Malaysia's Submission on Reference Levels for REDD+ Results Based Payments under UNFCCC

Ministry of Natural Resources and Environment, Malaysia

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1.0 Background

Recalling Decision 12/CP.17, where parties are invited to submit information and rationale on the development of their forest reference emission levels and/or forest reference levels, including details of national circumstances and if adjusted include details on how the national circumstances were considered, in accordance with the guidelines contained in the annex to this decision. In addition, a step-wise approach to national forest reference emission level and/or forest reference level (FRL) development, which enables Parties to improve the forest reference emission level and/or forest reference level by incorporating better data, improved methodologies and, where appropriate, additional pools.

Malaysia welcomes the opportunity to submit a forest reference emission level for a technical assessment in the context of results-based payments for *reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries* (REDD+) under the United Nations Framework Convention on Climate Change (UNFCCC).

The submission of FRELs and/or forest reference levels (FRLs) and subsequent Technical Annexes with results are voluntary and exclusively for the purpose of obtaining and receiving payments for REDD+ action.

2.0 National Circumstances considered

2.1 Governance

The land administration structure in Malaysia demarcates the power to manage land to the State Authority as land is a State matter pursuant to the Federal Constitution of Malaysia. Land administration and land law practices are based on the Torrens system introduced by the British. Under the Torrens System, the Register is everything. Hence, the legal entity of a forest is through the State gazette. The National Forestry Act, 1984 (NFA) for Peninsular Malaysia, the Forest Enactment,1968 for Sabah and the Forests Ordinance (Cap.126) for Sarawak allow State Authorities by notification in the *Gazette,* declare any area as permanent reserved forest.

The conservation of forests and their resources is also in tandem with the commitments outlined in the Convention on Biological Diversity, which Malaysia ratified in 1994. Malaysia's forests can be categorised according to the degree of protection and land use classification. Management of forested land falls under three broad categories:

(i) Totally protected areas consisting of Wildlife sanctuaries, National and State Parks;

(ii) Permanent Reserved Forests (PRFs), which are natural forests to be maintained and managed sustainably; and

(iii) Stateland which is forest land reserved for future development purposes.

2.2 Forest Management

The key objective of the forest management in Malaysia has been to ensure the continuity of product flow while conserving complex ecosystems rich and varied in flora and fauna. The annual felling rates (coupe) are monitored as of 1996 through the Seventh Malaysian Development Plan. Logging activities are conducted during the dry season. Malaysia is moving from managing forests for its commodity to managing forest for its natural resource.

Sustainable Forest Management (SFM) is defined as the process of managing forests to achieve one or more clearly specified objectives of management with regard to the production of continuous flow of desired forest products and services, without undue reduction of its inherent values and future productivity and without undue desirable effects on physical and social environment (Anon., 1992). This is in-line with the National Forestry Policy 1978 (Revised 1992) and state forest policies, which emphasize that the Permanent Reserved Forest (PFR) will be managed in accordance to with the principles of Sustainable Forest Management for the maximization of the social, economic and environmental benefits. One of the strategies to achieve SFM is to utilize PRF based on the inherent capability of the forest, its optimal use and on comprehensive forest land use through forest regeneration and rehabilitation.

Malaysia implements selective harvesting system, which is a technique providing openings in forest cover, to ensure the natural regeneration of seedlings. Details of how Malaysia's selective forest management is shown in Annex 1. In addition, a set of principles, criteria and indicators were used as a yardstick to assess sustainable forest management started in 1994 based on the ITTO Criteria and Indicators for Sustainable Forest Management. There are nine principles, 47 criteria and 97 indicators and 307 verifiers under the Malaysian Criteria (MC&I) and indicators for forest management certification.

2.3 Illegal logging and fuelwood gathering

Illegal logging is understood as the harvesting and transporting of timber in violation of the National Forestry Act. Section 15 of the NFA says that no person shall take any forest produce from a permanent forest except under the authority of a licence, minor licence or use

permit; or in accordance with any other written law. Any person who contravenes the above shall be guilty of an offence and shall on conviction be liable to a fine not exceeding RM500,000 and to imprisonment for a term which shall not be less than one year but shall not exceed 20years. Any person convicted of an offence under this section may, in addition to any penalty imposed on the conviction, be ordered to pay, in respect of any forest produce unlawfully taken, to the State Authority:

(i) a sum not exceeding ten times the royalty, premium and cess;
(ii) a sum not exceeding ten times the value of such forest produce; and
(iii) any other charges payable.

These are also consistent with the provision to address illegal logging in the Sabah, Forest Enactment, 1968 and Sarawak, Forests Ordinance (Cap.126).

Illegal logging activity is not common in the PRFs. Between 2006-14, a total of 65 cases of illegal logging were charged in the courts (Table 2). Logging activities can only be carried out after the issuance of permit.

Table 1: Number of illegal logging cases in Malaysia

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
No. cases	11	18	13	8	11	3	1	0	0	12	11	3

3.0 Information on FRL

Malaysia submitted the first FRL for Sustainable Management Forest in 2014. The reference period was from 1992-2005 and 1997-2010 for results period 2006-10 and 2011-15 respectively. As REDD+ is implemented in a step-wise approach, Malaysia is currently submitting an updated FRL.

The updated FRL covers all of managed forest covering an area of over 17.041 million ha in 2000 and 17.347 million ha in 2014 (Table 7). Forest plantations and unmanaged forest are not included in the construction of FRL. The activities covered are deforestation, Sustainable Management Forest and Conservation activities. The reference period was from 2000-14 for results period of 2016-2025.

PRFs are managed under sustainable forest management principles while State land forests are forest area reserved for development purposes and logged selectively. PRF may be degazetted first and then gazetted as TPA or deforested. For deforestation, gross

deforestation data was considered. Totally Protected Areas (TPA) consists of wildlife sanctuaries/reserves, national and state parks, nature reserves and protection forest. No logging activity is undertaken in the TPA.

Forest management activities considered are as follows:

(a) PRF where commercial harvesting is undertaken;
(b) New areas subjected to sustainable forest management through the gazettement as PRF;
(c) Extended harvesting rotation cycle;
(d) Designation of forest for conservation (TPA); and
(e) Enrichment planting as necessary.

3.1 Activity data and Emission factors

3.1.1 Consistency with GHG Inventory

The activity data and methods used for calculating the forest reference level are consistent; with the Malaysia greenhouse gas inventory for LULUCF sector. Same data set and emission factors are used in both the FRL and GHG inventory for LULUCF. Malaysia used 2006 IPCC Guidelines for the Third National Communication and Second Biennial Update Report as well as the current FRL, to be submitted in 2018.

3.1.2 Generation of activity data

The description of activity data is shown in Table 2. The total forest area is obtained from the gazettement notification and geospatial maps. The geospatial maps are used to determine the boundaries of forest areas, followed by ground verification and the issuance of gazettement notification. For the older gazettement, most of the area is mapped onto the geospatial images and verified. Forestry departments monitors and manage the forest reserves while the state land forest is under the purview of State Authorities. For the period, 2000 -2014, SPOT 5 was used with a spatial resolution of 10mx10m. The year 2000 was defined as the reference year for identifying changes and mapping, in the following periods: 2000-2002; 2002-2004; 2004-2006; 2006-2008; 2008-2010; 2010-2012 and 2012-2014.

Table 2: Activity data and emission factor used in the reference level

IPCC Category	REDD+ Activity	Activity	Activity Data	Emission factor
Forest land remaining forest land	Conservation of carbon stocks	Annual increase in carbon stocks due to	Area of PRF , TPA and State Land Forest	Data on annual growth rate obtained from

IPCC Category	REDD+ Activity	Activity	Activity Data	Emission factor
	Sustainable management of forest	biomass growth		National Forest Inventory and recent publications For below ground biomass, root: shoot ratio was applied.
		Annual decrease in carbon stocks due to biomass loss	Total commercial harvest Biomass loss from forest fires Emissions from drainined peatlands	Data on commercial harvest and allometric volume functions for total biomass loss
Forest land converted to settlement and other purposes and other purposes	Deforestation	Annual decrease in carbon stocks due to change in land use	Area of forest converted to settlement and other purposes	Forest loss and carbon stocks from National Forest Inventory

3.1.3 Emission factors

National Forest Inventory (NFI) where ground assessment is conducted every 10 years once in Peninsular Malaysia. NFI provides the information on the state and trends of the forest resources, their goods and services, and other related variables that supports monitoring activities in the PRF. Forest Inventories have been conducted in Peninsular Malaysia since 1972 with a variety of objectives and methods. The Fourth and Fifth NFI inventory design is described as a stratified satellite based on randomly distributed permanent sample units. The NFI has undergone improvement where more forest categories, medicinal plants and biodiversity are included.

The NFI measures ad records the number of trees in accordance to the diameter class, volume, basal area and biomass stocks.

Due to the geographical composition of Malaysia, different inventory efforts have taken place in Peninsular Malaysia and in the states of Sabah and Sarawak. However, methodologies and objectives have often overlapped. In Sabah, the first statewide forest inventory was conducted from 1969-72 and another set of forest inventory of logged over forest was carried out between 1986-87. Sabah Forestry Department is unable to conduct their NFI currently due to budgetary constraints. However, Sabah has conducted a number of studies on the carbon stocks and growth in their forest.

Forest resource inventory was carried out during the period 1969-72 in Sarawak by FAO. Currently, the Forest Department Sarawak is undertaking the forest resource inventory using geospatial technology in The Heart of Borneo (HoB) areas. The project is expected to be complete by December 2018.

The annual growth rate was derived from Fourth (2002) and Fifth National Forest (2012) Inventories, and compared against published literatures. Allometric equation developed from the data of National Forestry Inventories of 1972 and 1982 was used to determine the biomass (tonnes d.m./ha). The carbon fraction used is 0.47. The net annual increment was derived by capturing the net increment over these period and annualised by dividing by 10. Details on carbon increment are available on www.nre.gov.my//redd.

The mortality rate for inland and peat swamp forest is 0.06% to 2.1% and average value of 0.9 -1.1% is applied. The mortality rate considers both the natural and post harvest mortality. For mangrove, the mortality rate is between 1.28 to 10.3% and 8% applied.

Malaysia implemented zero burning policy in 1997 where burning is only allowed in special conditions and a permit must be issued by the Department of Environment. Biomass burning and fuel wood gathering do not occur in our forest. Forest fires occurrence are reported in Table 3.

Table 3: Area affected by fire damage

Year	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Fire damage (ha)	6	297	1350	1320	1301	2231	1325	1350
Year	2008	2009	2010	2011	2012	2013	2014	
Fire damage (ha)	60	1540	2480	10	448	1436	2683	

Peat draining or mining activities as well as fertilizer and tillage are not taken into consideration as these activities do not occur in the forest. Peat draining was common in the 1960-1970s period and emissions from this activity is considered. Emissions from past drained peat swamp forest is estimated. Disturbance like pest and diseases, lightning effect, drought, flooding and windfall are not common.

3.1.4 Consistent data collection on commercial harvest

(a) Monthly reports on the area opened for logging and the total harvest from district levels are provided to State Forestry Departments and Forestry Department Headquarters in Peninsular Malaysia. These reports are checked against the Annual allowable Cut and royalty paid at state level. In addition, third party verification is also undertaken in all certified forest**.** The annual coupe is based on the growing stocks, the net production areas for the period and net volume increment. Pre-felling inventory will determine the total amount of harvest and cannot exceed the 85m^3/ha harvest.

3.2 Pools and gases considered

The IPCC 2006 Guidelines were used to calculate these removal by sinks and emissions. The forest reference level only considered CO_2 emissions. Non-CO_2 emissions are normally associated with the burning of tree residues or with wild fires, or draining of the Peat Swamp Forest. The carbon pools and greenhouse gas sources considered are shown in Tables 4 and 5.

Tier 1 approach was used, the dead wood and litter carbon stocks are in equilibrium so that the change in carbon stock in the DOM pools are assumed to be zero. Likewise, soil carbon stocks do not change with forest management. The IPCC 2006 Software applies a Tier 1 assumption for litter carbon stocks.

Table 4: Changes in carbon pools included in the reference level

Above ground biomass	Below ground biomass	Litter	Deadwood	Soil Organic carbon
√	√	No	No	Drained peatlands

Table 5: Greenhouse gas sources included in the reference level

Fertilization N_2O	Drainage of soils - N_2O	Liming CO_2	Forest fires
Not occurring	√	Not occurring	√

CH_4	N_2O	CO	NO_x
√	√	√	√

Saner et al (2012) reported that the soil organic content was relatively low in both logged and unlogged forest in Sabah. The highest concentration was 22 MgC/ha in the top 30 cm while 17.6 Mg C in the sub soil (30-100cm).

Pinard et al (2000) reported that reduced impact logging disturbed 6% of soil as compared with the using conventional logging of about 17%. Saner et al (2012) also reported that the there were no significant difference in dead standing trees in logged and unlogged primary forest. The same observations were also noted in the permanent plots in Peninsular Malaysia and Sarawak.

Litter production in inland, peat swamp and mangrove forests is between 4.9 – 5.6 tC/ha/yr (Hossain et al, 2008, Saner et al, 2012, Ong (1993); Sasekumar &Loi (1983), Ong et al (2015).

For mangrove, the mean annual increment was reported from 0.58 to 18 t/ha/yr in Malaysia while regional values varied from 6 to 20 t/ha/yr (Ong et al (1995); Putz and Chan (1986); Hossain et al (2008); Hoque et al (2015)). Hence, 11t/ha/yr was applied, because most mangroves are intensively managed.

4.0 Malaysia's Proposed Reference Level

4.1 Scope

The forest reference level presented in this submission took into account the best available information on a number of key factors including:

(a) removals and emissions from activities based on Malaysia's greenhouse gas inventory;

(b) relevant historical data on forests and forest management; and

(c) National legislations and relevant policies.

4.2 Scale

Only managed forests are considered, covering a total area of about 17 million ha of forest (Table 6). The FRL considers all managed forest and national data, which include Peninsular Malaysia, Sabah and Sarawak. Forest plantations are excluded in the construction of FRL. However, for deforestation, all forest areas that are deforested was considered.

4.3 Methodology

Historical emission estimates are developed based on official statistics on the commercial harvest of logs from PRF. Historical period of 2000 - 2014 was used in the construction of the FRL.

The IPCC 2006 Guidelines were applied. Biomass gain-loss method was used to estimate the removals from conservation and sustainable management of forest activities, while stock change approach is used for deforestation. Subtracting the biomass carbon loss from the biomass carbon increment for the reporting year makes the calculation. The calculation are as follows:

$$\Delta C_{FFLB} = \Delta C_{FFG} + \Delta C_{FFL}$$ (2006 IPCC Guidelines)

Where:

ΔC_{FFLB} = annual change in carbon stocks in living biomass (includes above- and belowground biomass) in forest land remaining forest land, tonnes C yr^{-1}

ΔC_{FFG} = annual increase in carbon stocks due to biomass growth, tonnes C yr-1

ΔC_{FFL} = annual decrease in carbon stocks due to biomass loss, tonnes C yr^{-1}

Gain loss method was used to estimate the emissions and removals.

Gains include total (above-ground and below-ground) biomass growth, while emissions from harvest, mortality and forest fire considered. Emissions from peat draining has also been included.

Annual Change in Carbon Stocks in Biomass in Land Remaining in a Particular Land-Use Category (Gain-Loss Method)

$\Delta CB = \Delta CG - \Delta CL$

Where:

ΔCB = annual change in carbon stocks in biomass for each land sub-category, considering the total area, tonnes C yr^{-1}

ΔCG = annual increase in carbon stocks due to biomass growth for each land sub-category, considering the total area, tonnes C yr^{-1}

ΔCL = annual decrease in carbon stocks due to biomass loss for each land sub-category, considering the total area, tonnes C yr^{-1}

The annual change in carbon stocks in biomass is estimated using the gain-loss method, where the annual increase in carbon stocks due to biomass growth and annual decrease in carbon stocks due to biomass losses are estimated:

$\Delta CG = \Sigma (Ai\,j \bullet GTOTAL \bullet CFi\,j)$

ΔCG = annual increase in biomass carbon stocks due to biomass growth in land remaining in the same land-use category by vegetation type and climatic zone, tonnes C yr-1

A = area of land remaining in the same land-use category, ha

GTOTAL= mean annual biomass growth, tonnes d. m. ha-1 yr-1

CF = carbon fraction of dry matter, tonne C (tonne d.m.)-1

Average Annual Increment in Biomass

The below- ground biomass is estimated with a below-ground biomass to above-ground biomass ratio.

GTOTAL = Σ {*GW* • (1+ *R*)} Biomass increment data (dry matter) are used directly.

Where:

GTOTAL = average annual biomass growth above and below-ground, tonnes d. m. ha-1 yr^{-1}

GW = average annual above-ground biomass growth for a specific woody vegetation type, tonnes d. m.ha-1 yr^{-1}

R = ratio of below-ground biomass to above-ground biomass for a specific vegetation type, (in tonned.m. below-ground biomass tonne d.m: above-ground biomass).

The annual increase in biomass carbon stock is estimated, where area under each forest sub-category is multiplied by mean annual increment in tonnes of dry matter per hectare per year.

Estimating annual decrease in biomass carbon stocks due to losses (Gain-Loss Method), ΔCL

Loss estimates are needed for calculating biomass carbon stock change using the *Gain-Loss Method*. Annual biomass loss is the sum of losses from wood removal (harvest), fuelwood removal (not counting fuelwood gathered from woody debris), and other losses resulting from disturbances, such as fire, storms, and insect and diseases

Annual Decrease in Carbon Stocks Due To Biomass Losses in Land Remaining in The Same Land-Use Category

$\Delta CL = Lwood - removals + Lfuelwood + Ldisturbance$

Where:

ΔCL **=** annual decrease in carbon stocks due to biomass loss in land remaining in the same land-use category, tonnes C yr-1

Lwood-removals = annual carbon loss due to wood removals, tonnes C yr-1

Lfuelwood = annual biomass carbon loss due to fuelwood removals, tonnes C yr-1 *not counted

Ldisturbance = annual biomass carbon losses due to disturbances, tonnes C yr-1 *not counted

Annual Carbon Loss in Biomass of Wood Removals

$L_{wood-removals} = \{H \bullet BCEF \bullet (1+R) \bullet CF\}$

Where:

Lwood-removals = annual carbon loss due to biomass removals, tonnes C yr^{-1}
H = annual wood removals, roundwood, m^3 yr^{-1}

R = ratio of below-ground biomass to above-ground biomass, in tonne d.m. below-ground biomass (tonne d.m. above-ground biomass)$^{-1}$.

CF = carbon fraction of dry matter, tonne C (tonne d.m.)-1

BCEF = biomass conversion and expansion factor for conversion of removals in merchantable volume total biomass removals (including bark), tonnes biomass removal (m^3 of removals)$^{-1}$.

Stock change

$\Delta C = \{(B_i - B_i) \bullet \Delta A_i\} \bullet CF$

$\Delta C_{CONVERSION}$ = initial change in biomass carbon stocks on land converted to another land category, tonnes C yr^{-1}

B_{AFTER_i} = biomass stocks on land type *i* immediately after the conversion, tonnes d.m. ha^{-1} B_{BEFORE_i} = biomass stocks on land type *i* before the conversion, tonnes d.m. ha^{-1} $\Delta A_{TO\_OTHERS_i}$ = area of land use *i* converted to another land- use category in a certain year, ha yr^{-1}

CF =carbon fractiono drymatter,tonne C(tonnesd.m.)$^{-1}$

i = type of land use converted to another land-use category

4.4 Assumptions

(a) The construction of the forest reference level assumes existing domestic policies are maintained;

(b) The harvesting continues to be subjected to a regulatory framework designed to maintain environmental values and the productive capacity of forests;

(c) The effects of extreme weather patterns will not affect the Production forest – floods will not affect the seedling regeneration nor forest fires; and

(d) No projection is made for the future and therefore future policy is not considered.

4.5 Proposed Reference Level

The proposed reference level for result based payments is: the average net removals from 2000-2014 will be used for FRL period 2016-2024 is shown in Table 6.

Table 6: Malaysia's Proposed Forest Reference Level

	Million tonnes CO_{2eq}/yr
Deforestation	12.923
SMF + Conservation	-225.976
Net	-213.053

5.0 Transparent, complete, consistent and accurate, information including methodological information, description of data sets, approaches, methods in FRL construction

Transparent:

Allometic equations by Brown (1997) was used to estimate the aboveground biomass. Brown et al (1989) first developed allometric equations for estimating total above-ground biomass following the National Forest Inventory 1972 and 1982 and further improved the equation. This allometric equation has been used to determine the annual growth rate in the forest is as follows:

$$Y = 42.69 - 12.8 \times (D) + 1.242(D^2) \text{ – Brown 1997}$$

Y = biomass tonnes/ha

D = diameter

Data from the 4th and 5th National Forest Inventory and other published data have been used. (Table 13). 10cm dbh and above was considered to reduce the error. Detailed information on the calculations is available at http://www.nre.gov.my/sites/climatechange/Initiatives-and-Programmes/redd/Pages/default.aspx

Complete

Data used to construct the FRL is shown in Table 7, 8 and 9, while the emission factors are shown in table 10.

Table 7: Total forest covered under the FRL construction

Year	TPA (ha)		PRF (ha)					State Land Forest (ha)				Excluded from FRL(ha)
	PA	Protection Forest	Inland Forest	PSF	Mangrove	Fallow	Unmanaged	Natural Forest	Drained PSF	Fallow	Unmanaged	Plantation Forest
2000	1,206,855	586,000	9,504,274	780,000	440,000	450,639	605,391	2,816,756	200,000	1,056,030	394,609	155,000
2001	1,206,855	586,000	9,504,667	690,000	440,000	449,802	606,272	2,808,220	200,000	1,056,074	393,728	154,000
2002	1,213,465	588,000	10,290,607	700,000	440,000	354,236	789,165	1,943,125	200,000	1,143,401	210,835	163,000
2003	1,213,465	588,000	10,270,820	700,000	430,000	355,366	785,837	1,951,290	200,000	1,141,202	214,163	169,000
2004	1,273,282	588,000	10,258,124	670,000	420,000	348,704	791,087	1,884,338	200,000	1,139,792	208,913	183,500
2005	1,348,880	588,000	10,243,886	660,000	440,000	325,974	812,236	1,669,762	200,000	1,138,210	187,764	200,000
2006	1,348,880	589,000	10,243,680	660,000	440,000	321,594	816,593	1,621,347	200,000	1,138,187	183,407	232,000
2007	1,350,290	594,000	10,096,169	670,000	440,000	325,171	796,626	1,613,557	200,000	1,121,797	203,374	301,910
2008	1,350,290	611,000	10,064,485	660,000	440,000	323,627	794,649	1,594,168	200,000	1,118,276	205,351	318,662
2009	1,363,281	611,000	9,951,418	480,000	430,000	353,901	751,812	1,863,109	200,000	1,105,713	248,188	348,399
2010	1,387,879	723,000	9,812,456	490,000	430,000	374,553	715,720	2,050,588	200,000	1,090,273	284,280	368,215
2011	1,427,217	723,000	9,814,366	500,000	430,000	360,953	729,533	1,922,721	200,000	1,090,485	270,468	462,682
2012	1,429,954	1,029,000	10,198,850	510,000	440,000	194,327	105,458	2,035,621	200,000	1,000,000	374,327	495,714
2013	1,461,378	1,092,000	10,066,078	500,000	450,000	197,569	105,872	1,986,519	200,000	1,000,000	367,569	629,170
2014	1,461,362	1,296,000	9,975,221	510,000	460,000	84,839	59,785	2,702,786	200,000	600,000	374,327	495,714

Source: http://www.nre.gov.my/sites/climatechange/Initiatives-and-Programmes/redd/Pages/default.aspx

Table 8: Total Commercial Harvest for Malaysia

Malaysia	
Year	**Commercial harvest (million m^3)**
2000	22.473
2001	18,.22
2002	20.049
2003	20.931
2004	21.639
2005	21.799
2006	21.108
2007	21.333
2008	19.380
2009	17.636
2010	17.083
2011	15.171
2012	14.645
2013	12.920
2014	13.163

Table 9: Deforestation

Year	Stateland (ha)	Peat Swamp Forest (ha)	PRF (ha)	Total (ha)
2000	220000	20,000	0	240,000
2001	80000	20000	0	100,000
2002	60000	0	0	60,000
2003	16000	0	0	16,000
2004	54,000	0	0	54,000
2005	140000	0	0	140,000
2006	0	0	20000	20,000
2007	80000	0	0	80,000
2008	15,000	10000	7000	32,000
2009	0	0	0	0
2010	0	0	10000	10,000
2011	7000	0	0	7,000
2012	0	0	3128	3,128
2013	0	0	5521	5521
2014	0	0	2827	2827

Table 10: Growth rates for forest types

Forest type	Growth rate	Reference
Inland	9.3 tdm/ha/yr	NFI
Peat swamp	9.2 tdm/ha/yr	NFI5 and National Reports
Mangrove	11 tdm/ha/yr	Ong (1993)
Protection Forest	9.3 tdm/ha/yr	NFI
Totally Protected Area	4.3 3 tdm/ha/yr	NFI
State Land Forest	4.3 3 tdm/ha/yr	NFI
Fallow Forest	3.43 tdm/ha/yr	Kenzo et al (2010)
Root: shoot ratio Mangrove	0.18 0.49	Niiyama et al (2010), IPCC, Wetlands Supplementary
Biomass conversion expansion factor (commercial harvest)	1.05 t biomass of volume/ (m^3)	IPCC, 2006 GL
Drained peat swamp forest Emissions from drained peat swamp forest (CO_2) Direct N_2O emissions from managed organic soils	3.4 tdm/ha/yr 1.36 tC/ha/yr 8 kg N_2O-N/ha)	National Report IPCC, 2006 GL IPCC, 2006 GL
Carbon stocks		
Inland forest	194 tdm/ha	NFI
Peat swamp forest	180 tdm/ha	NFI
State Land Forest	140 tdm/ha	NFI
Forest fire	140tdm/ha	20% of biomass burnt

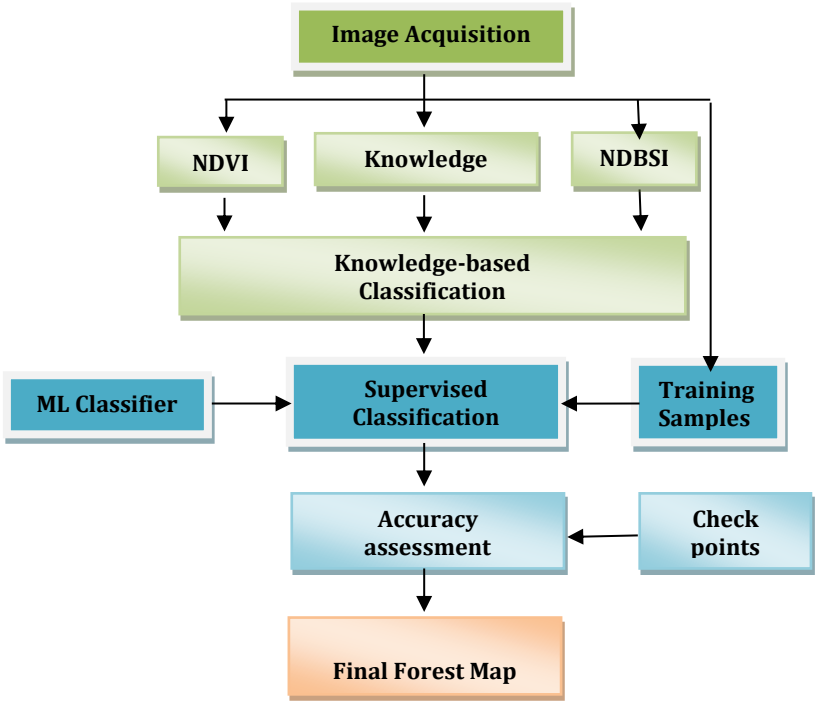
Table 11: Global warming potential used

Gas	Chemical formula	GWP
Methane	CH_4	23
Nitrous oxide	N_2O	298

Accurate

The activity data was generated based on the gazettes and geospatial images. Before the final maps can be produced, there are several steps involved in data analysis such as image pre-processing, image enhancement and image classification. Workflow and analysis was shown in **Figure 1.**

Figure 1: Generalised work flow of the analysis



When the image has been classified, checking on some test areas is imperative to ensure that the classes mapped do effectively correspond to the thematic classes they are supposed to belong to. Estimate of this mapping accuracy will be made through a confusion matrix, which will show for each class the respective proportion of omitted, committed, and well-classified pixels. These results can be used to create great base map, which provides an approach that is proportionate to the forest types involved. One of the major advantages of these efforts, was to deliver an up-to-date forest base map and keep the results looking subdued and uniform. The base map also can be regularly updated.

The emission factors used were derived from the National Forest Inventory for the period 2002 and 2012. The values were also compared against the values obtained from published figures and other reports (Table 12).

Banin et al (2014) had argued that trees belonging to the dominant South East Asian family, Dipterocarpaceae, gained woody biomass faster than non-dipterocarps, thus implying that the exceptional production of Bornean forests may be driven by floristic elements. On the other hand, Chave et al (2008) and Morley and Flenley (1987) had argued that the tropical forest in the region is recovering from past disturbance, resulting in significant increase in above ground biomass. Janzen (1970) proposed the density –dependent regulation in the tropical forest. Measurements from long- term ecological plots showed that biomass reduced after the *El Nino* in 1997-98 (Table 13) and the NFI5 captures the recovery from the 1997-1998 episode. 2014-15 was also another strong year *El Nino* episode and the effects will be quantified in the 6th NFI.

Table 12: Comparison of growth rates from other sites.

Site	**Growth rate (t/ha/yr)**	**Reference**
Amazonia	11.0 t/ha/yr	Malhi et al 2004
Bornoe (Sabah, Sarawak and Brunei)	9.73 t/ha/yr	Banin et al (2014)
Gunung Palung (Kalimantan, Indonesia)	5.8-23.6 (mean 12.0)	Paoli & Curran (2007)
Central Kalimantan (P4) (Kalimantan, Indonesia)	7.95	Miyamoto et al (2007)
Mount Kinabalu (Sabah, Malaysia)	8.03	Kitayama & Aiba (2002)

Table 13: Changes in Biomass in two long term ecological plots in Malaysia.

	Total biomass (Mg/ha)			
Year	**1986**	**1990-91**	**1995-97**	**2001-02**
Pasoh	326.36	337.54	346.26	339.50
Lambir		490.05	501.01	496.89

Source: Chave et al 2008 and Feeley et al 2007

Uncertanty assessment

The uncertainties associated with geospatial images would include:

(i) Image quality**:** the presence of noise may increase the error in classification especially in areas with limited accessibility;

(ii) Missing date**:** Cloud cover could affect the time series compilation of some images;

(iii) Ground conditions**:** in rocky terrain conditions, shadows may cover greater areas, thus causing equal features to display different behaviors or different features to display similar behaviors; and

(iv) Visual sharpness of the interpreter**:** thematic mapping involves the analysis of a number of elements such as the color, hue, shape, size, pattern, texture and location (association) of a target. To reduce error, two same interpreters assigned for each region. The analysis is more or less accurate according to the interpreter's experience, but also depends on his visual abilities.

The uncertainty associated with emission factors would include:

(i) Accuracy of measurement of tree diameter; and
(ii) Computation error during analysis at sub national and national level.

Uncertainty was calculated using the error propagation method. The uncertainty of activity data is 15% for forest land remaining forest land and 20% for deforestation. The uncertainty of emission level is 10% and 20% fore forest land remaining forest land and deforestation respectively. The average total uncertainty of the estimate is 20.72% and trend is 31.67% .

5.1 Forest definition

The forest definition used in the development of the reference level is based on the national legislation and circumstances are consistent with the national greenhouse gas inventory. However, the definition used by the FAO is not used as some agricultural land, rubber plantations would be considered as forest but these areas are not managed in a sustainable manner neither subjected by the National Forestry Act. The smallholders following the rubber management manage rubber plantations, while the state land forest is a land bank for future development. However, these areas maintain the forest threshold values Malaysia submitted under the Kyoto Protocol, a minimum area of 0.5 ha. 30% canopy cover and 5m height at maturity.

The National Forest Act prescribes that only the land under this Act will remain as forest reserves and management in a sustainable manner

6.0 Policy and Plan Considered

The following policies were considered in the construction of the FRL:

(a) National Policy on Climate Change

The main objectives of the National Policy on Climate Change include mainstreaming climate change through the wise management of resources and enhanced environmental conservation. The policy also aims to strengthen institutional and implementation capacity to better harmonise opportunities to reduce negative impacts of climate change.

(b) National Biological Diversity Policy

The National Biodiversity Policy aims to conserve Malaysia's national biological diversity and to ensure that its components are used in a sustainable manner for the continued progress and socio-economic development of the nation. The policy is currently undergoing a review process.

(c) Directives from the National Land Council

The maximum cutting limits and annual allowable cut are set by the Council and are reviewed periodically.

(d) Forest Policies

Revised National Forest Policy (1992) aims to achieve a more comprehensive approach that addresses in greater depth the requirements for sustainable

management, development, conservation and control of the resource to fulfill the needs of the people, industry and the protection of the environment.

It has been adopted by all the States in Peninsular and is consistent with by Sabah's State Forest Policy, 1954 and Sarawak's Statement of Forest Policy, 1954.

(e) 10th Malaysia Plan (2011-2015)

Specific strategies to ensure that sustainable utilisation of natural resources in all development efforts as follows:

- Introduce appropriate indicators to ensure sustainability of natural resources;
- Mainstreaming natural resource management towards achieving sustainable development;
- Strengthening financial mechanism in management of natural resources;
- Minimise impact of urbanisation on biodiversity and natural resources;
- Safeguarding natural resources; and
- Improving socio-economic benefits and alternative livelihood of indigenous and local communities.

7.0 Improvement plan and capacity needs

7.1 Malaysia has collected data on leaf litter but did not include in the FRL construction because the IPCC software is applicable to Tier 1 approach only. Malaysia's GHG Inventory used the IPCC 2006 software for their estimates and reporting.

7.2 Malaysia has started work on exploring soil modelling and it is anticipated to be reported in the next BUR.

7.3 Full assessment of forest data in some region has yet to be fully completed due to the accessibility.

7.4 Capacity building to conduct uncertainty assessment is required. The current guidelines.

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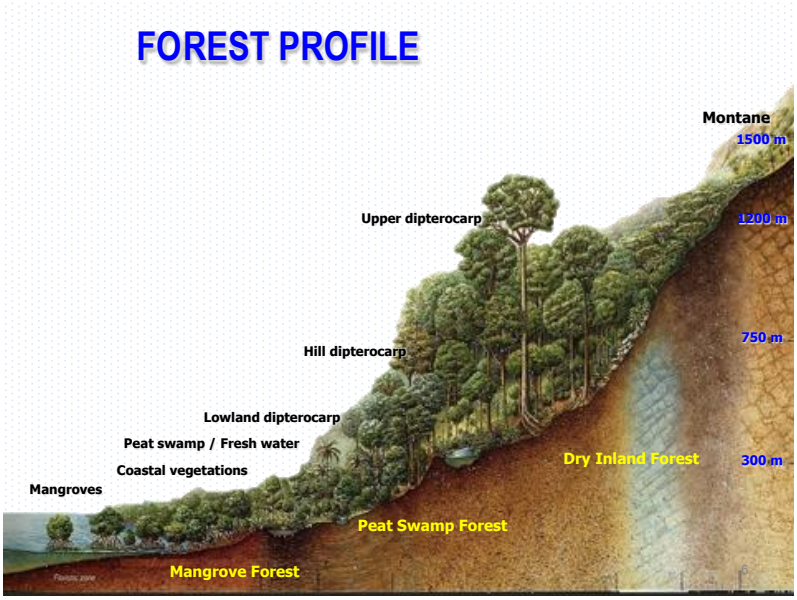
CLASSIFICATION OF PRFs INTO FUNCTIONAL CLASSES

Section 10, NFA 1984, allows PRFs to be classified into any of the following twelve (12) functional classes to promote sustainable forest management taking into account the multiple roles/uses of forest:

1. Timber Production Forest under sustained yield
2. Soil Protection Forest
3. Soil Reclamation Forest
4. Flood Control Forest
5. Water Catchment Forest
6. Forest Sanctuary for Wildlife
7. Virgin Jungle Reserves
8. Amenity Forest
9. Education Forest
10. Research Forest
11. Forest for Federal purposes
12. Forest State Parks

11

Forest profile in Malaysia



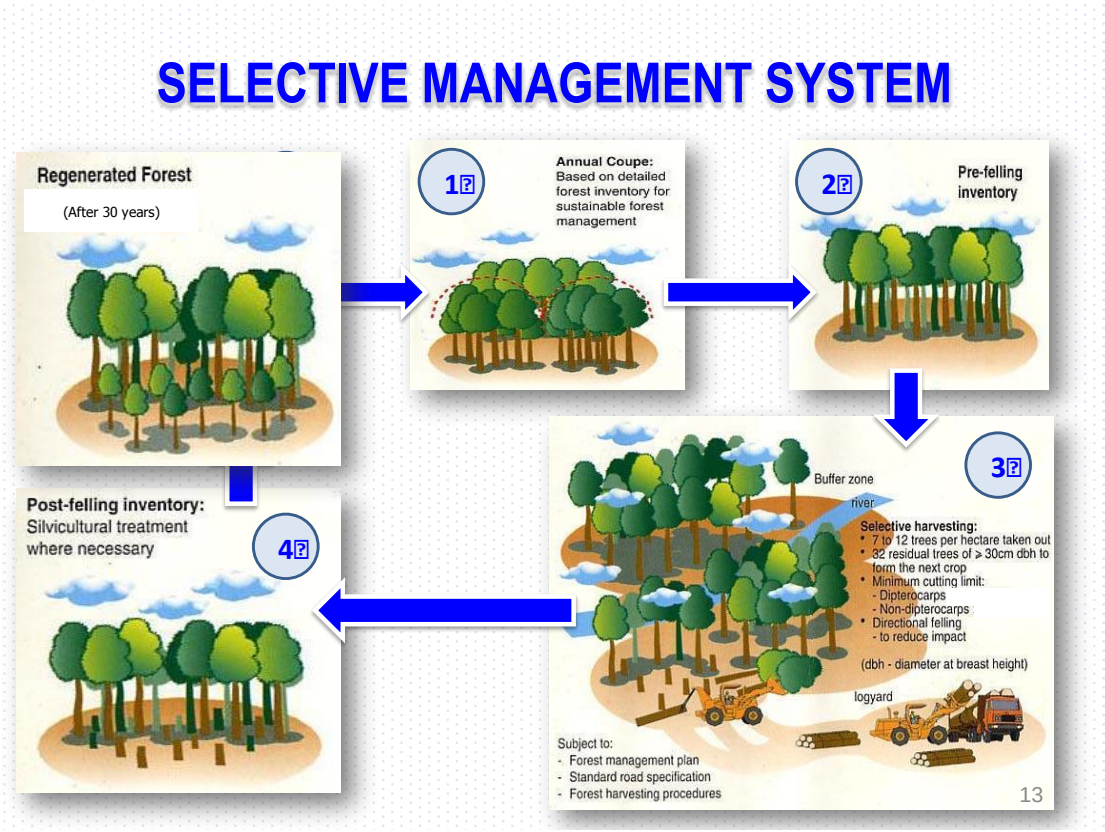

SELECTIVE MANAGEMENT SYSTEM
Regenerated Forest
(After 30 years)
1
Annual Coupe:
Based on detailed forest inventory for sustainable forest management
2
Pre-felling inventory
3
Buffer zone
river
Selective harvesting:
• 7 to 12 trees per hectare taken out
• 32 residual trees of ≥ 30cm dbh to form the next crop
• Minimum cutting limit:
- Dipterocarps
- Non-dipterocarps
• Directional felling
- to reduce impact
(dbh - diameter at breast height)
logyard
Subject to:
- Forest management plan
- Standard road specification
- Forest harvesting procedures
4
Post-felling inventory:
Silvicultural treatment where necessary
13

Table 14: Total removal by sinks and emissions from forest (million tonnes CO_2 eq)

Year	Forest land Remaining Forest land	Forest Land converted to Settlements	Net
2000	-215.098	59.283	-155.815
2001	-222.188	25.505	-196.683
2002	-225.966	14.476	-211.490
2003	-223.491	3.860	-219.631
2004	-220.779	13.028	-207.750
2005	-219.109	33.777	-185.332
2006	-220.198	6.687	-213.512
2007	-217.063	19.301	-197.762
2008	-220.638	9.061	-211.577
2009	-221.076	0.000	-221.076
2010	-223.772	3.343	-220.429
2011	-227.351	1.689	-225.662
2012	-241.211	1.046	-240.165
2013	-243.481	1.846	-241.636
2014	-248.219	0.945	-247.274

Table 15: Non CO2 gases

Year	Gg			
	CH_4	CO	N_2O	NO_x
2000	0.001	0.017	2.514	0.000
2001	0.057	0.865	2.516	0.013
2002	0.257	3.931	2.522	0.060
2003	0.251	3.844	2.521	0.059
2004	0.248	3.789	2.521	0.058
2005	0.467	7.146	2.528	0.110
2006	0.252	3.858	2.521	0.059
2007	0.257	3.931	2.522	0.060
2008	0.011	0.175	2.514	0.003
2009	0.293	4.484	2.523	0.069
2010	0.472	7.222	2.528	0.111
2011	0.002	0.029	2.514	0.000
2012	0.085	1.305	2.517	0.020
2013	0.273	4.181	2.522	0.064
2014	0.511	7.812	2.514	0.120