Revision to the A/R Methodological Tool

"Estimation of GHG emissions due to clearing, burning and decay of existing vegetation attributable to a CDM A/R project activity"

(Version 03)

I. SCOPE, APPLICABILITY, ASSUMPTIONS AND PARAMETERS

Scope

This tool can be used to estimate the increase in emissions of greenhouse gases due to live woody vegetation[1] existing within the proposed A/R project boundary—the "existing woody vegetation"—being cleared, burned, and/or left to decay as part of activities attributable to the A/R CDM project activity.

Applicability

Step 1: The use of this tool shall be preceded by the use the approved A/R CDM Guidance on conditions under which GHG emissions from removal of existing vegetation due to site preparation[2] are insignificant to determine whether the emissions are insignificant and may be accounted as zero, that is further use of this tool is not required.

Step 2: The tool provides a simplified default approach for estimating the increase in GHG emissions resulting from the clearance, burning and decay of existing vegetation due to site preparation and project implementation practices within the A/R CDM project boundary:

- **Increase in CO_2 emissions.** Project emissions may occur either as a result of clearance of existing live vegetation during site preparation (including by slash-and-burn practices) within the project boundary, and/or from decay of un-cleared existing live vegetation that dies as a result of competition from forest (or other vegetation) planted as part of the A/R project activity;
- **Increase in emissions of non-CO_2 greenhouse gases.** Project emissions will occur when existing live above-ground vegetation[3] within the project boundary is either partially or

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[1] In accordance with the guidance provided by the Executive Board at its forty-second meeting, GHG emissions from removal of herbaceous vegetation may be considered as insignificant and hence can be neglected in A/R baseline and monitoring methodologies and tools (refer to paragraph 35 of the meeting report).

[2] The term "site preparation" as used henceforth in this document includes all aspects of the A/R project activity that result in emissions from existing woody vegetation, whether these are specifically mentioned or not. This includes, *inter alia*, clearance of existing live woody vegetation by felling or fire, decay of felled or burned existing live woody vegetation, and decay of existing live woody vegetation that dies as a result of competition from forest (or other vegetation) planted as part of A/R project activities.

[3] Existing live vegetation that is involved in any of these site preparation activities is referred to henceforth simply as "existing vegetation". Note particularly that this tool does not provide methodology for estimating biomass in the dead organic matter pools at the time the project commences, nor for estimating emissions from these pools due to site preparation. If these pools are not accounted, both CO_2 and non-CO_2 emissions from the pools may be conservatively neglected, as it is expected that existing biomass stocks in these pools will be considerably smaller than in the project scenario. However, if either of these pools is accounted in a methodology that uses this tool, separate methodology must be provided to explicitly account for emissions from the dead organic matter pools—including those emissions due to site preparation.

totally burned as part of site preparation,[4] resulting in emissions of methane (CH_4) and nitrous oxide (N_2O)—although N_2O emissions are an insignificant proportion of total emissions from biomass burning and may be accounted as zero.

Assumptions

1. The following assumptions are made in developing this tool:

- If fire is used as part of site preparation the area burned shall be defined as a stratum, and all biomass in the stratum is considered to be burned;
- If fire is used as part of site preparation, all existing vegetation biomass remaining after fire is dead and instantaneously oxidised - whether felled as part of site preparation or not;
- If other site preparation methods are used the area cleared/felled shall be defined as a stratum, and all vegetation in the stratum is considered to be cleared/felled;
- Rates of decay of felled un-burned woody biomass, and of woody biomass left after burning, are the same. A constant rate of decay is assumed for woody biomass, consistent with IPCC default approaches.

Parameters

2. This tool provides procedures to determine the following parameters:

Parameter	SI Unit	Description
$E_{BiomassLoss,\,t}$	t CO_2	Increase in CO_2 emissions from loss of existing biomass due to site-preparation (including burning), and/or to competition from forest (or other vegetation) planted as part of the CDM-A/R project activity in year *t*
$E_{BiomassBurn,\,t}$	t CO_2-e	Increase in non-CO_2 emissions due to biomass burning of existing vegetation as part of site preparation in year *t*

Conventions Used in this Tool

3. In this methodological tool, biomass loss is determined separately for the tree and shrub vegetation classes. This is because these classes will usually have similar within-class—but very different between-class—values of mean biomass and combustion properties. Separating the emissions estimates by vegetation class is therefore expected to make calculations both simpler and more transparent.

4. There is no universal definition that uniquely distinguishes shrubs from smaller trees. If both smaller trees and shrubs are part of existing vegetation, then a practical working definition to distinguish these vegetation classes under field conditions shall be developed, and recorded in the CDM-AR-PDD as part of forest inventory standard operating procedures. Any such definition should be consistent with common practice in the region or country in which the project exists, and shall be

[4] For the purposes of this tool, the terms "existing live above-ground vegetation" and "existing vegetation" should always be taken as including that live vegetation that is felled as part of site preparation and so is actually dead at the time of burning (if fire is used). All such vegetation will be live at the time its biomass is assessed, at the time project commences.

applied uniformly to both existing vegetation, and vegetation established as part of A/R project implementation.

II. ESTIMATION OF EMISSIONS DUE TO CLEARING, BURNING AND DECAY OF EXISTING VEGETATION

5. An A/R CDM project activity may involve the partial or total clearance (including by burning) of existing vegetation as a result of site preparation. Alternatively, competition from forest or other vegetation established as part of A/R project activities can result in the death and decay of existing vegetation. These losses of existing biomass are treated as an increase in GHG emissions within the project boundary. In general, emissions from loss of existing biomass will occur as two components: emissions of CO_2 and non-CO_2 from biomass burning if "slash-and-burn" practices are used and emissions of CO_2 from decay of remaining burned and/or unburned vegetation.

6. To provide a simplified approach to estimation of CO_2 and non-CO_2 emissions associated with site preparation, the conservative default factors provided in Table 1 as derived from the IPCC literature can be used.

Table 1: The conservative default factors derived from the IPCC literature

Factor	Value	Description
CF_{tree}	0.50 t C (t d.m.)$^{-1}$	Average carbon fraction of biomass for tree vegetation
CF_{shrub}	0.49 t C (t d.m.)$^{-1}$	Average carbon fraction of biomass for shrub vegetation
$f_{BL, tree}$	0.4 t d.m. (t d.m.)$^{-1}$	The fraction of biomass of tree vegetation left to decay after burning
$f_{BL, shrub}$	0.05 t d.m. (t d.m.)$^{-1}$	The fraction of biomass of shrub vegetation left to decay after burning
R_{tree}	0.3 t d.m. (t d.m.)$^{-1}$	Average root:shoot ratio appropriate for biomass stocks, for tree vegetation
R_{shrub}	0.4 t d.m. (t d.m.)$^{-1}$	Average root:shoot ratio appropriate for biomass stocks, for shrub vegetation

The CO_2 emissions for each stratum in year *t* are given by:

$$E_{BiomassLoss, t} = \left(L_{SP, tree, t} + L_{SP, shrub, t}\right) {}^{44}\!/_{12} \quad \textbf{(1)}$$

and:

$$L_{SP, tree, t} = A_{S, t}\, B_{AB, tree} \left(1 + R_{tree}\right) CF_{tree} \quad \textbf{(2)}$$

$$L_{SP, shrub, t} = A_{S, t}\, B_{AB, shrub} \left(1 + R_{shrub}\right) CF_{shrub} \quad \textbf{(3)}$$

where:

$E_{BiomassLoss}$	Increase in CO_2 emissions from loss of biomass in existing vegetation as a result of site preparation; t CO_2
L_{SP}	Carbon stock loss in existing tree or shrub vegetation (as indicated by subscripts in equations) as a result of site preparation in year *t*; t C
$A_{S,\,t}$	Area of the stratum in year *t* (If fire is used as part of site preparation the area burned shall be defined as a stratum, and all biomass in the stratum is considered to be burned); ha
B_{AB}	Average above-ground biomass stock of tree or shrub vegetation (as indicated by subscripts in equations); t d.m. ha^{-1}
R	Average root:shoot ratio appropriate for biomass stocks, for tree or shrub vegetation (as indicated by subscripts in equations); t d.m. ha^{-1} (t d.m. ha^{-1})$^{-1}$
CF	Average carbon fraction of biomass for tree or shrub vegetation (as indicated by subscripts in equations); t C (t d.m.)$^{-1}$. IPCC default values for tree and shrub vegetation, respectively, are: 0.50, 0.49
$44/12$	Conversion factor: ratio of molecular weights of CO_2 and C; mol mol^{-1}

7. If fire is used for site preparation, in addition to the CO_2 emissions estimated using Equations (1) - (3) it is necessary to also estimate the instantaneous non-CO_2 emissions due to biomass burning. These are calculated as the fraction of above-ground biomass burned times the CH_4 emission ratio for biomass burning, and converted to CO_2 equivalents. For each stratum:

$$E_{BiomassBurn,\,t} = \left(L_{SP,\,fire,\,tree,\,t} + L_{SP,\,fire,\,shrub,\,t}\right) ER_{CH4} \; {}^{16}\!/_{12} \; GWP_{CH4} \qquad \textbf{(4)}$$

and:

$$L_{SP,\,fire,\,tree,\,t} = A_{S,\,t}\; B_{AB,\,tree} \left(1 - f_{BL,\,tree}\right) CF_{tree} \qquad \textbf{(5)}$$

$$L_{SP,\,fire,\,shrub,\,t} = A_{S,\,t}\; B_{AB,\,shrub} \left(1 - f_{BL,\,shrub}\right) CF_{shrub} \qquad \textbf{(6)}$$

where:

$E_{BiomassBurn,\,t}$	Increase in non-CO_2 greenhouse gas emissions due to biomass burning during site preparation in year *t*; t CO_2-e
$L_{SP,\,fire}$	Carbon stock loss from burning of existing tree or shrub vegetation (as indicated by subscripts in equations) during site preparation in year *t*; t C
ER_{CH4}	Emission ratio for CH_4 (IPCC default: 0.012),[5] kg C as CH_4 (kg C burned)$^{-1}$
GWP_{CH4}	Global warming potential for CH_4 (IPCC default: 21 for the first commitment period of the Kyoto Protocol); t CO_2-e (t CH_4)$^{-1}$
$A_{S,\,t}$	Area of the stratum in year *t*; ha
B_{AB}	Average above-ground biomass stock of existing tree or shrub vegetation (as indicated by subscripts in equations); t d.m. ha^{-1}

[5] Table 3A.1.15, Annex 3A.1, *GPG-LULUCF* (IPCC 2003).

f_{BL}	Average fraction of existing above-ground tree or shrub biomass (as indicated by subscripts in equations) left to decay after biomass burning; t d.m. ha^{-1} (t d.m. ha^{-1}) $^{-1}$
CF	Average carbon fraction of biomass for trees or shrub vegetation (as indicated by subscripts in equations); t C (t d.m.)$^{-1}$
$16/12$	Conversion factor: ratio of molecular weights of CH_4 and C; mol mol^{-1}

Data and parameters monitored

The following parameters should be monitored while using this tool. during the project activity. When applying all relevant equations provided in this methodology for the *ex ante* calculation of net anthropogenic GHG removals by sinks, project participants (PPs) shall provide transparent estimations for the parameters that are monitored during the crediting period. These estimates shall be based on measured or existing published data where possible and PPs should retain a conservative approach: that is, if different values for a parameter are equally plausible, a value that does not lead to over-estimation of net anthropogenic GHG removals by sinks should be selected.

Data / parameter:	A_s
Data unit:	ha
Used in equations:	2, 3, 5, 6
Description:	Area of stratum (If fire is used as part of site preparation the area burned shall be defined as a stratum, and all biomass in the stratum is considered to be burned)
Source of data:	Maps, orthorectified images, field-based GPS measurements
Measurement procedures (if any):	Monitoring of strata and stand boundaries shall be done preferably using a Geographical Information System (GIS), which allows for integrating data from different sources (including GPS coordinates and Remote Sensing data)
Monitoring frequency:	According to the applied schedule of site preparation activities in order to cover all of them
QA/QC procedures:	
Any comment:	

Data / parameter:	$B_{AB,\,tree}$
Data unit:	t d.m. ha^{-1}
Used in equations:	2,5
Description:	Average above-ground biomass stock of tree vegetation
Source of data:	Field measurement or estimate
Measurement procedures (if any):	Conservative estimate from IPCC or other default data[1]; by plot-based biomass inventory[2]; or by destructive harvest[2]
Monitoring frequency:	Project start;[1] or during field sampling of biomass[2]
QA/QC procedures:	
Any comment:	This parameter may be also estimated based on existing published data where possible

Data / parameter:	$B_{AB,\,shrub}$
Data unit:	t d.m. ha^{-1}
Used in equations:	3, 6
Description:	Average above-ground biomass stock of shrub vegetation
Source of data:	Field measurement or estimate
Measurement procedures:	Conservative estimate from IPCC or other default data;[1] by plot-based biomass inventory;[2] or by destructive harvest[2]
Monitoring frequency:	Project start;[1] or during field sampling of biomass[2]
QA/QC procedures:	
Any comment:	This parameter may be also estimated based on existing published data where possible

References

IPCC 2003. *Good Practice Guidance for Land Use, Land-use Change and Forestry*. This is available from the IPCC Secretariat <www.ipcc.ch>, or may be downloaded from the National Greenhouse Gas Inventory Programme at <http://www.ipcc-nggip.iges.or.jp>.

IPCC 2006. *Guidelines for National Greenhouse Gas Inventory. Volume 4; Agriculture, Forestry and Other Land*. Available from the IPCC Secretariat <www.ipcc.ch>, or downloadable from the National Greenhouse Gas Inventory Programme at <http://www.ipcc-nggip.iges.or.jp>.

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History of the document

Version	Date	Nature of revision
03	EB 50, Annex 22 16 October 2009	Following the classification of documents contained in the information note: Definitions of documents types issued by the Board (Annex 31 to EB 49 report) the guidance provided by the tool was updated and partitioned among several documents in order to allow their separate application.
02	EB 42, Para 35 26 September 2008	Following the guidance provided by the Executive Board at its forty second meeting, references to emissions from removals of herbaceous vegetation were removed (refer to paragraph 35 of the meeting report).
01	EB 36, Annex 20 30 November 2007	Initial adoption.
Decision Class: Regulatory **Document Type**: Tool **Business Function**: Methodology		