of the NSPSF gain some benefits from the forest in terms of irrigation water for farming, fishing, fruit collection, etc. However, for the majority of villagers, the main source of household income is generated from activities that are not related to the peat swamp forest. Still, the villagers hold strong opinions that the forest should be conserved.

The forest is also used for tourism and recreation. The present level of use of the forest for such purposes is very low, but the demand for tourism and recreational facilities in adjacent forest and park areas suggests that there is a potential to develop recreational and eco-tourism facilities.

Presently, the main economic benefits from the NSPSF are related to the impacts the forest has on its surroundings. At the local level, the adjacent Tanjong Karang Irrigation Project is by far the biggest beneficiary, as the peat swamp forest provides irrigation water for the project. However, it is estimated that the value of the benefits enjoyed by the global community from the function of the NSPSF as a carbon store is several times higher than the value of all other benefits put together.

5.4.4 Sustainability Permanent Forest Reserve (Moratorium)

State Government has imposed a moratorium on logging for 25 years since July 2010. Moratorium will be reviewed periodically by the State Government. In this regard new timber licenses are not issued. Enforcement of this moratorium to some extent have influenced the role of the economy in terms of production forest timber resources. Therefore, SSFD need to find alternative products to boost the economy of the forest resources that does not involve logging such as eco-tourism.

Instead, the moratorium has also helped SSFD to managed the forest under conservation. To ensure the state's forest resources are protected, an effective monitoring system should be established via the forest monitoring remote sensing system and regular patrols. Enforcement should also be carried out more effectively.

Selangor State Government is not focused on the production of forest harvesting from Forest Reserve. With the implementation of the moratorium, SSFD expected to reduce production logging licenses in the future. This will result in a significant reduction in the supply of wood to the existing timber industry in the state. Timber shortages will force the Wood-based Industries to make adjustments in the number and efficiency of processing plants, and can change the structure of the processing to accommodate smaller timber products mainly from forest plantations. Imported timber is another alternative in securing adequate supply of timber for the use of the existing plant.

In line with the policy of the State Government to reduce production forest harvesting activities, the SSFD will also need to develop some strategies and long-term plans to develop the area as a potential Permanent Reserve Forest for Recreational Forest and make it a popular tourist destination. Private sector involvement is important to the successful improvement of existing facilities in the area and the establishment of new recreation areas.

(source: Selangor Forestry Management Plan, 2011-2020)

Chapter 6: Forest Management Plan 2014-2023

6 Forest Management Plan 2014- 2023

6.1 Objectives and Strategies

The following section defines the management objectives applicable to the management of the North Selangor Peat Swamp Forest (NSPSF) for the period 2014-2023, and the strategies to be pursued to achieve the stated objectives. Three management levels are presented: the national level, the level of the NSPSF, and the level of specific management objectives within the NSPSF.

The objectives and strategies are developed on the basis of the descriptive part of the management plan provided in Chapters 2 to 5. Hence, a short discussion is presented for each objective and strategy to show how they are linked to the relevant sections in the descriptive part of the plan and to each other.

The period covered by this management plan is 10 years running from 2014- 2023.

6.1.1 National Level

National Forestry Objective:

“To conserve and manage the nation’s forests, based on the principles of sustainable management, and to protect the environment as well as to conserve biological diversity, genetic resources, and to enhance research and education.”

The National Forestry Council through the National Land Council approved the overall objective for forest management as stated above in 1992, and it applies to the states of Peninsular Malaysia. The national forestry objective is the overall guide for all forestry operations, and forest management plans developed for specific forest areas in Peninsular Malaysia should follow the overall objective, and through their implementation contribute to the achievement of it.

Strategy:

So far, the most noticeable government strategy towards pursuing the national forest management objective is formulation national laws, policies, strategies and plans applicable to forest management. Also, the government has established a number of committees to oversee and supervise the work of government agencies responsible for management the country’s forest resources.

At the operational level, State Forestry Departments are responsible for management of Malaysia's Forest Reserves. However, as pointed out in Chapter 2, management of Malaysia's natural resources is organised on a sector basis, and there are several government bodies at both Federal and State level, whose work and decisions directly or indirectly influence what happens to the country's forests. Hence, strengthening the co-ordination between government bodies at Federal and State level would further the chances of fulfilling the national forestry objective.

Generally this policy is geared towards ensuring environmental stability and smooth running of the development of the state. SSFD now prioritises the preservation and conservation of the State's forest resources which cover water supply, recreational facilities, land protection and conservation of flora and fauna. This approach is in contrast to the past where forest resources are mainly managed for the generation of revenue for harvesting of forest resources.

It also takes into account the state policy to conserve forest resources by imposing a moratorium (freeze) on logging for 25 years starting from 2010.

Below are some of the selected SSFD's strategies:

- Maintain existing forest reserves and increasing the size
- Provide adequate number of area as a place for recreation, eco-tourism, research, biodiversity conservation and education to the public on forestry
- Prepare a master plan and the development of State Park and Recreational Forest while promoting it as a tourist destination

6.1.2 Overall Management Plan Objective

The overall objective for the 10-year Management Plan for the North Selangor Peat Swamp Forest is:

"To maintain the geographical extent and integrity of the North Selangor Peat Swamp Forest to sustain and rehabilitate the functions of the ecosystem as a provider of goods and services for the benefit of the local and global communities."

The overall objective of the management plan is in accordance with the national forest management objective, and if achieved, it will contribute to the fulfilment of the national level objective.

The management plan objective emphasises that the total area of the present Peat Swamp Forest Reserves should be maintained, and that the forest ecosystem should be maintained and rehabilitated.

Significant sections of the original area covered with peat swamp forest in North Selangor were lost in the past through conversion to other land uses and encroachment. The target of the management plan is to stop any further conversion of the PSF and to rehabilitate degraded sites within the forest reserves.

The forest ecosystem in the NSPSF is severely depleted as a consequence of activities carried out in the past. The target of the management plan is to maintain and to rehabilitate the original forest ecosystem.

The overall objective implies that there are several beneficiaries of the peat swamp forest functions, both locally and globally. The forest provides various private and social and global services. By maintaining/rehabilitating the forest, the target is that the multiple functions of the PSF forest should continue to benefit the various stakeholders.

Two main approaches should be pursued to achieve the overall objective, with one focusing on actions inside the boundaries of the Forest Reserve, and the other focus on a buffer zone outside the Forest Reserve. A separate plan has been prepared for the buffer zone.

The Selangor State Forestry Department is responsible for management and supervision of activities carried out inside the Forest Reserve boundaries, and the management plan contains specific management prescriptions for interventions inside the forest in pursuance of the stated management plan objective. More specifically, the strategy inside the Forest Reserve is:

- a) to stop further drainage of the forest, and restore the natural hydrology
- b) Prevent fires through addressing root causes and rehabilitating areas affected by fire
- c) encourage natural forest regeneration and where necessary supplement with planting in severely degraded sites
- d) to divide the forest into management zones that represent the key functions of each management zone,
- e) to provide specific management prescriptions applicable to each forest management zone.

The NSPSF is affected by plans and interventions carried out in the buffer zone as it is under the supervision and control of individual land owners and other government bodies. To ensure that prescriptions to achieve the objectives of the NSPSF management plan are not undermined or offset by actions and events beyond the Forest Reserve boundaries and vice versa, plans and interventions in the NSPSF should be coordinated with those of relevant authorities. It is especially important that activities are co-ordinated with UPEN, DID, DOA, and DWNP and the respective district offices. It is proposed that the Selangor State Government to establish an inter-agency committee with participation of the Selangor State Forestry Department to co-ordinate forest management plans and operations inside the NSPSF with other government departments and other relevant interested parties.

The Selangor State Government is the authority that holds the overall responsibility for all matters related to land use in Selangor. To obtain the support from the State Government, and thereby enhancing the likelihood that planned activities are carried out and not undermined or overruled by events beyond the control of SSFD, the strategy is to present the management plan to the State Government for its endorsement.

6.1.3 Specific Management Plan Objectives

To achieve the overall management plan objective, the implementation of the management plan for the NSPSF aims to achieve the specific objectives stipulated below:

Specific Management Plan Objectives:

1. Re-establish the hydrological functions and the natural water balance of the NSPSF .
2. Prevent all fire occurrence and associated haze in and adjacent to NSPSF
3. Restore the Forest ecosystem of NSPSF by encouraging natural forest regeneration and where necessary supplement with planting in severely degraded sites
4. Establish a buffer zone of at least 500m width along the entire outer boundaries of the NSPSF to minimize impacts of activities in adjacent areas.
5. Develop and promote sustainable use of NSPSF including eco-tourism, harvesting of NTFP, recreation and environmental awareness, education and research
6. Promote conservation of peatland biodiversity and ecosystem functions
7. Maintain and enhance carbon stock, minimize GHG emission and develop options for carbon financing
8. Promote multi- stakeholder participation in the implementation of the IMP

Specific Objective 1: The hydrological functions and the natural water balance of the NSPSF are re-established.

The hydrology study and socio-economic survey showed that local communities use water from the NSPSF for domestic purposes, and that neighbouring farmers use the water for irrigation of their paddy fields. The economic study in 1999 estimated that on an annual basis this use of PSF water is worth RM 8.6 million. However, the hydrology study also revealed that the water retention capacity of the NSPSF is reduced compared with the capacity of an undisturbed PSF. This is due to the many logging canals that drain the forest. The above estimated value of water use of water from the NSPSP is therefore below its potential value; the value of water extracted from the PSF with its natural water retention capacity. Hence, there is scope for increasing the value of the NSPSF as a provider of water for irrigation and domestic use by re-establishing the hydrology of the NSPSF.

The large scale drainage of NSPSF is also the root cause of increasing fire and also a significant barrier for rehabilitation. The largest sources of GHG emission in NSPSF is a result of peatland drainage.

The strategies to implement this objective are as follows:

- a) Stop any further drainage of the NSPSF;
- b) Block all existing canals– both at the forest edge and at appropriate distances within the forest.
- c) Coordinate water management of the forest reserve and adjacent buffer
- d) Construct a clay dyke between forest and ex-tin mining land to the south of Raja Musa Forest reserve.
- e) Modify the structures along the Sg Bernam Diversion canal, sg tengi and main irrigation canal to avoid disruption of the hydrology of adjacent forest.
- f) Develop a detailed water management and monitoring plan for NSPSF

Specific Objective 2: To prevent all fire occurrence and associated haze in and adjacent to NSPSF

The surveys, studies and stakeholders consultation conducted as part of the project showed that there is a correlation between heavily drained, degraded peat swamp forest areas, buffer zone activities and used of fires for land clearing by small holders. Most clearly, this correlation was observed along the large canals and degraded forest areas adjacent to buffer zone, where fires appear to cause a steady retreat of the forest vegetation along the canals and degraded forest areas.

The strategy to implement this objective are as follows:

- a) Block abandoned logging canals in fire prone areas
- b) Construct a Clay dyke between the ex-mining area and the forest
- c) Restrict access to the forest especially in the dry season
- d) Enhance cooperation with surrounding landholders and communities in patrolling and preventing and controlling fires
- e) Implement a comprehensive cooperative fire management plan for NSPSF in conjunction with a range of agencies.

Specific Objective 3: Restored Forest ecosystem of NSPSF by encouraging natural forest regeneration and where necessary supplement with planting in severely degraded sites

Over the years, drainage, encroachment and repeated fire had resulted in about 7000 ha of the forest being seriously degraded and other portions being partly degraded. This area is in need of serious rehabilitation effort.

The strategies to implement this objective are as follows:

- a) Restore the natural hydrology of the forest (rewetting)
- b) Prevent and control fires in the areas under rehabilitation
- c) Encourage natural regeneration of the forest as far as possible
- d) Support re-vegetation of the seriously degraded areas by planting suitable tree species originating from PSF

Specific Objective 4: Establish buffer zone of 1 km width along the entire outer boundaries of the NSPSF to minimize impact

In order to maintain the integrity of the NSPSF it is necessary to reduce or mitigate the negative influences of activities taking place outside the forest reserve. Under the National Physical Plan (2010) and the Selangor State Structure Plan (2020) a 1km buffer zone along the border of the NSPSF has been mandated (500m as ESA2 and 500m as ESA 3). The overall buffer zone areas for NSPSF has been mapped in 9 zones to implement the concept of at least 1km buffer zone management effectively. The selection of these zones has been made according to the district, current land use and types of economic activity being carried out around the buffer zone for NSPSF.

The strategy to implement this objective is as follows:

- a) Finalise the determination of the boundary of the buffer zone and develop guidance for each buffer zone section within the frame work of a buffer zone plan.
- b) Integrate the buffer zone plan into the District Local Plans for the three related districts
- c) Ensure that management of water resources in the buffer zones does not disrupt the hydrology of adjacent NSPSF
- d) Support and promote buffer zones activities that are compatible with the objectives of the NSPSF.
- e) Promoting BMPs for the existing legal development in buffer zone
- f) Stop any new development in the buffer zone or adjacent areas in which biodiversity and ecological function would be adversely affected.
- g) Support the development of community-based forestry management initiatives as part of a broader set of approaches to land-use planning and developing local sustainable development strategies.
- h) Promote the development of partnerships with key stakeholders for planning and managing the use of resources within the buffer zone, and optimising benefits for local people
- i) Enhance the capacity of communities residing adjacent to NSPSF to participate in buffer zone through providing appropriate training and education, and through recognising local expertise and traditional institutions.

Specific Objective 5: Develop and promoted sustainable use of NSPSF including eco-tourism, harvesting of NTFP, recreation and environmental awareness, education and research

In recent years extraction of non-timber forest products in the NSPSF has been confined to local community use of the forest, and the scale of the extraction has been low and mainly non-commercial.

At the moment, the rate and method of extraction of non-timber products is at a low level and the activities are generally considered to be sustainable. However there is a risk that some activities such as fishing in the dry season lead to forest and peatland fires. With regard to collection of fruit and fishing, the strategy is to monitor and control these activities through permits to make sure that the harvest does not exceed the carrying capacity of the forest. Implementation of these strategies requires the co-operation of communities surrounding the Forest Reserve as well as the co-operation of relevant Government agencies such as Department of Fisheries.

The NSPSF is presently used for recreational activities such as bird watching and sports fishing, and there is a potential for development of eco-tourism facilities. The trend is that the local and global demand for recreational and eco-tourism sites and sites for nature awareness, education and research is growing, and the target is to meet this growing demand

The strategies to implement this objective are as follows:

- a) Designate specific areas for eco-tourism, recreation and for environmental education, awareness, and research,
- b) Develop special facilities such as observation towers, trails and boardwalks
- c) promote involvement of local communities, tour operators and others stakeholders in eco-tourism activities
- d) encourage local and international research institutions to undertake research in NSPSF

Specific Objective 6: Promote conservation of peatland biodiversity and ecosystem functions

Recent bio-diversity surveys showed that past logging and other activities have caused significant changes in the forest structure and composition, and the diversity of plants and animals has declined during recent decades. Even so, the NSPSF still provides habitat for several rare and endangered species, and the forest constitute the last remaining large area of this particular peat swamp forest type, that until recently was common along the West Coast of Peninsular Malaysia. It is generally recognised that many benefits are derived from species and ecosystem conservation, even though the benefits are rarely quantified. Some of the more important ones include the attraction value of the PSF ecosystem for development of ecotourism projects, and the potential value of future forest uses, for pharmaceutical purposes.

The strategy to implement this objective are as follows:

- a) to designate specific areas for bio-diversity conservation. Conservation areas should be located in those sections of the forest that provide habitats for species of particular Conservation areas, and where the potential of preserving representatives of the original PSF eco-system is high.
- b) For areas not specifically designated for conservation, activities should be carried out in a manner that helps maintain and keep intact the PSF ecosystem and its plant and animal species.

Specific Objective 7: Maintain and enhance carbon stock and minimize GHG emission and develop options for carbon financing

The economic valuation of the protective and productive functions of the NSPSF (Woon et al, 1999) showed that the value of the NSPSF for carbon sequestration/storage is several times higher than the total value of all other functions.

NSPSF has the potential to acquire funding from the carbon market through the REDD+ mechanism. With the revenue from logging is now stopped due to the moratorium, carbon funding could be the next revenue source for the forestry department.

The target is to maintain the capacity of the NSPSF to store underground carbon in the peat and above ground carbon in the trees.

The strategy is:

- a) Stop further drainage and restore natural hydrology to stop the decomposition of the peat, and to
- b) Re-establish and maintain a tree stocking level that is equivalent to the natural stocking level found in undisturbed PSF.
- c) Stop fires in the NSPSF and adjacent areas through effective prevention and control measures
- d) Develop carbon related projects to generate revenue to support the management of the forest.

Specific Objective 8: Promote multi- stakeholder participation in the implementation of the IMP

The effective management of the NSPSF requires the active engagement of a broad range of stakeholders. Without engagement of such stakeholders it will not be possible to prevent regular fires, manage the buffer zone in an appropriate way or maintain the integrity of the forest.

The strategy to implement this objective are as follows:

- a) Establish a multi stakeholders steering committee and working group to oversee the implementation of the IMP
- b) Organise regular stakeholder meetings/fora on the IMP implementation.
- c) Undertake regular monitoring and communicate progress in implementation of the IMP to various stakeholders

6.1.4 Summary of Objectives and Strategies

A summary of objectives and key strategies/means to achieve the stated objectives is provided in Table 6.1

Table 6-1: Summary of Objectives and Strategies

Level	Objective	Key Strategy
National Forest Management Objective	To conserve and manage the nation's forests in a sustainable way, that protects the environment, conserves biological diversity and genetic resources, and enhances research and education	Formulation of National Policies Laws and Strategies Establishment of Advisory/supervisory Committees Government Departments responsible for forest management, genetic resources and enhanced research and education.
Overall Management Objective for the NSPSF	To maintain the geographical extent and integrity of the North Selangor Peat Swamp to sustain and rehabilitate the ecosystem.	Stop conversion of Forest Reserve areas to other uses Preparation of a Plan with specific Forest management prescriptions Endorsement of management plan by State Government and enhanced coordination between relevant authorities and other relevant parties
Specific Objectives for Management of the NSPSF	1. The hydrological system of the NSPSF is re-established.	Stop any further drainage of the NSPSF; Block all existing canals– both at the forest edge and at appropriate distances within the forest. Coordinate water management of the forest reserve and adjacent buffer Construct a clay dyke between forest and ex-tin mining land to the south of Raja Musa Forest reserve. Modify the structures along the Sg Bernam Diversion canal, sg tengi and main irrigation canal to avoid disruption of the hydrology of adjacent forest. Develop a detailed water management and monitoring plan for NSPSF
	2. Forest ecosystem of NSPSF are restored by encouraging natural forest regeneration and where necessary supplement with planting in severely	Block abandoned logging canals in fire prone areas Construct a Clay dyke between the ex-mining area and the forest

	degraded sites	<p>Restrict access to the forest especially in the dry season</p> <p>Enhance cooperation with surrounding landholders and communities in patrolling and preventing and controlling fires</p> <p>Implement a comprehensive cooperative fire management plan for NSPSF in conjunction with a range of agencies.</p>
	3. To prevent all fire occurrence and associated haze in and adjacent to NSPSF	<p>Restore the natural hydrology of the forest (rewetting)</p> <p>Prevent and control fires in the areas under rehabilitation</p> <p>Encourage natural regeneration of the forest as far as possible</p> <p>Support re-vegetation of the seriously degraded areas by planting suitable tree species originating from PSF</p>
	4. Establish buffer zone of at least 1km wide along the entire outer boundaries of the NSPSF to minimize impact	<p>Finalise the determination of the boundary of the buffer zone and develop guidance for each buffer zone section within the frame work of a buffer zone plan.</p> <p>Integrate the buffer zone plan into the District Local Plans for the three related districts</p> <p>Ensure that management of water resources in the buffer zones does not disrupt the hydrology of adjacent NSPSF</p> <p>Support and promote buffer zones activities that are compatible with the objectives of the NSPSF.</p> <p>Promote BMPs for the existing legal development in buffer zone</p> <p>Stop any new development in the buffer zone or adjacent areas in which biodiversity and ecological function would be adversely affected.</p> <p>Support the development of community-based forestry management</p>

		<p>initiatives as part of a broader set of approaches to land-use planning and developing local sustainable development strategies.</p> <p>Promote the development of partnerships with key stakeholders for planning and managing the use of resources within the buffer zone, and optimising benefits for local people</p> <p>Enhance the capacity of communities residing adjacent to NSPSF to participate in buffer zone through providing appropriate training and education, and through recognising local expertise and traditional institutions.</p>
	<p>5. Develop and promoted sustainable use of NSPSF including eco-tourism, harvesting of NTFP, recreation and environmental awareness, education and research</p>	<p>Designate specific areas for eco-tourism, recreation and for environmental education, awareness, and research,</p> <p>Develop special facilities such as observation towers, trails and boardwalks</p> <p>Promote involvement of local communities, tour operators and others stakeholders in eco-tourism activities</p> <p>Encourage local and international research institutions to undertake research in NSPSF</p>
	<p>6. Promote conservation of peatland biodiversity and ecosystem functions</p>	<p>To designate specific areas for bio-diversity conservation.</p> <p>For areas not specifically designated for conservation, activities should be carried out in a manner that helps maintain and keep intact the PSF ecosystem and its plant and animal species.</p>
	<p>7. Maintain and enhance carbon stock and minimize GHG emission and develop options for carbon financing</p>	<p>Stop further drainage and restore natural hydrology to stop the decomposition of the peat, and to</p> <p>Re-establish and maintain a tree stocking level that is equivalent to the natural stocking level found in undisturbed PSF.</p>

		<p>Stop fires in the NSPSF and adjacent areas through effective prevention and control measures</p> <p>Develop carbon related projects to generate revenue to support the management of the forest.</p>
	<p>8. Promote multi- stakeholder participation in the implementation of the IMP</p>	<p>Establish a multi stakeholders steering committee and working group to oversee the implementation of the IMP</p> <p>Organise regular stakeholder meetings/fora on the IMP implementation.</p> <p>Undertake regular monitoring and communicate progress in implementation of the IMP to various stakeholders</p>

6.2 Forest Zoning

6.2.1 Management Zones

In Section 6.1 above it is argued that specific areas of the NSPSF should be set aside for pursuing specific management objectives. More specifically, the NSPSF should be divided into Management Zones allocated for:

- A. Potential production/Water catchment forest
- B. Rehabilitation zone
- C. Recreation/eco-tourism and Education/Research
- D. Biodiversity Conservation
- E. Community forest
- F. Agroforestry zone

Rehabilitation and conservation of the hydrological system" and "carbon sequestration", as the two specific objectives will be pursued across all Management Zones.

Table 6-2: Forest Management Zones, Specific and General Objectives of each Zone Management Zone:

	Specific Objective:	General Objectives
Potential Production/Water catchment	Restoring hydrology and forest resources	Rehabilitation and maintenance of natural carbon sequestration capacity Biodiversity conservation
Rehabilitation zone	Active rehabilitation of the degraded area by restoring hydrology, preventing fire and encouragement of natural regeneration supplemented by planting of appropriate species	Reducing GHG emission Biodiversity conservation Rehabilitation and maintenance of natural carbon sequestration capacity
Recreation/ eco-tourism and Education/ Research	Promotion the sustainable use of the forest for recreation/ eco-tourism	Rehabilitation and maintenance of natural hydrological functions. Rehabilitation and maintenance of

	promoting environmental awareness, education/research	natural carbon sequestration capacity Biodiversity conservation
Biodiversity Conservation	Conservation of the natural ecosystem and rare and endangered species	Rehabilitation and maintenance of natural hydrological functions Rehabilitation and maintenance of natural carbon sequestration capacity Education/research
Community Forestry	Production of non-timber forest products on a sustainable basis	Rehabilitation and maintenance of natural hydrological functions. Rehabilitation and maintenance of natural carbon sequestration capacity Biodiversity conservation
Agroforestry zone	Provide water storage for rice scheme and develop agroforestry products (jelutong etc)	Research

As described in Chapter 2, the National Forestry Policy divides the Permanent Forest Estate into four functions, while the National Forestry Act prescribes a division into 11 functional classes. Table 6-3 shows how the proposed management zones relate to these two classification systems.

Table 6-3: Forest Management Zones, Functions and Functional Classes

Management Zone:	Functions: (National Forestry Policy)	Functional Classes: (National Forestry Act)
A Potential Production/water catchment	Water storage and supply to the rice scheme and domestic use	Production/Water catchment forest
B Rehabilitation	Restore severely degraded area	After rehabilitation can become water catchment forest
C. Community Forestry	Non timber forest product	(Non-timber) Production Forest, Sustained Yield
D. Recreation and Education/ Research	Amenity Forest; Research and Education Forest	Amenity/Recreational Forest; Education Forest; Research Forest
E. Biodiversity Conservation	Protection Forest Research and Education Forest;	Forest Sanctuary for Wildlife; Virgin jungle Reserve; Education Forest; Research Forest
F. Agroforestry zone	Agroforestry	Community forestry

6.2.2 Criteria for Location of Management Zones

The studies and inventories conducted during the project showed that some parts of the forest are particularly suitable for pursuing certain objectives such as bio-diversity conservation. Table 6.4 below shows the criteria for determining the geographical location of Management Zone A-F in the NSPSF.

Table 6-4: Criteria for selection of sites for the Six Management Zones in the NSPSF

Management Zones:	Main Selection Criteria:
A. Potential Production/Water catchment forest	Remaining forest area not in other zones. Enhancing forest resources while at the same time providing water storage and supply to the rice scheme and domestic use as well as carbon storage.
B. Rehabilitation zone	Severely degraded area, prone to fire and will not recover without active rehabilitation
C. Recreation/ eco-tourism and Education/ Research	<p>Areas, that contain, or are adjacent to, a particular attraction such as a river for boat tours and sports fishing or an area of relatively undisturbed forest.</p> <p>Areas that are fairly accessible.</p> <p>Areas of special interest for research and education such as areas with established research plots.</p>
D. Biodiversity Conservation	<p>Areas, that are relatively undisturbed and representative of the original ecosystem</p> <p>Areas, that provide habitats for rare or endangered animal or plant species</p> <p>Buffer Zones to adjacent conservation areas such as Sungai Dusun Wildlife Reserve.</p> <p>Areas relatively large and not scattered.</p> <p>Sg Susun Wildlife Reserve is designated as a special zone (SD1) as it is under the jurisdiction of PERHILITAN</p>
E. Community Forestry	Areas, where local communities are presently harvesting NTFP
F. Agroforestry zone	Area that are permitted for other use eg. Retention pond Agroforestry/plantations

6.2.3 Specific Location of Management Zones

Summary of Management Zones:

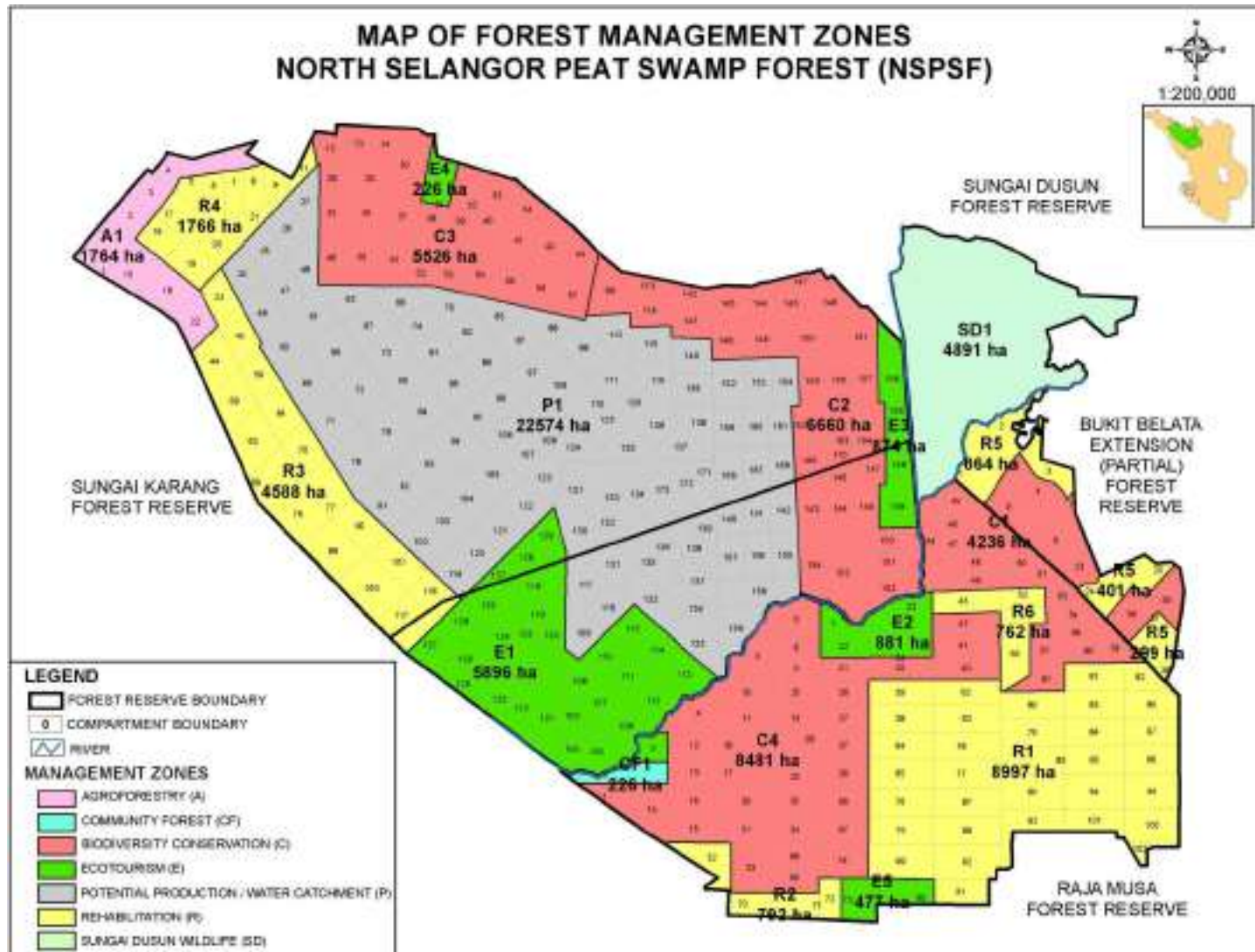


Figure 6-1: Map of Forest Management Zones of NSPSF

Table 6-5: Summary of specific Management Zones for NSPSF

Zone		Justification
A. Potential production/water catchment forest	P1 (22,595ha)	Portion of forest covering the deeper peat/peat dome of the Sg Karang FR and the northern portion of the RMFR. This deep peat plays a key role in the water storage and regulation function of the NSPSF and the water supply to the adjacent IADA Rice scheme.
B. Rehabilitation zone	R1 (9,019ha)	Severely degraded, fire prone area in se Corner of RMFR with more than 6000ha affected by fire over the last 10-20 years. Main root cause is the extensive network of large logging canals (57km long) in the western portion.
	R2 (793ha)	Degraded portion of forest along the SW corner of RMFR. Approximately 30ha affected by fire. Other portions affected by encroachment, small scale drainage and land clearing over past 6-8 years. Collaboration established with Sime Darby Plantation and communities in the adjacent buffer zone in 2014 to better protect and rehabilitate the area.
	R3 (4,592 ha)	Portion of SKFR along the western boundary adjacent to the main irrigation canal of the IADA Rice scheme. Area negatively impacted by construction of a peat/clay bund to prevent water flow from the forest to the main irrigation canal by IADA in 2010. The artificially high water levels have led to significant death of forest in an area of about 600 ha along the boundary.
	R4 (1768ha)	Combination of forest degraded by fire and encroachment and drainage as a result of adjacent oil palm development in the NW corner of the SKFR.
	R5 (2462 ha)	Two portions of the Bukit Belata Extension FR which have been affected by encroachment and fire.
	R6 (763ha)	Degraded forest in RMFR which has been affected by fire along an old logging canal connecting to the Sg Tenggi over the past 15 years. The western portion in Compartment 43 is recovering through natural regeneration but the eastern and southern portion has been affected by regular fires in recent times.
C. Recreation/eco-tourism and Education/Research	E1 (5901ha)	This area incorporates portions of two areas for research, and ecotourism included in the management plan 2000-2010. The area is in the north-west part of RMFR, to the north-west of the Tenggi River, RMFR compartment 3, 103-108, 110-115, 118-130 and SKFR 127-129. The forest is in relatively good

		condition, the area is easily accessible by boat along the Tenggi River along the south east side and from the main irrigation canal along the south western edge and a former logging track along the north west side. The area is currently being used for ecotourism use by recreational fishermen and by the Ecotourism programme at the Homestay at Kg Ampangan. An additional advantage of the area is its location adjacent to the conservation area in C4 on the eastern side of the tenggi River across the river. Visitors can experience the relatively intact ecosystem in C4 from the river or the riverbank without entering and thereby disturbing the conservation area. Compartments 127 and 129 of RMFR and 117, 127 and 129 of SKFR are all locations of establishment of permanent vegetation plots by FRIM and other researchers.
	E2(881 ha)	A relatively small area set aside for education and research in the 2000-2010 IMP. It is in the northern part of RMFR, along the River Tenggi, comprising compartment 7 and 22-24. During 1997-1999, logging trials were conducted in compartment 22 and biodiversity inventories were carried out in compartment 24 and 25. By including compartment 7 and 23 along the River Tenggi, access can be made from the river and there is an option for a base for ecotourism activities to link up Sites E1 and E3 along the Sg Tenggi.
	E3 (874ha)	A new proposed recreation/ecotourism zone along the eastern edge of the SKFR adjacent to the Sg Bernam-Sg Tenggi Diversion canal. This can be used as a location for recreation and ecotourism activities including boating and fishing in the Diversion canal and Sg Tenggi, visits to the adjacent Sg Dusun Wildlife reserve and visitor centre as well as a location for camping
	E4 (264 ha)	Compartment 31 is the existing ecotourism site for hornbill watching set up by the Sabak Bernam District.
	E5(478 ha)	Education and ecotourism site around the newly established "centre of excellence" which can act as a base for public education as well as research on remaining intact forest in Conservation zone C4 to the north west and the rehabilitation zone R1 to the north east.
D Conservation Zone	C1 (3330ha)	The area in the north-eastern part of Raja Musa FR around the hill ridge in the area, RMFR compartment 44-51, 53-54, 57-61 and BBEFR Compartment 5-6. This area is of particular conservation value because it contains some relatively dense

		and undisturbed patches of peat swamp forest as well as dry-land forest growing on the hill ridge running in the middle of the area north/south. By putting this particular area aside for biodiversity conservation, there is a potential of preserving habitats and species from both forest types. This one of two portions of NSPSF (other is SD1) with both lowland dipterocarp forest on mineral soil and peat swamp forest.
	C2 (6666ha)	The area in the eastern part of Sungai Karang, bordering the Feeder Canal and the Tenggi River, SKFR compartment 99, 113-114, 141-151, 155-157, 162-164, 169-170, and RMFR Compartment 143-147, 150-154. This area was heavily degraded from intensive logging and drainage in the past but has now recovered well and is of increasing importance for biodiversity conservation. The area is the type locality of a number of endemic fish species found nowhere else in the world and also support Tapir, sunbear and other rare mammals. The area forms a valuable buffer zone to Sungai Dusun Wildlife Reserve.
	C3 (5531ha)	Survey by DWNP have showed that a large hornbill population is nesting in Sungai Karang in compartment 31-34 and 43. It is proposed that the nesting area, including adjacent compartments be put aside for conservation. The compartments east of the nesting site and along the northern boundary of Sungai Karang should be included in the conservation area to connect it to the conservation area in D.4. The particulars are: The area along the northern boundary of Sungai Karang, compartment 12-14 28-43, 49-57 The area was heavily logged in the past but is slowly recovering. Compartment 31 is the existing ecotourism site for hornbill watching set up by the Sabak Bernam District.
	C4 (8489ha)	The area in the south-western part of Raja Musa, south-east of the Tenggi River, compartment 1, 4-6, 8-21, 25-31, 33-33-37, 40-42, 66-69, and 74. Most of the forest in this area is in relatively good condition, and has not been severely damaged by heavy logging and drainage (although a portion was logged between 2000-2007 using the railway system). Hence, the area provides an opportunity to protect one of the few and relatively authentic representatives of the original peat swamp forest ecosystem in the NSPSF. This area provides breeding habitat for Sun Bears Tapirs and the black form of the Clouded leopard – some of the most important endangered species occurring in the NSPSF.
	SD1 (4891ha)	Area jointly designated as Sg Dusun Wildlife reserve and Sg Dusun Forest Reserve and also a formally designated conservation area under the management of the Department of Wildlife and National parks.
E. Community Forestry	CF1	This zone comprises one compartment which is used by local communities for the harvesting of Daun Palas - a NTFP.

	(226ha)	
F. Agroforestry zone	A1 (1765ha)	This site comprises portions of the SKFR which have been developed for oil palm by the local community starting in the 1980s before the designation of the area as a Forest reserve. Starting 2012, IADA has been developing a 90ha water storage reservoir for water supply to the surrounding rice fields.

Table 6-6: proposed management measures for the different zones

Zone		Proposed Management measures
A. Potential production/water catchment forest	P1 (22,595ha)	Management will involve forest protection and blocking of main drainage channels and encouraging natural regeneration. Enrichment planting can be considered.
B. Rehabilitation zone	R1 (9,019ha)	The main rehabilitation action will be to block the large scale drainage, prevent fires and encourage natural regeneration. A clay bund needs to be constructed along the southern side to isolate the area from the ex-tin mining land to the south and prevent sub-surface drainage. The large network of ex-logging canals crossing the area need to be blocked and two fire towers need to be established in Comp 76 and adjacent to 96. Sub posts need to be established at compartments 73 and 99 to control access and act as bases for fire prevention and comp 76. Road access to Comp 73 needs to be upgraded and a road access constructed between the entrance at comp 73 and the proposed rehabilitation centre in Comp 76. Roads on comp 98-100 need to be upgraded to provide access for rehabilitation activities and also for fire prevention and control. A pumping station needs to be established at Comp 102 to pump water along the pipeline to prevent and fight fires on Comp 102 and 100.
	R2 (793ha)	Collaboration established with Sime Darby Plantation and communities in the adjacent buffer zone in 2014 to better protect and rehabilitate the area will be continued to rehabilitate the area.
	R3 (4,592 ha)	The main rehabilitation strategy will be to restore the natural hydrology by removing or breaching the bund (constructed in 2011 by IADA) to prevent impoundment of water in the zone as well as where necessary removal of

		dead trees in places where it is felt that this may impede regeneration. Natural regeneration will be encouraged with planting only in those areas with serious degradation/high density of dead trees.
	R4(1768ha)	Restoration of water levels and fire prevention should lead to natural regeneration.
	R5(2462 ha)	The main strategy will be to remove the encroachment, restore hydrology and encourage natural regeneration with some selected enrichment planting. A substation should be established nest comp 11 to enable regular monitoring and fire prevention in adjacent state land as well as in the FR.
	R6 (763ha)	Natural regeneration in the western portion in Compartment 43 will be monitored and supplemented as necessary. Ex-logging canals in the eastern and southern portion will be blocked and fire prevented by blocking access to the site through the Bukit Belata Forest Reserve. Natural regeneration will be supplemented by planting as necessary.
C. Recreation/ eco-tourism and Education/ Research	E1(5901ha)	The Ecotourism programme at the Homestay at Kg Ampangan will be enhanced and villagers trained to guide tourists in the area. Basic facilities such as trails, boardwalks and landing points will be established. Continuing research will be encouraged in Compartments 127 and 129 of RMFR and 117, 127 and 129 of SKFR are all locations of establishment of permanent vegetation plots by FRIM and other researchers.
	E2(881 ha)	Research will be continued or re-established at the research plots a base for ecotourism activities will be established to link up Sites E1 and E3 along the Sg Tenggi.
	E3 (874ha)	This area will be used as a location for recreation and ecotourism activities including boating and fishing along the JPS Diversion Canal and Sg Tenggi, visits to the adjacent Sg Dusun Wildlife Reserve and visitor centre as well as a location for camping. A suitable area for development of chalets, camping or ecotourism lodge is found in compartment 165 of SKFR where a laterite hill has been cleared of forest and excavated for construction of the JPS canal and is currently illegally occupied by cattle farm. Cattle should be removed from the area and a ranger substation established to control access.

	E4 (264 ha)	The existing ecotourism site for hornbill watching set up by the Sabak Bernam District will be maintained and enhanced and usage promoted.
	E5(478 ha)	This site will be developed as a base for public education as well as research on remaining intact forest in Conservation zone C4 to the north west and the rehabilitation zone R1 to the north east. A Centre of Excellence' is being established at the site by the Forestry Department.
D Conservation Zone	C1(3330ha)	Control of access to this area through Bukit Belata forest reserve Extension needs to be enhanced. Assessment of biodiversity in Peat swamp forest and lowland dipterocarp forest. Protection and Monitoring
	C2(6666ha)	Careful monitoring of northern boundary especially in areas close to the Tanjong malim- Sg Besar road. Prevention of drainage of forest edge as a result of roads and oil palm plantations along boundary. Rehabilitation of degraded portions of forest especially in Comp 147. Gazettment of remaining forest on stateland adjacent to FR boundary. Monitoring for encroachment and fire along Sg Tenggi and JPS diversion canal.
	C3(5531ha)	Protection and Monitoring of northern boundary adjacent to oil plam plantations. Special care to monitor Compartment 12 adjacent to fire prone site. . Management closely linked to the Ecotourism site at E4- hornbill nesting site. Assessment of hornbill population and habitat requirements.
	C4(8489 ha)	Regular monitoring from Sg Tenggi to prevent encroachment or fires. Removal of cattle grazing along the banks of Sg Tenggi. Biodiversity assessment.
	SD1(4891 ha)	Continued management by the Department of Wildlife and National Parks in line with the reserve management plan. Enhanced patrolling along the boundaries to detect fires and encroachment.
E. Community Forestry	CF1(226 ha)	A sustainable use plan will be developed in conjunction with the local community.
F. Special/agrop roduction zone	A1(1765 ha)	It is proposed that the area developed for oil palm be used in future for oil palm/agroforestry including trials for the development of indigenous peat swamp forest tree crops including Jelutong and illepe. A buffer zone should be established between the remaining forest and any area planted with oil palm and higher water tables maintained

		in such areas to enable jelutong and illepe cultivation.
--	--	--

The distribution of area to the six management zones is as presented in Table 6-7:

Table 6-7: Summary of overall Management Zones, NSPSF

Management Zone	Compartment (number)		Area (ha)	
	Number	Percent	Ha	Percent
A. Potential Production/Water catchment forest	102	28.9	22,595	27.7
B. Rehabilitation zone	83	23.5	19,397	23.8
C. Recreation/ eco-tourism and Education/ Research	40	11.3	8,398	10.3
D. Biodiversity Conservation	115	32.6	29,141	35.7
E. Community Forestry	1	0.3	226	0.2
F. Agroforestry zone	12	3.4	1765	2.2
	353	100	81,522	100

It should be noted that the proposed location of the six Management Zones is based on the information available at the time of writing. As additional information is obtained, it may be required to review the proposed zoning. E.g. should a particular site of scientific interest be identified in Zone A.1, it might be desirable reclassify the site to Management Zone C.

6.3 Management Prescriptions Applicable to All Management Zones

The two specific objectives “the hydrological system of the NSPSF re-established”, “the capacity of the NSPSF to store carbon is re-established and maintained, at its natural level” will be pursued in all Management Zones and the management prescriptions related to drainage apply to all Management Zones. Other topics common to all Management Zones are fire prevention, rehabilitation of heavily degraded areas; management; and boundary demarcation. The sections below give the management prescriptions common to all Forest Management Zones.

6.3.1 Peat Hydrological Management

Hydrological process is the most important factor that controls the healthiness of a peat swamp ecosystem. Therefore it is imperative that the disturbed hydrological function is restored.

Past logging activities in NSPSF had resulted in extensive networks of canals, either for draining out the peat water or for transportation of timber logs. It is estimated that 500km of canals stills exists in NSPSF even though logging activities had ceased since 2007.

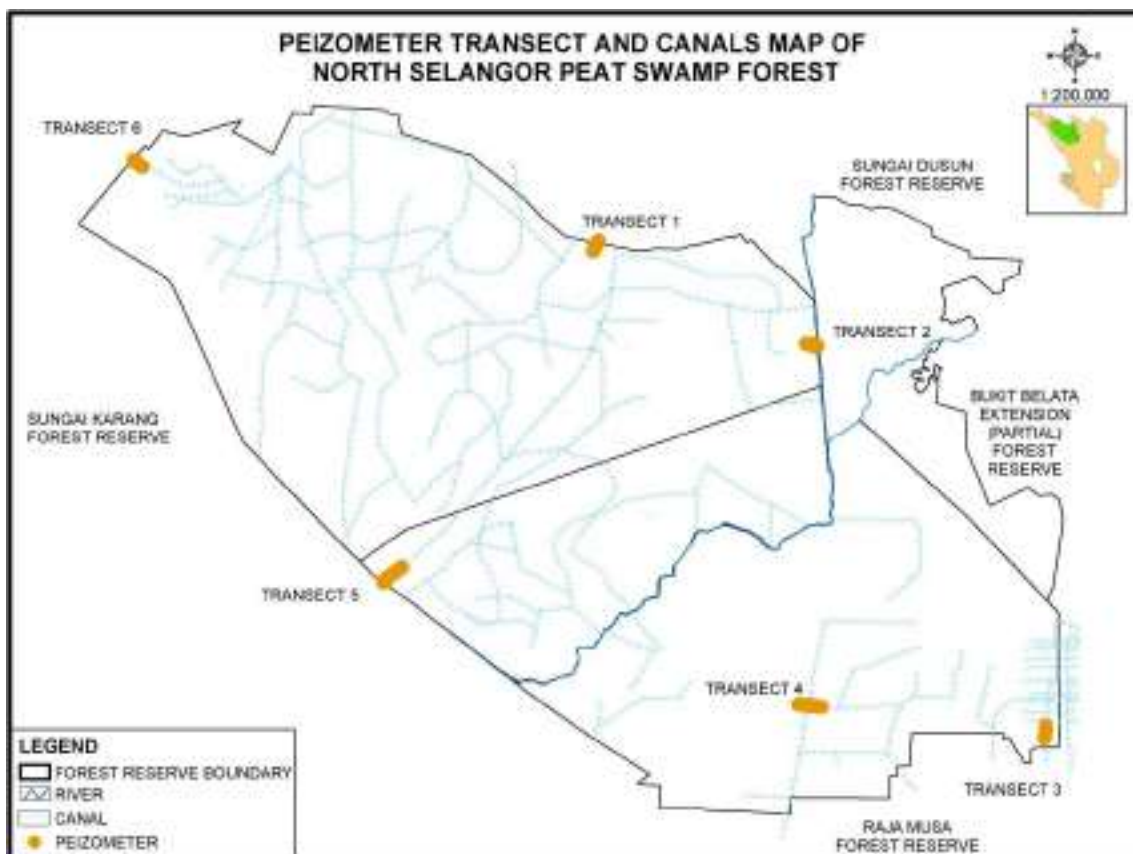


Figure 6-2: Map of NSPSF showing networks of drainage canals

Existing drainage canals had devastating impacts on the ecosystem of peat swamp forest as a whole and its functions. Left abandoned and un-blocked, some of these canals have acted as drains, draining water out of the peat body, as these canals often connected to the nearest river, thus reducing the water level of the peat swamp forest.

Lowering water table will result in irreversible drying and subsequently rendered the area fire prone. Prolonged drying also increases the oxidation rate of the organic material above the water level, which means carbon is released into the atmosphere. As peat usually stores huge amounts of carbon, the amount that is released into the atmosphere could be massive, and could contribute to global warming. Reduction of the natural water tables also will reduce the ability of peat swamp forest species to recover.

Means of Blocking the Canals

Hydrological restoration is relatively straightforward but requires a large scale effort given the extensive network of canals, difficulty of access and need to construct canal blocks that will last a sufficient time. Over the last five years, a few types of canal blocks have been applied in NSPSF in an effort to increase the water level. Below are five of the canal blocks that have been set up in Raja Musa Forest Reserve with some success. .

I. Peat filling at 50m intervals

By far the most effective canal blocking method for relatively small drains; A peat block about 1-2m wide is put in place by an excavator and compacted. Additional blocks are placed every 50m along the drain. After 2 years of blocking, the stretch in between 2 blocks will slowly fill up as water flow is reduced to minimum and the block itself would be covered with vegetation. This is more applicable to agricultural drainage as found along the southern and eastern boundaries of Raja Musa FR, rather than large ex-logging canals.

II. Mangrove pole and sand/ clay bags

Another practical, cheap and highly effective blocking method. Relatively easy to set up for small to medium size drainage canals, however could be a challenge for main canals. This type of block has been installed in agricultural drains in encroachment areas in the South east of Raja Musa Forest Reserve (Comp 99 and 100). Such blocks can be installed by hand and so don't need access by heavy machinery which can cause damage in partly vegetated sites or sites far into the forest. This type of block has been placed successfully 4km into the forest in compartment 76 on a 8m wide ex-logging canal.

III. Rock fill dam

This type of dam has proven to be very effective in blocking large drainage canals – for example at the edge of the RMFR at compartment 73, water level was raised significantly by the rock dam initially installed in 2007 and repaired in 2012. This type of dam is sufficiently strong to withstand the high water pressure from the long logging canals. However regular monitoring is needed to ensure that the dam is intact and the water does not cut around the edge of the dam and erode the peat.

IV. Tree trunk, geotextile and clay dam

This type of block is a larger version of the type II dams above but has yet to be installed in NSPSF but has been used effectively in Indonesia. This consists 2-3 rows of tree trunks across the canal with the gaps in between filled with either clay or sandbags wrapped in geotextile. This is suitable for large logging canals.

V. Clay bund

Relatively new method, where a stretch of few hundred meters of peat was dug up and replaced with clay. This type of block has been used very effectively adjacent to Comp 101 on the southern boundary of RMFR to prevent surface and subsurface drainage of the RMFR to adjacent mining areas. This method requires the usage of excavator and clay materials which is generally available along much of the southern boundary of the NSPSF.

Density and nature of Blockages

The number of block required to achieve effective result depends on the length of the drainage canals as well as the gradient of that area.

a) Length of canals

The longer the canals, the more blockage is needed, this is to reduce pressure in between the separate blocks. Solitary blocks at the end of the canals would result in extreme water pressure – increasing the risk of failure - as well as being ineffective in raising the water level in the interior of the forest due to the domed nature of the peat.

b) Gradient

The more steep the area from the centre of the peat dome, more blocks are required to achieve the desired water level. In areas of shallow slope – maybe 1-2 blocks per km will be needed whereas with steeper slopes – maybe one block every 300m is needed. For canals that run across the slope one block every km may be sufficient. Ideally the drop (ie height difference in water between the front and back of the block) should be no more than 20-30cm for optimal water levels. The average water level should be about 10-15cm below the surface level of the peat.

c) Sequence

It should be noted that although estimated 500km of canals are left abandoned from past logging activities, and blocking the canals will take significant time and resources. The proposed priority for selection of canals for blocking are:

- Fire prone area over non fire prone area
- Main canal over secondary canals
- Edge of the forest over centre of peat dome

d) Height and width

The canal block should preferably be higher than the surrounding land to cause the canal water to flow overbank into the surrounding landscape before it returns to the canal further downslope. A series of these canal infill points starting at the top of the canal system and moving down the canals toward their outflow points will slow the speed of drainage, reducing erosion risks. A requirement of the canal block is to also rapidly establish vegetation on top of the block and the fan walls to reduce the risk of erosion and washing away during peak rainfall events

6.3.2 Cooperative Fire Management Plan for NSPSF

The surveys, studies and stakeholders consultation conducted as part of the project showed that there is a correlation between heavily drained, degraded peat swamp forest areas, buffer zone activities and use of fires for land clearing by small holders. Most clearly, this correlation was observed along the large canals and degraded forest areas adjacent to buffer zone, where fires are causing a steady retreat of the forest vegetation along the canals and degraded forest areas. The Fire Risk map for NSPSF (see Figure 6-3) indicates the area most prone to repeated fire and regular burning. These will be focal areas of the plan.

NSPSF is prone to fire because of four major factors, it includes:-

i) Drainage

500 km of drains were cut as part of the logging operations up till 2005. Most of these drains have yet to be blocked and lower water levels and increase vulnerability to fire. Smaller scale drainage due to agriculture and plantation development at the edge of the forest helps fire spread to the forest area.

ii) Vegetation

Areas most vulnerable to fire are those areas with lalang or fern vegetation – which are normally well drained and subject to frequent fires. These vegetation types burn much more easily and faster than intact forest.

iii) Fire weather conditions

Fire risk increases with lower rainfall and increased temperatures – ie during dry seasons. Wind increases the fire intensity and spread.

iv) Source of fire

- ✓ Humans are the major source of ignition – by deliberate human activities like hunting and slash and burn method of land clearing for agriculture.
- ✓ Accidental fire escaping from land clearing activity and from villages and agricultural areas adjacent to NSPSF.

A Cooperative Fire Management Plan (CFMP) for the NSPSF was prepared through extensive consultation across the site, with the intention that this plan forms a component of this Integrated Management Plan.

The CFMP provides details and recommendations on fire prevention strategies, fire preparedness strategies, fire response strategies, recovery post fire strategies and proposed a budget for five years related to the CFMP for NSPSF. Essentially, the CFMP for NSPSF provides a list of strategies and action that must be carried out and implement at different times of the year, and a list of equipment and tools required for preparedness and suppression. Any fire management measures without addressing underlying causes would be irrelevant. The following are the summary of the main elements related to CFMP for NSPSF, that are considered as most important for this management plan:

The plan is divided into three components, the first being the development of fire management strategies. Secondly, a resource planning budget is developed at a high level to provide guidance toward the costs of implementing the plan across the site. Thirdly an implementation plan has been prepared for both the prevention and suppression components. The implementation plans are in the form of a single A3 page with attached map and it is expected that they will be updated on an annual basis to reflect changes and features that are to be implemented across the coming 12 month period.

Preparation of the cooperative fire management plan provides a consistent framework to define the principles and strategies to meet the primary objectives for the site while the implementation plans will define activities to better manage prevention, preparedness and response actions to be taken by agencies, communities and private sector participants.

With this contextual appreciation in mind the overriding objective within the actions and activities of this plan is to prevent any fire from igniting within the site, and if it should ignite, to respond rapidly to minimise the overall area burnt and costs of fire suppression.

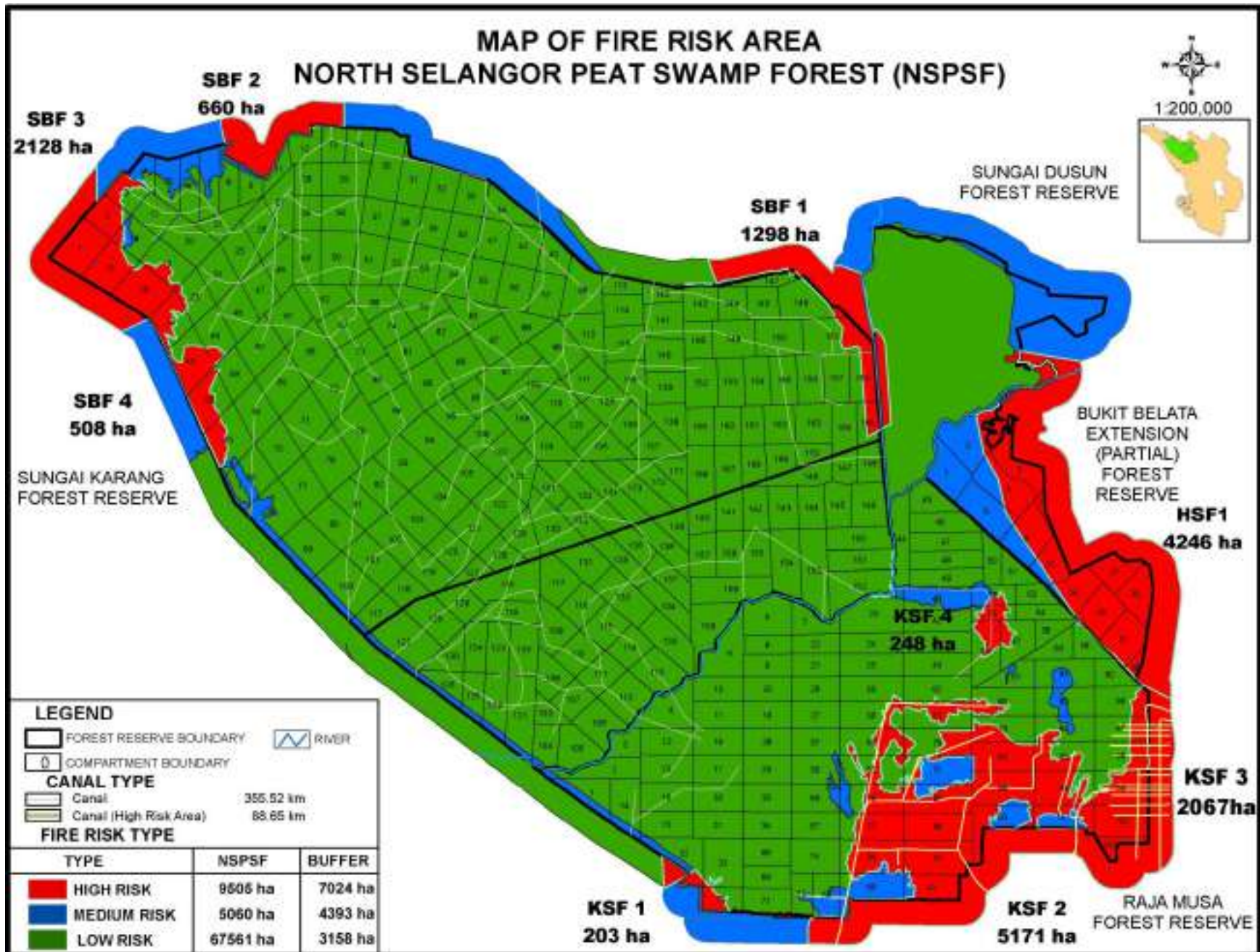


Figure 6-3: Map of fire risk area for NSPSF

The future of this plan is proposed to reside under the auspice of the proposed Cooperative Fire Management Committee who would oversight its implementation and allocation of actions to various cooperative partners. Cooperative Fire Management is the technique where multiple agencies, private and community teams can join together during fire prevention and suppression efforts to support each other. Cooperative fire management engages with stakeholders and will increase the effectiveness of fire prevention and suppression efforts. Cooperative Fire Management recognises that:

- Fires in NSPSF cannot be prevented or controlled by one single agency or landholder, and
- Fire should be a shared responsibility across all land managers in the public sector and private sector, both small holder and large land holders.

To engage in Cooperative Fire Management there are two key needs to be fulfilled to achieve success, which are:

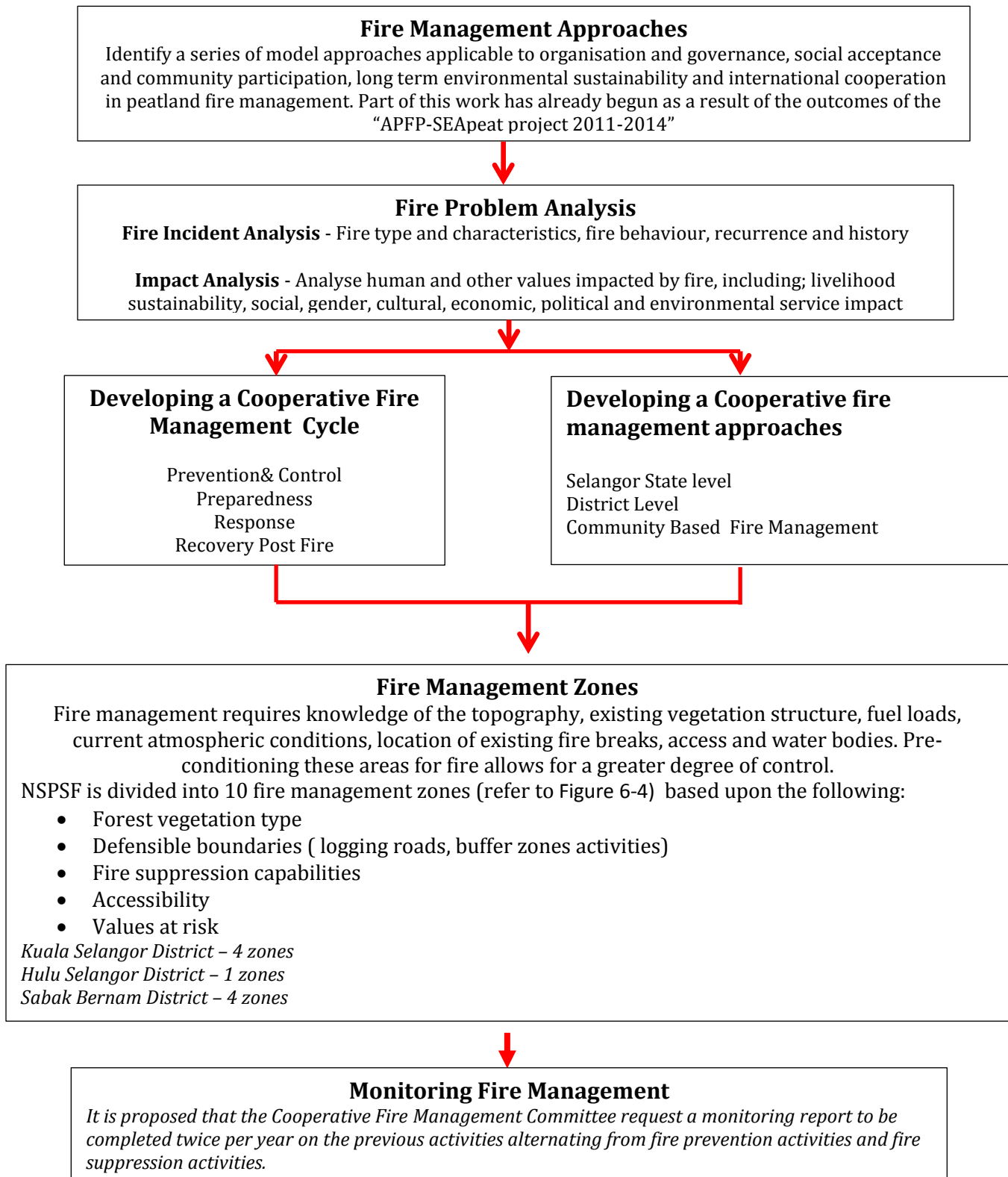
- A willingness from all participants to jointly work together on fire prevention and suppression activities in a cooperative and collaborative manner, and
- A task force or committee that can meet and oversee activities, creating a formal driving force behind the collaborative efforts.

It must be emphasised that the burden of fire management should not be placed upon the shoulders of any one agency, private owner or community group, but rather the efforts should be shared proportionally to the relative strength and capability of the individual or agency.

The cooperative fire management plan is proposed to be implemented from 2014 to 2023. It is suggested that a 5 year highlight review occur to examine the newly introduced concepts and confirm that their implementation is positive and working within NSPSF or if it requires some adjustment.

The operational implementation plans will be reviewed and updated annually dependent upon changes and achievements in the operational aspects completed in the year prior.

Flow chart representing a systematic approach to the preparation and development of Cooperative Fire Management Plan and Guidelines



The CFMP cycle was developed to be used in the first framework for Peatland Fire Management in NSPSF. Below are the details for the CFMP cycle:-

a) Fire Prevention

Fire Prevention includes initial risk reduction action by the respective government agencies, landowners and the community to reduce the possibility of peatland fires start, spread and cause damage. It includes:

Strategy 1 – Block abandoned logging canals

Drainage as a result of 500km of abandoned logging canals in NSPSF is a key root cause of fire. It is critical to block these channels in areas of the forest reserve that are more fire prone – to raise water levels and reduce fire risk. Canal blocks are described in section 6.3.1 above.

There are approximately 60km of canal within the high fire risk area. This area covers more than 5000ha of NSPSF and has been repeatedly burnt over the past 15 years. In order to rehabilitate this area and reduce the incidence of fire occurrence, closing of canals, and stopping the drainage of this area will be the key element for future success. It is estimated that a block will be required every 250-500m along these canals requiring approximately 100-200 separate canal blocks.

Strategy 2 – Construct a Clay dyke between the ex-mining area and the forest and Firebreak (between plantations and the forest reserve)

The lowering of the water table by the tin, clay and sand mining activities to the south of the NSPSF is causing significant drainage in the adjacent forest resulting in this location being repeatedly burnt and becoming one of the highest fire prone locations in the NSPSF. It is proposed to prevent this by constructing a clay bund for about 15km across the southeast edge of the forest between the forest and the mining area to maintain high water levels in the forest edge.

A successful demonstration of this approach was completed in 2012 at PKPS clay mining site which is 50m from the forest reserve boundary. A 600m long trench was dug through the peat to the clay layer beneath. The trench was filled with clay and compacted. This stopped the rapid outflow or seepage of water into the adjacent clay mine, and lifted the water level in the remaining peatland allowing vegetation to recover and minimising fire risk.

Firebreak known as a closed canal system should be constructed to act as a firebreak on the boundary. Firebreak consists in strips of land between the plantations and forest reserve, about 1m wide, 1m depth and 200m length, able to stop the progress of a fire front, or at least reducing the fire spreading and contained the high water level. Firebreaks contribute to protection of vegetation from fires in the dry season, isolating separate areas by wide strips designed to reduce or halt the

progression of fire in plantation or forest. They constitute an important technique to control or prevent fire, especially when used together with other fire prevention and control measures.

Strategy 3 – Restricting access to the forest

It is important to control people entering the forest by strengthening the patrolling by forestry staff and establishment of control at strategic points vulnerable to fire. In tropical forests nearly 100% of fire ignitions are caused by people, either by accident or intentional purposes. With this in mind, restriction in public access into the forest reserve in the dry season is vitally important to manage and reduce the chance of an accidental fire ignition.

There is long standing community history of using the forest for fishing and collection of non-timber forest products (NTFP's) purposes. It is not desirable for community relations to put a blanket ban on access to the forest, it is more appropriate to manage access through a permit system and forest staff stationed at vulnerable locations so that people are known to be entering, for which purpose, at which location and for how long.

Strategy 4 – Cooperation with surrounding landholders

There is both legal and illegal land clearing that has occurred on the edges of the forest reserve and also encroachment into the boundaries of NSPSF in the past. In addition most fires are started on legal and illegal land developments near to the forest reserve. It is important that joint patrols continue to be made by the forest officers of the Selangor Forestry Department working together with the officers of the District and land office. It is also suggested that a series of consultative workshops and discussions occur with surrounding landowners to develop workable solutions that for fire prevention on their land.

Strategy 5 - Conducting Effective Public Information and Awareness Campaigns

The Cooperative Fire Management Plan points out that most forest fires are started by human beings. Hence, it is recommended that fire awareness campaigns should be conducted schools and communities located in the vicinity of the forest. The aim is to increase the understanding and awareness of the impact / implications of fires and reduce the risk of peat fires. Among the activities proposed are as follows:

- Provides monitoring and patrolling with the calendar;
- Distribute reference materials such as Fire Prevention Guidelines, posters, banners and pamphlets related;
- Fire risk warning signs (FDRS) should be erected at suitable and easily visible; and
- Talks and / or exhibit in public places and / or school.

The importance of maintaining a good relationship to people from neighboring areas is stressed, and it is proposed that community based fire management should be established in villages in areas, that are known to be of high risk

Strategy 6 - Enhancing Integrated Enforcement

Enhancing integrated and holistic enforcement can prevent peatland fires between the relevant enforcement agencies, such as SSFD, DOE, DO and other relevant departments. Take enforcement action against any person / agency who is found guilty of an offense in accordance with relevant legislation. For example, under Section 29A of the Environmental Quality Act 1974 Any person who commits an open fire can be fined up to RM500,000 or five years imprisonment or both, if convicted.

b) FIRE PREPAREDNESS STRATEGIES

Fire Preparedness ensures that when peatland fires occur, the government agencies, the community and individual land managers are ready to respond in ways that are effective and soundly based. These will include early detection, having appropriately trained and experienced firefighters, a prepared community and the necessary plans, physical and information resources in place to respond to peatland fires and provide information, advice and warnings to the community. It includes:

Strategy 1 – Preparation of annual implementation plans

The annual implementation plans are both single page plans that denote locations of planned activities that require specific work to be undertaken each year. The detail of each activity and costs of the activities, such as developing a new part of the clay dyke can be prepared separately, however the implementation plan simply notes the activity and its location and requirements to be completed.

Strategy 2 – Enhancement of communication system for fire risk and danger rating tool

Enhanced communication of fire risk to the right people (communities, private landholders and forest rangers and community patrolling team) is important during and before periods of high fire risk. The Fire Danger Rating System (FDRS) and water levels across the forest can increasingly become an effective communication point with communities, individual landholders and the forest permit officers when the FDRS is in increasing and the water levels are falling – increasing dryness and potential for fire occurrence.

As the Fire Danger Rating (FDR) rises, it is desired that an alert message is sent to a selected number of forestry, local government, GEC, plantation, community and members of the Cooperative Fire Management Committee via a smart phone app. As part of the fire implementation plan, a series of triggers including FDR and hot spot will be used as sufficient fire warning tool to initiate different preparation actions and mechanism to be applied for fire detection and compacting on the ground in NSPSF.

Strategy 3 – Enhancing Community Based Fire Management

Community Based Fire Management is recommended for inclusion to enable community participation in the preparation and development of peatland fire management guidelines. Patrols by local community members in coordination with the Forestry Department are an important part of preventing fires for land clearing and also notifying agencies of fires. It is proposed to expand the local patrol efforts to encompass the entire area surrounding NSPSF with the ambition of creating a community support for stopping fire ignitions in the dry season. It can be actively promote through the Sahabat Hutan Gambut Selangor Utara (SHGSU) which is currently active in all villages around Raja Musa Forest Reserve. In the future this will be expanded to cover the villages around the rest of NSPSF.

Strategy 4 – Utilising Aerial fire detection

Fire management relies upon the use of rapid response, once a fire begins. The basis for this is that for every hour waiting, the fire is growing in size and growing in cost and complexity to suppress, therefore a rapid response to a fire will catch it at its smallest possible size and the overall suppression cost will be lower.

The use of aircraft is desired to confirm a fire and its location, as fire towers and lookout points on surrounding lands are not able to locate a small fire in the centre of the NSPSF as the smoke is obscured from ground based observation points by background smog, high humidity related issues and other smoke haze.

Strategy 5 – Ensuring availability of sufficient firefighters with sufficient capabilities

This strategy enables us to identify the required number of firefighters and provide robust motivation to prevent, control and suppress peatland fires more efficiently. Prepared the firefighters mentally and physically were strong to undertake fire suppression activities.

A training needs assessment is required to determine the number of people from different agencies who will participate in an incident management team or a firefighting team for NSPSF. The numbers of people need to be determined, training courses established and and monitoring of training effectiveness, for relevant agencies and individuals. Fire training should encompass Fire Prevention and Fire Preparedness. Listed below are the recommended trainings and is performed once a year or before an impending drought period.

- Safety and first aid
- Fire suppression tactics

- Fire patrols, monitoring and response services (fire patrol groups / forestry guard)
- Usage of handtools and maintenance
- Manning portable water pumps
- Water delivery systems and layout of water hoses
- Mapping of the fire area
- Communication with radios
- Fire weather and fire behaviour
- Fireline organization
- Fire assessment
- Fire cause investigation

c) FIRE RESPONSE STRATEGIES

Effective Fire Response to peatland fire when they start can mitigate peatland fire risk, through limiting the spread and the consequences of peatland fire. Response includes the firefighting component of the overall peatland fire management process. Firefighting is generally the role of the Fire Services but, just as importantly response includes those critical actions that community members will take when peatland fire threatens. Responses may include:

Strategy 1 – Improving access to funds for fire prevention and suppression

Fire begins at a small size. The concept of "fast initial attack" is to quickly suppress any fire which starts and keep the burnt area to a minimum. This method of fire suppression minimises cost and damage.

The increased level of effort and exponential costs of fire suppression in a peatland fire as compared to a mineral soil fire justify a re-negotiation of the trigger criteria that enables access to State emergency funding for support during a peatland fire.

It is important to secure rapid access to needed funds for fire suppression operations as soon as possible. Mechanisms and procedures need to be established at district level to secure and channel resources. It is planned to support the District Offices to steadily discuss and lobby the emergency funds administration to move the criteria for access to emergency funds in peatland fires from 1000 ha toward 10 ha. The shift in these criteria will support the transition toward rapid response and also overall cost profile of fire suppression to a lower total cost base.

Strategy 2 – Pre-established specialised equipment contracts, fire control resources and personnel

In order to gain rapid access to specialised equipment (eg excavators) some pre-planned contracts need to be developed with equipment contractors for the supply of the right equipment. It is planned to source and negotiate one or more suppliers of smaller scale excavators that meet the needs of peatland fire suppression so as to be able to mobilise them quickly at the start of any fire season.

Documenting and updating lists of potential fire control resources and personnel, their location and the contact arrangement to the equipment owner are essential for cooperative fire management efforts. It is planned to establish a resource schedule of capabilities of all agencies under a Cooperative Fire Management arrangement including personnel and equipment.

Strategy 3 – Develop new transportation options for peatland access

As one of the options to consider for transporting people and equipment across the peatland to reach a fire it is planned to conduct some research into the suitability, cost and use of tracked wheels that can be fitted to a 4wd vehicle or on availability of lightweight tracked vehicles.

Strategy 4 – Incident Command and Fire Fighting team structures for Cooperative Fire Management Committee

The pre-planned teams will use some standard organisational charts common to the Incident Command System (ICS), used by the Malaysian Fire and Rescue Department. The ICS structure, roles, responsibilities and management techniques are already available through the Fire and Rescue Department.

Under the auspice of Cooperative Fire Management Committee it is proposed to establish standards for teams of people for the incident command and field fire fighting teams should a fire occur in NSPSF. It is proposed to establish two levels of pre-planned team, a small scale or initial fire team, and a large scale or emergency fire team. This will allow for the staged growth of a fire team should a routine fire suppression effort grow to become a large scale emergency response.

Strategy 5 : Ongoing mopping up and patrolling of fire on affected areas,

This strategy ensures to prevent re-ignition and limit further damage on the fire for affected areas. A team should establish to handle this strategy activity. Those are involved in the task has to be provided the latest information on the situation to the Incident Command for further actions and updates.

Strategy 6 – Formalise a Cooperative Fire Management Committee in each District

A formal Cooperative Fire Management Committee should be established in each District to oversee peatland fire prevention and control. It is suggested that the Committee have a full committee and a smaller Executive Committee. It is proposed that the full committee work to influence and develop the fire prevention aspects of the plan and when it comes to fire suppression operations these will be largely pre-planned and the smaller Executive Committee can meet and support the immediate suppression efforts more quickly and in an agile manner.

It is recommended that the three Districts that surround NSPSF each establish a fire management committee related to its area of influence and that the executive of each committee meet twice per year (before the dry season to confirm the pre-planned fire suppression arrangements and after the dry season to confirm the pre-planned fire prevention efforts).

It is proposed that the Cooperative Fire Management Committee request a monitoring report to be completed twice per year on the previous activities alternating from fire prevention activities and fire suppression activities.

The report would be prepared by member of the Cooperative Committee such as the Department of Forestry and GEC and would form a routine part of the planning, implementation and monitoring of results.

d) POST FIRE RECOVERY STRATEGIES

Post Fire Recovery Strategies

Recovery describes actions taken to limit the consequences following the fire. Recovery may be complex, as it deals with economic, physical and environmental rehabilitation. It is an integral part of the framework and should be considered consciously during the other elements of the framework. It encompasses the development and implementation of economic, physical and environmental recovery plans and strategies, and includes:

Strategy 1 : Post fire assessment post mortem and documentation of lessons learned

In this strategy, a detailed fire report must be prepared with the size and map, identify the roots causes of the fire and a comprehensive investigation, and including the fire suppression costs for prepare future fire prevention plans for the area. Success or failure of the fire suppression should be recorded and suggestions made to enhance the existing strategies accordingly.

Strategy 2 : Post fire equipment and infrastructure repair and maintenance.

After the completion of firefighting operations, the equipment and infrastructure have to be maintained and repaired. Equipment maintenance and infrastructure repair costs should be included in the annual budget of fire management.

Strategy 3: Post fire site rehabilitation

Firebreak which was built should be blocked as appropriate so that the water from the NSPSF will not flow out. This will raise or maintain the water level in the degraded area by fire. Any access roads built during fire fighting should be blocked by a fence or gate so that no encroachers / hunters can get in to the burnt area. The degraded areas should be rehabilitated with the participation of local communities, land owners and local authorities in partnership with the Selangor State Forestry Department. Rehabilitation of the site will reduce the fire risk in the future

Table 6-8: Detailed description of each high fire risk area

Fire Risk Areas / zones / Districts	Size of the area		Description	Generalised prevention strategies
	Forest Reserve (Ha)	Buffer zone (Ha)		
Kuala Selangor District				
KSF 1*	120	83	<ul style="list-style-type: none"> • KSF 1 is located in the district of Kuala Selangor (Mukim Tanjung Karang 1 & 2) and West of NSPSF. • The land-uses adjoining the forest reserve is smallholder oil palm plantation and one larger plantaion (Sime Darby) to the south-west of the NSPSF. • This zone has relatively few problems for NSPSF, such as encroachment, fires and others but one portion of about 20 ha has adjacent to the Sime darby plantation has burnt each year for the past 3 years. <p>Along the eastern side of the main canal there is a gas pipeline and also a</p>	<p>Prevention</p> <ul style="list-style-type: none"> • Strategy 1 - Block abandoned logging canals • Strategy 3 - Restricting access to the forest • Strategy 4 - Cooperation with surrounding landholders (Sime Darby/smallholders) • Strategy 5 - Conducting Effective Public Information and Awareness Campaigns • Strategy 6 - Enhancing Integrated Enforcement

			<p>TNB transmission line. Thee periodic clearing of vegetation along the pipeline and transmission line can enhance the risk of fire.</p> <ul style="list-style-type: none"> The FR type is poor forest and degraded by fires, covered with lalang grass, which is very prone to fire. 	
KSF 2*	3726	1418	<ul style="list-style-type: none"> KSF 2 is located in the district of Kuala Selangor (Mukim Ulu Tinggi) and South NSPSF. The area has been leased to the Selangor State Government Linked Corporations (GLC) to carry out mining activities of clay, sand and palm oil plantations such as PKPS, KDEB, MBI and others. These activities impact negatively to Raja Musa Forest Reserve, especially drying out peat swamp forest through poor hydrology management. Extensively burnt in 2010 - 2014. Fires are very frequent in this area and have affected about 4000ha. Some areas has a buffer of 20m-50m between the development and the forest reserve and other areas do not have any buffer and are developed until the forest reserve boundary. The FR type is poor forest and degraded by fires, covered with lalang grass, which is very prone to fire. 	<p>Prevention</p> <ul style="list-style-type: none"> Strategy 1 - Block abandoned logging canals Strategy 2 - Construct a Clay dyke between the ex-mining area and the forest Strategy 3 - Restricting access to the forest Strategy 4 - Cooperation with surrounding landholders Strategy 5 - Conducting Effective Public Information and Awareness Campaigns Strategy 6 - Enhancing Integrated Enforcement
KSF 3*	700	1366	<ul style="list-style-type: none"> KSF 3 is located in the district of Kuala Selangor (Mukim Ulu Tinggi) and is to the south east of NSPSF. The land-uses adjoining the forest reserve are oil palm plantation primarily controlled by small holder/ local community. Activities are undertaken not following good management practices for peat. The areas are over-drained with little or no water management and subject to subsidence and periodic fires. Extensively burnt in March 2014. Fires are very frequent in this area. Fires start outside FR boundary and spread in. 	<p>Prevention</p> <ul style="list-style-type: none"> Strategy 1 - Block abandoned logging canals Strategy 2 - Construct a firebreak between FR and oil palm plantations Strategy 3 - Restricting access to the forest Strategy 4 - Cooperation with surrounding landholders Strategy 5 - Conducting Effective Public Information and Awareness Campaigns Strategy 6 - Enhancing Integrated Enforcement

			<ul style="list-style-type: none"> The FR type is poor forest and degraded by fires, with patches of lalang grass, which is very prone to fire. Rehabilitation was undertaken in 2008-2014 but degraded by fire in 2014. 	
KSF 4*	231		<ul style="list-style-type: none"> KSF 4 is located in the district of Kuala Selangor, to the southeast of Sungai Tenggi. The area is a former logging area with unblocked drainage system. Drains were built are still active and drain the water from Raja Musa Forest Reserve to the Tenggi River. There is an access trail (by motorbike) from Kg tawakal through Bukit belatas Extension FR. Fires are likely started by hunting or fishing groups. The area is covered by lalang grassland and takes a long time to recover and is vulnerable to fire. 	Prevention <ul style="list-style-type: none"> Strategy 1 - Block abandoned logging canals Strategy 3 - Restricting access to the forest Strategy 6 - Enhancing Integrated Enforcement
Hulu Selangor District				
HSF 1*	2070	2093	<ul style="list-style-type: none"> HSF 1 is located in the district of Hulu Selangor (Mukim Hulu Selangor) and North-East portion of NSPSF. The land-uses adjoining the forest reserve are oil palm plantations developed and managed by Felda Sungai Tinggi Selatan, Sungai Tinggi Plantation, PKPS and local communities from Kampung Tawakal A & B. The area developed by the local community includes a mixture of legal and illegal land development. There has been significant encroachment and fires affecting the forest reserve with oil palm planted inside thre Bukit belata FR extension. Activities undertaken at community-owned lands are not following the good farming practices for peat. . 	Prevention <ul style="list-style-type: none"> Strategy 1 - Block abandoned logging canals Strategy 2 - Construct a firebreak between FR and oil palm plantations Strategy 3 - Restricting access to the forest Strategy 4 - Cooperation with surrounding landholders and remove encroachment in FR. Strategy 5 - Conducting Effective Public Information and Awareness Campaigns Strategy 6 - Enhancing Integrated Enforcement
Sabak Bernam District				
SBF 1*	507	795	<ul style="list-style-type: none"> SBF 1 is located in the district of Sabak Bernam (Mukim Sungai Panjang) and North-West NSPSF. 	Prevention <ul style="list-style-type: none"> Strategy 1 - Block abandoned logging canals

			<ul style="list-style-type: none"> An oil palm plantation has recently been developed is located near Sungai Dusun Forest (Wildlife Conservation Centre Sungai Dusun) and managed by PKPS. Local community members also graze cattle on the banks of the JPS bund and in some locations keep the cattle overnight – this leads to some impacts on the forest reserve and risk of fires. The FR is good forested area. 	<ul style="list-style-type: none"> Strategy 2 – Construct a firebreak between FR and oil palm plantations Strategy 3 – Restricting access to the forest Strategy 4 – Cooperation with surrounding landholders Strategy 5 - Conducting Effective Public Information and Awareness Campaigns Strategy 6 - Enhancing Integrated Enforcement <p>This oil palm plantation should prepare the environmental management plan that can be managed perfectly well without any impact on conservation areas and forest reserve.</p> <p>The illegal cattle farm should be moved out of the forest reserve.</p>
SBF 2*	-	662	<ul style="list-style-type: none"> SBF 2 is located in the district of Sabak Bernam (Mukim Sungai Panjang) and North-West NSPSF. Mara Junior Science College (Maktab Rendah Sains Mara-MRSM) is under the construction in the buffer zone. The project is expected to be completed in early 2015. Surrounding area (except Forest Reserve areas) MRSM encroached by the local community, for the purpose of planting oil palm. Local people involved in the clearing work at the area by using fires. This activity has been stopped and the encroached land has recently been given to PKPS for oil palm cultivation <p>The FR type is relatively good forest which is recovering. Some portions have been affected by fire</p>	<p>Prevention</p> <ul style="list-style-type: none"> Strategy 1 – Block abandoned logging canals Strategy 3 – Restricting access to the forest Strategy 4 – Cooperation with surrounding landholders (MRSM/PKPS) Strategy 5 - Conducting Effective Public Information and Awareness Campaigns Strategy 6 - Enhancing Integrated Enforcement
SBF 3*	1846	282	<ul style="list-style-type: none"> SBF 3 is located in the district of Sabak Bernam (Mukim Sungai Panjang) and North-West portion of the NSPSF. The land-uses adjoining the forest reserve are oil palm plantations and agriculture. 	<p>Prevention</p> <ul style="list-style-type: none"> Strategy 1 – Block abandoned logging canals Strategy 2 – Construct a firebreak between FR and oil palm

			<ul style="list-style-type: none"> • The planting of oil palm and yam was carried out by farmers who settled in the area mainly prior to the establishment for the Forest reserve. • Local people involved in the clearing work at the area by using fires. This activity has been recently stopped and the encroached land been given to PKPS through MBI for oil palm cultivation with proper management to prevent the further threats to the forest reserve. • Construction of a 90ha reservoir by IADA within the Sg Karang Forest Reserve at Kampung Sungai Hj Doraini adjacent to the feeder canal to store the water during the rainy season and supply to the rice fields during the dry season. • This has resulted in 90ha of forest being cleared and excavation/disposal of up to 4 metres of peat, construction of an earth bund and drainage/disruption of the hydrology of adjacent forest areas. • The FR type is poor forest and mostly converted ot oil palm and degraded by fires, 	<p>plantations</p> <ul style="list-style-type: none"> • Strategy 3 – Restricting access to the forest • Strategy 4 – Cooperation with surrounding landholders • Strategy 5 - Conducting Effective Public Information and Awareness Campaigns • Strategy 6 - Enhancing Integrated Enforcement
SBF 4*	508	-	<ul style="list-style-type: none"> • SBF 4 is located in the district of Sabak Bernam (Mukim Sungai Panjang) and North-West portion of the NSPSF. • The area is poor forest for the trees because the trees died as a result of high water levels from the ground up to 50cm. this has led to death of trees which may provide fuel for future fires Local community members also graze cattle on the banks of the IADA bund and in some locations keep the cattle overnight – this leads to some impacts on the forest reserve and risk of fires. 	<p>Prevention</p> <ul style="list-style-type: none"> • Strategy 1 – Block abandoned logging canals • Strategy 3 – Restricting access to the forest • Strategy 4 – Cooperation with surrounding landholders • Strategy 5 - Conducting Effective Public Information and Awareness Campaigns • Strategy 6 - Enhancing Integrated Enforcement <p>The clay bund has been constructed along the main canal and Tengi river needed a comprehensive management plan including maintenance and others action to prevent from forest</p>

				mortality due to high water level in the forest reserve including installation of water gate. The illegal cattle farm should be moved out of the forest reserve.
Total Area	9,708	6,699		

Note *:

- I. CFMP cycle for strategic preparedness, response and recovery post fire can be implemented as fire management actions in all fire risk areas.
- II. All the fire risk areas boundary should be re-demarcate with the help from Selangor State Forestry Department and District and Land Offices from Kuala Selangor, Hulu Selangor & Sabak Bernam.
- III. The degraded area has to be rehabilitated and imposed all these prevention strategies to stop the peatland fires and haze and reduction in GHG emissions

6.3.3 The Rehabilitation Plan of Severely Degraded Areas in NSPSF

Over the years, large portion of NSPSF had been degraded due to a few factors-namely illegal land clearing, drainages and fires. Combination of these factors had resulted in large area of NSPSF- close to 20,000 hectares presently degraded, though degree of degradation varied greatly from site to site. At the southern portion of NSPSF, most areas had been burned repeatedly that the area had been severely degraded, it was void of trees and only covered in grass/ lallang grass. If no mitigating measures were taken to rehabilitate these areas, it may degrade further as the chances that it will burn again is very high. Therefore, priority should be given to rehabilitate these severely degraded areas.

a) Addressing the Root Cause of Degradation

Understanding the root causes of degradation requires careful and honest assessment of the role or impact of various actors in the area that have an impact on the peat swamp forest. The main root causes leading to forest degradation in NSPSF ar as follows:

- b) Drainage (primarily from former logging operations)
- c) Fire (primarily in areas with drainage canals and areas subject to encroachment along the boundaries of the NSPSF.
- d) Logging (up to 2007)
- e) Illegal encroachment and land clearing

Management Strategies for Rehabilitation Plan for NSPSF

The management strategies for implementing peat swamp forest rehabilitation plan have been developed to rehabilitate the severely degraded peat swamp forest areas in NSPSF. The following are the summary of the management strategies for implementing peat swamp forest rehabilitation plan for NSPSF. Further details are provided in a separate report- Rehabilitation Plan for North Selangor Peat Swamp Forest.

Strategy 1: Hydrology restoration/ rewetting

Peat swamp forest is a delicate wetland ecosystem, where water can be considered the “life” of a peat swamp ecosystem, therefore, if the “life” continuously being drained out from the entire system, it is inevitably that it will “bleed” to death slowly. Since badly managed drainage is the biggest cause for PSF degradation, it is imperative that the first step in rehabilitation should focus on stopping the “bleeding” process through restoring hydrology of the degraded site. Some of the actions that can be taken are:

- a) Detailed mapping of the canal network in the degraded area
- b) Identifying the outlet points of drainage channels
- c) Build canal blocks at major outlet points and every 250-500m along the canals to increase water levels
- d) Quickly establish ground cover to improve the soil moisture if the area is void of vegetation

STRATEGY 2: Fire prevention and control

Fire prevention and control is one of the most important parts of rehabilitation process as fire can easily destroy the rehabilitated area. Fire prevention should not only focus on the rehabilitation zone inside NSPSF, but also pay attention to the adjacent land. This is because fires associated with land clearing in adjacent areas are common and could spread inside the rehabilitation zone and damaged the area.

Some of the actions that can be taken are:

- a) Maintain high water level (link to Strategy 1)
- b) Regular patrolling and monitoring to prevent fire incident
- c) Coordination with related agencies to established rapid response once a fire is spotted
- d) Active dialogue with adjacent land owner/ local communities on the fire risk on peat

STRATEGY 3: Encourage natural regeneration

If the extent of degraded area is too big, it will not be practical to conduct assisted planting program to rehabilitate the whole area. Detailed assessments should be carried out at the various rehabilitation zones to determine if the area should be left for natural regeneration with minimum intervention. Past experiences had shown that if the root cause of degradation is addressed i.e. water level had increased by putting canal block, nature often will regenerate itself.

Conditions where natural regeneration can take place:

- a) The area degraded is relatively small
- b) The surrounding area is forested- provide ample seeds/ seeds dispersal agents
- c) Water level has been raised to the natural levels
- d) Fire is not a threat

STRATEGY 4: Assisted re-vegetation

Nature is its own best doctor, usually forests will recover through natural regeneration, if the extent of the damage is not too big and the damage is not recurring. However, this process may take years to achieve. Sometimes, the nature needs a helping as the area may never recover without human intervention due to the degree of the degradation; seedbanks destroyed by fire, seeds dispersal is not available as the forested area is too far away. Establishment of vegetation may be slow despite high water level and fire prevention.

Often this type of assisted re-generation requires high maintenance.

Some of the actions that can be taken are:

- a) Sourcing of suitable planted materials – only use indigenous peat swamp forest species found in NSPSF.
- b) Selected species for different sites- pioneer species in open area and primary species in shaded conditions.
- c) Regular maintenance of the planted trees until 2m tall.

6.4 Buffer Zone Management Plan for NSPSF

In order to maintain the integrity of the NSPSF it is necessary to reduce or mitigate the negative influences of activities taking place outside the forest reserve. Under the National Physical Plan (2010) and the Selangor State Structure Plan (2020) a 500 m buffer zone along the border of the NSPSF has been mandated. The overall buffer zone areas for NSPSF had been mapped in 9 zones to implement the concept of at least 500m buffer zone management effectively. The selection of these zones has been made according to the district, current land use and types of economic activity being carried out around the buffer zone for NSPSF.

The strategy for the buffer zone management plan is as follows:

- a) Finalise the determination of the boundary of the buffer zone and develop guidance for each buffer zone section within the frame work of a buffer zone plan.
- b) Integrate the buffer zone plan into the District local Plans for the three related districts
- c) Ensure that management of water resources in the buffer zones does not disrupt the hydrology of adjacent NSPSF
- d) Support and promote buffer zones activities that are compatible with the objectives of the NSPSF.
- e) Promoting BMPs for the existing legal development in buffer zone
- f) Stop any new development in the buffer zone or adjacent areas in which biodiversity and ecological function would be adversely affected.
- g) Support the development of community-based forestry management initiatives as part of a broader set of approaches to land-use planning and developing local sustainable development strategies.
- h) Promote the development of partnerships with key stakeholders for planning and managing the use of resources within the buffer zone, and optimising benefits for local people
- i) Enhance the capacity of communities residing adjacent to NSPSF to participate in buffer zone through providing appropriate training and education, and through recognising local expertise and traditional institutions.

This buffer zone management plan further explains the buffer zone concept and reviews its significance for buffer zones management strategies for NSPSF and surrounding area. Based on experiences so far, the plan includes guidelines for 'do's and don'ts' of buffer zone management and suggests points of attention and strategies for enhancing buffer zone development. The plan emphasises the situation-specific character of buffer zone projects needing a participatory process approach and a long-term perspective as well as continuous monitoring and evaluation as tools for feed-back.

The following goals and strategies have been drafted to incorporate the key points coming from discussions that took place during the Buffer Zone stakeholder consultation workshop held in November 2013 – April 2014.

6.4.1 Proposed management strategies for buffer zone management adjacent to NSPSF

Strategy 1: Finalise the determination of the boundary of the buffer zone and develop guidance for each buffer zone section within the frame work of a buffer zone plan

The NPP and SSP specify a minimum buffer zone of 500m for the NSPSF. However in some cases – eg. where there is intact forest beyond 500m or potential activities such as mining may negatively impact the FR even though they are more than 500 m from the boundary - then the buffer zone should be up to 1000m or 1km wide. Maps for this should be determined based on site assessment and consultation with stakeholders.

Strategy 2: Integrate the buffer zone plan into the District local Plans for the three related districts

Develop and introduce appropriate strategies, mechanisms and incentives to integrate ESA 1 & 2 components in buffer zones and NSPSF within the broader ecological and social landscape, and encourage conservation in adjacent private and communal areas. To establish buffer zones around NSPSF:-

- Establish these buffer zones by inclusion in the District Local Plan & State Structure Plan ;
- Integrate the buffer zones into municipal spatial development frameworks as special control/natural area where appropriate; and
- Where necessary or appropriate, declare the buffer zones or parts thereof as protected environments in terms of the Act or/and Enactment

Strategy 3 : Ensure that management of water resources in the buffer zones does not disrupt the hydrology of adjacent NSPSF

The hydrological functions and the natural water balance of the NSPSF need to be re-established. It is key to ensure that management of water resources in the buffer zones does not disrupt the hydrology of adjacent NSPSF.

Strategy 4: Support and promote buffer zones activities that are compatible with and which complement the objectives of the NSPSF.

The activities identified compatible with and which complement the objectives of NSPSF may include:-

Nature conservation;

- Agrotourism ;
- Sustainable resource use. This may include fishing, controlled harvesting of Non Forest Timber product including food items, medicinal plants, craft, or any other appropriate form of sustainable use; or
- Nature based tourism or/and eco-tourism
- Community forestry
- Agroforestry tourism

To support these activities, the establishment of community conservation areas (or community forestry) within the buffer zone and NSPSF will be actively encouraged.

Strategy 5 : Promoting BMPs for the existing legal development in ESA 2 area adjacent NSPSF

To provide practical guidance based on field experience and current knowledge on the BMPs to the existing legal development in the buffer zone adjacent to the NSPSF.

Identify, evaluate, and incorporate into the plan documents the appropriate BMPs.

The recommended BMPs for guidance and reference are as follows: -

- RSPO Manual on Best management Practices (BMP's) for existing oil palm cultivation on peat.
- RSPO Manual on Best Management Practises (BMPs) – For management and rehabilitation of natural vegetation associated with oil palm cultivation on peat
- Guidelines for the development of a standard operating Procedure for oil palm cultivation on peat

The most important BMPs are those related to water management. The BMPs adopted in the buffer zone should be such as to prevent any drainage of the NSPSF. This can include:

- Construction of clay bunds to isolate the buffer zone from the NSPSF
- Maintenance of high water levels (eg at the surface or no more than 20cm below the surface) in perimeter drains of developments in the buffer zone.
- No deepening of existing canals and construction of new drainage canals in the buffer zone
- Avoiding use of any pesticides in the buffer zone that could spread by wind-drift to the NSPSF
- No Use of fire in the buffer zone.

Strategy 6 : Stop any new development in areas in which biodiversity and ecological function would be adversely affected.

All development in the buffer zone which may have negative impact on NSPSF will not be permitted. Development which may have a negative impact or effect on NSPSF includes:-

- Mining;
- Agricultural development & Urban development;
- Industrial development;
- Large scale resort or housing estate development;
- Transport infrastructure development;

In line with the provisions of the NPP and the SSSP – the only activities permitted in the mandatory 500m buffer for the NSPSF are sustainable forest management, ecotourism and research.

Strategy 7: Support the development of community-based forestry management initiatives as part of a broader set of approaches to land-use planning and developing local sustainable development strategies.

Local communities use of natural resources often plays a vital role in the household economics of many of these communities. Ensuring the conservation and sustainable use of natural resources in NSPSF buffer zones, and minimizing adverse impacts on the ecosystem of such areas will require several common approaches to be adopted.

Partnerships need to be developed to enhance and ensure the sustainability of the natural resources (see also Goal 5). An active partnership between Selangor State Forestry Department, local district office, local community and other relevant is encouraged. All district offices have District Local Plans (DLP) which is plans for the development of the local area. These plans aim to:—

- Enhance sustainable livelihoods
- Develop the area to provide long lasting economic opportunities and a better quality of life; and
- Protect the natural resources of the NSPSF

Strategy 8: Promote the development of partnerships with key stakeholders for planning and managing the use of resources within the buffer zone, and optimising benefits for local people

Partnership between Selangor State Forestry Department (NSPSF management authority) and the State authority or authorities responsible for preservation and conservation is essential as these organizations are all working towards the same goal. Written agreements or mutual understanding between the organizations are encouraged to ensure collaboration and cooperation in sustainable management of peatlands, especially in the buffer zones or in state land.

Partnerships between the NSPSF management authority (Selangor State Forestry Department) and district offices will be guided primarily through the integration of the NSPSF and its buffer zone into the district council development frameworks and the integrated development plans.

Partnerships between the NSPSF management authority and its neighbouring communities are encouraged through this strategy.

NSPSF must be seen and must operate as local economic drivers which contribute substantially to the long term sustainability of the district and state. People living in the buffer zone, in providing both protection and support for NSPSF should see direct benefits accruing to them from the NSPSF.

The NSPSF management authority will promote local and social development in the state by:-

- Where possible, securing goods and services from the communities in the buffer zone;
- Employing personnel from the buffer zone as far as possible;
- Facilitating joint venture schemes with enterprises in the buffer zone, especially by the development of infrastructure which will serve both the NSPSF and the community;
- Providing community services;
- Providing environmental education and opportunities within protected areas;
- Promoting community management of conservation areas in the buffer zone;
- Where relevant promoting co-management agreements for the management of NSPSF;
- Where appropriate, designating areas for sustainable resource use in the NSPSF;

Strategy 9: Enhance the capacity of communities residing adjacent to NSPSF to participate in protected area management through providing appropriate training and education, and through recognising local expertise and traditional institutions.

Capacity development continues to be critical to the continued successful existence of NSPSF. Development of the communities capacity in the buffer zone management for the conservation of biodiversity both in the NSPSF and in its buffer zone will enhance the long term viability of the NSPSF.

A number of programmes are already in place, namely enhance sustainable livelihoods programmes—especially to improve buffer zone by rehabilitation of systems (e.g. community based rehabilitation), as well as the development programmes such as the extended public volunteering programme.

Government will continue to provide support for these programmes. Additional assistance to communities will be provided to ensure best practice methods of buffer zone management, as well as developing strategies and programmes for the promotion of enterprise which will support the NSPSF and their management as well as provide opportunities for economic development in the buffer zone.

Strategy 10: Improve benefit flows to people in and around NSPSF.

In summary, this buffer zone management plan for NSPSF highlights the importance goals and strategies to implement at the buffer zone area adjacent to NSPSF. This buffer zone management plan has to be adopted as a guide or/and regulation. Without this adoption, any activity in the buffer zone will result in problems between the SSFD and land owners.

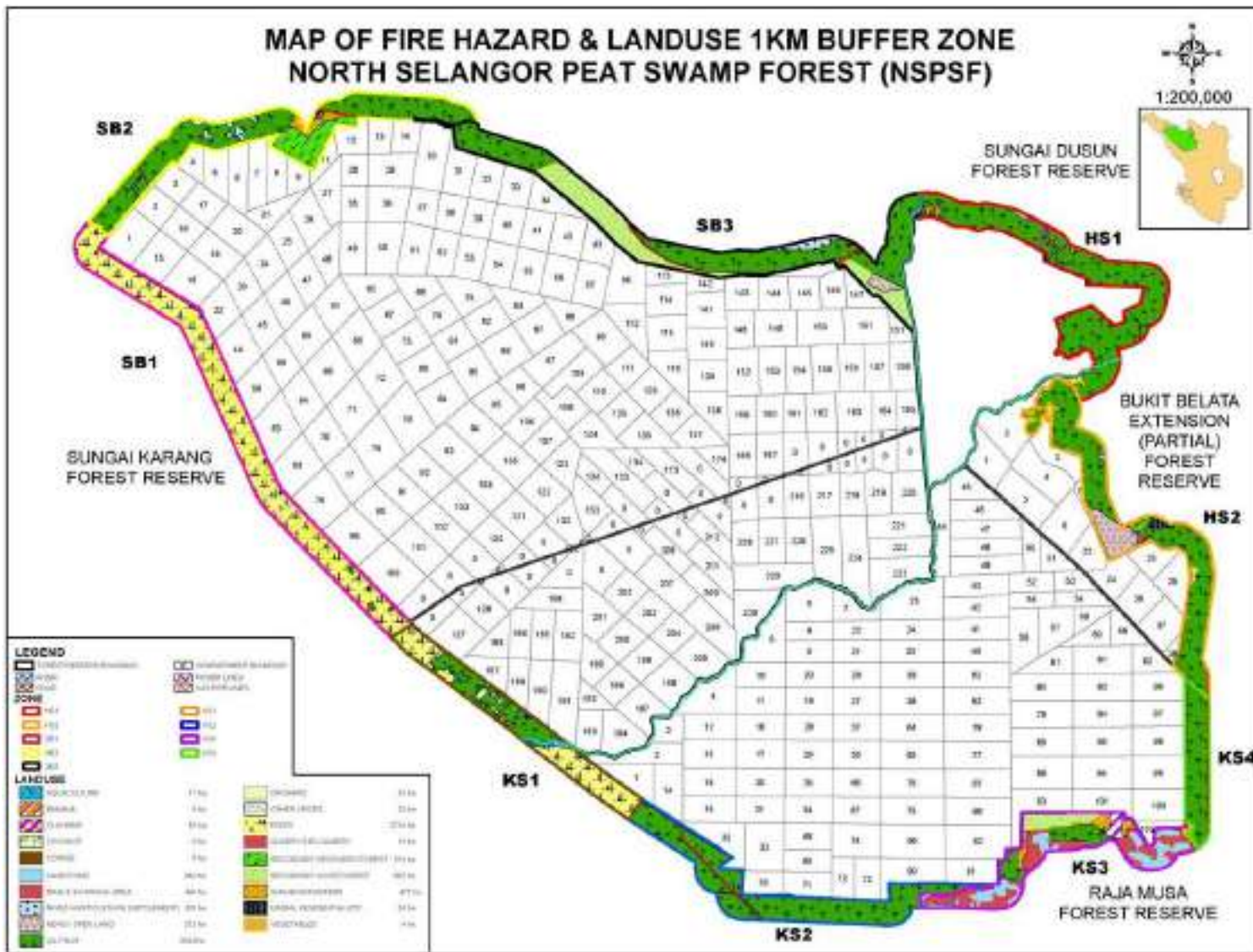


Figure 6-5: Map of Landuse of Buffer zone for NSPSF

6.5 Boundary Demarcation

An important requirement of long-term sustainable forest management is the stability of external and internal boundaries. The two main activities to secure and maintain these boundaries are:

- a) Repeated demarcation.
- b) Periodic field inspection

External Boundaries:

To maintain the geographical extent of the NSPSF and to prevent encroachment and other illegal activities, external boundaries must be stable. The measures required for maintaining external boundaries are to clearly mark the boundaries with signposts at regular intervals and field inspections. The specific activities needed for boundary control depend on the nature of the boundary and the land use and ownership of neighboring land.

The NSPSF is to the south-east, south, west, and north surrounded by private land, used for farming and mining. To the south-west, the boundary follows the Main Irrigation Canal, while the remaining external boundary to private land does not follow any distinctive geographical feature. Records show that the external boundaries to the north of Sungai Karang FR, east of Bukit Belata Extension FR and Sg Dusun FR and to the east and south of Raja Musa FR are subject to highest external pressure from fires, farming, and encroachment. Repeated demarcation every year with Forest Reserve signposts and regular field visits are therefore required for maintaining these boundaries, while it is sufficient to repeat the boundary demarcation every five years on boundaries under less pressure, such as along the Main Irrigation Canal.

There is little or no need to mark the internal boundaries between eg RMFR and SKFR and Between RMFR and BB Extension FR. Provided that the four Forest reserves are managed as an integrated entity – there is no need to mark the internal boundaries.

Integrated enforcement and field inspections should be carried out along the boundary in accordance with a fixed schedule and field reports should be made, that contain the following information:

- a) Date of inspection
- b) Name and rank of Staff involved in the field visit
- c) Description of any observed cases of encroachment or any other illegal activities
- d) Report on measures already in place to prevent/stop illegal activity

6.6 Management prescription applicable to specific zones

The following sections provide the specific management guidelines applicable to all six zones.

A. Potential Production Forest/Water Catchment Forest

The specific management objective is to maintain and enhance the forest resources and restore hydrology. In the immediate term, it is desired to set aside most of the area as water catchment area to ensure that the hydrology of the area is protected and can continue to provide valuable freshwater resources for agricultural and domestic uses.

The specific management prescriptions to implement this strategy are provided below:

- a) Protection and encouragement of natural regeneration
- b) Blocking of drainage channels and restoration of natural hydrology.

B. Rehabilitation Zone

The specific management objective is active rehabilitation of the severely degraded area by restoring hydrology, preventing fire and encouragement of natural regeneration. Thousands of hectares of lands had been degraded due to drainage, encroachment and fire, and these areas should be set aside for the rehabilitation.

The specific management prescriptions to implement this strategy are provided below:

- a) Restore the natural hydrology of the forest (rewetting)
- b) Prevent and control fires in the areas under rehabilitation
- c) Encourage natural regeneration of the forest as far as possible
- d) Support re-vegetation of the seriously degraded areas by planting suitable tree species originating from PSF

Since 2008, SSFD had been working closely with GEC and local communities on rehabilitation. An CBO called Sahabat Hutan Gambut Selangor Utara (SHGSU) was established in 2012 and the organization had been actively involved in the tree planting activities, canal blocking. They had involved in fire prevention through regular patrolling and also assisted in fire fighting. Apart from that private sector had been brought in to fund part of the rehabilitation efforts. Among the companies that had contributed substantially are HSBC Bank Malaysia Berhad, Bridgestone Tyre (Sales) Malaysia Sdn. Bhd, Timberlands Lifestyle Brand Sdn. Bhd, United Way/Fedex and 99 Speedmart Sdn. Bhd.

C. Biodiversity Conservation

The specific management objective is conservation of the natural ecosystem and of rare and endangered species. Entailed in this objective are the rehabilitation of the hydrology and the capacity of the PSF to store carbon. Ecosystem and habitat conservation is also of importance for research, education, and use of the forest for recreational purposes.

The overall strategy is to set aside areas where logging is not permitted and where extraction of non-timber products is restricted, and to ensure that interventions in other areas are carried out in an environmentally friendly manner. The specific management prescriptions to implement this strategy are provided below.

a) Protection

The main protection activity is regular monitoring of conservation areas. An important task of the management is, therefore, to ensure that the conservation areas are protected from such activities, and that non-timber uses follows the prescriptions established in the relevant Forest Use Agreements.

The main protection activities are demarcation and field inspections of the external boundaries of such conservation areas. Whenever the field inspections of external boundaries indicate that illegal activities might take place inside a protected area, the external inspections should be supplemented with inspections of the interior of the conservation area. In such cases, due note should be taken of making as little disturbance as possible to vegetation and wildlife

b) Monitoring

The purpose of protecting specific areas from logging and encroachment is to conserve the PSF ecosystem and certain plant and animal species. To assess if these measures are effective, their impacts should be monitored.

The most appropriate method of monitoring particular plant or animal species depends on the character of the species. Counting of flying or resting birds, or counting of nests or nesting sites (if breeding), for example, is used for monitoring of changes in bird populations.

Monitoring of changes in the ecosystem is more complicated, as the ecosystem may include hundreds of plant and animal species, all interacting with each other. In reality, it is not possible to register all changes in an ecosystem. Hence, ecosystem changes are most commonly monitored indirectly by registration of changes in the composition of indicator species; species that have been identified as reliable indicators of the overall condition of and development of the ecosystem.

The present ecological knowledge of the NSPSF is insufficient to prescribe with certainty how the impacts of conservation measures are best monitored. Further research into this is, therefore, required. External expertise for identification and design of appropriate research programmes and for identification of indicator species and development of appropriate monitoring methods should be sought. Potential partners include Department of Wildlife and National Parks, Department of Environment, local and international research institutions, and local and international NGOs, and development organisations.

With appropriate training, it is anticipated that Forestry Department field staff on a daily basis would be able to carry out basic ecological monitoring by identification and registration of relevant plant and wildlife species. Such monitoring could easily be incorporated into other tasks such as boundary inspection and supervision of logging operations, and the monitoring should not be restricted to conservation areas, but should cover the entire Forest Reserve.

D. Recreation/Eco-tourism , Education, and Research

The specific management objective is to promote the use of the NSPSF for recreation and education and research. This objective must be reconciled with the general objectives of maintenance of the PSF hydrology and carbon sequestration capacity, and of biodiversity conservation.

The overall strategy is to set aside specific areas for the promotion of activities related to recreation and education/research, and to stipulate the steps to be taken by the management to achieve the management objectives.

Specific management prescriptions to implement the above strategy are provided in the following sections.

- a) Designate specific areas for eco-tourism, recreation and for environmental education, awareness, and research,
- b) Develop special facilities such as observation towers, trails and boardwalks
- c) promote involvement of local communities, tour operators and others stakeholders in eco-tourism activities
- d) encourage local and international research institutions to undertake research in NSPSF

Recreation and Eco-Tourism Development

The NSPSF is used for recreational activities; at the moment primarily in terms of fishing and bird watching. The potential of sustainable tourism development has been identified, as it is believed that the unique PSF ecosystem and its wildlife, if promoted, would catch the attention of national and international visitors. Potential eco-tourism activities include guided boat trips and forest walks.

Some recreational uses require infrastructure installations such as jetties, towers for bird watching, and board walks. While it is recommended that boat-tours, bush walks, and similar activities should be allowed throughout the forest except perhaps in certain particularly sensitive sites in Forest Management Zone C for conservation, development of infrastructure should be carefully planned.

It is believed that it is best to leave the handling of the business of promoting and organising tours and activities for tourist and local visitors to private enterprises. Hence, Forestry Department should not, as such, go into this business. However, a potential role of field staff from SSFD is as resource persons, providing more detailed explanation to visitors on the forest ecosystem, logging systems, and particular wildlife habitats. SSFD should consider charging a suitable fee for such services.

Another important management task of the SSFD, related to recreation and tourism development in the forest, is supervision and design of establishment of nature trails, jetties, and similar infrastructure installations. With their detailed local knowledge, SSFD staff would be able to identify the most suitable locations of the different installations, while external expertise might be required for the actual design and construction work.

Encouraging and promoting tour organisers and tourists to enter the Forest Reserve require that rules and regulations for the visitors be defined. It is recommended that specific rules, including enforcement measures such as inspections and fines, should be agreed with the responsible tourism operators. Key elements of such rules include:

- Collection and disposal of litter.
- Restrictions in the use of fire, including cigarette smoking, etc.
- Protection of wildlife and vegetation, including restrictions on collection of plants and other specimens.

It should be the responsibility of the tourist operators to ensure that their clients respect the applicable rules. To support the enforcement, signboards explaining rules and regulations should be put up at suitable locations such as at jetties and boardwalks.

Environmental Education

Presently, the educational use of the NSPSF is limited to the occasional visit by persons from organisations and institutions, typically involved in management of peat swamp forest or other forest types elsewhere. These "expert" visitors are typically interested in technical aspects of the PSF management, and, naturally, different research plots in the NSPSF are normally visited. SSFD should continue to host such visits, and it is recommended that appropriate information material, for example the books and leaflets produced by this project, should be given to interested visitors.

So far, the use of the NSPSF for environmental education of the general public, including school children, has been limited. However, the considerable interest from school children and their parents and teachers in the two drawing competitions and the calendars, posters, and booklets produced by the project shows that there is a widespread demand for environmental education in North Selangor and elsewhere in Malaysia. It is recommended that SSFD should contribute to satisfying this demand by:

- Collaboration with local schools through the Peatland Forest Ranger programme established in 2010 by Global Environment Centre and SHGSU together with a number of schools around NSPSF. Local Community members should be trained to act as guides for such groups. SSFD should when possible, provide logistical support in terms of vehicles and boats. In some cases, it might be desirable to complement the field visits with classroom presentations and exercises; activities where SSFD staff could function as resource persons.
- Reprinting and updating of posters and booklets to be distributed to local schools, visitors, and other interested parties.

Generally, educational activities should be allowed throughout the forest. However, care should be taken to ensure that sensitive sites in Forest Management Zone C for conservation are disturbed as little as possible. Due to the logistics of the NSPSF, it is anticipated that most educational activities would be fielded in Area E1 and along the Sungai Tenggi.

Research

Previously, permanent research sites in the NSPSF were located within Area E1. However there was little active research as these sites between 2000-2014 and some of the sites have been negatively impacted by flooding associated with the IADA project. It is not the role of SSFD to carry out scientific research. However, as a potential beneficiary of the results from PSF research, SSFD should continue to support research efforts by providing suitable sites for establishment of field trials, and by supporting researchers with field staff and logistics.

For the future it is proposed that research be encouraged in other zones including the rehabilitation zone and the buffer zone where the research can contribute to the management of these areas.

E. Community Forestry

Harvesting of Non-Timber Forest Products:

A limited number of villagers are presently using the NSPSF for collection of fruit and medicinal plants, and for hunting and fishing. It should be considered that future uses of the forest for these activities be restricted primarily to CF1. Exceptionally, however, permission might be given to use the forest located in Forest Management Zone A or E for extraction of non-timber products, provided of course, that the use does not conflict with the objectives of these areas; i.e., education, research and tourism development, and conservation.

Villagers should not be allowed to target endangered animal or plant species for hunting or collection. Also, the intensity of the harvesting and collections activities should be at a level that does not exceed the carrying capacity of the targeted produce. As the capacity of the NSPSF to produce, for example, forest fruit is not known, it is recommended that a conservative approach be followed, when collection and harvesting permits are granted. If routine field visits and forest monitoring indicate that some of the harvested products and species are becoming rare, no new permits should be issued for this particular product. Also, the reasons for the decline that could be related to natural processes or use of the product beyond its carrying capacity should be further investigated.

All activities such as hunting, fishing activity and collecting of NTFPs from the forest reserve and as well ecotourism during the dry season should strictly not be allowed. This is as part of peat fire mitigation plan to prevent peat fire occurrences.

Research and Development

The recommendations presented in this management plan are based on preliminary findings from studies and inventories. Further research into various aspects of peat swamp forest management is required to further refine and develop the management of the NSPSF. It is not the role of SSFD to carry out scientific research. However, it is recommended that SSFD should give its support to research project carried out by relevant partners by making field sites available, and by supporting researchers logistically and with field staff.

The list below gives a description of areas, where further research and development would be of special importance for the further development of the management of the NSPSF. The list is not complete but contains areas that are presently considered to be urgent:

Hydrology:

Research to further detail the hydrology and monitor the fluctuations in water levels as well as assess the effectiveness of the canal blocking activities should be undertaken. The exact role and contribution of the PSF for flood control and irrigation should be investigated further. .

Conservation:

The present knowledge of the ecology of the peat swamp forest and its plant and animal species is insufficient, and is not fully understood and described. Research that would help to improve the baseline information on the PSF ecology and plants and animal species living in it should be promoted.

In spite of the lack of baseline knowledge, it is generally accepted that it is important to ensure the survival of some of the original PSF ecosystem and certain plant and animal species living in it. Consequently, conservation areas have been put aside,

The Economics of Local and Global Environmental Services from the PSF

a) Carbon Sequestration.

Millions of tonnes of carbon are stored in the NSPSF for the benefit of the local and global community. Presently, this service is provided "free of charge." Studies to quantify the carbon storage capacity of the NSPSF and its economic value, including the value of the NSPSF on the carbon off-set market, should be promoted.

b) Ecosystem and species conservation.

Likewise, the conservation of the PSF ecosystem and of rare and endangered plant and animal species provides benefits to the local and the global community. Studies to clarify and quantify such benefits, including estimating their economic values, should be supported.

Chapter 7 – Implementation

7. Implementation

7.1 Administrative and Organisational Measures

The Implementation of the Integrated Management Plan (IMP) is under the overall responsibility of the State Director of Forestry. Since the NSPSF is divided into two Forestry Districts the implementation is divided between the District Forest Officer (DFO) for Hulu Selangor based in Rawang (who is responsible for Raja Musa Forest Reserve (south of the Sg Tenggi) and Bukit Belata Extension Forest Reserve and Sg Dusun Forest Reserve) and the DFO for Pantai Klang based in Klang (who is responsible for Sg Karang Forest Reserve and Raja Musa Forest Reserve north of the Sg Tenggi).

Each District Forest Officer (DFO) will have the sole responsibility for implementing the respective portions of the IMP and the preparation of Annual Work Plans in accordance to this IMP. The person will be responsible for the submission of all Annual Work Plans and liaison with the Selangor State Forest Department (SSFD) Director. The DFO will be accountable to the State Forest Director for the overall forestry activities carried out under the IMP.

7.1.1 Organisation and Staffing

The administration and management of the NSPSF is split between two District Forest Offices in Hulu Selangor and Pantai Klang Forestry Districts.

The proposed organisational and staffing requirement has been significantly increased compared to the previous IMP. This is inline with the changes in the responsibilities of the SSFD and scope of IMP, from activities centred around logging to a focus on conservation, fire prevention and rehabilitation activities. Significantly more human resources and equipment are needed to actively manage and rehabilitate the area compared to administration of logging operations.

In order to enhance management it is proposed that the current Sub-range office at Bestari Jaya (under the Batu Arang Range) be upgraded to a Range office and a sub office established at compartment 73 which is the main area planned for rehabilitation activities and is central location for fire control. It is also proposed that a post is established at Parit 6 and Compartment 99 – to strengthen management and fire prevention in this key portion of Raja Musa FR as well as acting as a base for patrolling Bukit Belata Extension FR.

In Pantai Klang District – the NSPSF is managed by a range office in Kuala Selangor. This office has to patrol the entire boundary of Sg Karang FR as well as part of Raja Musa FR. It is proposed that this range be split into two with a new range office to be established in Sabak Bernam District.

A summary of the organisational set-up and the staff working with management and administration of the NSPSF is presented in Table 7-1.

Table 7-1: Organisation and staffing requirement within the administration and management of the NSPSF

Forest Reserve	Forestry District	Range	SSFD Staff, Level and Number					
			Range Office	Sub-range/post	Ranger	Forester	Worker	Driver
Raja Musa (south of Sg Tenggi) Bukit Belata Tambah Sg Dusun	Hulu Selangor	Bestari Jaya (upgraded)	1	2	1	8	20	2
Raja Musa (north of Sg Tenggi) Sungai Karang	Pantai Klang	Kuala Selangor	1	1	1	8	10	2
		Sungai Panjang (new)	1	2	1	8	15	2

Buildings and Equipment

The three Forest Range Offices will need their own buildings from where all operations will be coordinated. A summary of proposed buildings and equipment are listed in Table 7-2. Equipment which is related to monitoring (vehicles, boat, motorcycle) and fire prevention and control (water pump, watch tower) have been increased substantially, owing to the recent year fire incidents which occurred almost annually. It is also proposed additional post/ sub range for effectiveness in monitoring works.

Figure 7-1 shows the location of the proposed locations of the sub-range office, forest guard post, watch tower, pump house and eco-tourism entry point.

a) Sub-range office

Four additional sub-range offices are proposed in NSPSF, with 3 in RMFR: compartment 73, compartment 99/100(at parit 6) , compartment 104 and 1 in SKFR: compartment 1. For compartment 73 and 99/100 as these 2 areas are prone to fire and regular monitoring will be crucial in prevent fire and encroachment. Compartment 104 is the entry point to Sungai Tengi, a sub-range office here is strategic for monitoring activities along the Sungai Tengi as well as along the main irrigation canals. For SKFR, a sub-range office (under the proposed new range office in Sabak Bernam District)is proposed near the IADA retention pond and proposed Agroforestry Zone both of which are vulnerable to fire and encroachment so that activities in these areas can be monitor closely. This will also be the base for patrols of the boundary of the SKFR and management of the Post on the JPDS diversion Canal near SKFR Compartment 104.

b) Forest guard post

Forest guard posts were proposed at 2 places: compartment 7 (Bukit Belata Extension FR) and compartment 167 (SKFR). Placement of a gurad post at compartment 7 is to monitor and prevent encroachment activities at kg Tawakal, control access into Bukit Belata Extension FR and also to prevent fire incidents. The proposed post at Sg Karang FR is to control access into the Sg karang FR and Raja Musa Forest reserve along the JPS diversion canal and adjacent road. At present there is no restriction on access by boats and vehicles along the JPS canal.

c) Watch tower

Watch towers are proposed in 3 strategic locations in order to cover most area where fire risk is high. One watch tower to be placed at compartment 75 (RMFR) so that area on both sides along the main canal and beyond can be monitor closely. Another watch tower is proposed at compartment 38 (BBEFR) to monitor for areas both in RMFR and BBEFR . The third tower is proposed at PKPS area near clay mine (either as a separate tower – or by upgrading the current lookout on the PKPS water tower). A watch tower here is strategic for monitoring the forest reserve as well as buffer zone area.

d) Pump house

A pump house is proposed at buffer zone adjacent to compartment 102 (RMFR). A pump house here would facilitate the fire fighting activities in this areas by pumping water from one the mining pools into the RMFR along the pipeline that was installed in March 2014.

e) Eco-tourism

Three designated entry points for eco-tourism activities are proposed: one is at the Homestay Sg. Sireh, a second is at Sungai Dusun and the third at the Centre of excellence at Comp 73.. All these locations can be monitored by the sub-range office / guard post located nearby. Homestay Sg Sireh has facilities such as boats to cater for tourist interested in recreation fishing, jungle trekking, birdwatching or just boating.

Table 7-2: Buildings and Equipment required within the implementation of IMP

Forest Reserve	Forest District	Forest Range	Buildings and Equipments						Watch tower
			Ranger Office	Post / sub range	Vehicles 4X4	Boat	Water pump/fire equipment	Motorcycle	
Raja Musa (south of Sg Tenggi) Bukit Belata Tambahan Sg Dusun	Hulu Selangor	Bestari Jaya	1	3	3	2	10	3	3
Raja Musa (north of Sg Tenggi) Sungai Karang	Pantai Klang	Kuala Selangor	1	2	2	2	2	1	0
		Sungai Panjang	1	2	2	2	6	2	0

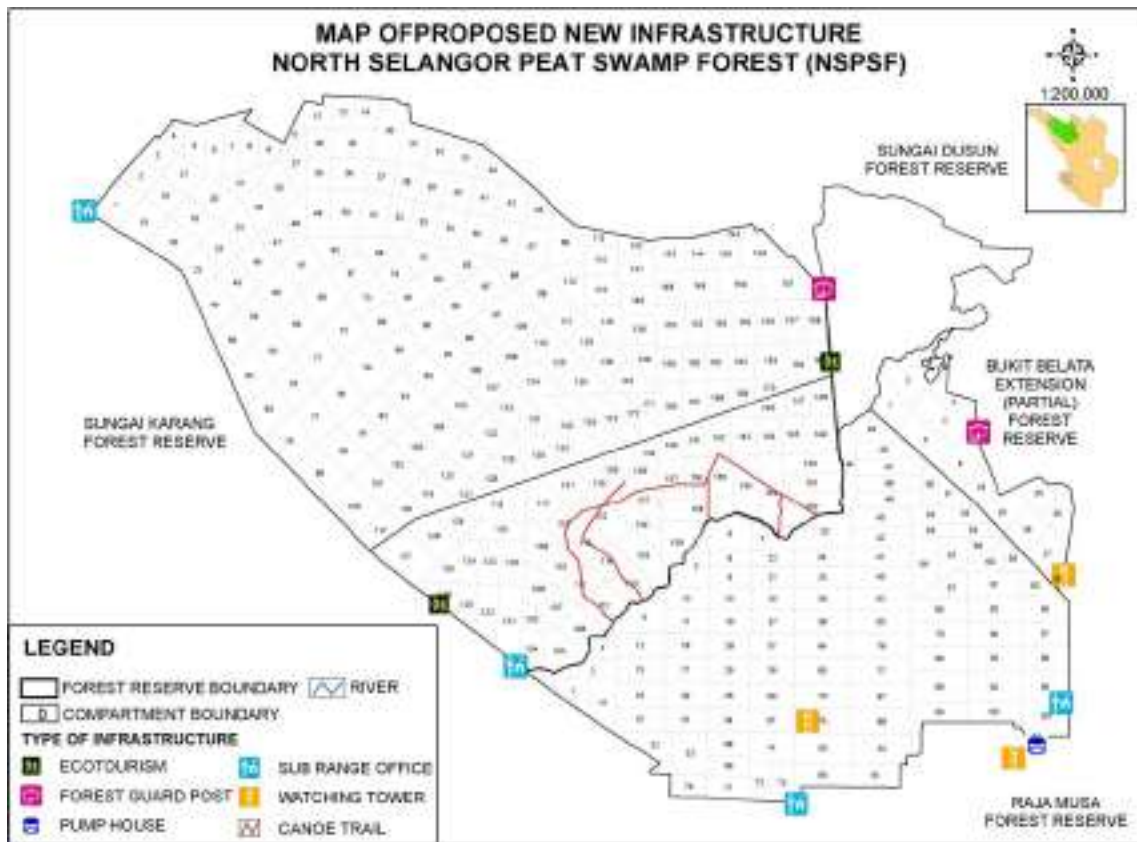


Figure 7-1: Map showing the proposed locations of the sub-range office forest, guard post, watch tower, pump house and eco-tourism entry point

7.1.2 Inter-Agency Co-Operation

Apart from the outreach activities to schools and communities surrounding the forest, the management prescriptions in Chapter 6 deal with activities to be implemented by SSFD inside the boundaries of the forest reserve. The results of many of these activities depend on the activities and plans of other government agencies and vice versa. The impacts, for example, of interventions in the NSPSF to stop the drainage of the NSPSF depend on measures to regulate the flow of water in the River Tenggi and the River Bernam that are under the control of DID. The planned activities in this management plan will therefore only lead to the achievement of the stated objectives, if they are co-ordinated with plans and activities of other relevant government agencies.

Lists of the Government Departments of importance for management of the PSF are provided in Section 2.2.1 and 2.2.2. Most importantly, co-ordination among the following bodies is important for the management of the NSPSF:

- **UPEN.** UPEN is responsible for economic planning at state level. To be effective, the planned activities in the NSPSF must be co-ordinated with development proposals and plans, for example, for infrastructure and land development in the area.
- **SSFD.** SSFD is responsible for preparation and revision of management plans for the NSPSF and management, administration, and supervision of activities carried out inside the Forest Reserve.
- **DID.** DID is responsible for management of water resources, including the irrigation water for the neighbouring Tanjung Karang Irrigation Scheme. Interventions related to the hydrology of the NSPSF should be co-ordinated with DID's plans for the area.
- **DOA.** DOA provides extension services to farmers to improve their agricultural productivity. The development of suitable agro-forestry systems in the Agroforestry Zone in the NSPSF requires the co-operation of extension officers from DOA.
- **DWNP.** DWNP is responsible for the management of the Sungai Dusun Wildlife Reserve. Conservation measures and monitoring of wildlife in the NSPSF should be co-ordinated with the activities and plans of DWNP in Sungai Dusun Wildlife Reserve and elsewhere.
- **LDO.** LDO responsible for all the matter related to land tenure and it's role is vital in managing the land in the buffer zone

The State government has already established the following committees at state level to address peatland issues:

Selangor State Steering Committee on Peatlands - chaired by the State Secretary

Selangor State Technical Working Group on Peatlands – chaired by the State Director of Forestry

It is recommended that sub-committees are established to review the management of the NSPSF and monitor the implementation of the IMP and Buffer zone plan.

The key tasks of the sub-committee should be to:

- Review implementation of the IMP with focus on buffer zone plan and CFMP
- Review development proposals that may affect the NSPSF.
- Review management plans and annual reports prepared by Government Agencies that are represented in the committee.
- Review reports, proposals, and ideas submitted by other parties with an interest in the NSPSF.

The proposed members of the sub-committee are in Table 7-3.

Table 7-3: Proposed member of the NSPSF IMP sub-committee

	Members
1	UPEN
2	Selangor State Forestry Department
	Department of the Environment, Department of Irrigation and Drainage, PERHILITAN, Department of Agriculture. Selangor State Fire and Rescue Department
3	District Officers from Kuala Selangor, Hulu Selangor and Sabak Bernam
4	District Council from KS, HS and SB
5	Key stakeholders of buffer zone- KDEB, PKPS, MBI, Sime Darby, Felda
6	NGOs- Global Environment Centre, Sahabat Hutan Gambut Selangor Utara

7.1.2 Stakeholder Engagement

Buffer zone stakeholders

Besides inter agency coordination on buffer zone management, it is also crucial to engage various stakeholders who had activities inside the buffer zone area. Active engagement including dialogues should be undertaken with the the following stakeholders: PKPS, KDEB, MBI, Semester, IADA and all the smallholders to ensure BMP is practiced and impacts to NSPSF can be minimized.

Community – Friend of North Selangor Peat Swamp Forest

A local community association called “Friend of North Selangor Peat Swamp Forest” was established in August 2012 designated to empower the engagement of the local community in participating in rehabilitation of Raja Musa Forest Reserve. .. Local community participation is a key part of management of the Buffer zone as well as the cooperative fire management plan. Community involvement is also important for the rehabilitation programme.

Private Company Partners and Corporate Social Responsibility (CSR)

SSFD could seek funding from private company through the company CSR program. Companies nowadays are more “green” minded and many are willing to be involved in the environmental related activities. Raja Musa community based rehabilitation program developed in partnership by SSFD and GEC attracted a number of companies to fund the rehabilitation activities such as tree planting, canal blocking as well as seedlings procurement. Among the companies that had contributed substantially are HSBC Bank Malaysia Berhad, Bridgestone Tyre (Sales) Malaysia Sdn. Bhd, Timberlands Lifestyle Brand Sdn. Bhd, United Way/Fedex and 99 Speedmart Sdn. Bhd.

7.1.3 Human Resources Development

Implementation of the Management Plan entails that SSFD staff must deal with new tasks and roles in addition to the more traditional functions related to forestry. To enhance the performance of the SSFD staff, it is recommended that additional training should be provided. The major steps in relation to training are to:

- Conduct an assessment of the training needs, including a review of the future functions and responsibilities of the SSFD staff.
- Prepare a training programme, including identification and development of suitable training courses, and organisation of held tours and co-operation programmes with relevant external parties.
- Implement the training programme

7.2 Operational Measures

7.2.1 Protection

To protect the NSPSF from external threats such as encroachment, external boundaries must be demarcated and inspected on a regular basis. For “internal” protection, SSFD must visit all areas, where operations are carried out, to ensure that users of the forest follow the relevant prescriptions, and that the activities are carried out at the agreed locations.

The most important elements of forest protection in the NSPSF include:

- Demarcation and surveillance of external and boundaries between Management Zones.
- Regular patrol with communities
- Field inspections and monitoring of the field activities carried out by the different user groups.
- Record keeping of the progress and impacts of all field operations and other observations from field visits, and prescription and monitoring of measures to prevent or stop undesirable circumstances.
- General monitoring of the health status of the forest, including identification of wind throw areas, insect attacks, and other calamities.

Table 7-4: Proposed responsibilities for range/ sub-range office

Range/ Sub-range office	Proposed responsibilities for patrolling
Bestari Jaya	Raja Musa FR south of Sg Tenggi Bukit Belata Tambahan FR Sg Dusun FR
Kuala Selangor	Sungai Tenggi from irrigation canal (compartment 104) to compartment 158 Raja Musa FR western boundary north of Sg Tenggi Sungai Karang FR from compartment 117- compartment 44
Sabak Bernam	Sungai Karang FR western boundary compartment 22 to compartment 1 and northern boundary compartment 1- compartment 151 JPS diversion canal (SKFR compartment 151- RMFR compartment 155)

7.2.2 Blocking of Old Logging Canals

Drainage of the NSPSF constitutes a severe threat to the PSF ecosystem, and measures to address this threat should be initiated immediately. The key steps are to:

- Identify and establish contacts with suitable external partners to advise on technical aspects of the requirements to block old logging canals.
- Conduct of a field inventory, using existing maps of logging canals, to identify the canals, where blocking is most urgently required.
- Prepare a work programme that stipulates that canals should be blocked when and how, and detailed cost estimates for the exercise.
- Implement the work programme using local contractors.

7.2.3 Recreation, Eco-tourism, Education and Research

The role of SSFD in development of the NSPSF for recreation and eco-tourism, and for using the forest for education and research will primarily be to provide staff to function as resource persons and hosts for recreational visitors, school classes, and researchers. Hence, it is anticipated that the relevant partners in such activities, including tourism promoters, teachers and researchers should take the lead in planning and organising specific events. However, to facilitate the use of the forest for the above purposes, SSFD should take the following steps:

- Liaison with Tourism Malaysia/ Tourism Selangor, local education authorities, and local research institutions for the planning and organisation of activities, and identification of suitable locations for visits and other activities.
- Preparation/ reprinting of posters, folders, and information materials to be used for environmental awareness campaigns for tourists and students.
- Preparation of rules and regulations to be followed by groups using the forest, including the development of signboards explaining the rules to be placed at strategic locations.

Below are some of the examples where the potential of eco-tourism can be tapped.

- a) Homestay Sungai Sireh is a well established homestay in the State of Selangor. It is located adjacent to the western site of NSPSF and could provide one of the entry points for eco-tourism activities along the main canals as well as along the Sungai Tengi. SSFD could work closely with the Homestay to promote eco-tourism packages for NSPSF. Activities that can be carried out under the tourism packages includes recreational fishing, birdwatching, boating and forest walk etc.
- b) Hornbill Conservation Area. A hornbill watch tower had been established by Perhilitan at Compartment 31, SKFR for research purposes. It could become the hotspot for birdwatches if it is promoted properly. This could be a win-win situation if SSFD could work with Perhilitan to combine research and eco-tourism activities.
- c) Another entry point for the proposed eco-tourism zone is at Sungai Dusun. Apart from visiting the Sungai Dusun Wildlife Centre, boating, recreational fishing and birdwatching could become the main activities in this area. SSFD and Perhilitan and local tour promoter can work together in promoting the eco-tourism here.

For research and education, it is recommended that SSFD continue to work with research institution such as Forest Research Institute Malaysia (FRIM) as FRIM had a long term research plot at compartment 127, SKFR. SSFD may also invite other higher learning institution such as local university to conduct various researches in the proposed zones to enhance the knowledge of the PSF and NSPSF.

7.2.4 Conservation

A task of SSFD in relation to conservation that applies to all Management Zones is general environmental monitoring and protection. The key elements are:

- Identification and registration of indicator species and important plant and wildlife habitats.
- Prescription of measures to protect the specific types of wildlife, and monitoring of the effectiveness of the prescribed measures. E.g., if a rare bird species is nesting in a tree in a logging area, it may be necessary to abstain from logging this particular area, and to relocate the logging operations to another area.
- Monitoring of the effectiveness of general conservation measures such as protection of conservation areas, environmentally friendly logging methods, etc

Department of Wildlife and National Park (Perhilitan)

To ensure the survival of a wide range of wildlife and its habitats the management of the IMP focus on the preventing further destruction of the habitats, conservation and rehabilitation of the forests. Sungai Dusun Wildlife Reserve will be managed by Perhilitan. A joint effort with Perhilitan need to be strengthen to monitor and take action against poacher.

7.2.5 Buffer Zone Management Plan

Buffer zone management plan is a separate but important plan for the implementation of IMP as a whole. (see also section 6.4) Various activities at the buffer zone must be monitored regularly to ensure its' activities does not impact the NSPSF. Inter-agencies coordination should be strengthen and the all stakeholders at buffer zone shall be advised on the available BMP for their activities. Technical advice shall be given to the stakeholders when needed i.e. how to maintain high water level for the farm/ estate.

Information on buffer zone management plan and cooperative fire management plan should be incorporated into the Kuala Selangor & Sabak Bernam District Local Plan 2025 and the Selangor State Structure plan 2035 being developed under the Town and country Planning Act, 1976. However, it is also recommended that the buffer zone is also gazetted under section 62 of the National Land Code 1965. This action will further strengthen the protection of the NSPSF.

Table 7-5: Proposed Nature of Buffer Zone

Buffer zone type/ Current development status	ESA Class 2 (0-500m) from FR No development or agriculture.	ESA Class 3 (500-1000m) from FR Controlled development
No current development (Stateland)	No development or agriculture permitted . Sustainable timber harvesting and eco-tourism may be permitted subject to local constraints Remaining forested land to be gazetted as FR	Controlled development Agriculture, plantations may be permitted (after study) provided that does not negatively impact the water levels/quality and fire risk in class 2 buffer zone. Mining only permitted after study and clay bund construction No housing permitted

No current development (Private land)	Sustainable timber harvesting or forest replanting and eco-tourism may be permitted subject to local constraints.	Controlled development Agriculture, plantations may be permitted provided that don't impact the water levels and fire risk in class 2 buffer zone. Mining or housing only permitted if approved by district government and meets certain guidelines
Existing Legal development (approved prior to ESA requirement (2005) Private land	Legal structures (eg houses) in private land to remain. Mining to be phased out (depending on current agreements) Existing agriculture and plantation to be permitted to continue but adopt BMP to manage water tables so as to avoid any drainage of NSPSF/ minimise fire risk and minimise pollution (agrochemicals)	Existing/new mining only permitted to continue if prior study with conditions including Clay bund to isolate from drainage impact on Class 2 buffer.

7.2.6 Cooperative Fire Management Plan

The CFMP can be treated a separate plan and funded and implemented separately but its implementation should be coordinated with the implementation of the Integrated Management Plan for NSPSF 2014-2023. The most important measures proposed in this CFMP to control the occurrence of fires are related to addressing some of the underlying causes of fire by block abandoned logging canals, construct a clay dyke between the ex-mining area and the forest, restricting access to the forest, cooperation with surrounding landholders, formalise a CFMP in each district and integrated enforcement on fire prevention and control in buffer zone adjacent to NSPSF

Forest Fire Management Organisation

Fire control and prevention is essentially an emergency response function. It is essential that the management structure for a forest fire management organisation in NSPSF be as direct and action oriented as possible.

A Fire Operation Leader or Forest Fire Officer from SSFD has a mandate to act in anticipation of fire problems as well as to coordinate all fire control resources at his disposal within his jurisdiction.

The District Forest Officer (DFO) in consultation with the Director and Forest Fire Officer sets fire control priorities in NSPSF and controls the strategic deployment of fire control resources. Regardless of the fire size and complexity, lines of authority remain the same. The organisation must be flexible in order to cope with changing requirements of any forest fire.

Back up Unit

Back up units are additional firefighting crews mobilised from other Forest Districts not affected by fire or State or District level Authorities or Private sectors or NGOs, or Local Community, if the fire situation in NSPSF gets out of control.

Centre of Operation

The base camp is the centre of operation where supervisory, strategical planning, discussion, briefing and other related works to combat forest fire is conducted.

**FOREST FIRE MANAGEMENT ORGANISATION CHART
NORTH SELANGOR PEAT SWAMP FOREST (FOREST RESERVE ONLY)**

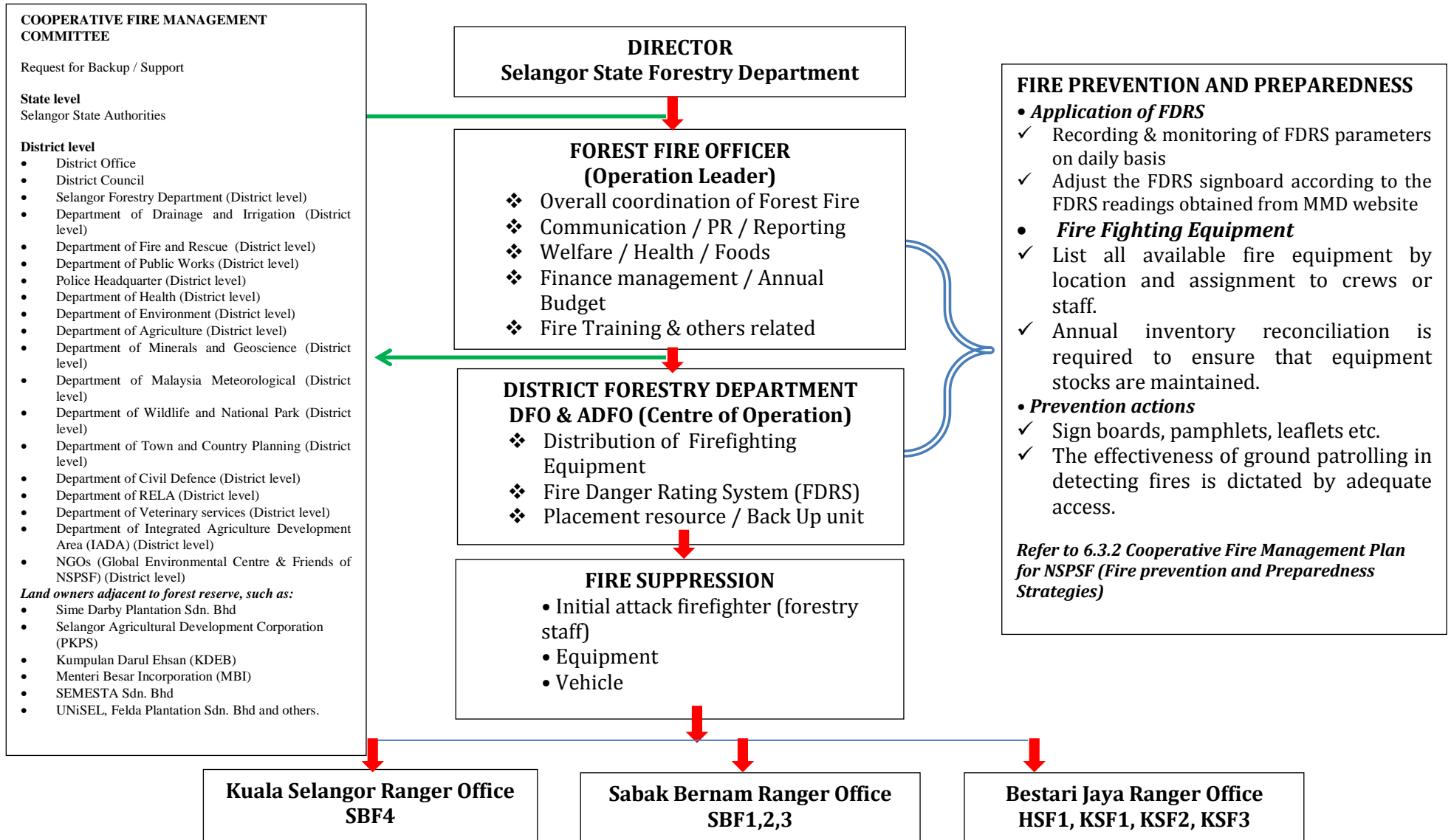


Figure 7-2: Diagram of forest fire management organisation chart for NSPSF

7.2.7 Rehabilitation Plan

Rehabilitation plan should be carried out together with CFMP to achieve maximum result. SSFD should start the rehabilitation work for the degraded area as soon as possible, especially those areas that were severely degraded by drainages and repeated fire. Priority should be given to the rehabilitation zone R1 where most damages had been done. SSFD could collaborate with GEC/FRIM and other institution for the technical input on hydrology restoration and re-vegetation. SSFD could also source funding from private sectors for the rehabilitation plan as this work required huge amount for financial resources.

7.2.8 Carbon Project

Being the largest peat swamp forest complex in Selangor, NSPSF had the potential of getting funding through carbon project. GEC with the technical assistance from Deltares and Winrock, had embarked on a feasibility study on the potential of NSPSF as carbon project. Based on a very preliminary report (Walker et al., 2014,) it was estimated that potential emission of 270,000 tCO_{2e}/year. This would result in potential carbon credits valued at USD814,000/ year, assuming a conservative estimate of USD3/ credit.

However, more work is needed in order to secure a carbon project in the voluntary market. Steps below described the actions that are essential in a carbon project:

a) Securing the legal right for carbon credit

As the rightful owner NSPSF, Selangor State Government or SSFD must demonstrate the commitment to support NSPSF for carbon project. They may assign third party to develop a carbon project, and written agreement shall be establish detailing the willingness.

b) Conduct detailed carbon assessment of the project area

Carbon stock can be determined using remote sensing tools and follow by ground thruthing for verification. For peatlands, besides the aboveground biomass and below ground biomass, peat soil carbon shall also be determined.

c) Estimate claimable carbon credit under voluntary market

Although total carbon stock of the project area will be estimated, only emission reductions under project scenario can be qualified a verified carbon Unit. Therefore, baseline emission and project emission shall be estimated to determine the carbon credit

d) Develop project budget

Project budget is very important as this could be the factor that will determined whether a project is feasible or not. A realistic estimate of budget shall include project activities, human resources required to carry out project, assessment and monitoring.

e) Secure financing

It is essential to secure financing as early as possible as initial stage of a carbon project required huge amount of resources. Public and Private Partnership could be the potential sources.

7.3 Management Planning

7.3.1 Monitoring and Record Keeping

The specific requirements to field monitoring and record keeping of the different forestry operations are presented in Section 7.2. Day-to-day management of field operations is under the responsibility of the Range Offices, and records of monitoring and supervision of field operations are kept there. However, to use this information systematically for the monitoring of the overall status of NSPSF, and for revision and improvement of the present management prescriptions, the information should be compiled at the SSPD Headquarters. It is recommended that Range Offices and District Forest Offices should report all changes in their records to the SSFD Headquarters on a monthly basis.

7.3.2 Annual Operation Plans (AOP)

Annual Operations Plans should be prepared for each of the two Forest Reserves in the NSPSF. The AOP should review the activities and results of last year's activities, and based on this review, a plan of operations to be carried out next year should be prepared. The AOP should cover the following topics:

- Protection measures, including a schedule of activities to be carried out.
- Harvesting Schedule and other matters related to logging.
- Activities in relation to community forestry.
- Activities in relation to recreation, environmental education.
- Conservation measures and monitoring.
- Yield forecast of timber and non-timber forest products, including revenue collection.
- Infrastructure, including schedule for blocking of old logging canals.
- Staff, including training programme.
- Budget.

7.3.3 Annual Report

Based on the information provided in the AOP and the annual review of the AOP, SSFD should prepare an annual report on the NSPSF. The annual report should also report other developments in the State of Selangor of relevance to the management of the NSPSF as well as new legislation and other prescriptions to be followed.

The annual report is a review carried out by SSFD to evaluate the implementation of the AOP. It should review the achievement of stated targets, the progress of activities and operations, the use of inputs, and the delivered outputs in terms of timber harvested, number of visitors, status of indicator species, etc..

Internally, the annual report should be used by SSFD to evaluate the year's result as well as assessing the year's achievements in relation to the objectives and prescriptions provided in the Ten-Year Management Plan.

The report should also be the means to inform external parties about the work of SSFD in connections with the NSPSF. The annual report should be presented to the proposed interagency committee, and copies of the report should be available to other interested parties.

7.3.4 Mid-Term Review of The Ten-Year Management Plan

A mid-term review will be carried out in 2019. The review process provides for the refinement of management prescriptions and zoning scheme in response to new information or changes in government policies, technology and market conditions. However, any refinements or changes to the Plan will be made in a systematic manner to avoid disruption to planning and operations.

The Plan was formulated based on the best available information. In drawing up the Plan, both primary and secondary data will be used.

The mid-term review will consider:

- New information obtained during the period.
- Results obtained from Conservation studies undertaken
- Results of Research and Development and Valuation undertaken in the area.

The plan will undergo revision at the end of the planning period in 2020. A new resource assessment and evaluation of the past management (2014 – 2020) will be undertaken and new plan formulated.

8. References

- Alias, MS. 2013. Remote sensing images for NSPSF 1999 and 2014. UPM.
- Appanah, S., Ismail Harun, Samsudin Musa and Sadali Sabat, 1999. *Flora Survey in North Selangor Peat Swamp Forest*. Project Document Number 17, Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest.
- Appanah, S., Chan, H.T., 8: Khali, A., 1989. Peat Swamp Forests of Peninsular Malaysia. Current Status, Ecology, Management, and *Conservation*. FRI Report No. 51/60. In Appanah *et al*, 1999.
- Buch-Andersen, J & Cold, A., 1999. *A Study on The Ecology of Black-Water Fish in The North Selangor Peat Swamp Forest*. (Preliminary) Project Document Number 23, Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest.
- Chan, H. T., 1989. *A Forestry Action Plan For The North Selangor Peat Swamp Forest*. IPT Asian Wetland Bureau/WWF-Malaysia, Kuala Lumpur. In: Prentice, 1990.
- Chew, M.Y., T.L. Yao, S. Kamarudin & C.L. Lim. *A Brief Flora Survey of North Selangor Peat Swamp Forest*.
- Davies, J., Abdullah, A.R., 1989. *Freshwater Survey of The North Selangor Peat Swamp Forest*. Asian Wetland Bureau Publication Number 46. IPT Asian Wetland Bureau/WWF Malaysia, Kuala Lumpur. In Prentice, 1990.
- FDHQ and DANCED, 1997. *Ecology of Peat Swamp Forests in Peninsular Malaysia*. Project Document Number 1, Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest.
- Forestry Department, Peninsular Malaysia & Forest Maps G. Glesean AB, 1999. Mapping with Aerial Photographs and Satellite Data and The Development of Computerised Planning System for Effective Management of Mangrove and Peat Swamp Forest in The States of Perak and Selangor. Final Report for Swedish International Development Co-operation Agency (SIDA) June 1996 to October 1999
- FRIM. 2014. Draft Document of Selangor Action Plan for Peatlands (SAPP). Asean Peatland Forest Project (APFP) Malaysia Component.
- Global Environment Centre, 2014. *Summary Report of Peat Depth and Clay Depth Assessment at Forest Boundary of Raja Musa Forest Reserve*.
- Global Environment Centre, 2014. *Laporan Latihan Pengurusan Hidrologi Di Hutan Simpan Raja Musa Dan Sungai Karang Pada 2-10 Disember 2013*
- Hahn-Shilling, B., 1994. Struktur, Sukzessionale Entwicklung und Bewirtschaftung selektiv genutzter Moor walder in Malaysia. Gottinger Beitrags zur Lamd- und Forstwirtschaft in den Tropen und Subtropen. Heft 94. In Appanah *et al*, 1999 & Feilberg and Sorensen, 1999b.

Havmoeller, P., Chin, TX., and Razani, U., 1997. Proceedings of Workshop on Sustainable Management of Peat Swamp Forests, Kuala Selangor, September 29-October 1. Project Document Number 4, Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest.

Jabatan Perhutanan Negeri Selangor. 2011. Rancangan Pengurusan Hutan Negeri Selangor 2011 – 2020. Jabatan Perhutanan Negeri Selangor

Lo, Julia, 2013. *Preliminary result on the Floristic composition of North Selangor Peat Swamp Forest and it's correlation to peat depth.*

Kumari, K., 1995. *An Environmental and Economic Assessment of Forest Management Options: A Case Study in Malaysia.* The World Bank: Environment Department Papers No. 026. In: Woon et al, 1999.

Kumari, K. 1996. *An Application of the Incremental Cost Framework to Biodiversity Conservation: A Wetland Case Study in Malaysia.* Centre for Social and Economic Research on the Global Environment Working Paper GEC 96-15

Lim, K.H., Lim, S.S., Parish, F and Suharto, T+R. (Eds) 2012. RSPO Manual On Best Management Practices (BMPs) For Existing Oil Palm Cultivation On Peat. RSPO, Kuala Lumpur.

Lim, Hin Fui, Woon, Weng Chuen, and Mohd., Parid Mamat, 1999. *The Socio-Economic Impacts of North Selangor Peat Swamp Forest Utilisation on Local Communities.* Project Document Number 9. Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest.

Low, K.S. and Balamurugan, 1989. *A Preliminary Hydrological Investigation of the North Selangor Peat Swamp Forest.* WWF Malaysia and IPT Asian Wetland Bureau, Kuala Lumpur. In Prentice, 1990.

Malaysia Meteorology Department, 2013. Daily Rainfall Data for Tennamaram Estate.

Muhammad Aqeel Ashraf, 2011. Analysis of Physio-chemical Parameters and Distribution of Heavy Metals in Soil and Water of Ex-Mining Area of Bestari Jaya, Peninsular Malaysia

Mohd. Zuber Mohd Zain. 1983. A Review of the Status and Approximate Range of Sumatran Rhinoceros Population in Sg. Dusun Game Reserve and Surrounding Area. *Journal of Wildlife and Parks.* Vol. 2.

National Physical Plan 2, 2010. Federal Department of Town and Country Planning. Ministry of Housing and Local Government.

NG, Peter K.L., LB Tay, & Kelvin K.P.Lim, 1994. *Diversity and Conservation of Black Water Fishes in Peninsular Malaysia, Particularly in the North Selangor Peat Swamp Forest.* *Hydrobiologia*, 285: 203-218.1n: Zakaria Ismail, 1999.

Page, S., Rieley, J. O. and Banks, C. 2011. Global And Regional Importance of the Tropical Peatland carbon Pool. *Global Change Biology* 17 798-818. Doi: 10.1111/j.1356-2486.2010.02279.x

Perhilitan. 2009. Laporan Inventori Biodiversiti Rezab Hidupan Liar Sungai Dusun 2008.

- Pons, L.J., Prentice, C., and Aikanathan, S., 1988. *A Preliminary Assessment of Two Peat Swamps in Selangor State, Peninsular Malaysia, in Relation to Their Optimal Use*. Asian Wetland Bureau Publication number 30. IPT Asian Wetland Bureau, Kuala Lumpur.
- Prentice, C., 1990. *Environmental Action Plan for The North Selangor Peat Swamp Forest*. Asian Wetland Bureau Kuala Lumpur and WWP Malaysia.
- Prentice, C. and Aikanathan, S., 1989. *A Preliminary Fauna! Survey of The North Selangor Peat Swamp Forest*. Asian Wetland Bureau Publ. No 30, Kuala Lumpur In: Prentice, C., 1990.
- Prentice, C. and Parish F., 1990. *Integrated Management*. In: Prentice, 1990.
- Ramon, John, 1999a. *Fire Management Plan for the Peat Swamp Forest Estates of North Selangor and Pahang*. Project Document Number 18a, Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest.
- Razani, U., 1997. Status of The Peat Swamp Forest Management in Selangor. In: Havmøeller *et al*, 1997.
- Regional Centre for Forest Management (RCFM) and Ecosystem Management Services (EMS), 2000. *Report on The Management Inventory of the North Selangor Peat Swamp Forest*. Project Document Number 25, Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest.
- Salleh Endot, M.Azman Yahya, Aziz Mamat, Zailan Mohd Nor, Razali Awang Hamat, Zulkifli Rabi & Nur Atiqah Tahir, 2013. Tumbuhan tinggi dan tumbuhan ubatan di hutan paya gambut selangor utara, Selangor Darul Ehsan.
- Selangor State Structure Plan 2020, 2007. Selangor Town and Country Planning. Shah Alam.
- Shamsudin Ibrahim, 1997. *Population Structure of Tree Species in Peat Swamp Forests: Management and Implications*. In: Havmøeller *et al*, 1997.
- Shamsudin Ibrahim & Chong, P.F., 1992. *Floristic Composition of Virgin jungle Reserve at Kuala Langat South Peat Swamp Forest, Selangor, Peninsular Malaysia*. Malayan Nature 46: 85-95. In: In Appanah *et al*, 1999.
- Shamsudin, Ibrahim, Khali Aziz Hamzah, and Mohammad Farid Abd. Rashid, 1997. *A Report on Baseline Information of Peat Swamp Forest in Peninsular Malaysia*. Report submitted to DANCED (Small Grant Facility), Ministry of Environment and Energy. Denmark.
- Universiti Putra Malaysia. 2004. *Sungai Dusun Wildlife Reserve Development and Management Plan*. Department of Wildlife and National Parks Peninsular Malaysia, Malaysia
- Vernimmen, R, Hooijer, A, and Mulyadi D. 2014. *Tentative quickscan assessment of carbon loss from the peat stock for the North Selangor Peat Swamp Forest, Peninsular Malaysia*. Deltares. Report to LEAF

Verwer C. C and van der Meer P. J. 2010. Carbon Pools In Tropical Peat Forests – Towards A Reference Value For Forest Biomass Carbon In Relatively Undisturbed Peat Swamp Forests In Southeast Asia. Wageningen. Alterra Report 2108.

Walker, M. Sarah, Swails, E., Vernimmen, R., Hooijer, A, and Mulyadi D. 2014, Parish, F. *Feasibility Assessment of the Proposed North Selangor Peat Swamp Forest Rewetting Project, Malaysia.*

Woon, W.C., Lim, H.F., and Mohd., PM., 1999. *The Economic Valuation of The Protective and Productive Functions of The North Selangor Peat Swamp Forest.* Project Document Number 13, Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest.

Zakaria Ismail, 1999. *Survey of Fish Diversity in Peat Swamp Forest.* Project Document Number 10, Malaysian-DANCED Project on Sustainable Management of Peat Swamp Forest.

Zulkifi Yusop, Villy Krogh, and Baharuddin Kastan, 1999. *Hydrological Characteristics of the North Selangor Peat Swamp Forest.* Project Document Number 15, Malaysian DANCED Project on Sustainable Management of Peat Swamp Forest.