

# **Modified Proposed Forest Reference Levels for REDD Plus Results Based Payments under UNFCCC**

Ministry of Water, Land and Natural Resources and  
Ministry of Energy, Science, Technology, Environment and Climate Change  
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 (PRF) 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 20 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:

- (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 2006-17, a total of 91 cases of illegal logging cases were reported (Table 1). 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

#### 3.1 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.

REDD Plus activities covered are deforestation, sustainable management forest and conservation activities. The reference period is from 2005-2015 for results period of 2016-2025. A summary of forest categories and their associated activities is listed in Table 2.

Deforestation refers the conversion of forest to non-forest. Non forest includes conversion of forest for agricultural purposes. Emission factors were assigned based on the category and type of forest converted. Rubber plantations in Malaysia is a cropland. Hence, conversion of rubber plantations to oil palm or settlements are not considered as deforestation. International databases, have included the conversion of rubber plantations to oil palm and settlements as deforestation.

Sustainable management of forest refers to forest management activities undertaken in a forest. Forest management activities include resource assessment, logging and other silvicultural practice. Emission factors are assigned based on the type of forest.

Conservation activity refers to forest areas that conserved for biological diversity, soil, flood mitigation and climate amelioration and classified as Totally Protected Area (TPA). These areas are not logged and recently a number of sub national governments have designated more PRF for conservation area. Emission factors are assigned based on if the forest was previously logged.

Table 2: Scale of activities under FRL

Activity	Scale	Forest Category
Deforestation	National	PRF, TPA, State Land Forest
SFM	National	PRF, State Land Forest
Conservation	National	TPA

### 3.2 *FRL Maintains Consistency with GHG Inventory*

The activity data and methods used for calculating the forest reference level are consistent with the greenhouse gas inventory for LULUCF sector. Same data set and emission factors are used in both the FRL and GHG inventory for LULUCF. The current FRL has included the forest types for TPA and State Land forest, which is new information. Overall, the total forest remains the same. Malaysia used 2006 IPCC Guidelines for the Third National Communication and Second Biennial Update Report.

### 3.3 *Historical data have been taken into account in the establishment of the FRL*

Historical period of 2005 to 2015 was used in the construction of the FRL. It was constructed by averaging the historical emissions and removals from 2005 to 2015. Historical data taken into account are the changes in the forest areas, logging volume and forest disturbance.

### 3.4 *Transparent, complete, consistent and accurate information*

#### **A. Transparent**

##### *3.4.1 Methodological information*

2006 IPCC Guidelines for National Greenhouse Gas Inventories were applied. Forest remaining forest category was used to estimate the emissions and removal from Sustainable management of forest and conservation activities. Emission from deforestation is estimated from forest land converted to settlement.

Biomass gain-loss method was used to estimate the removals and emissions 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 general equation used is as follows:

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

Where:

$\Delta C_{FFLB}$  = annual change in carbon stocks in living biomass (includes above- and belowground biomass) in forest land remaining forest land, tonnes C yr<sup>-1</sup>

$\Delta C_{FFG}$  = annual increase in carbon stocks due to biomass growth, tonnes C yr<sup>-1</sup>

$\Delta C_{FFL}$  = annual decrease in carbon stocks due to biomass loss, tonnes C yr<sup>-1</sup>

## A. Sustainable management of forest and conservation activities

### Equation 2.7

Annual change in carbon stocks in biomass in land remaining in a particular land-use category (gain-loss method), tonnes C yr<sup>-1</sup>

$$\Delta C_B = \Delta C_G - \Delta C_L$$

$\Delta C_G$  = annual increase in carbon stocks due to biomass growth for each land sub-category, (PRF, TPA and SL Forest) considering the total area, tonnes C yr<sup>-1</sup>

$\Delta C_L$  = annual decrease in carbon stocks due to biomass loss for each land sub-category, (PRF and SL Forest) considering the total area, tonnes C yr<sup>-1</sup>

### Equation 2.9

Annual increase in biomass carbon stocks due to biomass increment in land remaining in same category

$$\Delta C_G = A * G_{TOTAL} * CF$$

A = Area of Forest Land Remaining Forest Land, (ha)

$G_{TOTAL}$  = Average annual biomass growth above- and below-ground, (tonnes dm ha<sup>-1</sup> yr<sup>-1</sup>)

CF = Carbon fraction of dry matter, [tonnes C (tonne dm)<sup>-1</sup> – 0.47

### Equation 2.10

Average annual increment in biomass, (tonnes dm ha<sup>-1</sup> yr<sup>-1</sup>)

$$G_{TOTAL} = G_W * (1+R)$$

$G_W$  = Average annual above-ground biomass growth, (tonnes dm ha<sup>-1</sup> yr<sup>-1</sup>)

R = Ratio of below-ground biomass to above-ground biomass, [tonnes bg dm (tonne ag dm)<sup>-1</sup>]

### Equation 2.11

Annual decrease in carbon stocks due to biomass loss, (tonnes C yr<sup>-1</sup>)

$$DC_L = L_{wood-removals} + L_{disturbances}$$

### Equation 2.12

Annual carbon loss due to biomass removals, (tonnes C yr<sup>-1</sup>)

$$L_{wood-removals} = H * BCEF_R * (1+R) * CF$$

H = Annual wood removal, (m<sup>3</sup> yr<sup>-1</sup>)

$BCEF_R$  = Biomass conversion and expansion factor for conversion of removals in merchantable volume to total biomass removals (including bark), [tonnes of biomass removals (m<sup>3</sup> of removals)<sup>-1</sup>]

R = Ratio of below-ground biomass to above-ground biomass, [tonnes bg dm (tonne ag dm)<sup>-1</sup>]

CF = Carbon fraction of dry matter, [tonnes C (tonne dm)<sup>-1</sup>]

### Equation 2.14

Annual other losses of carbon, (tonnes C yr<sup>-1</sup>)

$$L_{\text{disturbances}} = A * B_w * (1+R) * CF * fd$$

A = Area affected by disturbances, (ha)

B<sub>w</sub> = Average above-ground biomass of areas affected, (tonnes dm ha<sup>-1</sup>)

R = Ratio of below-ground biomass to above-ground biomass, [tonnes bg dm (tonne ag dm)<sup>-1</sup>]

CF = Carbon fraction of dry matter, [tonnes C (tonne dm)<sup>-1</sup>]

Fd = Fraction of biomass lost in disturbance,

For carbon emissions from organic soils

#### **Equation 2.26**

Annual carbon loss from drained organic soils, (tonnes C yr<sup>-1</sup>)

$$L_{\text{organic}} = A * EF$$

A = Land area of drained organic soil, (ha)

EF = Emission factor for climate type, (tonnes C ha<sup>-1</sup> yr<sup>-1</sup>)

#### Forest land converted to settlement

#### **Equation 2.15**

Annual Change In Biomass Carbon Stocks On Land Converted To Other Land-Use Category, tonnes C yr<sup>-1</sup>

$$\Delta CB = \Delta CG + \Delta C_{\text{CONVERSION}} - \Delta CL$$

ΔCG = annual increase in carbon stocks in biomass due to growth on land converted to settlement, in tonnes C yr<sup>-1</sup>

ΔC<sub>CONVERSION</sub> = initial change in carbon stocks in biomass on land converted to settlement, in tonnes C yr<sup>-1</sup>

ΔCL = annual decrease in biomass carbon stocks due to losses from harvesting, fuel wood gathering and disturbances on land converted to other land-use category, in tonnes C yr<sup>-1</sup>

#### **Equation 2.16**

Initial change in biomass carbon stocks on land converted to another land category, tonnes C yr<sup>-1</sup>

$$\Delta C_{\text{CONVERSION}} = (0 - B_{\text{BEFORE}}) * \Delta A_{\text{TO\_OTHERS}} * CF$$

B<sub>BEFORE</sub> = biomass stocks on forest category before the conversion, tonnes d.m. ha<sup>-1</sup>

ΔA<sub>TO\_OTHERS</sub> = area of land use *i* converted to settlement in a certain year, ha yr<sup>-1</sup>

CF = carbon fraction of dry matter, tonne C (tonnes d.m.)<sup>-1</sup>

#### **Equation 4.40 for direct N<sub>2</sub>O from drained organic soils**

Malaysia used the IPCC software to calculate the emissions and removals.

### *3.4.2 Pools and gases*

The pools and gases covered in the construction of FRL are shown in Tables 3 and 4. Tier 1 approach was applied where, dead wood and litter carbon stocks are in equilibrium; the change in carbon stock in the DOM pools is assumed to



be zero. The 2006 IPCC 2006 Software applies a Tier 1 assumption for litter carbon stocks. Likewise, soil carbon stocks do not change with forest management and conservation activities. For deforestation, limited data is available for soil organic carbon.

CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O emissions were considered in the construction of the FRL. Non-CO<sub>2</sub> emissions are normally from forest fires, or drained Peat Swamp Forest.

Table 3: Changes in carbon pools included in the reference level

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

Table 4: Greenhouse gas sources included in the reference level

Fertilization N <sub>2</sub> O	Drainage of soils – N <sub>2</sub> O	Liming CO <sub>2</sub>	Forest fires
Not occurring	√	Not occurring	√

CH <sub>4</sub>	N <sub>2</sub> O	CO	NO <sub>x</sub>
√	√	√	√

### 3.4.3 Description of data sets and approaches

#### 3.4.3.1 Activity data

For Sustainable management of forest and conservation, activity data used are based on the forest types and classification based on degree of protection. Some sub national governments have increased there conservation area and moved the forest from PRF to TPA. In some cases, SL Forest is also converted to PRF or TPA especially when species of conservation importance are observed and documented.

Deforestation activity data is obtained from degazettement of forest reserved and/or based on the forest converted annually. For deforestation, gross deforestation data was considered. Deforestation is considered when an areas of forest is degazetted and reflected in the reduction in total forest areas from 2004 to 2008. From 2009 onwards, net forest area increased and deforestation data was obtained from the degazettement. The description of activity data is shown in Table 4. The reduction in peat swamp forest in the State Land is due to the establishment of plantations in 2012. In 2012, the reduction in peat swamp forest in State Land Forest is due to the reclassification of the forest. Deforestation increased 2015 onwards due to the implementation of East

Coast Rail Line (ECRL), High Speed Rail Kuala Lumpur- Singapore and Pan Borneo Highway.

The total mangrove forest area used in the calculation is averaged to 0.428 million ha for period 2005 to 2013 and 0.5 million ha for 2014-15. These variations are due to the high and low tides. The peat swamp forest was gazetted in 2005 onwards and so the PRF growth rates are applied.

Table 4: Description of activity data

IPCC Category	REDD+ Activity	Activity	Activity Data
Forest land remaining forest land	Conservation of carbon stocks	Annual increase in carbon stocks due to biomass growth	Total area of TPA
	Sustainable management of forest	Annual increase/decrease in carbon stocks due to biomass growth/loss	Total area of PRF and SL Forest Total commercial harvest Biomass loss from forest fires Area of drained Peat Swamp Forest
Forest land converted to settlement	Deforestation	Annual decrease in carbon stocks due to change in land use	Area of forest converted to settlement – PRF and SL Forest
Soil type			
Inland forest	Mineral soil – low activity soil		
Peat swamp forest	Organic soil		
Mangrove soil	Mineral soil –high activity soil		

### 3.4.3.2 Generation of activity data and its consistency

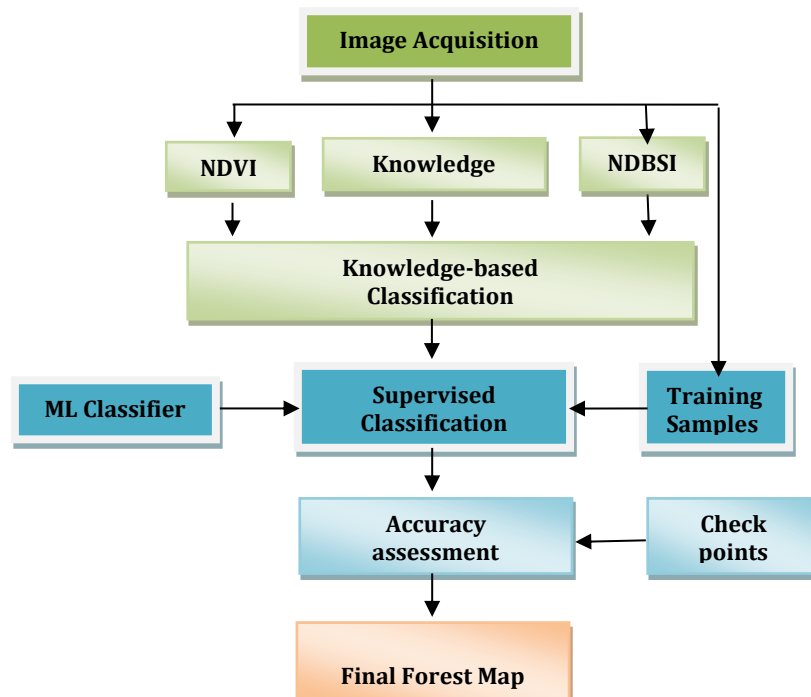
The total forest area is obtained from the gazette notification and geospatial maps. The geospatial maps are used to determine the boundaries of forest areas of new gazettes, followed by ground verification and the issuance of gazette notification. Adjustments of forest area may occur when ground surveys are undertaken prior to official gazette. For the older gazette, most of the area is mapped onto the geospatial images and verified. It is undertaken by overlaying the Forest Resource Maps with the satellite images. The scale of forest resource maps is 1:50,000.

Forestry departments monitor and manage the forest reserves while the state land forest is under the purview of State Authorities. SPOT 5 was used with a spatial resolution of 10mX10m to identify changes biennially. The forest resource map and the satellite images are used to identify changes.

Some of the forest area was gazetted as PRF or TPA or SL pre-independence and as early as 1905. These areas include areas like montane and forest areas with limited access. No human induced activities occurred here and the area is only monitored remotely. They are classified as unmanaged forest.

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.

#### 3.4.3.3 Emissions factors

National Forest Inventory (NFI) where ground assessment is conducted every 10 years once in Peninsular Malaysia. NFI provides information on the state and trends of the forest resources, their goods and services, and other related variables that supports monitoring activities in the forest. 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 and 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 from 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 data collection is complete and the analysis work is on-going.

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 net annual increment was derived by capturing the net increment over these periods and annualised by dividing by 10. Details on carbon increment are available on [www.mestec.gov.my](http://www.mestec.gov.my)

The mortality rate for inland and peat swamp forest is 0.06% to 2.1% and average value of 0.9 and 1.1% applied respectively. The mortality rate considers both the natural and postharvest mortality. For mangrove, the

mortality rate is between 1.28 to 10.3% and 8% applied. Net growth rates were obtained by subtracting the mortality rate.

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 during the dry season primarily induced from activities outside the forest areas moving towards the boundaries of State Land Forest. However, prolong dry season during the *El Nino* years increase the forest fire occurrence.

Allometric 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. 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 4<sup>th</sup> and 5<sup>th</sup> National Forest Inventory and other published data have been used. 10cm dbh and above was considered to reduce the error. Detailed information on the calculations is available at <http://www.mestecc.gov.my>.

#### B. Complete

Data used to construct the FRL is shown in Table 5, 6 and 7, 8 while the emission factors are shown in table 9.

Peat draining or mining activities as well as fertilizer and tillage 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 peat swamp forest draining (occurred per 1980) is estimated. Disturbance caused by pest and diseases, lightning effect, drought, flooding and wind resulting in death has been considered in the mortality.

Table 5: Area affected by fire damage

Year	2005	2006	2007	2008	2009	2010
Fire damage (ha)	2231	1325	1350	60	1540	2480
Year	2011	2012	2013	2014	2015	
Fire damage (ha)	10	448	1436	2683	886	

C. Consistent

Consistent commercial harvest data collection

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<sup>3</sup>/ha harvest.

D. Accurate

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.

Comparison of growth rates with other tropical forest is shown in Table 11. The growth rates are between 5 to 23 t/ha/yr and were within the IPCC default values.

Measurements from long- term ecological plots showed that biomass reduced after the *El Nino* in 1997-98 (Table 12) 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 6<sup>th</sup> NFI.

Table 11: Comparison of growth rates from other sites.

Site	Growth rate (t/ha/yr)	Reference
Amazonia	11.0 t/ha/yr	Malhi et al 2004
Borneo (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 12: Changes in Biomass in two long term ecological plots in Malaysia.

Year	Total biomass (Mg/ha)			
	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

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 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.

### ***Uncertainty 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% for forest land remaining forest land and deforestation respectively. The average total uncertainty of the estimate is 20.72% and trend is 31.67%.

#### ***3.4.4 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 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.

#### ***3.4.5 Coverage***



Malaysia has included all of its forest area except unmanaged and forest plantations. Forest are categorized by the degree of protection. They are gazetted under the law and some gazettes are as early as 1905.

In complying to international obligations and trade requirements, the Government has enhanced its Forest Policies, and implemented third party auditing of its forest management through the Malaysian Timber Certification Scheme. This will incur additional cost in terms of making timber harvesting from natural forest will be more expensive. Hence, the Government made a decision in 2005 to establish large scale forest plantation to ensure continuous supply of timber. Incentives are provided by government to establish forest plantation. The National Timber Industry Policy (2009-2020) projects future timber supply will come from the plantation forest.

Malaysia views REDD Plus as an incentive mechanism to maintain, protect and sustainably manage the forests. Plantation forest, although is part of managed forest, is not covered in the current FRL. This is to avoid double incentives for one activity. Malaysia may cover forest plantations once the incentive period from the Government expires.

Unmanaged land refers to forest areas that has no management plan or ground assessment activities. These areas remain unmanaged because of limited accessibility. Unmanaged forest is not included in the construction of FRL.

### 3.5 *Description of relevant policies and plans*

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 (2015-2025)

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 Sabah's State Forest Policy, 1954 and Sarawak's Statement of Forest Policy, 1954.

(e) 10<sup>th</sup> 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.

3.6 *Description of changes in the previously submitted FRL*

A step-wise approach is undertaken in the implementation of REDD Plus in Malaysia. A summary of description and changes in all the FRL submissions is shown in Table 14. Preparatory work for the next phase of National Forest Inventory provided better information on unmanaged land and peat swamp forest. The information has been updated accordingly.

The reference period of 2005 -15 was used due to more information became available. 2005 is the reference year for Malaysia's Nationally Determined Contribution under the Paris Agreement.

Table 14: Description of changes in the previously submitted FRL

	1 <sup>st</sup> FRL	2018 FRL	2019 FRL
REDD Plus Activities covered	One	Three	Three
Reference period	1992-2005 1997-2010	2000-2014	2005-2015
Results period	2006-15	2016-25	2016-2025
Forest types	PRF	PRF, TPA, SL excluding forest plantations and unmanaged forest	PRF, TPA, SL excluding forest plantations and unmanaged forest

Gases & pools	CO <sub>2</sub> and ABG	CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O;AGB, BGB; Emissions from drained peat swamp	CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O;AGB, BGB; Emissions from drained peat swamp
Scope	National	National	National
Methodology	2006 IPCC GL for National Greenhouse Gas Inventories	2006 IPCC GL for National Greenhouse Gas Inventories	2006 IPCC GL for National Greenhouse Gas Inventories
NC/BUR methodology	NC2 (2011)- Revised 1996 IPCC & GPG 2003	BUR1(2016) - Revised 1996 IPCC & GPG 2003 NC3/BUR2(2018) – 2006 IPCC GL for GHG Inventories	NC3/BUR2 (2018) – 2006 IPCC GL for GHG Inventories

## 4.0 Forest definition

The forest definition used in the development of the reference level is based on the national legislation and circumstances, and is consistent with that used in 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 subjected under the National Forestry Act. Forest threshold values used are, a minimum area of 0.5 ha, 30% canopy cover and 5m height at maturity. The same thresholds are also applied under the Kyoto Protocol.

## 5.0 Malaysia's Proposed Reference Level

### 5.1 Proposed Reference Level

The proposed reference level for result based payments is the average net removals from 2005-2015 will be used for FRL period 2016-2025 is shown in Table 14.

Table 14: Malaysia's Proposed Forest Reference Level

Activity	Gg CO <sub>2</sub> eq/yr
Deforestation	9,983
Sustainable Management of forest	-195,030
Conservation	-20,725
Net	-205,771

Table 6: Total forest covered under the FRL construction

Year	PRF (mil ha)				TPA (mil ha)		State land Forest (mil ha)				Excluded from FRL (mil ha)	
	Inland	Fallow	PSF	Mangrove	Inland	PSF	Inland	PSF	Drained PS*	Fallow	Unmanaged	Forest Plantation
2005	10.235	0.61	0.611	0.438	1.82	0.095	1.201	0.369	0.2	1.04	0.969	0.2261
2006	10.239	0.607	0.623	0.438	1.821	0.095	1.162	0.376	0.2	1.04	0.969	0.2247
2007	10.234	0.48	0.625	0.438	1.827	0.096	1.182	0.393	0.2	1.04	0.969	0.2282
2008	10.26	0.42	0.622	0.438	1.845	0.096	1.163	0.397	0.2	1.042	0.962	0.2379
2009	10.133	0.42	0.442	0.428	1.858	0.096	1.484	0.375	0.2	1.042	0.962	0.2673
2010	9.978	0.42	0.453	0.428	1.975	0.12	1.728	0.34	0.2	1.042	0.955	0.2883
2011	9.98	0.42	0.463	0.428	2.014	0.12	1.603	0.329	0.2	1.042	0.955	0.377
2012	9.546	0.454	0.474	0.428	2.323	0.12	1.917	0.204	0.2	1	0.94	0.4061
2013	9.437	0.454	0.466	0.428	2.418	0.12	1.833	0.208	0.2	1	0.94	0.5515
2014	9.051	0.473	0.488	0.5	2.625	0.12	2.25	0.055	0.152	1.02	0.925	0.6201
2015	8.829	0.473	0.361	0.504	2.961	0.13	2.248	0.151	0.152	1.02	0.925	0.6352

Table 7: Total Commercial Harvest for Malaysia

Malaysia	
Year	Commercial harvest (million m <sup>3</sup> )
2005	24.299
2006	22.363
2007	24.060
2008	21.857
2009	19.346
2010	18.451
2011	16.519
2012	14.781
2013	13.123
2014	13.640
2015	14.221

Table 8: Deforestation

Year	PRF (ha)			State Land Forest (ha)				Total (ha)
	Peat Swamp Forest	Inland Forest	Fallow	Inland	Fallow	Plantation	Peat Swamp Forest	
2005				149,000	2000			151,000
2006			10,000	10,000				20,000
2007				80000				82,000
2008			30,0000	1,000		1000		32,000
2009								
2010		10000						10,000
2011				7000				7,000
2012		3128						3,128
2013		5521						5521
2014		2827						2827
2015				136,000				136,000

Table 9: Growth rates for forest types

Forest type	Growth rate	Reference
PRF- Inland	9.3 tdm/ha/yr	NFI
PRF -Peat swamp	9.2 tdm/ha/yr	NFI5 and National Reports

PRF -Mangrove	11 tdm/ha/yr	Ong (1993)
TPA – Peat Swamp	9.2 tdm/ha/yr	NFI5 and National Reports
TPA- Inland Forest	4.3 tdm/ha/yr	NFI
State Land Forest	4.3 tdm/ha/yr	NFI
Fallow Forest	3.4 tdm/ha/yr	Kenzo et al (2010)
Drained Peat Swamp Forest/ State Land Peat Swmap Forest	3.4 tdm/ha/yr	National Report
Root: shoot ratio All forest except mangrove 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 <sup>3</sup> )	IPCC, 2006 GL
Emissions from organic soils		
Emissions from drained peat swamp forest (CO <sub>2</sub> )	1.36 tC/ha/yr	IPCC, 2006 GL
Direct N <sub>2</sub> O emissions from managed organic soils	8 kg (N <sub>2</sub> O-N/ha)	IPCC, 2006 GL
Biomass stocks ( AGB and BGB)		
Inland forest	228.92 tdm/ha	NFI5
Peat swamp forest	212.4 tdm/ha	NFI5
Inland State Land Forest	165.20 tdm/ha	NFI5
Inland Peat swamp Forest	113.28 tdm/ha	NFI5
Fallow	68.62 tdm/ha	Kenzo et al (2010)
Plantation	259.60 tdm/ha	IPCC,2003
Emissions from natural disturbance		
Forest fire	165.2 tdm/ha	20% of biomass burnt
CH <sub>4</sub> (g/kg d.m)	6.8	IPCC 20006
CO (g/kg d.m)	104	
N <sub>2</sub> O (g/kg d.m)	0.2	
NO <sub>x</sub> (g/kg d.m)	1.6	

Table 10: Global warming potential used

Gas	Chemical formula	GWP
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Methane	CH <sub>4</sub>	25
Nitrous oxide	N <sub>2</sub> O	298

## 6.0 Improvement plan and capacity needs

- 6.1 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.
- 6.2 Malaysia has started work on exploring soil modelling and it is anticipated to be reported in the next BUR.
- 6.3 Full assessment of forest data in some region has yet to be fully completed due to the accessibility.
- 6.4 Capacity building to conduct uncertainty assessment and projection is required.
- 6.5 Malaysia has started work for the next round of National Forest Inventory.



## 7.0 References

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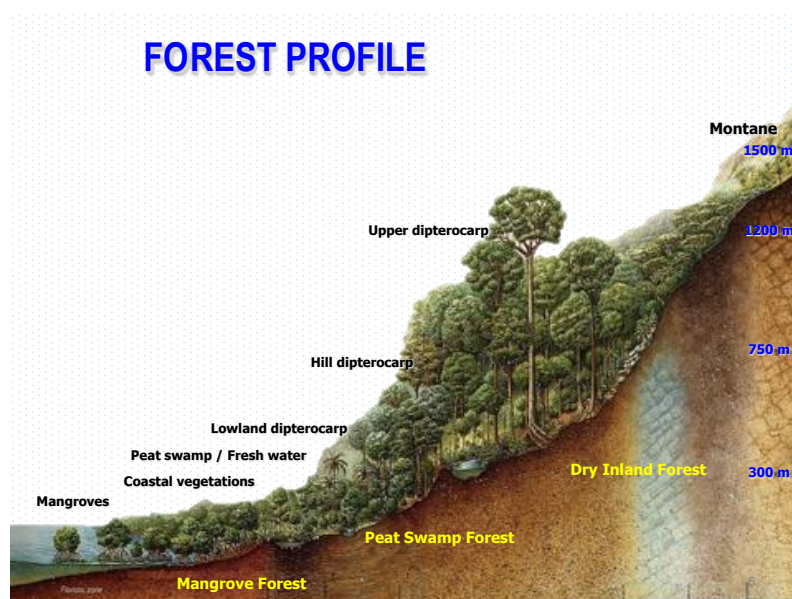
## CLASSIFICATION OF PRFs INTO FUNCTIONAL CLASSES

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:

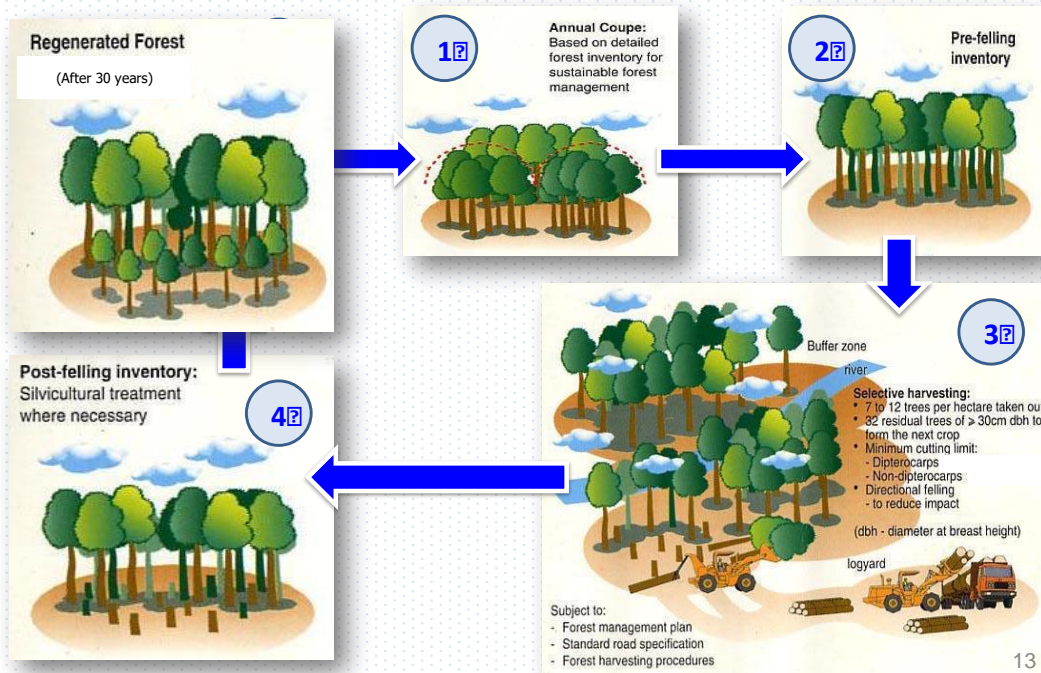
1. Timber Production Forest under sustained yield
2. Soil Protection Forest
3. Soil Reclamation Forest
4. Flood Control Forest
5. Water Catchment Forest
6. Forest Sanctuary for Wildlife
7. Virgin Jungle Reserves
8. Amenity Forest
9. Education Forest
10. Research Forest
11. Forest for Federal purposes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

11

## Forest profile in Malaysia



# SELECTIVE MANAGEMENT SYSTEM



**Table 14: Total removal by sinks and emissions from forest (million tonnes CO<sub>2</sub> eq)**

Year	Emission Gg CO <sub>2</sub> eq			
	PRF & SL	TPA	FL convert to Settlement	Total
2005	-189,833	-17,702	42,659	-164,205
2006	-194,019	-17,708	4,047	-206,997
2007	-189,800	-17,770	9,598	-197,254
2008	-194,423	-17,916	4,331	-207,313
2009	-196,617	-18,030	0	-213,926
2010	-197,632	-19,514	3,945	-212,501
2011	-200,994	-19,858	1,993	-218,119
2012	-198,506	-22,563	1,234	-219,099
2013	-199,044	-23,387	2,178	-219,546
2014	-195,746	-25,198	1,115	-219,312
2015	-188,717	-28,328	38,718	-177,907

Table 15: Non CO<sub>2</sub> gases

Year	Gg CO <sub>2</sub> eq			Gg	
	CH <sub>4</sub>	N <sub>2</sub> O	N <sub>2</sub> O-PSF	CO	NO <sub>x</sub>
2005	12.531	4.393	749.172	7.666	0.118
2006	7.442	2.609	749.172	4.553	0.070
2007	7.583	2.658	749.172	4.639	0.071
2008	0.337	0.118	749.172	0.206	0.003
2009	8.650	3.033	749.172	5.292	0.081
2010	13.930	4.884	749.172	8.522	0.131
2011	0.056	0.020	749.172	0.034	0.001
2012	2.516	0.882	749.172	1.539	0.024
2013	8.064	2.828	749.172	4.933	0.076
2014	15.068	5.283	569.18	9.218	0.142
2015	4.976	1.745	569.18	3.044	0.047

## ***Additional information***

### **Procedures for National Forest Inventory**

The NFI is stratified following the management and forest type.

1. Forest type in Malaysia is classified into 2 types as follows:
  - a. Inland forest
  - b. Peat swamp forest
2. In the Inland and Peat swamp forest, the category of forest are categorised following the management as follows:
  - a. Conservation forest as in State or National Parks, Wildlife Reserves
  - b. Permanent Reserved Forest where forest is managed under the sustainable forest management and where harvesting occurs.
  - c. State land forest, where forest is land bank for future development.
3. Emission factors are developed based on the forest type and management.
4. Each stratum is based on the forest type and management. The NFI 4 and 5 have the same stratification and design.
5. The stock in each stratum is calculated based on Brown's equation for both inventory periods.
6. The NFI is conducted as follows :

- i. Determining Number of Sampling Unit

The total number of Sampling Units (S.U.) for each forest stratum was determined according to the Coefficient of Varian (CV) and Standard Error (SE) at 95% probability level.

- ii. Inventory Method

The design is as below:

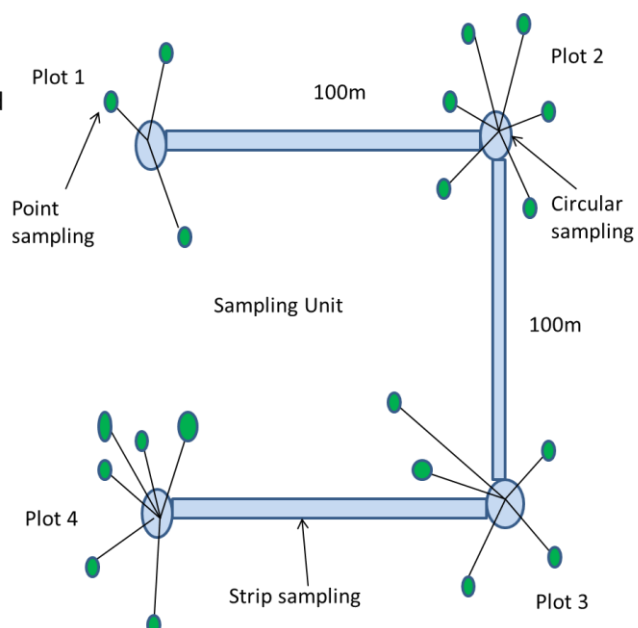
**Stratified random sampling**  
based on randomly distributed permanent sample units

**Circular Plots:**  
r = 4 m each, 0.02 ha

**Point Sampling:**  
Radius  $\leq$  50m from center of plot.

**Sample Strip:**  
Rectangular 100 m length, 4 m width each, 0.12 ha

**Total sample area: 0.14ha**





Inventory is carried using Relascope for point sample.

7. The increment is calculated by subtracting the stocks of each stratum between NFI4 and NFI5 and annualised.

### **Incremental Change in Tree Carbon Stocks Over Time**

These methods are used to estimate the change in tree carbon stocks over time using the tree increment method. This method to estimate change can only be used with permanent plots with tagged trees.

#### **Information required to complete the analysis:**

- Field data from permanent plots from at least two points in time

#### **Calculation Steps:**

- Calculate the AG biomass of each tree using an appropriate equation. Repeat for each monitoring period.
- Calculate the biomass per plot.
- Calculate AG Biomass of plot using allometric equation and expansion factors for time n. The mortality is subtracted from the AG biomass.
- Repeat for each plot and then calculate the mean incremental change and 95% CI for each stratum.

#### **Calculate incremental increase in AG biomass**

8. The IPCC software is used to estimate the removals and emissions. Aggregated national figure of commercial harvest is available and accordingly subtracted from the uptake together with biomass lost from fires.
9. Deforestation emission is accounted based on the forest type and management. Table 8 shows the total area of forest deforested based on the forest type and management.
10. Loss in carbon stocks is accounted with the assumption that all of the stocks are harvested and post development growth is not accounted.