

REDD Methodological Module

“Estimation of greenhouse gas emissions from biomass burning” – E-BB

Version – April 2010

I. SCOPE, APPLICABILITY AND PARAMETERS

Scope

This module provides a step-wise approach for estimating greenhouse emissions from biomass burning.

Applicability

If fire is used to clear the land or constitutes a cause of forest degradation, emissions of CO₂, N₂O and CH₄ result. Inclusion in the baseline is always optional. Where used in the baseline, accounting must occur under both the baseline and with project scenarios, and both ex-ante and ex-post. Tool **T-SIG** must be used to determine whether or not the emission source has to be included ex-post. Analysis using **T-SIG** shall be conducted for both the project area and the leakage belt.

As described in the Framework **REDD-MF** the use of this module is mandatory.

- Baseline:
 - In all cases, inclusion of greenhouse gas emissions from biomass burning is optional. If included in the baseline, emissions must be monitored ex-post
- Where not included in the baseline, an ex-ante assessment of the significance of greenhouse gas emissions from biomass burning shall be made using Tool **T-SIG**:
 - If biomass burning emissions are projected to be higher within the project boundaries in the with-project scenario than in the baseline and significant then the module shall be used ex-post for all emissions within the project boundaries
 - If biomass burning emissions are projected to be higher within the leakage belt in the with-project scenario than in the baseline and significant then the module shall be used ex-post for all emissions within the leakage belt
- Where emissions from biomass burning are shown ex-ante to not be significant, an ex-post analysis is required to justify continued omission of the emission source:
 - Tool **T-SIG** must be applied ex-post to any area of deforestation in the project area or the leakage belt. Where emissions are

significant the module shall be used to account greenhouse gas emissions.

- Where areas of fire are identified ex-post in the project area and these areas coincide with areas deforested in the baseline case the module shall be used to account greenhouse gas emissions

Parameters

Parameter	SI Unit	Description
$E_{BiomassBurn}$	tCO ₂ -e	Non-CO ₂ emissions due to biomass burning as part of deforestation activities

II. PROCEDURE

Greenhouse emissions from biomass burning can result from:

1. Conversion of forest land to non-forest land using fire
2. Periodical burning of grassland or agricultural land after deforestation.
3. Burning in forest land remaining forest land

This module describes how greenhouse emissions from biomass burning shall be estimated. Carbon dioxide may be omitted from calculations under this module if it can be shown that accounting of carbon dioxide emissions is accounted through stock change (e.g. where fire is used during deforestation).

Some GHG emissions can be measured, but because of the high spatial and temporal variability the following method shall be used. Based on the IPCC 2006 Inventory Guidelines, estimating greenhouse gas emissions from biomass burning shall be determined as:

$$E_{BiomassBurn} = \sum_{t=1}^T \sum_{i=1}^M \sum_{g=1}^G A_{burn,i,t} * B_{i,t} * COMF_i * G_{g,i} * 10^3 \quad (1)$$

Where:

$E_{BiomassBurn}$ Greenhouse emissions due to biomass burning as part of deforestation activities, tCO₂-e of each GHG (CO₂, CH₄, N₂O)

$A_{burn,i,t}$ area burnt for stratum i at time t , ha

$B_{i,t}$	average above-ground biomass stock before burning stratum i , time t ; tonnes d. m. ha ⁻¹
$COMF_i$	combustion factor for stratum i , dimensionless (see annex 1 for default values as derived from Table 2.6 of IPCC, 2006)
$G_{g,i}$	emission factor for stratum i for gas g , kg t ⁻¹ dry matter burnt (see section III and annex 2 for default values as derived from Table 2.5 of IPCC, 2006)
g	1, 2, 3 ... G greenhouse gases (to include carbon dioxide ¹ , methane and nitrous oxide)
i	1, 2, 3 ... M strata
t	1, 2, 3, ... t years elapsed since the start of the REDD project activity

$B_{i,t}$ The average above-ground biomass stock before burning for a particular stratum is estimated as follows:

$$B_{i,t} = (C_{AB_tree,i,t} + C_{DWi,t} + C_{LL,i,t}) * 12/44 * (1/CF) \quad (2)$$

Where:

$B_{i,t}$	average above-ground biomass stock before burning for stratum i , time t ; tonnes d. m. ha ⁻¹
$C_{AB_tree,i,t}$	Mean aboveground biomass carbon stock in stratum i at time t ; t CO ₂ -e ha ⁻¹ (estimated using the CP-AB)
$C_{DWi,t}$	carbon stock in dead wood for stratum i , at time t ; t CO ₂ -e ha ⁻¹ (estimated using CP-D)
$C_{LL,i,t}$	Mean carbon stock in litter for stratum i , at time t ; t CO ₂ -e ha ⁻¹ (estimated using CP-L)
$12/44$	Inverse ratio of molecular weight of CO ₂ to carbon, t CO ₂ -e t C ⁻¹
CF	Carbon fraction of biomass; t C t ⁻¹ d.m. (default carbon fraction of biomass is 0.47 tC t ⁻¹ d.m. (see also section III))

¹ Carbon dioxide may be omitted where carbon dioxide emissions are calculated in an alternate module through stock change

- i 1, 2, 3 ... M strata
- t 1, 2, 3, ... t years elapsed since the start of the REDD project activity

III. DATA AND PARAMETERS NOT MONITORED (DEFAULT OR MEASURED ONE TIME)

Data / parameter:	CF
Data unit:	$t\ C\ t^{-1}\ d.m.$
Used in equations:	2
Description:	Carbon fraction of dry matter
Source of data:	Default value $0.47\ t\ C\ t^{-1}\ d.m.$ can be used, or species specific values from the literature (e.g. IPCC 2006 INV GLs AFOLU Chapter 4 Table 4.3)
Measurement procedures (if any):	
Any comment:	

Data / parameter:	$COMF_i$
Data unit:	dimensionless
Used in equations:	1
Description:	combustion factor for stratum i (vegetation type)
Source of data:	default values in Table 2.6 of IPCC, 2006 (Annex 2)
Measurement procedures (if any):	
Any comment:	<p>The combustion factor is a measure of the proportion of the fuel that is actually combusted, which varies as a function of the size and architecture of the fuel load (i.e., a smaller proportion of large, coarse fuel such as tree stems will be burnt compared to fine fuels, such as grass leaves), the moisture content of the fuel and the type of fire (i.e., intensity and rate of spread).</p> <p>Default values shall be updated whenever new guidelines are produced by the IPCC</p>

Data / parameter:	G_{gi}
Data unit:	$g\ kg^{-1}\ dry\ matter\ burnt$

Used in equations:	1
Description:	Emission factor for stratum i for gas g ,
Source of data:	Defaults can be found in Volume 4, Chapter 2, of the IPCC 2006 Inventory Guidelines in table 2.5 (see Annex 2: emission factors for various types of burning for CH ₄ and N ₂ O).
Measurement procedures (if any):	
Any comment:	Default values shall be updated whenever new guidelines are produced by the IPCC

IV. DATA AND PARAMETERS MONITORED

V. PARAMETERS ORIGINATING IN OTHER MODULES

Data / parameter:	$A_{burn,i,t}$
Data unit:	ha
Used in equations:	1
Description:	Area burnt in stratum i at time t
Module parameter originates in:	M-EXP
Any comment:	Corresponding information shall be included in the PDD

Data / parameter:	$C_{AB,tree,i}$
Data unit:	t CO ₂ -e ha ⁻¹
Used in equations:	2
Description:	Carbon stock in aboveground biomass in trees in stratum i
Module parameter originates in:	CP-AB
Any comment:	Corresponding information shall be included in the PDD

Data / parameter:	$C_{DW,i}$
Data unit:	t CO ₂ -e ha ⁻¹

Used in equations:	2
Description:	Carbon stock in dead wood in the baseline in stratum <i>i</i>
Module parameter originates in:	CP-W
Any comment:	Corresponding information shall be included in the PDD

Data / parameter:	$C_{L,i}$
Data unit:	t CO ₂ -e ha ⁻¹
Used in equations:	2
Description:	Carbon stock in litter in the baseline in stratum <i>i</i>
Module parameter originates in:	CP-L
Any comment:	Corresponding information shall be included in the PDD



Annex 1:

Table 1.4 A summary of the total avoided deforestation for the top 10 forest types, calculated conservatively from 2010 to a national net land use change index (Values in million tons) and in the last five years (2010-2014)				
Vegetation type	Subcategory	2010	2014	2010-2014
Primary tropical forest (tropical rain forest)	Primary tropical forest	4.12	4.12	11.4, 11.4, 11.4, 11.4, 11.4
	Primary upland tropical forest	4.12	4.12	11.4
	Primary tropical peat forest	4.12	4.12	11.4, 11.4
	Primary tropical dry forest	-	-	11.4
All primary tropical forest		4.12	4.12	
Secondary tropical forest (tropical rain forest)	Young secondary tropical forest (0-10 years)	4.12	-	11.4
	Intermediate secondary tropical forest (10-20 years)	4.12	4.12	11.4, 11.4
	Advanced secondary tropical forest (20-100 years)	4.12	4.12	11.4, 11.4
All secondary tropical forest		4.12	4.12	11.4, 11.4, 11.4
All tropical forest		4.12	-	11.4, 11.4
Boreal forest	Wetland (peatland)	4.12	4.12	11.4
	Conifer forest	4.12	4.12	11.4, 11.4, 11.4, 11.4
	Deciduous forest	4.12	4.12	11.4, 11.4
	Forest logging (deciduous forest)	4.12	4.12	11.4, 11.4, 11.4
	Land clearing (deciduous forest)	4.12	-	11.4
All boreal forest		4.12	4.12	11.4, 11.4
Temperate forest	Wetland	-	-	
	Deciduous forest (temperate)	4.12	4.12	11.4, 11.4, 11.4
	Forest logging (deciduous forest)	4.12	4.12	11.4, 11.4
	Land clearing (deciduous forest)	4.12	-	11.4
All temperate forest		4.12	4.12	
Other tropical forest	Forest logging (deciduous forest)	4.12	4.12	11.4, 11.4, 11.4
	Land clearing (deciduous forest)	4.12	-	11.4, 11.4
All other tropical forest		4.12	4.12	11.4, 11.4



Table 1: Summary of avoided deforestation emissions (tCO ₂ e) by region and crop type				
(Values are in tCO ₂ e/ha/yr and are based on the 2010-2012 period)				
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Crop type	Technology	Mean	SD	Maximum
Soybean	Doublet (green)	0.01	—	44
	Coffee (brown)	0.13	0.08	38, 50, 59
	Pepper	0.04	0.04	70, 80
All doublet		0.01	0.08	
Soybean (doublet) early dry season (brown)	Soybean (doublet)	0.01	—	38
	Soybean (doublet)	0.13	—	31
	Other soybean (doublet)	0.01	0.08	31, 38
All soybean (doublet) early dry season (brown)		0.04	0.08	
Soybean (doublet) mid/late dry season (brown)	Soybean (doublet)	0.13	—	44, 51
	Soybean (doublet)	0.01	0.01	31, 4, 39
	Tropical soybean	0.13	0.08	31, 38, 44, 51
	Other soybean (doublet)	0.04	0.08	31, 38, 44, 51, 57
All soybean (doublet) mid/late dry season (brown)		0.19	0.08	
Soybean (doublet) mid/late dry season (brown)	Tropical soybean (doublet)	0.13	—	38
	Doublet	—	—	88
All soybean (doublet) mid/late dry season (brown)		0.19	—	
Soybean (doublet) mid/late dry season (brown)	Tropical soybean (doublet)	0.01	0.01	44, 51, 58, 51, 51
	Tropical soybean	0.01	0.01	4, 31, 38, 44
	Soybean	0.04	0.01	31, 3, 38, 44, 51, 5, 47, 31, 44, 47, 58
All soybean (doublet) mid/late dry season (brown)		0.11	0.08	
Other soybean type	Doublet	0.01	—	38, 44
	Tropical soybean	0.13	—	44
Soybean (doublet) mid/late dry season (brown)	Other soybean	0.04	—	see Note 1
	Other soybean	0.01	—	see Note 1
	Other soybean	0.01	—	see Note 1
	Other soybean	0.01	—	see Note 1

1. Soybean (doublet) early dry season (brown)

2. Soybean (doublet) mid/late dry season (brown) (includes soybean (doublet) early dry season)

3. For soybean (doublet) mid/late dry season (brown) (includes soybean (doublet) early dry season)

4. Soybean (doublet) early dry season (brown)



Annex 2:

TABLE 2.6 Emissions (in tonnes kg^{-1} dry matter weight) for various types of burning. Values are means \pm SD and are based on the comprehensive review by Janssens et al. and Schellekens (2005). (To be used as quantity kg^{-1} as Equation 2.17)					
Category	CO_2	CO	CH_4	N_2O	SO_2
Forces and grassland	1413 \pm 91	40 \pm 35	2.1 \pm 0.9	0.21 \pm 0.00	3.9 \pm 2.4
Agricultural residues	1310 \pm 177	90 \pm 84	2.7 \pm 1.0	0.07 \pm 0.00	2.3 \pm 1.0
Tropical forest	1780 \pm 90	106 \pm 30	6.8 \pm 2.9	0.20 \pm 0.00	1.8 \pm 0.7
Extra tropical forest	1549 \pm 131	107 \pm 37	6.7 \pm 1.9	0.26 \pm 0.07	3.0 \pm 1.4
Biomass burning	1150 \pm 93	78 \pm 31	6.1 \pm 2.7	0.06 \pm 0.00	1.1 \pm 0.4

Note: The 'extra tropical forest' category includes all other forest types.

Note: The combustion of non-woody biomass in Grassland and Cropland, CO_2 emissions do not need to be estimated and reported, because it is assumed that natural CO_2 emissions (through growth) and emissions (release by decay or fire) by biomass are in balance (see further discussion on cropland in Section 2.4).

