T-VER-P-TOOL-01-05

Calculation for non-CO_2 greenhouse gas emissions from burning of biomass in forest project activities

Version 01

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Thailand Greenhouse Gas Management Organization (Public Organization) (TGO)

1. Introduction

This document is a tool for estimating greenhouse gas emissions estimating non-CO_2 greenhouse gas emissions from burning of biomass in forest project activities, excluding carbon dioxide emissions from biomass burning which can be used to estimate greenhouse gas emissions in both baseline and project scenarios.

2. Relevant Definitions

Details appear in Annex 1

3. Characteristics of Relevant Activities and Conditions

This tool is suitable for estimating greenhouse gas emissions from biomass burning and forest fires occurring in the project area.

Greenhouse gas emissions from fires in project areas will be assessed if the fire area is more than 5 percent of the total project area.

4. Hypothesis

This tool provides assumptions to scope greenhouse gas emission estimation from biomass burning

1) Not estimate greenhouse gas emissions from above-ground biomass burning of trees in cases where
    a. A forest fire burn from the understory and do not spread to the tree canopy
    b. A forest fire are spreading and burning trees, but not putting trees down and still allowing new leaves regeneration within 6 months. This can be demonstrated by remote sensing imagery
2) The biomass of dead organic matter that has been burned completely is at least 60%.

5. Estimation of greenhouse gas emissions from biomass burning and forest fire

Estimation of greenhouse gas emissions resulting from biomass burning and forest fires in the project area consists of the emission in site preparation activities, management of plant residues and forest fire. The estimation is shown as follows:

$$GHG_{Burning,t} = GHG_{SPE,t} + GHG_{FMF,t} + GHG_{FF,t}$$

Where

$GHG_{Burning,t}$ = Greenhouse gas emissions from biomass burning and forest fires in the project area in the year t (tons of carbon dioxide equivalent)

$GHG_{SPE,t}$ = Greenhouse gas emissions from fire in the site preparation activities in the year t (tons of carbon dioxide equivalent)

$GHG_{FMF,t}$	=	Greenhouse gas emissions from fire in harvest residue management activities before replanting in the year t (tons of carbon dioxide equivalent)
$GHG_{FF,t}$	=	Greenhouse gas emissions from forest fires in year t (tons of carbon dioxide equivalent)
t	=	1, 2, 3, ... year since project initiation

<u>Option 1</u> **Greenhouse gas emissions** from use of fire in site preparation

The greenhouse gas emissions from use of fire and site preparation activities in year t is estimated as follows:

(1) If the baseline (not exceed 10 years) before the project operation was not slashed and burned as common practice, the area will be estimate GHG emission from site preparation activities with 0 burning value.

$$GHG_{SPE,t} = 0$$

(2) If the project area is prepared in other ways, the emission is estimated with the following equation

$$GHG_{SPE,t} = 0.07\ x \sum_{i=1}^{M} A_{SPE,i,t}\ x\ \frac{44}{12}\ x\ (CF_{TREE}\ x\ b_{TREE})$$

Where

$GHG_{SPE,t}$	=	Non-carbon oxide GHGs emissions from use of fire in site preparation activities in the year t (tons of carbon dioxide equivalent)
0.07	=	Ratio non-carbon oxide GHGs to carbon oxide emission resulting from burning of biomass (adapted from Table 2.52006 IPCC Guidelines for National GHG Inventories considering only methane and nitrous oxide)
$A_{SPE,i,t}$	=	Area of land in which fire is used in site preparation in stratum i in year t (rai)
$\frac{44}{12}$	=	Proportion of carbon dioxide to carbon molecular mass
CF_{TREE}	=	Carbon fraction of biomass (tons of carbon per ton of dry weight)
$b_{TREE,i,t}$	=	Mean tree biomass per rai in stratum i of the project area at the project start date (ton dry weight per rai)

(1) Calculation using " T-VER-P-TOOL-01- 0 2 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities" tool

(2) If the trees presented before the project were not burned during the site preparation, set the value $b_{TREE,i}$ equivalent to 0.

t = 1, 2, 3, ... year since project initiation

i = Stratum within the baseline

Option 2 Greenhouse gas emissions from harvest residual management from burning before replanting

The greenhouse gas emissions from burning harvest residual to clear the land before replanting of the land in year t was estimated using the ratio of the biomass left at project area to the biomass harvested. In this regard, the fuelwood harvest has a lower ratio than the timber harvest by using two methods of calculation as follows:

(1) In the case of the data collected from the biomass of trees cut and removed from project area.

$$GHG_{FMF,t} = 0.07 \; x \; B_{HARVEST,t} \; x \; \frac{44}{12} x \; f_{BL} \; x \; CF_{TREE}$$

Where

$GHG_{FMF,t}$ = Non-carbon oxide GHGs emissions from use of fire to clear the land of harvest residue before replanting of the land in the year t (ton of carbon dioxide equivalent)

0.07 = Ratio non-carbon oxide GHGs to carbon oxide emission resulting from burning of biomass (adapted from Table 2.52006 IPCC Guidelines for National GHG Inventories considering only methane and nitrous oxide)

$B_{HARVEST,t}$ = Biomass harvested from area subjected to use of fire to clear the land of harvest residue prior to replanting of the land in year t (ton dry weight)

$\frac{44}{12}$ = Proportion of carbon dioxide to carbon molecular mass

CF_{TREE} = Carbon fraction of biomass (tons of carbon per ton of dry weight)

f_{BL} = The fraction of aboveground tree biomass out of total harvest left on project area

t = 1, 2, 3, ... year since project initiation
i = Stratum within the baseline

(1) In the absence of data of removed biomass

$$B_{HARVEST,t} = \frac{B_{FOREST}}{BEF_2} x\ A_{FMF,t}$$

Where

$B_{HARVEST,t}$ = Biomass harvested from area subjected to use of fire to clear the land of harvest residue prior to replanting of the land in year t (ton dry weight)

B_{FOREST} = Default aboveground biomass in forests in the region/country where the project is located (ton dry weight per rai)

BEF_2 = Biomass coefficient/density of any type of biomass content (value is equivalent to 1.25)

$A_{FMF,t}$ = Area of land subjected to use of fire to clear the land of harvest residue before replanting of the land in year t (rai)

t = 1, 2, 3, ... years since project initiation

Option 3 Greenhouse gas emissions from forest fires

The greenhouse gas emissions from forest fires are estimated from the loss of aboveground tree biomass and dead trees from forest fires in the project area. This does not include burning from site preparation and/or burning of post-harvest residues of crops. The estimation was made by using the above ground biomass in trees and dead trees of relevant project area in last verification. The estimated equation is as follows.

$$GHG_{FF,t} = GHG_{FF\_TREE,t} + GHG_{FF\_DOM,t}$$

Where

$GHG_{FF,t}$ = Non-carbon oxide emissions from forest fires in the project area in the year t (ton of carbon dioxide equivalent)

$GHG_{FF\_TREE,t}$ = Non-carbon oxide emissions from the loss of aboveground biomass of trees caused by forest fire in project areas in year t (tons of carbon dioxide equivalent)

$GHG_{FF\_DOM,t}$ = Non-carbon oxide emissions from the loss of dead organic matter due to forest fire in the project area in year t (tons of carbon dioxide equivalent)

1) Greenhouse gas emissions from aboveground biomass from loss of trees caused by forest fires

$$GHG_{FF\_TREE,t} = 0.001 \; x \sum_{i=1}^{M} A_{BURN,i,t} \; x \; b_{TREE,i,t_L} \; x \; COMF_i \; x \; (EF_{CH4,i} \; x \; GWP_{CH4} + EF_{N2O,i} \; x \; GWP_{N2O})$$

Where

$GHG_{FF\_TREE,t}$	=	Non-carbon oxide emissions from the loss of aboveground biomass of trees caused by forest fire in the project area in year t (tons of carbon dioxide equivalent)
$A_{BURN,i,t}$	=	Area burnt in stratum in stratum i in year t (rai)
b_{TREE,i,t_L}	=	Mean aboveground tree biomass per hectare in stratum i in year t_L which is the year in which last verification was carried out before occurrence of the fire (ton dry weight per Rai) If the pre-projected trees are not burned by a forest fire, set the value b_{TREE,i,t_L} to 0
$COMF_i$	=	Combustion factor in stratum i
$EF_{CH4,i}$	=	Emission factor for methane in stratum i (grams of methane per kilogram dry weight burned)
GWP_{CH4}	=	Global warming potential of methane
$EF_{N2O,i}$	=	Emission factor for nitrous oxide in stratum i (gram of gas nitrous oxide per kilogram dry weight burned)
GWP_{N2O}	=	Global warming potential of nitrous oxide
t	=	1, 2, 3, ... years since project initiation
i	=	1, 2, 3, ... M Strata

2) Greenhouse gas emissions from the loss of dead wood and organic matter caused by forest fires

Estimation of greenhouse gas emission from loss of dead wood and organic matter caused by forest fires is calculated using the dead organic matter stock at the last verification. In the following cases, their respective estimated equation is as follows.

(1) Where dead organic matter is not accounted at the verification period, the dead organic matter stock is assumed to be zero

(2) Where dead organic matter is accounted, for the first verification period emission resulting from the loss of dead organic matter due to fire is assumed to be zero and for subsequent verification periods, emissions are estimated as follows.

$$GHG_{FF\_DOM,t} = 0.07\ x \sum_{i=1}^{M} A_{BURN,i,t}\ x\ (C_{DW,i,t_L} + C_{LI,,i,t_L})$$

Where

$GHG_{FF\_DOM,t}$ = Non-carbon oxide emissions from the loss of dead wood and organic matter caused by forest fires in the project area in year t (tons of carbon dioxide equivalent)

$A_{BURN,i,t}$ = Area burned by forest fires in stratum i in year t (rai)

C_{DW,i,t_L} = Carbon stock in dead wood in the i^{th} stratum in the last validated tL year was carried out before occurrence of the fire. (tons of carbon dioxide equivalent per rai) using "T-VER-P-TOOL-01-03 Calculation of carbon stocks and change in carbon stocks in dead wood and litter in forest project activities"

$C_{LI,,i,t_L}$ = Carbon stock in litter in stratum i in year t which is the year in which last verification was carried out before occurrence of the fire (tons of carbon dioxide equivalent per Rai) using "T-VER-P-TOOL-01-03 Calculation of carbon stocks and change in carbon stocks in dead wood and litter in forest project activities"

t = 1, 2, 3, ... years since project initiation

i = 1, 2, 3, ... M Strata

6. Relevant Parameters

6.1 Parameter not required monitoring

Parameter	CF_{TREE}
Unit	Tons of carbon per ton of dry weight
Definition	Carbon fraction of biomass
Source of Information	Option 1 2019 refinement to the 2006 IPCC guidelines for national greenhouse gas inventories: Volume 4 Agriculture, Forestry and Other Land Use Option 2 As specified by TGO in the reference manual for the development of T-VER project according to the Thailand Forestry and Agriculture standards

	Option 3 Values derived from research published in recognized academic articles and can be identified as appropriate for the project area.
Remark	-

Parameter	B_{FOREST}
Unit	Tons of dry weight per rai
Definition	Default aboveground biomass in forests in the region/country where the project is located.
Source of Information	Option 1 2019 refinement to the 2006 IPCC guidelines for national greenhouse gas inventories: Volume 4 Agriculture, Forestry and Other Land Use Option 2 As specified by TGO in the reference manual for the development of T-VER project according to the Thailand Forestry and Agriculture standards Option 3 Values derived from research published in recognized academic articles and can be identified as appropriate for the project area.
Remark	-

Parameter	f_{BL}
Unit	No unit
Definition	The fraction of aboveground tree biomass out of total harvest left on project area
Source of Information	Option 1 A value equal to 0.25 is a conservative value. Refer to Table 3A.1.11 according to IPCC GPG LULUCF 2003. Option 2 As specified by TGO in the reference manual for the development of T-VER project according to the Thailand Forestry and Agriculture standards Option 3 Values derived from research published in recognized academic articles and can be identified as appropriate for the project area.
Remark	-

Parameter	$COMF_i$
Unit	No unit
Definition	Combustion coefficient (by vegetation type) at stratum i
Source of Information	Option 1 Recommended value as in Appendix 2 Option 2 As specified by TGO in the reference manual for the development of T-VER project according to the Thailand Forestry and Agriculture standards Option 3 Values derived from research published in recognized academic articles and can be identified as appropriate for the project area.
Remark	-

Parameter	EF_{CH4}
Unit	grams of methane per kilogram of dry weight burned
Definition	Emission factor for methane in the stratum i
Source of Information	Recommended values for tropical forests and other forests are 0.20 and 0.26 g of nitrous oxide per kg dry weight burned, respectively.
Remark	-

Parameter	EF_{N2O}
Unit	grams of nitrous oxide per kilogram of dry weight burned
Definition	Emission factor for nitrous oxide in the stratum i
Source of Information	Recommended values for tropical forests and other forests were 6.8 and 4.7 g of methane per kg dry weight burned, respectively.
Remark	-

6.2Parameter for monitoring

Parameter	$A_{SPF,t}$
Unit	Rai

Definition	Area of land in which fire is used in site preparation in stratum i in year t
Source of Information	- Area exploration - Use of Satellite/aerial imagery
Frequency of Monitoring	This area will be monitored whenever fire is used to prepare the area.
Remark	-

Parameter	$A_{FMF,t}$
Unit	Rai
Definition	Area of land subjected to use of fire to clear the land of harvest residue before replanting of the land in year t
Source of Information	- Area exploration - Use of Satellite/aerial imagery
Frequency of Monitoring	This area is monitored whenever plant residues from sintering are handled in incineration before replanting
Remark	-

Parameter	$A_{BURN,t}$
Unit	Rai
Definition	Area burned by forest fires in year t
Source of Information	- Area exploration - Use of Satellite/aerial imagery
Frequency of Monitoring	This area is monitored every time a forest fire occurs.
Remark	-

Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
Definition	The global warming potential of methane
Source of Information	Use data from the Climate Change Situation Assessment Report released by the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change or IPCC announced by TGO

Monitoring Method	For the preparation of project design document - Use the latest GWP_{CH4} value announced by TGO For monitoring the results of greenhouse gas emission reduction - Use the value of GWP_{N2O} as announced by TGO for greenhouse gas amount calculation during the crediting period for which the amount of greenhouse gas certification is requested.

Parameter	GWP_{N2O}
Unit	tCO_2e/tN_2O
Definition	The global warming potential of nitrous oxide
Source of Information	Use data from the Climate Change Situation Assessment Report released by the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change or IPCC announced by TGO
Monitoring Method	For the preparation of project design document - Use the latest GWP_{N2O} value announced by TGO For monitoring the results of greenhouse gas emission reduction - Use the value of GWP_{N2O} as announced by TGO for greenhouse gas amount calculation during the crediting period for which the amount of greenhouse gas certification is requested.

7. References

1. Clean Development Mechanism (CDM)

A/R Methodological Tool: Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity (Version 04.0.0)

2. 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 4 Agriculture, Forestry and Other Land Use

Annex

Annex 1 Relevant Definitions

Biomass burning	Burning parts of trees and sapling
Tree	Tree, perennial plant, or long-live timber with a height exceeding 1.30 m and a where the diameter at 1.30-meter height is 4.50 cm and above, except shrubs except shrubs
Aboveground biomass	The dry weight of all parts of a tree appeared above the ground such as trunk, branches, leaves, flowers and fruits.
Sapling	A tree that possesses characteristics of a tree, meaning having more than 1.30 meters in height where the diameter at 1.30-meter height is less than 4.50 cm
Diameter at Breath Height: DBH	The diameter of the tree was measured at the height of 1.30 meters from the ground or according to the selected biomass estimation equation conditions

Annex 2 Combustion coefficient (by vegetation type)

Forest type	Mean age (years)	Default value
Tropical forest	3-5	0.46
	6-10	0.67
	11-17	0.50
	18 and above	0.32
Boreal forest	all	0.40
Temperate forest	all	0.45

Source: A/R Methodological Tool: Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity (Version 04.0.0)

Document information

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