

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 (NFA) allows State Authority may, by notification in the *Gazette*, declare any area as permanent reserved forest. Although land administration is at the state level, Article 76 Clauses (4) (Malaysia Federal Constitution, 2008) mentions that the federal government has the power to ensure uniformity of law and policy such as to make laws with respect to land tenure; registration of titles and deeds relating to land; transfer of land; mortgages; leases and charges in respect of land; and local government. The National Land Code, 1965 performs this role.

The NFA, defines the Permanent Reserved Forest (PRF) as any land constituted or deemed to have been constituted a permanent reserved forest under this Act. It also allows PRFs to be classified into any of the twelve (12) functional classes identified in the NFA to promote sustainable forest management taking into account the multiple roles/uses of forest (Annex 1). Out of the 12 functional classes, only the production forest will be subjected to harvest.

De-gazetted of PRF is also allowed under the NFA, for the following purposes:

- a) if it is no longer required for the purpose for which it was classified;
- b) if it is required for economic use higher than that for which it is being utilized.

Although currently most activities provide greater economic returns than the forestry sector but the government is committed to maintaining the PRF. The gazettement and de-gazettement of PRF is monitored at the National Land Council.

De-gazettement of PRFs is primarily for development purposes. The National Forestry Act also requires that de-gazetted PRF must be replaced with an approximately equal area of land as permanent reserved forest. The replaced PRF will only be considered once the gazettement is done. Land here would refer to forest land.

Once a PRF is de-gazetted, it is no longer considered a PRF. De-gazettement of PRF is deforestation. Hence de-gazetted PRFs are not considered in the construction of FRL. Emissions from deforestation are accounted and monitored through the greenhouse gas inventory for LULUCF/AFOLU. In addition, the National Forest Monitoring System was recently upgraded with a better server software and additional important layers inserted such as the forest harvesting licenses, forest use permit, the forest functional classes besides the PRFs and its compartments as well as the use of latest satellite imageries to provide more comprehensive information for illegal harvesting and encroachment detection in PRF.

Risk of displacement of emissions is monitored through the Malaysian Criteria and Indicators (MC&I) for Sustainable Forest Management (Natural Forest) for Forest Certification and is reported through the National greenhouse gas inventory for LULUCF under the Greenhouse gas inventory chapter of the Biennial Update Report and National Communication to UNFCCC. The following Principles under the MC&I will ensure the risk of displacement of emissions are reduced:

Principle 5: Benefits from the forest

Forest management operations shall encourage the efficient use of the forest's multiple products and services to ensure economic viability and a wide range of environmental and social benefits.

Principle 6: Environmental Impact

Forest management shall conserve biological diversity and its associated values, water resources, soils and unique and fragile ecosystems and landscapes, and, by so doing, maintain the ecological functions and the integrity of the forest.

Principle 8: Monitoring and Assessment

Monitoring shall be conducted – appropriate to the scale and intensity of forest management – to assess the condition of the forest, yields of forest products, chain of custody, management activities and their social and environmental impacts.

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 consists of Wildlife sanctuaries, National and State Parks,
- ii. Permanent Reserved Forests (PRFs), are natural forests to be maintained and managed sustainably, and
- iii. Stateland is forest land reserved for future development purposes

2.2 Forest Management

The management of all types of forests is enshrined in the National Forestry Policy 1978 (revised 1992) (NFP). This policy provided for greater uniformity in the implementation of strategies for the achievement of forest conservation, management as well as social and educational needs. It represents an important legislation, which is unequivocal in maintaining that forest management must fulfil environmental, social and conservation needs besides meeting rational economic production goals. It provides guidelines and a strong emphasis on the necessity for sound management, conservation, utilization, development and protection of the forests. This commitment is duly recognized and given specific attention by the National Forestry Act in its 1993 revision.

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.

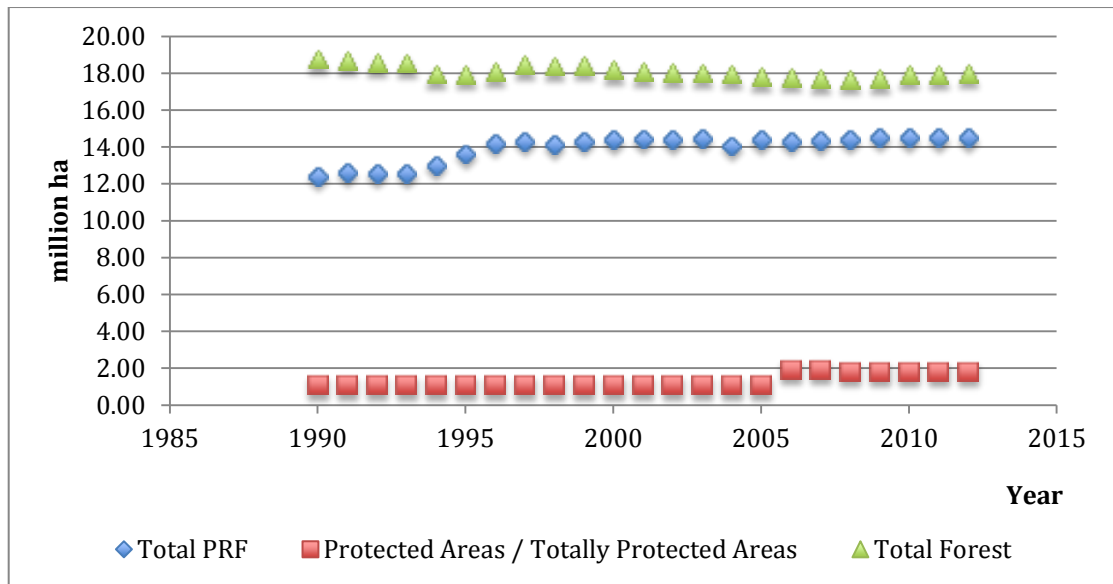
Malaysia has implemented selective harvesting system, which is a technique providing openings in forest cover, to ensure the natural regeneration of seedlings. Details of how Malaysia's selective forest management is shown in Annex 1. In addition, a set of principles, criteria and indicators as a yardstick 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.

Malaysia started project based forest certification in 1997. The Malaysian Timber Certification Council was established in October 1998 as an independent organisation to develop and operate the Malaysian Timber Certification Scheme (MTCS) (Annex2). The MTCS provides for independent assessment of forest management practices, to ensure the sustainable management of Malaysia's natural forest as well as to meet the demand for certified timber products. In addition, a peer reviewer is responsible to provide a second independent expert opinion on the level of compliance of the forest management unit by assessing the reports prepared by a certification body against the requirements of the standard.

The MC&I for forest management certification was implemented in 2005. As of August 2014, about 5 million ha of natural forest has been certified. There is a plan to certify another 2.2 million ha in the next 2 years.

The changes in forested area in Malaysia between 1990 to 2012 has under 1%. (Figure 1). Some of the forest reserves were gazetted as early as 1903 and therefore, the units in these gazettes were not in metric. In order to harmonise the units in the gazettes to current units in the newer gazettes, geospatial images were used. Between 2010 to 2014, Malaysia moved towards harmonising the geospatial and statistical forest figures to ensure the total forest areas and recalibration was completed in 2014. Through the recalibration, some regions gained forested area while others lost. States with oldest gazette had the most challenge in harmonising their figures. This was also one of the gaps identified in the Second National Communication when the uncertainty of the activity data was high, 85%.

Figure 1 : Changes in forest cover in Malaysia from 1990 to 2012



The deforestation rates in Malaysia between 1990 -2010 is shown in Table 1. The deforestation rate dropped from 0.31% to 0.25% for the period 1990-2000 and 2000-2010 respectively. The reason for the drop in the deforestation rates is primarily due to improved forest management and the enhancement of agricultural crop production in 3rd National Agriculture Policy (NAP3). NAP3 (1998-2010) focused on new approaches to increase productivity and competitiveness, deepen linkages with other sectors, venture into new frontier areas as well as conserve and utilise natural resources on a sustainable basis. Miyamoto et al (2014) also reported that based on Regression models analysis, poverty rate affected forest area between 1970- 1984 in Malaysia. Poverty rate of 20% and below did not affect the forest area, while oil palm had a significant negative relationship with forest change.

Malaysia’s growth is outlined in the New Economic Model (NEM) and the 10th Malaysian Plan (2011-15). It is envisioned that the environmental assets and ecological resources are managed sustainably, so that present developmental needs are met without compromising the future. In this endeavor, proper valuation_of our environmental resources will be enabled, through assessing the opportunity cost and environmental impact of public or private investments, including carbon.

Addressing climate change issues, the Government focused on adaptation strategies to ensure sustainable growth and mitigation strategies to reduce the emission of greenhouse gases. The National Climate Change Policy and the National Green Technology Policy adopted in 2009 to address the pressing issue of climate change. Through these policies, Malaysia aims to implement strategies to move towards a low-carbon economy and achieve sustainable development. In addition, a Green Technology Financing Scheme amounting to RM1.5 billion was established to promote green technology. The Government has embarked on several programmes aimed at reducing emissions of GHGs. During the Plan period, these efforts will continue to focus on five areas:

- Creating stronger incentives for investments in renewable energy (RE);
- Promoting energy efficiency to encourage productive use of energy;
- Improving solid waste management;
- Conserving forests; and
- Reducing emissions to improve air quality

In the 10th Malaysian Plan, the Government of Malaysia, *Valuing Our Environmental Endowments*, enhancing forest management was one the priorities. The Natural

Resources Conservation Trust Fund was established in 2013 to further enhance sustainable forest management and conservation of biodiversity. The Central Forest Spine (CFS) in Peninsular Malaysia and the Heart of Borneo (HoB) in Sabah and Sarawak are enablers to increase connectivity between forest and reduce fragmentation while improving natural resource management. The government has allocated about US\$30 million for these projects between 2010-15. Thus far, about 100,000 ha of State land and other alienated forest lands have been gazetted into Permanent Reserved Forest and Totally Protected Areas.

Additionally, the Economic Transformation Programme (ETP) was formulated as part of Malaysia's National Transformation Programme and launched in 2010. The ETP's targets for 2020 will be achieved through the implementation of 12 National Key Economic Areas (NKEAs), representing economic sectors, which account for significant contributions to GNI. The programme is also centred on raising Malaysia's competitiveness through the implementation of six Strategic Reform Initiatives (SRIs). The SRIs comprise policies, which strengthen the country's commercial environment to ensure that Malaysian companies are globally competitive.

At least two of the 12 NKEAs are significant to the REDD+ action. The 9th Chapter addressed the need for expansion of both upstream and downstream activities of the palm oil sector. As of 2011, about 5 million ha is planted with oil palm in Malaysia and the report suggested that the potential arable land for oil palm cultivation is limited and the maximum expansion potential is estimated at 1.0 million ha, thus capping the cultivated area of oil palm in Malaysia to 6 million ha. Environmental performance regulations and sustainability criteria are complied with through the Roundtable on Sustainable Palm Oil (RSPO) and other sustainability certification schemes. Currently, most oil palm plantations are RSPO certified. Under the NKEA, the average oil yield is targeted at 6t/ha/yr and Fresh Fruit Bunch (FFB) yields to increase from the current 21 t/ha in 2009 to 26 t/ha by 2020. The increased oil yield will thus meet the global demand.

The 10th Chapter on tourism, focussed on the promotion of ecotourism. The Malaysia Mega-biodiversity Hub (MMBH) will showcase a network of different biodiversity sites of international calibre and these sites will be accredited. These initiatives will promote responsible tourism and foster sustainable management of natural ecosystems.

Table 1 : Total deforestation rate in Malaysia

	1990-2000	2001-2010
Deforestation rate (%)	#0.31	#0.25
Deforestation (FAO)	0.4	0.5*
Annual change in forested area (ha)	60,000	30,000
Annual change in forested area (FAO) (ha)	79,000	114,000

#Recalibration on 1990 forest figures in 2014 * FAO used projected 2010 figures in the calculation.

Illegal logging and fuelwood gathering

Illegal logging is understood as harvesting and transporting of timber in violation of the National Forestry Act. Section 15 of 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 five hundred thousand ringgit and to imprisonment for a term which shall not be less than one year but shall not exceed twenty years. 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—

- (a) a sum not exceeding ten times the royalty, premium and cess;
- (b) a sum not exceeding ten times the value of such forest produce; and
- (c) any other charges payable,

Illegal logging activities are not common in the PRFs. Between 2006-14, a total of 65 cases of illegal logging were charged in the courts (Table 2). On the other hand, the Enforcement Division of the Forestry Departments has recorded a number of forest offences. Forest offences committed when concessioners start logging activities after the issuance of the contract but before the logging permit is issued. Logging activities can only be carried out after acceptance of the contract and permit issued. Additionally, the royalty or cess is not paid in full.

Table 2: Number of illegal logging cases in Malaysia

	2006	2007	2008	2009	2010	2011	2012	2013	2014
No cases	11	18	13	8	11	3	1	0	0

The 2006 IPCC Guidelines on fuelwood removal are divided into two components:

- a. fuelwood of living trees and parts of trees such as tops and branches, where the tree itself remains in the forest.
- b. Gathering of dead wood and logging slash

Malaysia understands that fuelwood removal refers to removal of wood for the purposes of subsistence. Hence, both these activities are not carried out in the PRF. Fuelwood gathering was common until 1970s and permits were issued by the Forestry Departments. Logging slash cannot be removed from the forest.

Under the FAO, woodfuel removals are defined as wood removed for energy production purposes, regardless of whether the intended purpose is for industrial, commercial or domestic use. FAO collects this information through the FAO/ITTO/UNECE Joint Forest Sector Questionnaire and generates the woodfuel from FAO modelled estimates, which also does accounts mangrove harvest for charcoal production as woodfuel.

2.3 Greenhouse gas emissions from Land Use, Land Use Change and Forestry (LULUCF)

The Second National Communication to UNFCCC indicated that the LULUCF sector was a net sink for the reported years of 2000, 2005 and 2007. The total removal was about 240 million tonnes CO₂ and the emissions were 26 million tonnes CO_{2e}. The sources of emissions were from annual biomass loss through annual removal, deforestation and emissions and removals from soils (Table 3).

Based on these results and the national policies and Development Plan, Malaysia choose to develop reference level on sustainable management of forest.

Table 3 : Total emissions and removals from LULUCF for year 2000

Activity data	(Gg CO ₂)
Amount of biomass removed from forest as commercial harvest	88,902
Total Carbon Uptake Increment	-247,950
Forest land and grassland conversion	24,952
Emissions and removals from soils	4,638

Negative value indicates removal; source Malaysia Second National Communication

2.4 Step wise approach to FRL

Recalling decision 12/CP.17 where a step wise approach could be applied in the construction of FRL. Malaysia's current FRL will address the annual biomass loss through annual removal as national data is available and verified. The other REDD+ activities, conservation and enhancement of carbon stocks will be included when more data becomes available.

Reducing the rate of deforestation and degradation is currently being addressed through the Central Forest Spine and Heart of Borneo projects under the 10th Malaysian Plan. Malaysia may construct a forest reference emission level when deforestation data can be separated from the forest management activities. Additional data and information is being collected from Stateland Forest. Changes in forested areas and PRF are shown in Tables 17 and 18 respectively as additional information only.

3.0 Information on FRL

Based on our forest management goal, Malaysia proposes a national reference level for sustainable management of forest for result based payment for REDD+ activity. All PRFs are managed under sustainable forest management principles and remains forested as far as possible and therefore considered in the construction of the FRL. PRF is also degazetted in some cases for gazettelement as Totally Protected Areas (TPA). No logging activity is conducted in the Totally Protected Area/Protected Area.

Table 4 shows the total area of PRF logged from 1990-2010. The actual historical commercial harvest was lower than approved 5 years coupe is due to the bad weather and accessibility to the forest sites are some of the reasons the approved annual allowable cut is not met. Additionally, the price of the timber may not be lucrative. Besides, one of the major timber producing state has a logging moratorium from 2008 onwards, while another state has planned to extend its harvesting cycle.

Table 5 shows the total growing stocks and the harvest. The growing stocks were derived from the National Forest Inventory and reported in the FAO- FRA reports accordingly. Forest management activities considered are as follows:

- a. PRF where commercial harvest is undertaken
- b. New areas subjected to sustainable forest management through the gazettelement as PRF
- c. Extended harvesting rotation cycle.
- d. Designation of forest for conservation

The construction of FRL considered only Production Forest within the PRF where sustainable forest management and commercial harvest is undertaken. The other forest management activities mentioned above, will be included when addition information becomes available. Other forested areas outside the forest reserves are

not managed in a sustainable manner and are land banks for future development activities. Most of these areas have been logged long time ago and logging occurs often deforested.

Table 4: Trends in total areas logged.

	1996-2000	2001-05	2006-10	2011-15
Approved 5 years coupe (ha)	1,382,000	1,364,350	1,334,700	1,274,165
Actual harvested area (ha)	1,185,581	1,548,412	1,323,682	630,636*

* Upto June 2014

Table 5: Growing stocks and harvest in PRF

	1990	2000	2005	2011
Growing stocks (million m ³)	2977	2721	2813	2648
Commercial harvest (million m ³)	40.1	23.07	22.36	16.08

3.1 Activity data and Emission factors

The activity data and methods used for calculating the forest management reference levels are consistent with the Malaysia greenhouse gas inventory. For the Second National Communication, Malaysia used the Revised 1996 Guidelines for the reporting of the GHG inventory, while 2006 IPCC Guidelines were used for the construction of the FRL.

The activity data used are the total area of PRF based on the forest types and total commercial harvest extracted from PRF (Table 6). The total area of PRF was obtained from the Annual Reports of the Forest Departments and validated using Landsat images for 1990 and 2000 and SPOT 5 for 2010 (Annex 3). This is part of the National Forest Monitoring System where biennial geospatial images were used to verify the changes in the PRF from 2010 onwards.

The land cover classification scheme used to verify the changes in the PRF was based on the International Geosphere Biosphere Programme. The land cover category provided by the programme was used as a guide to learn the class reparability of imagery. The first level was created using a knowledge based, which returned objects of suitable size and variation for the desired classes. These classes were: i) *bare ground*, including barren fields, very young plantations; ii) *built-up*, including residential, commercial and industrial areas; iii) *vegetation*, including agriculture, and natural vegetation and plantations. Training classes were created iteratively for each class, where the classification result of each iteration determined the refinement of training classes for the next iteration until a satisfactory classification was obtained.

Once a satisfactory classification has been achieved for the first level, the vegetation class was further segmented, resulting in smaller “child” vegetation objects, more suitable for specific vegetation distinction. For the classification of objects in this sub-

level, training areas were again iteratively created and refined for the following classes: *farmland, mangroves, peat swamp, natural forest, natural vegetation and plantation forest*. On the whole, the final classification was *mangrove, peat swamp, inland and plantation forest* as well as *natural vegetation, built-up, bare ground and water*.

Forest monitoring system Using Remote Sensing (FMRS) is a web-based application system using geospatial data generated and remote sensing satellite images. Malaysian Remote Sensing Agency (MRSA) and Forestry Departments has developed the system by in-house expertise. The objective of the system is to enhance the effectiveness of monitoring of forest resource including logging activities.

FMRS has been operated by the Forestry Departments. The existence of the FMRS online has revolutionized monitoring of forest compared to the periodic ground monitoring, which is often time-consuming, expensive, complicated and difficult to access. The system developed has changed the monitoring program to be more focused, improve the efficiency and effectiveness. In addition, FMRS system can also be used to estimate forest degradation, illegal encroachment in forest area, reducing the need for ground monitoring, and can be used as a more proactive in monitoring forests. FMRS was developed in phases, starting in 2008, where it was first tested in Peninsular Malaysia and is being expanded to Sabah and Sarawak.

Additionally, National Forest Inventory (NFI) where ground assessment is conducted every 10 years once. 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. National Forest Inventories are conducted to obtain information on the stands of forest districts to provide information for management decisions. National Forest inventories were aimed at providing data for large scale planning. Due to the geographical composition of Malaysia, different inventory efforts have taken place in Peninsular Malaysia and in the state of Sabah and Sarawak. However, methodologies and objectives have often overlapped. Sabah and Sarawak conducted their forest inventories between 1969-72 and 1986-87. Permanent plots and growth plots have also been established in Sabah and Sarawak and assessments are done periodically.

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 records the number of trees following the diameter class, volume, basal area, carbon stocks.

Table 6: Activity data and emission factor used in the reference level

Activity	Activity Data	Emission factor
Annual increase in carbon stocks due to biomass growth	Area of PRF obtained	Data on annual growth rate obtained from 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	Data on commercial harvest and allometric volume functions for total biomass loss

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 National Commodity Statistic Report produced annually from 1994 onwards (1994-2012), provided the data for commercial harvest. The actual commercial harvest was validated against the allowed annual coupe.

Wild fires have been reported in the FRA-FAO (2010) but these fires are limited to forested areas outside the PRF (Table 7). Biomass burning and fuel wood gathering do not occur in the PRF. Malaysia implemented zero burning policy in 1996 where burning is only allowed in special conditions and a permit must be issued by the Department of Environment.

Table 7: Area affected by fire damage

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fire damage (ha)	690	116	418	56	156	25	18	26	1646	27	6
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Fire damage (ha)	297	1350	1320	1301	2231	1325	1350	60	1540	2480	10

Peat draining or mining activities as well as fertilizer and tillage are not taken into consideration as these activities do not occur in the PRF. Disturbance like pest and diseases, lightning effects, drought, flooding and windfall are not common in the PRF. The low lying areas like the Mangrove and Peat Swamp Forest are flooded during the monsoon season, which is a characteristic of wetlands. Hence, emission from the commercial harvest is only taken into account.

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 CO₂ emissions. Non-CO₂ emissions are normally associated with the burning of tree residues or with wild fires, or draining of the Peat Swamp Forest. None of these activities are common in the PRF. The carbon pools and greenhouse gas sources considered are shown in Tables 8 and 9.

Tier 1 approach was used where, the dead wood and litter carbon stocks are in equilibrium so that the changes 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 8: Changes in carbon pools included in the reference level

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

Table 9: Green house gas sources included in the reference level

Fertilization N ₂ O	Drainage of soils - N ₂ O	Liming CO ₂	Biomass burning
Not occurring	Not occurring	Not occurring	Not occurring

Soil carbon investigation in Peninsular Malaysia is limited and representative national data is unavailable. The estimated amount of soil carbon in different ecosystems in Malaysia is given in Table 10. On the other hand, 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).

Table 10: **Soil carbon estimation in different ecosystems in Peninsular Malaysia 1970-1972 (adapted from Chan, 1982)**

Ecosystem type	Carbon in mineral soil (kg m ⁻²) ^a
Forest	
Mangrove	24-36 (30)
Peatswamp	38-114 (76)
Upperhill, poor edaphic	4-8 (7)
Disturbed	3-11 (8)
Dipterocarp	4-11 (8)
Total hill forest	4-10 (8)
Total forest	15-36 (25)
Agricultural lands	
Rubber	4-11 (8)
Oil palm, coconut	5-19 (10)
Paddy	27-38 (33)
Other crops	5-10 (8)

^a Numbers in parentheses are estimated average values over wide areas; Source: Kho, (2009).

Draining of peat swamp forest within the PRF is not done in Malaysia. The peat swamp forest is also not drained during the commercial harvest.

The PRF is not subjected to fertilization, irrigation, and direct additional carbon inputs through organic amendments, hence the soil organic component did not change significantly. Moreover, the harvesting activities do not remove the below ground biomass.

Reduced impact logging (RIL) can be defined as 'the intensively planned and carefully controlled implementation of timber harvesting operations to minimise the environmental impact on forest stands and soils. It involves a number of practical measures, such as:

1. pre-harvest inventory and the mapping of individual crop trees;
2. pre-harvesting planning of roads, skid trails and landings to minimise soil disturbance and to protect streams and waterways with appropriate crossings;
3. construction of roads, landings and skid trails following environmentally friendly design guidelines;
4. use of appropriate felling and bucking techniques including directional felling, cutting stumps low to the ground to avoid waste, and the optimal crosscutting of tree stems into logs in a way that maximises the recovery of useful wood;

5. winching of logs to planned skid trails and ensuring that skidding machines remain on the trails at all times;

6. where feasible, using yarding systems that protect soils and residual vegetation by suspending logs above the ground or by otherwise minimising soil disturbance; and

Pinard et al (2000) reported that RIL showed that only 6% of soil was disturbed as compared with the using conventional logging of about 17%.

Saner et al (2012) also reported that 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 are 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 mangrove are intensively managed.

There are restrictions in terms of diameter at breast height (DBH) size and species that can be harvested. Endemic, threatened protected and 32 species of fruit trees cannot be harvested. Four mother trees must be retained per ha before a tree could be removed. The cutting limit is 45cm and 60cm DBH for non dipterocarps and dipterocarps respectively to provide greater protection to the residual stand.

3.3 Rotation cycle

The rotation cycle is between 25-30 years and States may elect to extend their rotations. For Peat swamp forest, the rotation cycle is between 45-55 years and cutting limits of more than 40 cm dbh. The mangrove forest undergoes a 30 years rotation. In addition, the maximum gross volume of harvest is 85 m³/ha, as of 2004 onwards was set by the National Forestry Council.

3.4 Business as usual scenario

The business as usual scenario would be harvesting following the pre felling inventory data which is based on the total commercial logs available. With the implementation of sustainable forest management and forest certification, the maximum harvest is limited to 85m³ and follows all the principles, criteria and indicators set in MC&I. Since 2005, the harvesting intensity has been below 85m³.

4.0 Malaysia's Proposed Reference Level

Malaysia's proposed reference level addressed the improved forest management post 2005. Table 16 shows a reduction in emission from 89 million t CO₂ to 34 million CO₂ between 1990 and 2011. The CO₂ uptake remains the same at about 230 million tonnes CO₂. The improvement includes a cap on cutting limits, implementation of Malaysian criteria and indicators for sustainable forest management.

Malaysia undertook a step wise approach in the improvement of the commercial harvesting protocol and the implementation of reduced impact logging from 1990 to 2003. The maximum harvest limit of 85m³ is based on the findings from 1990-2003 and

the change in forest management. Reducing the cutting limit, affected the income of the State while increasing the cost of forest management. Hence, in the construction of the FRL, Malaysia used historical data from 1992 -2010 to capture step wise improvements and implementation phases.

4.1 Approach

Historical emission estimates are developed based on official statistics on the commercial harvest of logs from PRF. 1990 was used as the time of the FRL historic period because of a series of improvements in forest management started from 1978 onwards. The logging intensity and methodology was adjusted from 1990, with the national implementation in 2005. Hence, time series from 1992 -2010 was used to generate the reference level. The baseline is recalculated every 5 years, for period 2006-2010, historic emissions from 1992-2005; and 2011-2015, historic emission from 1997-2010 respectively.

The IPCC 2006 Guidelines were applied. Subtracting the biomass carbon loss from the biomass carbon increment for the reporting year makes the calculation. The biomass carbon loss is from the commercial harvest. The calculation are as follows:

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

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. Losses are roundwood removal/harvest.

Method (Biomass Gain-Loss Method)

The method requires the biomass carbon loss to be subtracted from the biomass carbon gain.

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:

$$\Delta CG = \sum (A_{ij} \cdot GTOTAL \cdot CF_{ij})$$

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.

$GTOTAL = \sum \{GW \cdot (1 + R)\}$ 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

$$\Delta CL = L_{wood\text{-removals}} + L_{fuelwood} + L_{disturbance}$$

Where:

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

L_{wood-removals} = annual carbon loss due to wood removals, tonnes C yr⁻¹

L_{fuelwood} = annual biomass carbon loss due to fuelwood removals, tonnes C yr⁻¹
*not counted

L_{disturbance} = annual biomass carbon losses due to disturbances, tonnes C yr⁻¹
*not counted

Annual Carbon Loss In Biomass Of Wood Removals

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

Where:

L_{wood-removals} = annual carbon loss due to biomass removals, tonnes C yr⁻¹
H = annual wood removals, roundwood, m³ 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 (m³ of removals)⁻¹.

Forest disturbance like pest and disease outbreaks, wind throw, wild or controlled fires or soil disturbance during logging activities are not common in the PRF. Temporary soil compaction may occur post logging activities.

4.2 Scope

The Sustainable Management of Forest reference levels presented in this submission were estimated taking into account the best available information on a number of key factors including:

- (a) removals and emissions from forest management activities based on Malaysia's greenhouse gas inventory
- (b) relevant historical data on forest management;
- (c) National legislations and relevant policies

4.3 Scale

Only sustainably managed forest where commercial harvest is undertaken as part of the management plan is considered, covering a total area of about 12 million ha of forest (Annex 3). The FRL considers all sustainable managed forest and national data, which includes Peninsular Malaysia, Sabah and Sarawak. The Protected Areas/ Totally Protected Areas were not considered because no logging activities are carried out in these areas.

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 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 85m³/ha harvest.
- d) The effects of extreme weather patterns will not affect the Production forest – floods will not affect the seedling regeneration nor forest fires.
- e) No projection is made for the future and therefore future policy is not considered.

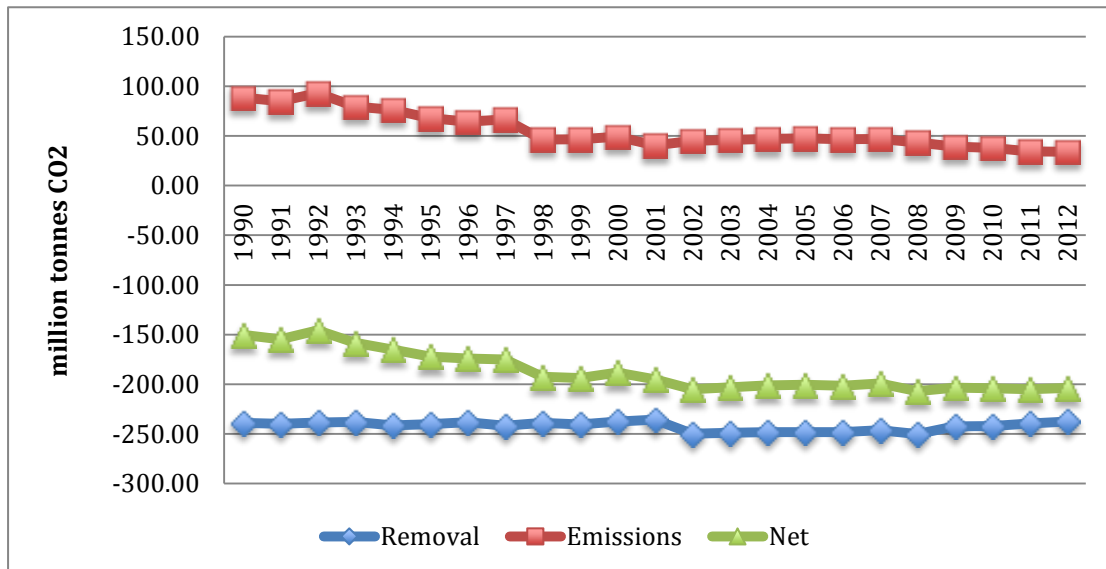
The proposed reference level for result based payments are as follows:

- a. the average net removals from 1992-2005 will be used as reference level for period 2006-10 is -183.55 million tonnes CO₂/yr (Table 11).
- b. The average net removals from 1997-2010 will be used as reference level for period 2011-15 is -197.83 million tonnes CO₂/yr (Table 11).
- c. The trend in removal and emissions from 1990-2010 is shown in Figure 2.

Table 11: Malaysia's Proposed Forest Reference Level

For Result Based Payments Period, 2006-10	For Result based Payment Period, 2011-15
-183.55 million tonnes CO ₂	-197.83 million tonnes CO ₂

Figure 2: Trends in removals and emissions from Sustainable Management of Forest



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

Transparent:

Published data was used for the construction of the FRL annual reports. The data has been provided to ensure that the same calculations can be used to develop the same values. The summary is provided in Table 12 and the details are provided in Annex 3.

Table 12 Changes in PRF (million ha) from 1990-2012

	1990	2000	2005	2010	2012
Inland	10.91	11.13	11.81	11.66	11.42
PSF	1.04	0.78	0.66	0.5	0.51
Mangrove	0.47	0.44	0.45	0.43	0.43
Total	12.42	12.35	12.91	12.59	12.36

Source: www.nre.gov.my/forestry

The Protection Areas/Totally Protected Areas are not included in the construction of FRL.

Complete

Complete means the provision of information that allows for the reconstruction of forest reference emission levels and/or forest reference levels as in the footnote of 12/CP.17 Annex

For the construction of the forest reference level for results based payments only the carbon uptake and commercial harvest was taken into consideration. The other forest management activities have yet to be included. The forest profile shown below is based on the vegetation type (reference) is shown in Figure 3.

Tier 1 approach is assumed for dead organic matter and soil carbon. It is assumed that dead wood and litter carbon stocks are in equilibrium and changes in the dead organic matter are assumed to be zero. The forest soil carbon stock does not change with management. The 2006 IPCC Software assumes a T1 approach from these pools.

There are a number of publications on the carbon stocks in forest available. However for the construction of the forest reference level allometric equations by Brown (1997) was used. 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:

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

(is based on the National Forest Inventory)
Y= biomass tonnes/ha
D = diameter

The 4th, 5th National Forest Inventory and other published data have been used. (Table 13). 10cm dbh and above was considered to reduce the error.

Figure 3: Forest profile in Malaysia

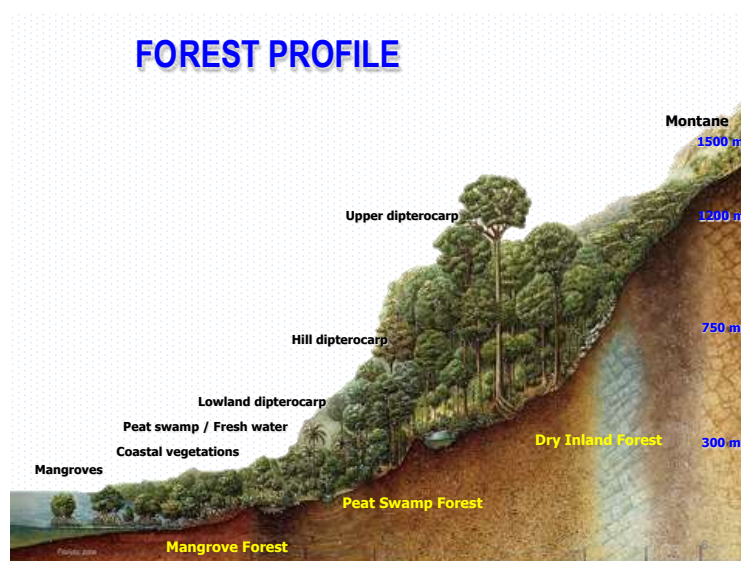


Table 13: Growth rates for forest types

Forest type	Growth rate	Reference
Inland	9.3 tdm/ha/yr	NFI5 and Banin et al (2014)
Peat swamp	9.2 tdm/ha/yr	NFI5 and National Reports
Mangrove	11 tdm/ha/yr	Ong (1993)
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

Acknowledging that not all carbon pools have been accounted for, but all production forest has been included. Additional information is provided in Annex 8.

Consistent

Decision 12/CP.17 requires that the forest reference emission levels shall maintain consistent with anthropogenic forest related greenhouse gas emissions by sources and removals by sinks as contained in the country's national greenhouse gas inventory. This implied that the same methodologies and consistent data sets are used to estimate the removal and emissions from sustainable forest management activities in the construction of the reference level and in the national greenhouse gas inventory.

Consistent activity data and emission factors have been used throughout the construction of FRL and is consistent with the activity data and emission factors in the national greenhouse gas inventory.

Accurate

The national forest inventory data has cv of 90% while the carbon stock assessment had an overall accuracy of 97%. Effort has been taken to ensure that the information is as accurate as possible. Quality Control process was also carried out.

The uncertainty remains in the following:

- a. verification of area using geospatial images.
- b. total area expressed in ha as some gazettelement was done in the 1900s and the area measured were in different unit. A series of unit conversion have taken place.

The reference level construction considered the National Forestry Policy, The Climate Change Policy, the 10th Malaysian Development Plan and relevant State Policies.

Forest definition

The forest definition used in the development of the reference level is based on the national legislation and is consistent with the national greenhouse gas inventory. However, the definition used by the FAO is not used as some agricultural land, like the state land and 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 Forestry Policy –
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.
- b. 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.
- c. 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.
- d. Directives from the National Land Council
The maximum cutting limits and annual coupe are set by the Council and are reviewed periodically.

The 10th Malaysian Development Plan (2011-15)

The 10th Malaysian Development Plan outlines that in responding to global climate change, the Government will focus on adaptation strategies to ensure sustainable growth and mitigation strategies to reduce the emission of greenhouse gases. Two major initiatives were launched to ensure sustainable use of forests and their natural resources: the Central Forest Spine project covering 4.3 million hectares in Peninsular Malaysia and the Heart of Borneo project covering 6.0 million hectares in Sabah and Sarawak.

7.0 Capacity needs

- 7.1 Technical capacity is needed to develop the national soil organic carbon database.

Due to budget cuts for monitoring activities in Malaysia, the national soil organic database has not been updated since 1980. Peat depth is important in determining the soil organic carbon and there is no updates on peat depth in PRF. Technical issues like status of peatlands drained in the 1950s to 1970 are yet to be resolved.

- 7.2 Technology to enhance forest management and conservation- logging damage

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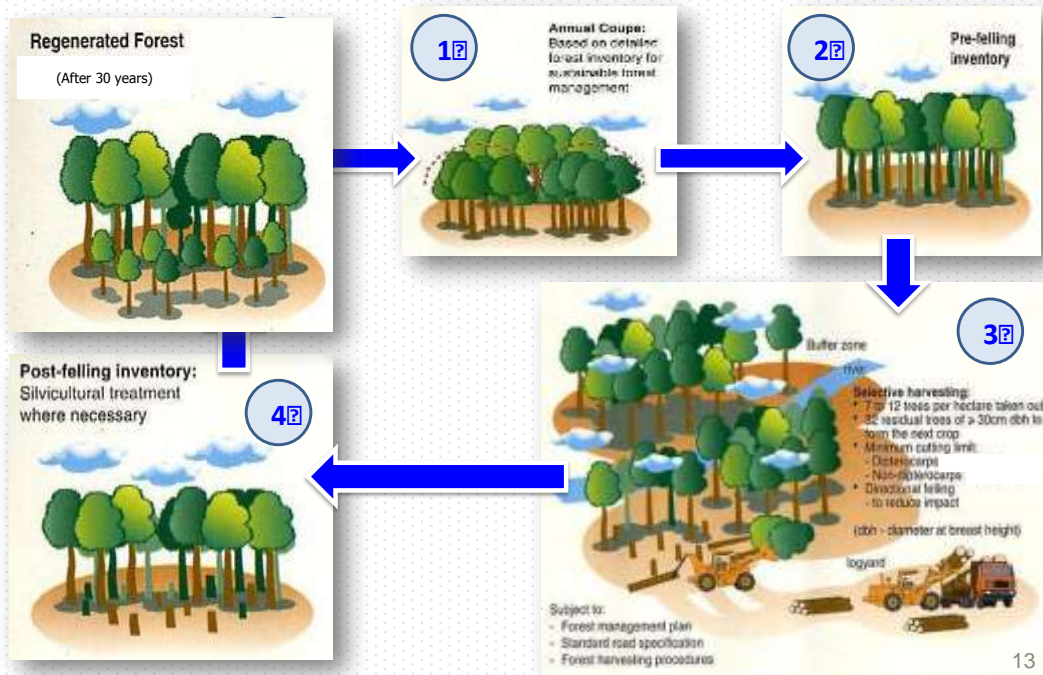
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CLASSIFICATION OF PRFs INTO FUNCTIONAL CLASSES

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

SELECTIVE MANAGEMENT SYSTEM



Malaysian Timber Certification Scheme

MTCC was established in October 1998 as an independent organisation to develop and operate the Malaysian Timber Certification Scheme (MTCS). As a voluntary national scheme, the MTCS provides for independent assessment of forest management practices, to ensure the sustainable management of Malaysia's natural forest and forest plantations, as well as to meet the demand for certified timber products.

The MTCS has been endorsed by the Programme for the Endorsement of Forest Certification (PEFC) schemes, the largest forest certification programme, representing more than 200 million ha of certified forests worldwide. The MTCS is also the first tropical timber certification scheme in the Asia Pacific region to be endorsed by the PEFC.

MTCC started operating its timber certification programme known as the Malaysian Timber Certification Scheme (MTCS) in October 2001 which comprises two components as follows:

Forest Management Certification

This is a process of third party audit of the forest management practices of natural forest in a Forest Management Unit (FMU) or forest plantation in a Forest Plantation Management Unit (FPMU) to assess compliance with the requirements of a prescribed standard, leading to an award of a Certificate for Forest Management or Certificate for Forest Plantation Management under the MTCS.

The standard used for certification of natural forest is the Malaysian Criteria and Indicators for Forest Management Certification or in short MC&I (2002). The MC&I (2002) has undergone a review process and the revised standard, Malaysian Criteria and Indicators for Forest Management Certification (Natural Forest) or in short MC&I (Natural Forest) has come into force on 1 July 2012 and will become mandatory beginning 1 June 2013. All applications for forest management certification are receive and process by certification bodies (CBs).

Peer Review

Peer review is an integral part of the decision making process in forest management certification. A peer reviewer is responsible to provide a second independent expert opinion on the level of a compliance of the forest management unit by assessing the reports prepared by a certification body against the requirements of the standard.

Table 14: Total Production Forest within Permanent Reserved Forest for Malaysia

MALAYSIA				
Production Forest (million ha)				
Year	Inland/Hill	Peat Swamp	Mangrove	Total
1990	10.91	1.04	0.47	12.42
1991	10.94	1.05	0.47	12.46
1992	10.94	1.01	0.46	12.41
1993	10.92	0.99	0.45	12.36
1994	11.15	0.96	0.44	12.55
1995	11.11	0.94	0.44	12.49
1996	11.12	0.83	0.44	12.39
1997	11.27	0.86	0.44	12.57
1998	11.14	0.84	0.44	12.42
1999	11.19	0.88	0.44	12.51
2000	11.13	0.78	0.44	12.35
2001	11.12	0.69	0.44	12.25
2002	11.87	0.70	0.44	13.01
2003	11.83	0.70	0.43	12.96
2004	11.82	0.68	0.43	12.92
2005	11.82	0.65	0.44	12.91
2006	11.81	0.66	0.45	12.92
2007	11.70	0.67	0.44	12.81
2008	11.92	0.66	0.44	13.03
2009	11.69	0.49	0.43	12.61
2010	11.66	0.50	0.43	12.59
2011	11.52	0.50	0.43	12.45
2012	11.42	0.51	0.43	12.36

Source : Annual Report Forest Department Sabah
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Annual Report Forest Department Peninsular Malaysia
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These figures have been adapted following verification through the gazette order and geospatial images

Table 15: Total Commercial Harvest for Malaysia

Malaysia	
Year	Commercial harvest (million m ³)
1990	40.10
1991	39.86
1992	43.51
1993	37.27
1994	35.67
1995	31.84
1996	30.09
1997	31.17
1998	21.70
1999	21.83
2000	23.07
2001	18.92
2002	21.05
2003	21.53
2004	22.04
2005	22.36
2006	21.89
2007	22.05
2008	20.26
2009	18.31
2010	17.80
2011	16.08
2012	15.89

Source : MPIC -Statistics on Commodities
 FDPM – Forestry Statistics Peninsular Malaysia

Table 16: Total removal by sinks and emissions from Sustainable management of forest

Year	Uptake (million ton CO ₂)	Harvest (million ton CO ₂)
1990	238.94	88.67
1991	239.79	85.11
1992	238.66	92.90
1993	237.77	79.58
1994	241.38	76.16
1995	240.11	67.99
1996	238.23	64.25
1997	241.64	66.55
1998	238.79	46.33
1999	240.44	46.61
2000	237.45	49.26
2001	235.56	40.40
2002	249.94	44.95
2003	248.90	45.97
2004	248.27	47.06
2005	248.24	47.74
2006	248.28	46.74
2007	246.37	47.08
2008	250.27	43.26
2009	242.47	39.10
2010	241.99	38.01
2011	239.36	34.33

Changes in forest area in Malaysia

Malaysia undertook a comprehensive verification of its PRF from 2008 onwards followed by TPA from 2011 and State land forest in 2013. The verification was conducted with a combination of geospatial, ground truth and gazettes orders. Today, verification of PRF and TPA is complete while the preliminary verification of the State land forest is complete. Double counting especially between PRF and TPA in some sub national was corrected and the units of area updated to metrics. The forest figures were revised and hence submitted to FRA,FAO in August 2015. The revised figures are shown in the Table below.

Table 17: Changes in forested area in Malaysia between 1990-2012

Year	PRF (mill ha)	State land	TPA	Total
1990	12.490	5.235	1.057	18.782
1991	12.550	5.032	1.125	18.707
1992	12.500	4.966	1.125	18.592
1993	12.460	4.982	1.125	18.568
1994	12.650	4.197	1.126	17.974
1995	12.610	4.219	1.126	17.956
1996	14.279	1.993	1.830	18.102
1997	14.326	2.314	1.830	18.470
1998	14.326	2.241	1.830	18.397
1999	14.454	2.155	1.830	18.438
2000	14.432	1.933	1.830	18.195
2001	14.435	1.830	1.830	18.096
2002	14.433	1.773	1.830	18.036
2003	14.415	1.774	1.830	18.019
2004	14.399	1.736	1.830	17.965
2005	14.426	1.532	1.857	17.815
2006	14.452	1.486	1.857	17.795
2007	14.418	1.438	1.857	17.713
2008	14.412	1.411	1.857	17.680
2009	14.535	1.312	1.859	17.707
2010	14.526	1.541	1.859	17.927
2011	14.519	1.552	1.859	17.931
2012	14.503	1.652	1.859	18.014

Table 18: Changes in the PRF from 1990 to 2011

Annex 7

Annex 8

Table 17b: Total removals and emissions from forest areas not included in FRL

Year	Total Removal (million tonnes CO ₂)	Total Emissions (million tonnes CO ₂)
1991	45.63	19.37
1992	45.14	33.60
1993	45.26	13.46
1994	39.45	153.98
1995	39.61	13.32
1996	28.33	33.00
1997	30.71	0.00
1998	30.17	20.19
1999	29.53	0.00
2000	27.89	5.73
2001	27.13	25.53
2002	26.70	16.14
2003	26.71	6.37
2004	26.43	13.95
2005	25.11	38.58
2006	24.78	5.16
2007	24.42	24.27
2008	24.22	8.75
2009	23.51	9.90
2010	25.20	3.24
2011	25.28	2.49
2012	26.02	3.56

Note: Emissions are from deforestation where it is assumed that loss in forested area as deforestation. Estimates are preliminary.

Table 18: The gazettelement and de-gazettment of PRF.

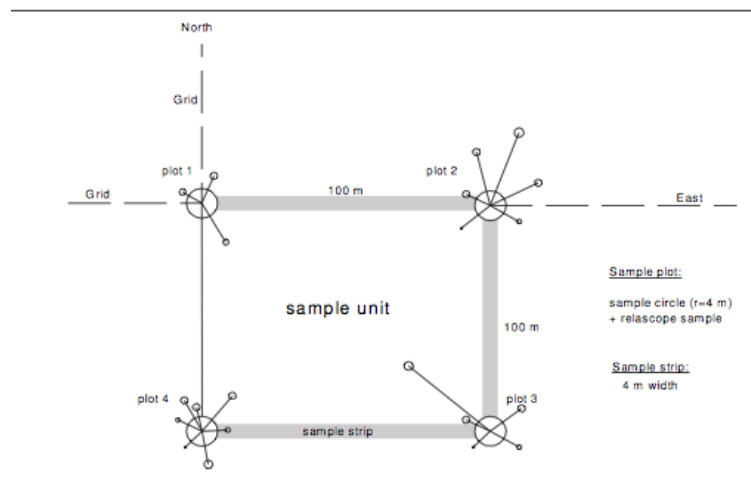
Year	Production Forest (mill ha)	Protection Forest (mill ha)	Total PRF (mill ha)	Degazettelement of PRF (mill ha)	Gazettelement of PRF (mill ha)
1990	12.42	0.07	12.490		
1991	12.46	0.09	12.550	0	0.06
1992	12.41	0.09	12.500	0.05	
1993	12.36	0.10	12.460	0.04	
1994	12.55	0.10	12.650	0	0.19
1995	12.49	0.12	12.610	0.04	
1996	12.39	1.89	14.279	0	1.67
1997	12.57	1.76	14.326	0	0.05
1998	12.42	1.91	14.326	0.00	
1999	12.51	1.95	14.454	0	0.13
2000	12.35	2.09	14.432	0.02	0.13
2001	12.25	2.18	14.435	0	
2002	13.01	1.42	14.433	0.00	0.00
2003	12.96	1.45	14.415	0.02	0.00
2004	12.92	1.48	14.399	0.02	
2005	12.91	1.51	14.426	0	0.03
2006	12.92	1.53	14.452	0	0.03
2007	12.81	1.60	14.418	0.03	
2008	13.03	1.38	14.412	0.01	
2009	12.61	1.93	14.535	0	0.12
2010	12.59	1.94	14.526	0.09	
2011	12.33	2.19	14.519	0.07	
2012	12.36	2.14	14.503	0.02	

Additional information on mean annual increment calculation

The values used by Malaysia are higher than the values in the IPCC default values. The IPCC default values are similar with the values of Protection Forest in the 1992 in Malaysia. The growth rates were generated from growth and yield plots and National Forest Inventory (NFI).

The 4th and 5th NFI inventory design is described as a stratified satellite based on randomly distributed permanent sample units. The sampling design consists of permanent sample units (satellites) of square shape with one sample plot in each corner. Each sample plot consists of a sample circle for small size trees and a point sample. Each sample unit consists of four (4) sample plots and three (3) sample strips. Each sample plot is a combination of a fixed sample circle of 4 m in radius and a point reference. The distance between the sample plot is 100 m. The total sample area is 0.12 hectare. Within the sample circle only commercial trees <10 cm Dbh and >1.5 m in height and some key medicinal plants are assessed. The strip sample area is about 0.02 hectare resulting in total sample area at 0.14 hectare. For growth and yield plots, the diameter of all free-standing trees ≥ 10 cm diameter at breast height (dbh) was measured at least twice, using standard protocols.

Figure 1: Layout of sampling unit



Tree diameter growth was checked for all stems, and outliers were treated. Tree diameter and height was measured for all trees per hectare, using a standardized stratified-random sampling approach whereby trees were randomly selected from four size classes (10–20, 20–30, 30–40 and >40 cm diameter). The stratification are based on forest type and post logging years. Based on the National Forest Inventory, the biomass increment for forest logged between 1-10 years, 11-20 years and 20-30 years is between 9.2 – 12t/ha/yr. However, a significant decline is noted after 30 years to 4.3 t/ha/yr. Hence, Malaysia's set its logging cycle of 25-30 years, based on these figures.

Above-ground biomass (AGB) increments cannot be directly measured but estimated by applying allometric relationships relating stem diameter, height and wood density to AGB. The increment was calculated by

comparing the growth difference in ABG. The increment was determined for each diameter class and forest stratification between 2002 and 2012 Inventory cycle. For means of comparison, biomass increment was also calculated using the equation presented by Brown (1997), as follows:

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

Y= biomass tonne

For mangrove, Ong and Gong (1993) were used. Allometric techniques, were also used to estimate the mean annual increment based on age of the forest. National studies were undertaken between 2011-15 to assess the growth of mangroves and the reports are being finalised. The initial reports indicated that the growth rates for mangrove forest are between 10- 17 t/ha/yr. The equation is as follows: $Y = 0.0277DBH^{2.1668}$

Biomass density of a strata is estimated using the equation above. Number of trees/ha is obtained from the Forest inventories and the mid point of biomass class is determined. Biomass of tree at mid point is determined using the equation above and biomass of all trees is determined by multiplying the number of trees with the biomass of tree at mid point.

For the analyses of individual trees, both diameter growth and above ground biomass were calculated using the census interval that was > 5 year to reduce noise associated with inter-annual differences and that minimized the difference from the median date for all censuses.