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A Global Benchmark for Carbon

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Methodology for Improved Forest Management Through Extension of Rotation Age (IFM ERA)

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This document contains methodology revisions proposed by Forest Carbon Works on January 23, 2023. All changes are proposed in red. Text that will be removed is proposed in ~~strikethrough~~ red text. This is the public comment version of the methodology and maintains the old format. After all public comments are collected and addressed the new version (v1.3) will be reformatted in the most recent VCS methodology template.

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1   SOURCES

This methodology is based on elements from the following methodologies:
- AR-ACM0001 *Afforestation and reforestation of degraded land*
- The *Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities*

This methodology also refers to the latest approved versions of the following tools:
- The CDM Additionality Tests (available at: http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf)
- The UNFCCC *Tool for testing significance of GHG emissions in A/R project activities* (available at: http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-04-v1.pdf)
- The UNFCCC tool for the *Calculation of the number of sample plots for measurements within A/R CDM project activities* (available at: http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.pdf)

2   SUMMARY DESCRIPTION OF THE METHODOLOGY

This methodology quantifies the GHG emission reductions and removals generated from improving forest management practices to increase the carbon stock on land by extending the rotation age of a forest or patch of forest before harvesting. By extending the age at which trees are cut, projects increase the average carbon stock on the land and remove more emissions from the atmosphere.

3   DEFINITIONS

Terms

Clear Cut: The harvest of all trees in an area

Logging Slash: Branches, other dead wood residues, and foliage left on the forest floor after timber removal

Patch Cut: A clear cut on a small area (less than one hectare)

Seed Tree: A variant system on clear cut with limited mature trees being left to provide seeds for regeneration

Group Selection: A variant on clear cut with groups of trees being left for wildlife habitat, wind firmness, soil retention or other silvicultural goals

Individual Tree Selection: A management practice that removes only the largest most valuable individual trees, also known as "high grading"

Tree: A perennial woody plant with a diameter at breast height > 5 cm and a height greater than 1.3 m.

Commercial Harvesting: Removing any trees from the project area for any purpose other than for the limited collection of Firewood or Sanitation Removal.

Firewood: Wood harvested and burned for personal use or for the limited sale as a heating fuel in the immediate vicinity.

Sanitation Removal: The intentional removal of trees for the purpose of preventing disease or to correct a natural disturbance.

List of acronyms

A/R	Afforestation/Reforestation (under CDM)
AFOLU Guidelines	Agriculture, Forestry and Other Land Uses section of the IPCC Guidelines for National Greenhouse Gas Inventories 2006.
CDM	Clean Development Mechanism
GPG LULUCF	Intergovernmental Panel on Climate Change's Good Practice Guidance for Land-Use Land Use Change and Forestry
IFM	Improved forest management (under VCS)
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit (units of credit under VCS)
FSC	Forest Stewardship Council

4   APPLICABILITY CONDITIONS

This methodology is applicable to Improved Forest Management (IFM) project activities that involve an extension in rotation age (ERA).

The conditions under which the methodology is applicable are:

- Forest management in both baseline and projects cases that involves harvesting techniques such as clear cuts, patch cuts, seed tree, continuous thinning or group selection practices.
- Forests which are unmanaged, or managed by individual tree selection, in the baseline case are not eligible under this methodology.
- Forests must be certified by the Forest Stewardship Council (FSC) prior to any harvesting or active management.
- Prior to the first verification event, the project area must meet one of the following conditions: Certified to Forest Stewardship Council (FSC); OR Subject to an easement, or equivalent instrument, recorded against the deed of property that prohibits Commercial Harvesting for the duration of the crediting period, unless later certified to FSC
- Project proponents must define the minimum project length in their project description document.
- The project does not encompass managed peat forests and the proportion of wetlands are not expected to change as part of the project
- Project proponents must have a projection of management practices in both with and without project scenarios.
- If fire is used as part of forest management then fire control measures, such as installation of fire-breaks or back-burning, shall be taken to ensure fire does not spread outside the project area—that is, no biomass burning shall be permitted to occur beyond the project area due to forest management activities.
- There may be no leakage through activity shifting to other lands owned or managed by project proponents outside the bounds of the project area.

5   PROJECT BOUNDARY

5.1   GHG Sources and Sinks

The carbon pools included in or excluded from the project boundary are shown in Table 1.

Table 1: Selected Carbon Pools

Carbon pools	Selected (Yes or No)	Justification / Explanation of choice
Above-ground biomass	Yes	Major carbon pool subjected to the project activity
Below-ground biomass	Yes	Below-ground biomass stock is expected to increase due to the implementation of the VCS IFM project activity. Belowground biomass subsequent to harvest is not assessed with the conservative assumption of immediate emission.
Dead wood	Conditional	Dead wood stocks can be conservatively excluded UNLESS the project scenario produces greater levels of slash than the baseline AND slash is burned as part of forest management. If slash produced in the project case is left in the forest to become part of the dead wood pool, dead wood may be conservatively excluded. Alternatively, project proponents may elect to include the pool (where included the pool must be estimated in both the baseline and with project cases) as long as the dead wood pool represents less than 50% of total carbon volume on the site in any given modeled year.
Litter	No	Changes in the litter pool will be *de minimis* as a result of rotation extension.
Soil organic carbon	No	Changes in the soil organic carbon pool will be *de minimis* as a result of rotation extension.
Wood products	Conditional	This stock may increase or decrease (when compared to baseline) due to implementation of the project activity. The methodology provides an approach for accounting for this pool, but it allows also for exclusion of the wood products pool if transparent and verifiable information can be provided that carbon stocks in wood products are rising faster in the project case than in the baseline or are decreasing faster in the baseline than in the project case.

The emission sources included in or excluded from the project boundary area shown in Table 2. Any one of these sources can be neglected, i.e. accounted as zero, if the application of the most recent UNFCCC CDM *Tool for testing significance of GHG emissions in A/R project activities* (see section 10 References) leads to the conclusion that the emission source is insignificant.

Table 2: Emissions sources included in the project boundary

Sources	Gas	Included / Excluded	Justification / Explanation of choice
Burning of biomass	CO_2	Excluded	However, carbon stock decreases due to burning are accounted as a carbon stock change
	CH_4	Included	Non-CO_2 gas emitted from biomass burning
	N_2O	Excluded	Potential emissions are negligibly small

Following the guidance of the Executive Board of the CDM, emissions caused by combustion of fossil fuels and through the use of fertilizers are considered insignificant and are not considered here (UNFCCC CDM EB 44, UNFCCC CDM EB 42).

5.2   Project area and eligibility of land

The project area geographically delineates the improved forest management project activity under the control of the project proponents. The IFM project activity may contain more than one discrete area of land. At the time the project description is validated, the following shall be defined:

- Each discrete area of land shall have a unique geographic identification;
- Aggregation of forest properties with multiple landowners is permitted under the methodology with aggregated areas treated as a single project area;
- The project proponents shall describe legal title to the forest, rights of access to the sequestered carbon (or avoided carbon emissions), current land tenure, and forest management for each discrete area of forest;
- The project proponents shall justify that, during the project lifetime, each discrete area of land is expected to be subject to a change in forest management through activities under the control of the project proponents.

6   PROCEDURE FOR DETERMINING THE BASELINE SCENARIO

6.1   Selected Baseline Approach

"Changes in carbon stocks in the pools within the project boundary from the most likely land use at the time the project starts".

6.2   Preliminary screening based on the starting date of the IFM project activity

In accordance to the *VCS Standard v3*, or latest version, the start date for AFOLU projects can be earlier than 1 January 2002, provided that project validation and verification against the VCS has been completed by 1 October 2011, the project proponent can verifiably demonstrate that it had been designed and implemented as a climate change mitigation project from its inception, and that prior to 1 January 2002 the project engaged independent verifiers/monitoring experts and applied methodologies that now conform to this VCS-approved methodology to assess and quantify the project's baseline scenario, leakage and net emissions reductions/removals.

If the project proponents claim that the start date of the IFM project activity is before the date of validation, then the project proponents shall:

- Provide evidence that the starting date of the IFM project activity was after 1 January 2002, and
- Provide evidence that the incentive from the planned sale of VCUs was seriously considered in the decision to proceed with the project activity. This evidence shall be based on (preferably official, legal and/or other corporate) documentation that was available to third parties at, or prior to, the start of the project activity.

6.3   Determination of Baseline Scenario

Step 1a. Identify credible alternative forest management scenarios to the proposed VCS project activity

As per the applicability conditions the project must demonstrate a baseline that involves clear cut, patch cut, seed tree, continuous thinning or group selection forest management techniques, using such evidence as management plans, forest inventories, assessments by reputable forestry consultants, the common practice of alternative land owners and common practice in the region. If such a baseline cannot be demonstrated then this methodology cannot be applied. Unmanaged forest and management by individual tree selection must be excluded as per the

methodology applicability conditions.

Identify realistic and credible land-use scenarios that would have occurred on the land within the proposed project area in the absence of the IFM project activity under the VCS.[1] The scenario should be feasible for the project proponents or similar project proponents taking into account relevant national and/or sectoral policies[2] and circumstances, such as historical land uses, practices and economic trends. The identified land use scenario shall be limited to forested land uses. This process should clearly identify barriers and benefits of all potential scenarios. The possible land-use scenarios to be evaluated shall include:

- Continuation of the pre-project forest management (Historical Baseline),
- Legal requirements for forest management in the region (Legal Baseline),
- Common practice forest management in the region (Common Practice Baseline), and
- Forest management as modeled under the project but in the absence of registration as an IFM project activity.

For identifying realistic and credible land-use scenarios, land use records, field surveys, data and feedback from stakeholders, and information from other appropriate sources, including Participatory Rural Appraisal (PRA)[3] may be used as appropriate. All current land uses within the boundary of the proposed IFM project activity may be deemed realistic and credible.

IFM project proponents should use the following guidelines to define these possible land-use scenarios.

Guidance for Defining the Legal Baseline

The Legal Baseline is defined by the forest management scenario that maximizes net present value to the forest owner(s) through timber harvesting while reflecting all legal requirements for forest management. In many cases, the specific management practices defined by the project proponent in the Legal Baseline may not be explicitly addressed in the relevant forest practices regulations, and the legality and plausibility of these practices must be confirmed by an independent forest consulting entity.

Guidance for Defining the Common Practice Baseline

Common practice in the project region must be defined by an independent forest consulting entity and should consider the following elements of forest management:

1) Harvest rotations,
2) Harvest methods,
3) Species harvested and planted,
4) No harvest zones,
5) Riparian management areas,

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[1] For example, continuation of the pre-project land-use or switch to land-use typical for region where the IFM project is planned to be located, establishing agricultural plantation, tourist resort, hunting area/farm, utilizing regionally typical forms of funds investment or other economically attractive activities.

[2] The Annex 3 to the report of the EB at its twenty-second meeting and the Annex 19 to the report of the EB at its twenty-third meeting clarify how the relevant national and/or sectoral policies shall be taken into account during identification of a baseline scenario. See: http://cdm.unfccc.int/Reference/Guidclarif.

[3] Participatory rural appraisal (PRA) is an approach to the analysis of local problems and the formulation of tentative solutions with local stakeholders. It makes use of a wide range of visualisation methods for group-based analysis to deal with spatial and temporal aspects of social and environmental problems. This methodology is, for example, described in:
  • Chambers R (1992): Rural Appraisal: Rapid, Relaxed, and Participatory. Discussion Paper 311, Institute of Development Studies, Sussex.
  • Theis J, Grady H (1991): Participatory rapid appraisal for community development. Save the Children Fund, London.

6) Areas of steep slope or unstable soils, and/or

7) Maximum patch cut areas.

Step 1b. Selection of a single baseline forest management scenario

IFM project proponents must evaluate the identified plausible baseline management regimes relative to:

- A documented history of the operator (e.g., operator must have at least 20 years of management records to show normal historical practices). Common records to document history include data on timber cruise volumes, inventory levels, harvest levels, etc. on the property; and
- The legal requirements for forest management and land use in the area; and,
- A common practice standard among similar landowners in the area.

In all cases these three scenarios must be described by the project proponent, then reviewed, and approved as plausible and accurate by an independent forest consulting entity. Requirements for forest consultant qualifications will vary by region, however, the verifier should consider the following elements when reviewing consultant qualifications:

1) In those regions where a legally recognized certified forester designation exists, the forest consulting entity must have that designation

2) In those areas where there are no legal certified forester designations, the consultant must have either:

   a. Accreditation under a widely recognized elective accreditation program that grants "certified forester" designation (e.g. Society of American Foresters); or,

   b. Publicly filed management plans or harvest plans that demonstrate the participation of the consulting entity and their qualifications to review the required documentation. The alternative/land use scenario that is not prevented by any barrier or is the most financially viable shall be identified as the baseline scenario.

IFM project proponents should use the following guidelines to select the most plausible baseline scenario   to be modeled.

Historical Baseline

The Historical Baseline must be selected as the most plausible baseline scenario if the following documents exist for the forest property:

1) Historical records of forest management exist for 20 or more years preceding the project start date.

2) Historical records indicate that the management practices have surpassed the legal barriers provided by conforming with all local and regional forest legislation.

3) Historical records that indicate that the historical management does not surpasses financial barriers as indicated by providing below average market returns.[4]

If these documents do not exist, the project must be developed using the Legal or Common Practice Baselines.

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[4] Below-market returns shall be defined as 80% or less of the current prevailing internal rate of return for forestland investment in comparable forest types and locations, after considering the full array of timber, non-timber and ecosystem service net revenues associated with the property, averaged over the last five years. Forestland investment in comparable forest types and locations shall be defined as the common practice management.

Legal Baseline

If the Historical Baseline is not applicable based on the criteria above, the Legal Baseline must be selected as the most plausible baseline scenario if regulations of forest management practices exist and are readily enforced within the project region.

An independent forest consulting entity must confirm that the practices defined in the Legal Baseline by the project proponent are plausible considering verifiable evidence. During validation the forest consultant shall share with the validation/verification body evidence for their determination of the plausibility of the Legal Baseline. Such evidence shall in all situations be considered confidential and shall not be published or shared by the validation/verification body. Such evidence may include, for example: management plans, records of timber sales or harvesting by the project proponent within the project area or in other properties under their control; management plans, records of timber sales, or harvesting by other entities similar to the project proponent in the region; national or regional government statistics on forest management in the region; published data and analyses on forest management in the region; and/or spatial analyses on management options and/or carbon stocks in the focal region. As needed, the validation/verification body may consult additional independent forest consulting entities to verify the opinion provided by the independent forest consulting entity selected by the proponent and to determine that the Legal Baseline is plausible.

Common Practice Baseline

The Common Practice Baseline shall be selected as the most plausible baseline scenario whenever there is insufficient documentation to utilize the Historical Baseline and where forest management regulations do not exist or are not readily enforced in the project region.

It is possible that the Common Practice Baseline and project scenarios are the same, in which case the project scenario would not be considered additional.

During validation the forest consultant shall share with the validation/verification body evidence for their determination of common practice. Such evidence shall in all situations be considered confidential and shall not be published or shared by the validation/verification body. Such evidence may include, for example: management plans, records of timber sales or harvesting by the project proponent within the project area or in other properties under their control; management plans, records of timber sales, or harvesting by other entities similar to the project proponent in the region; national or regional government statistics on forest management in the region; published data and analyses on forest management in the region; and/or spatial analyses on management options and/or carbon stocks in the focal region.

7 PROCEDURE FOR DEMONSTRATING ADDITIONALITY

The project proponent shall test the additionality of the project using the current UNFCCC CDM *Tool for the demonstration and assessment of additionality* (see Section 10 References). In application of the Additionality Tool the project scenario as described ex-ante using this methodology and monitored using this methodology shall be evaluated alongside the baseline scenario identified in Step 1. If a financial analysis or a demonstration of barriers does not lead the preclusion of the project scenario, then the project shall be considered non-additional.

8 QUANTIFICATION OF EMISSION REDUCTIONS AND REMOVALS

8.1 Stratification

If the project area is not homogeneous, stratification must be carried out to improve the accuracy and precision of carbon stock estimates. Different stratifications may be required for the baseline and project scenarios in order to achieve optimal accuracy and precision of the estimates of net GHG emissions reductions or GHG removal by sinks.

For estimation of baseline carbon stocks strata must be defined on the basis of parameters that are key variables in any method used to estimate changes in managed forest carbon stocks, for example:

- Management regime,
- Site index / anticipated growth rates,
- Forest species, or
- Age class.

For this methodology, it will be important to stratify by management regime so that all areas to be clear cut or patch cut within a given year or within the years between monitoring events must be a stratum with further division if differences exist in site index, species and/or age class.

The project area must be stratified *ex-ante*. Further stratification beyond the parameters given above is not usually warranted. However, other parameters (e.g. soil type, climate) may be useful for *ex-post* stratification.

Note: In the equations used in this methodology, the letter I is used to represent a stratum and the letter M for the total number of strata: M_B is the number of *ex-ante* defined baseline strata as determined with the procedures above; M_B remains fixed. M_{PS} is the number of strata in the project scenario as determined *ex-ante*. *Ex-post* adjustments of the project scenario strata may be needed if unexpected disturbances occur during the project crediting period (e.g. due to fire, pests or disease outbreaks), severely affecting different parts of an originally homogeneous stratum or stand, or when forest management (thinning, harvesting, replanting) occurs at different intensities, dates and spatial locations than originally planned. In such a situation the project area affected by the disturbance and / or variation in forest management may be delineated as a separate stratum for the purpose of monitoring the carbon stock changes.

8.2 Baseline Net GHG Removals by Sinks

The baseline net removals are averaged over a modeled 100 year period to remove fluctuations and the impact of fluctuations on the difference between the baseline and the project cases.

The baseline net GHG Removals by sinks will be determined as:

$$\Delta C_{BSL} = \Delta C_{BSL,P} - GHG_{BSL,E}$$

(1)

where:

ΔC_{BSL} Baseline net greenhouse gas removals by sinks; t CO_2-e

$\Delta C_{BSL,P}$ Carbon stock changes in all pools in the baseline; t CO_2-e

$GHG_{BSL,E}$ Greenhouse gas emissions as a result of forest management activities within the project area in the baseline; t CO_2-e

$$\Delta C_{BSL,P} = \Delta C_{BSL,tree} + \left(\Delta C_{BSL,DW} \right) + \left(\Delta C_{BSL,WP} \right) \tag{2}$$

where:

$\Delta C_{BSL,P}$ Carbon stock changes in all pools in the baseline; t CO_2-e

$\Delta C_{BSL,tree}$ Carbon stock changes in trees in the baseline; t CO_2-e

$\Delta C_{BSL,DW}$ Carbon stock changes in dead wood in the baseline; t CO_2-e

$\Delta C_{BSL,WP}$ Carbon stock changes in wood products in the baseline; t CO_2-e

Dead wood may conservatively be excluded. Wood products may also conservatively be excluded if it can be shown that carbon stocks in the baseline scenario can be expected to decrease more or increase less, relative to the project scenario.

$$\Delta C_{BSL,tree} = \frac{\left(\sum_{i=1}^{M_B} \Delta C_{BSL,AG|BG,i,100} * \frac{44}{12} \right)}{100} * t^{*} \tag{3}$$

where:

$\Delta C_{BSL,tree}$ Carbon stock changes in above-ground and below-ground biomass of trees in the baseline; t CO_2-e

$\Delta C_{BSL,AG|BG,i,100}$ Summed annual net carbon stock change in above-ground and below-ground biomass for stratum i, (summed over the 100 year modeled baseline); t C

i 1, 2, 3 …M_B strata in the baseline scenario

t 1, 2, 3, … t^{*} years elapsed since the start of the IFM project activity

$44/12$ Ratio of molecular weight of CO_2 to carbon, t CO_2-e t C^{-1}

If dead wood is selected in Table 1:

$$\Delta C_{BSL,DW} = \frac{\left(\sum_{i=1}^{M_B} \Delta C_{BSL,DW,i,100} * \frac{44}{12} \right)}{100} * t^{*} \tag{4}$$

where:

$\Delta C_{BSL,DW}$ Carbon stock changes in dead wood in the baseline; t CO_2-e

$\Delta C_{BSL,DW,i,100}$ Summed annual net carbon stock change in dead wood for stratum i, (summed over the 100 year modeled baseline); t C

i 1, 2, 3 …M_B strata in the baseline scenario

t 1, 2, 3, … t^* years elapsed since the start of the IFM project activity

$44/12$ Ratio of molecular weight of CO_2 to carbon, t CO_2-e t C^{-1}

If wood products are selected in Table 1:

$$\Delta C_{BSL,WP} = \frac{\left(\sum_{i=1}^{M_B} \Delta C_{BSL,WP,i,t} * \frac{44}{12} \right)}{100} * t^*$$

(5)

where:

$\Delta C_{BSL,WP}$ Carbon stock changes in wood products in the baseline; t CO_2-e

$\Delta C_{BSL,WP,i,t}$ Baseline annual net carbon stock change in wood products for stratum i, at time t; t C yr^{-1}

i 1, 2, 3 …M_B strata in the baseline scenario

t 1, 2, 3, … t^* years elapsed since the start of the IFM VCS project activity

$44/12$ Ratio of molecular weight of CO_2 to carbon, t CO_2-e t C^{-1}

8.3   Carbon Stock Changes in the Baseline

$\Delta C_{BSL,AG|BG}$, $\Delta C_{BSL,DW}$ and $\Delta C_{BSL,WP}$ must be estimated using models of forest management across the baseline period. Modeling can be conducted with relative ease and confidence using a peer-reviewed forestry model. The PD must detail what model is being used and what variants have been selected. All model inputs and outputs must be available for inspection by the validator. The baseline must be modeled over 100 years.

The model must not assume the immediately release of carbon stock in the dead wood pool, as set out in the most recent version of the VCS *AFOLU Requirements*.

Examples of appropriate models include:
- US Forest Service's FVS: Forest Vegetation Simulator
- SPS: Stand Projection System
- FPS: Forest Projection System by Forest Biometrics
- CRYPTOS and CACTOS: California Conifer Timber Output Simulator

Models must be:

- Peer reviewed in a process involving experts in modeling and biology/forestry/ecology
- Used only in scenarios relevant to the scope for which the model was developed and evaluated
- Parameterized for the specific conditions of the project

In countries and regions where specific forestry models do not exist or are not available it is valid to employ a simple spreadsheet based model (including common simple growth models such as the Chapman Richards model of tree growth appropriately parameterized). Such models must be clearly labeled with all assumptions and justifications for assumptions presented. Spreadsheet models may also be necessary to extrapolate some growth models to include additional pools and harvest schedules.

It is inevitable that the input to models will be inventory data. However, the exact form of the input data is not prescribed here as this will vary by model but may include: cruised volumes, stand tables or plot data. The equations given in Section 5 must be used and detailed in full in the project description.[5]

The output of the models must be the annual changes in stocks of carbon in live aboveground tree biomass ($\Delta C_{BSL,AG|BG,i,t}$), dead wood ($\Delta C_{BSL,DW,i,t}$)and wood products ($\Delta C_{BSL,WP,i,t}$) by strata in the baseline scenario through the duration of the project.[6] If the model output is the annual stock (C) the change (ΔC) would be calculated as: $C_{t2} - C_{t1}$.

If the output for the tree is the volume then this must be converted to biomass and carbon using equations 13-18 in Section 5. If processing of alternative data on dead wood and wood products is necessary, equations 24-37~~5~~ may be used.

8.4   Baseline Emissions

The GHG emissions in the baseline within the project area can be estimated as:

$$GHG_{BSL,E} = \sum_{t=1}^{t^*} \left(E_{BSL,BiomassBurn,t} \right)$$

(6)

where:

$GHG_{BSL,E}$ Greenhouse gas emissions as a result of forest management activities within the project area

in the baseline; t CO_2-e

$E_{BSL,BiomassBurn,t}$ Non-CO_2 emissions due to biomass burning as part of forest management during the year t in

the baseline; t CO_2-e

t 1, 2, 3 …t^* years elapsed since the start of the IFM project activity

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[5] Input data including precision bounds must be made available to verifying organizations

[6] Where modeling produces changes in carbon stocks over five year periods the numbers shall be annualized to give a stock change number for each year.

GHG emission sources included or excluded from the project area can be neglected, i.e. accounted as zero, if the application of the most recent version of the CDM Additionality Tools (see section 10 References) leads to the conclusion that the emission source is insignificant.

8.4.1   Estimation of baseline non-CO2 emissions due to biomass burning

The non-CO_2 emissions due to biomass burning as part of forest management ($E_{BiomassBurn}$) shall be estimated by:

$$E_{BiomassBurn,t} = E_{BiomassBurn,CH_4,t}$$

(7)

where:

$E_{BiomassBurn,t}$ Non-CO_2 greenhouse gas emission at time t as a result of biomass burning due to forest management; t CO_2-e

$E_{BiomassBurn,CH4,t}$ CH_4 emissions at time t as a result of forest management; t CO_2-e

Estimation of CH_4 emissions based on the carbon stock loss from biomass burning during forest management is based on the biomass of logging slash burned, *BS* calculated using equation 9. This is multiplied by factors that adjust for the mass of CH_4 versus carbon released, and for the global warming potential of CH_4.

$$E_{BiomassBurn,CH_4,t} = BS_{BSL,t} * ER_{CH_4} * \frac{16}{12} * GWP_{CH_4}$$

(8)

where:

$E_{BiomassBurn,CH4,t}$ CH_4 emissions at time t as a result of forest management; t CO_2-e

$BS_{BSL,t}$ Carbon stock in logging slash subject to burning as part of forest management; t C

ER_{CH4} Emission ratio for CH_4 (if local data on combustion efficiency is not available or if combustion efficiency can not be estimated from fuel information, use IPCC default value, 0.012[7]); kg C as CH_4 (kg C burned)$^{-1}$

GWP_{CH4} Global warming potential for CH4 (IPCC default: 21 for the first commitment period of the Kyoto Protocol); t CO_2-e (t CH_4)$^{-1}$

16/12   Ratio of molecular weights of CH_4 and C; mol mol^{-1}

t   1, 2, 3, … t years elapsed since the start of IFM VCS project activities

If logging slash is not burned as part of forest management then:

$$BS_{BSL,t} = 0$$, otherwise:

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

$$BS_{BSL,t} = \sum_{j=1}^{S_{BSL}} \sum_{l=1}^{N_{j,t}} \left(\left(\left(f_j \left(DBH, H \right) \right) - \left(V_{l,j,t} * D_j \right) \right) * CF_j \right)$$

(9)

where:

$BS_{BSL,t}$ Carbon stock in logging slash subject to burning as part of forest management; t C

$V_{l,j,t}$ Harvested merchantable volume of tree l of species j at time t, m^3

D_j Basic wood density of species j; t d.m.m^{-3}

$f_j(DBH,H)$ Allometric equation for species j linking diameter at breast height (DBH) and possibly height (H) to above-ground biomass of living trees; t d.m. $tree^{-1}$

CFj Carbon fraction of biomass for tree species j; t C t^{-1} d.m. (IPCC default value = 0.5 t C t^{-1} d.m.)

l Sequence number of trees harvested

j 1, 2, 3 … S_{BSL} tree species in the baseline scenario

t   1, 2, 3, … t years elapsed since the start of IFM VCS project activities

8.5   Project net GHG removals by sinks

The actual net greenhouse gas removals shall be estimated using the equations in this section. When applying these equations for the *ex-ante* calculation of net anthropogenic GHG removals by sinks, project participants shall provide estimates of the values of those parameters that are not available before the start of monitoring activities.[8] Project proponents must retain a conservative approach in making these estimates.

$$\Delta C_{ACTUAL} = \Delta C_P - GHG_E$$

(10)

where:

ΔC_{ACTUAL} Actual net greenhouse gas removals by sinks; t CO_2-e

ΔC_P Sum of the changes in above-ground biomass, dead wood and wood products in the project scenario; t CO_2-e

GHG_E Increase in GHG emissions as a result of the implementation of the proposed IFM project activity within the project area; t CO_2-e

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[8] For the ex-ante estimation of changes in above-ground biomass, dead wood and wood products in the project scenario projects shall model the expected changes in stocks through the with-project management scenario using methods as described in Section 4.1

Note: In this methodology Equation (14) is used to estimate actual net greenhouse gas removals by sinks for the period of time elapsed between project start ($t = 1$) and the year $t = t^*$, t^* being the year for which actual net greenhouse gas removals by sinks are estimated. The "stock change" method must be used to determine annual, or periodic values.

8.5.1   Estimation of changes in the carbon stock

The verifiable changes in the carbon stock in tree above-ground biomass, dead wood and wood products are estimated using the following approach[9]:

$$\Delta C_P = \sum_{t=1}^{t^*} \Delta C_t * \frac{44}{12}$$

$$(11)$$

where:

ΔC_P Sum of the changes in above-ground biomass, dead wood and wood products in the project scenario; t CO_2-e

ΔC_t Annual change in carbon stock in all selected carbon pools for year t; t C yr^{-1}

t 1, 2, 3 … t^* years elapsed since the start of the IFM project activity

44/12   Ratio of molecular weights of CO_2 and carbon; t CO_2 t^{-1} C

ΔC_t shall be estimated using the following equation:

$$\Delta C_t = \sum_{i=1}^{M_{PS}} \left(\Delta C_{AG,i,t} + \Delta C_{BG,i,t} + \Delta C_{DW,i,t} + \Delta C_{WP,i,t} \right)$$

$$(12)$$

where:

ΔC_t Annual change in carbon stock in all selected carbon pools for year t; t C yr^{-1}

$\Delta C_{AG,i,t}$ Annual carbon stock change in above-ground biomass of trees for stratum i, (possibly average over a monitoring period); t C yr^{-1}

$\Delta C_{BG,i,t}$ Annual carbon stock change in below-ground biomass of trees for stratum i, (possibly average over a monitoring period); t C yr^{-1}

$\Delta C_{DW,i,t}$ Annual change in the dead wood carbon pool for stratum i, (possibly average over a monitoring period); t C yr^{-1}

$\Delta C_{WP,i,t}$ Annual change in the wood products carbon pool for stratum i, (possibly average over a monitoring period); t C yr^{-1}

i 1, 2, 3 … M_{PS} strata in the project scenario

---

[9] IPCC GPG-LULUCF 2003, equation 3.2.3

t   *1, 2, 3 … t* years elapsed since the start of the IFM project activity

Changes in carbon pools that are conservatively excluded from accounting shall be set equal to zero.

8.5.1.1 Tree Biomass

The mean carbon stock in aboveground biomass per unit area is estimated based on field measurements in sample plots. Plots may be permanent or temporary[10], they may have a defined boundary or be variable radius plots. Two methods are available: the Biomass Expansion Factors (*BEF*) method, and the Allometric Equations method.

Method 1: BEF method

Step 1: Determine based on available data, e.g. volume tables (*ex-ante*) and measurements (*ex-post*), the diameter (*DBH*, at typically 1.3 m [4.5 ft] above-ground level), and also preferably height (*H*), of all the trees above some minimum *DBH* in the sample plots.

Step 2: Estimate the volume of the commercial (merchantable) component of trees based on available equations or yield tables (if locally derived equations or yield tables are not available use relevant regional, national or default data as appropriate). It is possible to combine Steps 1 and 2 if there are field instruments (e.g. a relascope) that measure the volume of each tree more directly.

Step 3: Choose *BEF*, and root-shoot ratio *R* – see Section II.8 for guidance on source of data. If relevant information is available the *BEF* and *R* should be adjusted for forest type or stand structure.

Step 4: Convert the volume of the commercial component of the trees into the mean plot level carbon stock biomass of the commercial component of trees via wood density and carbon fraction:

$$CV_{AB\_plot,i,t} = \sum_{j=1}^{S_{PS}} \sum_{l=1}^{N_{j,i,sp,t}} (V_{l,j,i,sp,t} * D_j * CF_j)$$

<div align="right">(13)</div>

where:

$CV_{AB\_plot,sp,i\,t}$ Carbon stock of the commercial component of trees in plot *sp*, in stratum *i* at time *t*; t C

$V_{l,j,i,sp,t}$ Merchantable volume of tree *l* of species *j* in plot *sp* in stratum *i* at time *t*, m³ (if necessary convert from ft³ to m³ by multiplying by 0.0283)

D_j Basic wood density of species *j*; t d.m.m⁻³

CF_j Carbon fraction of biomass for tree species *j*; t C t⁻¹ d.m. (IPCC default value = 0.5 t C t⁻¹ d.m.)

l   Sequence number of trees on plot *sp*

i   *1, 2, 3, …M$_{PS}$* strata in the project scenario

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[10] Note that due to covariance tighter precision and hence fewer measurements can be used if permanent plots are elected. See guidance in IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry – Section 4.3. Available at: http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp4/Chp4_3_Projects.pdf

j		*1, 2, 3 … S_{PS} tree species in the baseline scenario*
t		*1, 2, 3 … t years elapsed since start of IFM project activity*

Step 5: Calculate the carbon stock in the commercial component of the trees for each stratum:

$$CV_{AB,i,t} = \sum_{sp=1}^{P_i} \frac{10000}{Ap} * CV_{AB\_plot,i,t}$$

(14)

where:

$CV_{AB,i,t}$	Carbon stock of the commercial component of trees in stratum i at time t; t C ha^{-1}
$CV_{AB\_plot,sp,i\,t}$	Carbon stock of the commercial component of trees in plot sp, in stratum i at time t; t C
Ap	Area of sample plot; m^2 (if necessary convert from ft^2 to m^2 by multiplying by 0.0929)
sp	*1, 2, 3 … Pi sample plots in stratum i in the project scenario*
i	*1, 2, 3 … M_{PS} strata in the project scenario*
t	*1, 2, 3 … t years elapsed since the start of the IFM VCS project activity*

If point sampling/basal area prism sampling is used then under Step 4 each tree should be multiplied by the number of trees per acre that it represents and under Step 5 the – 10000/Ap – factor should be omitted.

Step 6: Convert the mean carbon stock in the commercial component of the trees for each stratum into the total carbon stock in aboveground biomass via the BEF:

$$C_{AB,i,t} = CV_{AB,i,t} * BEF$$

(15)

where:

$C_{AB,i,t}$	Carbon stock in above-ground biomass of trees in stratum i at time t; t C ha^{-1}
$CV_{AB,i,t}$	Carbon stock of the commercial component of trees in stratum i at time t; t C ha^{-1}
BEF	Biomass expansion factor for conversion of merchantable biomass to total above-ground tree biomass; dimensionless
i	*1, 2, 3, …M_{PS} strata in the project scenario*
t	*1, 2, 3 … t years elapsed since the start of the IFM project activity*

Step 7: Calculate the carbon stock in below-ground biomass of all trees present in stratum i at time t:

$$C_{BB,i,t} = C_{AB,i,t} * R$$

(16)

where:

$C_{AB,i,t}$	Carbon stock in above-ground biomass of trees in stratum i at time t; t C ha^{-1}
$C_{BB,i,t}$	Carbon stock in below-ground biomass of trees in stratum i at time t; t C ha^{-1}
R	Root-shoot ratio appropriate for biomass stock; dimensionless

i	1, 2, 3 … M_{PS} strata in the project scenario
t	1, 2, 3 … t years elapsed since the start of the IFM project activity

Alternatively, the equations of Cairns et al. (1997)[11] may be used to calculate below-ground biomass stock (t ha^{-1}) from aboveground biomass stock (t ha^{-1})

If an appropriate equation exists to calculate belowground biomass directly from DBH it would be equally valid in this step.

Step 8: Calculate the mean carbon stock in tree biomass for each stratum:

$$C_{tree,i,t} = A_i * (C_{AB,i,t} + C_{BB,i,t})$$

(17)

where:

$C_{tree,i,t}$	Carbon stock in trees in stratum i at time t; t C
$C_{AB,i,t}$	Carbon stock in above-ground biomass of trees in stratum i at time t; t C ha^{-1}
$C_{BB,i,t}$	Carbon stock in below-ground biomass of trees in stratum i at time t; t C ha^{-1}
A_i	Area of stratum i; ha
i	1, 2, 3 … M_{PS} strata in the project scenario
t	1, 2, 3 … t years elapsed since the start of the IFM project activity

Step 8: Calculate the mean carbon stock change:

$$\Delta C_{AG,i,t} + \Delta C_{BG,i,t} = \frac{C_{tree,i,t2} - C_{tree,i,t1}}{T}$$

(18)

where:

$\Delta C_{AG,i,t}$	Annual carbon stock change in above-ground biomass of trees for stratum i; t C yr^{-1}
$\Delta C_{BG,i,t}$	Annual carbon stock change in below-ground biomass of trees for stratum i; t C yr^{-1}
$C_{tree,i,t}$	Carbon stock in trees in stratum i at time t; t C
T	Number of years between monitoring time $t1$ and $t2$ ($T = t2 – t1$); yr
i	1, 2, 3 … M_{PS} strata in the project scenario
t	1, 2, 3 … t years elapsed since the start of the IFM VCS project activity

Method 2: Allometric method

Step 1: As with Step 1 of the *BEF* method.

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[11] Cairns, M. A., S. Brown, E. H. Helmer, and G. A. Baumgardner. 1997. Root biomass allocation in the world's upland forests. Oecologia 111: 1-11

Step 2: Select or develop an appropriate allometric equation (if possible species-specific, or if not from a similar species) – see Section II.8 for additional guidance.

Step 3: Estimate carbon stock in above-ground biomass for each individual tree l of species j in the sample plot located in stratum i using the selected or developed allometric equation applied to the tree dimensions resulting from Step 1, and sum the carbon stocks in the sample plot:

$$C_{AB\_tree,j,i,sp,t} = \sum_{l=1}^{N_{j,sp}} f_j(DBH,H)*CF_j$$

(19)

where:

$C_{AB\_tree,l,j,i,sp,t}$ Carbon stock in above-ground biomass of trees of species j in plot sp in stratum i at time t; t C tree^{-1}

CFj Carbon fraction of biomass for tree species j; t C t^{-1} d.m. (IPCC default value = 0.5 t C t^{-1} d.m.)

$f_j(DBH,H)$ Allometric equation for species j linking diameter at breast height (DBH) and possibly height (H) to above-ground biomass of trees; t. d.m. tree^{-1}

i 1, 2, 3, …M_{PS} strata in the project scenario

j 1, 2, 3 … S_{PS} tree species in the baseline scenario

l 1, 2, 3, …$N_{j,sp}$ sequence number of individual trees of species j in sample plot sp

t 1, 2, 3 … t years elapsed since start of IFM project activity

Step 4: Convert the carbon stock in above-ground biomass to the carbon stock in below-ground biomass via root-shoot ratio, given by:

$$C_{BB\_tree,j,i,sp,t} = C_{AB\_tree,j,i,sp,t}*R$$

(20)

where:

$C_{BB\_tree,l,j,i,sp,t}$ Carbon stock in below-ground biomass of tree l of species j in plot sp in stratum i at time t, t C tree^{-1}

$C_{AB\_tree,l,j,i,sp,t}$ Carbon stock in above-ground biomass of tree l of species j in plot sp in stratum i at time t, t C tree^{-1}

R_j Root-shoot ratio appropriate for biomass stock; dimensionless

If an appropriate equation exists to calculate belowground biomass directly from DBH it would be equally valid in this step.

Step 5: Calculate total carbon stock in the biomass of all trees present in the sample plot sp in stratum i at time t

$$C_{tree,i,sp,t} = \sum_{j=1}^{S_{PS}} \left(C_{AB\_tree,j,i,sp,t} + C_{BB\_tree,j,i,sp,t} \right)$$

(21)

where:

$C_{tree,i,sp,t}$ — Carbon stock in trees in plot sp of stratum i at time t, t C

$C_{AB\_tree,l,j,i,sp,t}$ — Carbon stock in above-ground biomass of tree l of species j in plot sp in stratum i at time t; t C tree^{-1}

$C_{BB\_tree,l,j,i,sp,t}$ — Carbon stock in below-ground biomass of tree l of species j in plot sp in stratum i at time t, t C tree^{-1}

$N_{j,i,sp,t}$ — Number of trees of species j in plot sp of stratum i at time t

i — 1, 2, 3, …M_{PS} strata in the project scenario

j — 1, 2, 3 … S_{PS} tree species in the baseline scenario

t — 1, 2, 3 … t years elapsed since the start of the IFM project activity

Step 6: Calculate the mean carbon stock in tree biomass for each stratum:

$$C_{tree,i,t} = \frac{A_i}{Asp_i} \sum_{sp=1}^{P_i} C_{tree,i,sp,t}$$

(22)

where:

$C_{tree,i,t}$ — Carbon stock in trees in stratum i at time t; t C

$C_{tree,i,sp,t}$ — Carbon stock in trees in plot sp of stratum i at time t, t C

Asp_i — Total area of all sample plots in stratum i; ha

A_i — Area of stratum i; ha

sp — 1, 2, 3 … P_i sample plots in stratum i in the project scenario

i — 1, 2, 3 … M_{PS} strata in the project scenario

t — 1, 2, 3 … t years elapsed since the start of the IFM project activity

Step 7: Calculate the mean carbon stock change:

$$\Delta C_{AG,i,t} + \Delta C_{BG,i,t} = \frac{C_{tree,i,t2} - C_{tree,i,t1}}{T}$$

(23)

where:

$\Delta C_{AG,i,t}$ — Annual carbon stock change in above-ground biomass of trees for stratum i; t C yr^{-1}

$\Delta C_{BG,i,t}$ Annual carbon stock change in below-ground biomass of trees for stratum i; t C yr^{-1}

$C_{tree,i,t}$ Carbon stock in trees in stratum i at time t; t C

T Number of years between monitoring time $t1$ and $t2$ ($T = t2 − t1$); yr

i 1, 2, 3 … M_{PS} strata in the project scenario

t 1, 2, 3 … t years elapsed since the start of the IFM project activity

Note that for permanent plots with tagged trees, change in carbon stocks are tracked directly through estimates of carbon stock increments in individual trees summed across plots and strata. For detailed guidance see Pearson et al 2005.[12]

8.5.1.2   Dead wood (if selected in Table 1)

Dead wood included in the methodology comprises two components only – *standing dead wood* and *lying dead wood* (that is, below-ground dead wood is conservatively neglected). Considering the differences in the two components, different sampling and estimation procedures shall be used to calculate the changes in dead wood biomass of the two components. In all cases, dead wood modeling must include a decay function that is a 10-year linear decay or a more conservative alternative for dead wood that reflects a pattern of carbon loss over time.

$$\Delta C_{DW,i,t} = \frac{C_{DW,i,t2} - C_{DW,i,t1}}{T}$$

                                                          (24)

where:

$\Delta C_{DW,i,t}$ Annual carbon stock change in dead wood for stratum i, (averaged over a monitoring period); t C yr^{-1}

$C_{DW,i,t2}$ Carbon stock of dead wood in stratum i at time $t=2$; t C

$C_{DW,i,t2}$ Carbon stock of dead wood in stratum i at time $t=1$; t C

T Number of years between monitoring $t2$ and $t1$ ($T = t2-t1$); yr

i 1, 2, 3 … M_{PS} strata in the project scenario

t 1, 2, 3 … t years elapsed since the start of the IFM project activity

The methods to be followed in the measurement of the standing dead wood and the lying dead wood biomass are outlined below:

$$C_{DW,i,t} = \left(B_{SDW,i,t} + B_{LDW,i,t} \right) * CF_{DW}$$

                                                          (25)

where:

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[12] Pearson, T., Walker, S. and Brown, S. 2005. Sourcebook for Land Use, Land-Use Change and Forestry Projects. Winrock International and the World Bank Biocarbon Fund. 57pp. Available at: http://www.winrock.org/Ecosystems/files/Winrock-BioCarbon_Fund_Sourcebook-compressed.pdf

$C_{DW,i,t}$ Carbon stock of dead wood in stratum i at time t; t C

$B_{SDW,i,t}$ Biomass of standing dead wood in stratum i at time t; t d.m.

$B_{LDW,i,t}$ Biomass of lying dead wood in stratum i at time t; t d.m.

CF_{DW} Carbon fraction of dry matter in dead wood; t C t^{-1} d.m.

i 1, 2, 3 … M_{PS} strata in the project scenario

t 1, 2, 3 … t years elapsed since the start of the IFM project activity

Method: Standing Dead Wood

Step 1: Standing dead trees shall be measured using the same criteria and monitoring frequency used for measuring live trees. The decomposed portion that corresponds to the original above-ground biomass is discounted. Stumps must be inventoried as if they are very short standing dead trees.

Step 2: The decomposition class of the dead tree and the diameter at breast height shall be recorded and the standing dead wood is categorized under the following four decomposition classes:
- Tree with branches and twigs that resembles a live tree (except for leaves);
- Tree with no twigs but with persistent small and large branches;
- Tree with large branches only;
- Bole only, no branches.

Step 3: Biomass must be estimated using an allometric equation for live trees in the decomposition class 1. When the bole is in decomposition classes 2, 3 or 4, it is recommended to limit the estimate of the biomass to the main trunk of the tree.
If the top of the standing dead tree is missing, then the top diameter:
- May be assumed to be zero;
- May be measured if reachable or the broken top is identifiable on the ground or by using an instrument such as a relascope or laser inventory instrument;
- May be calculated proportionally to height assuming that the height of the intact dead tree would be equal to average height of all intact dead trees present in the same sample plot.

Step 4: The volume of dead wood is converted to biomass using the appropriate dead wood density class.

Method: Lying Dead Wood
The lying dead wood pool is highly variable, and stocks may or may not increase as the stands age depending if the forest was previously unmanaged (mature or unlogged) where it would likely increase or logged with logging slash left behind where it may decrease through time.

Step 1: Lying dead wood must be sampled using the line intersect method (Harmon and Sexton 1996).[13,14] Two 50-meter lines (164 ft) are established bisecting each plot and the diameters of the lying dead wood ($\geq$ 10 cm diameter [$\geq$ 3.9 inches]) intersecting the lines are measured.

Step 2: The dead wood is assigned to one of the three density states (sound, intermediate and rotten) using the 'machete test', as recommended by *IPCC Good Practice Guidance for LULUCF* (2003), Section 4.3.3.5.3.

Step 3: The volume of lying dead wood per unit area is calculated using the equation (Warren and Olsen 1964)[15] as modified by Van Wagner (1968)[16] separately for each density state:

$$V_{LDW,i,t} = \frac{\pi^2 * \left(\sum_{n=1}^{N} D_{n,i,t}^2 \right)}{8 * L} \tag{26}$$

where:

$V_{LDW,i,t}$ Volume of lying dead wood per unit area in stratum *i* at time *t*; m^3 ha^{-1}

$D_{n,i,t}$ Diameter of piece n of dead wood along the transect in stratum *i* at time *t*; cm (if necessary convert inches to cm by multiplying by 2.54)

N Total number of wood pieces intersecting the transect; dimensionless

L Length of the transect; m (if necessary convert ft to me by multiplying by 0.3048)

i 1, 2, 3 … M_{PS} strata in the project scenario

t 1, 2, 3 … *t* years elapsed since the start of the IFM project activity

To convert this to a mass per unit area multiply the volumes of each density state by their respective wood densities.

Step 4: Volume of lying dead wood shall be converted into biomass using the following relationship:

$$B_{LDW,i,t} = A_i * \sum_{dc=1}^{3} V_{LDW,i,t} * D_{DW,dc} \tag{27}$$

where:

$B_{LDW,i,t}$ Biomass of lying dead wood per unit area in stratum *i* at time *t*; d.m. ha^{-1}

$V_{LDW,i,t}$ Volume of lying dead wood per unit area in stratum *i* at time *t*; m^3 ha^{-1}

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[13] Harmon, M.E. and J. Sexton. (1996) Guidelines for measurements of wood detritus in forest ecosystems. US LTER Publication No. 20. US LTER Network Office, University of Washington, Seattle, WA, USA.

[14] A variant on the line intersect method is described by Waddell, K.L. 2002. Sampling coarse wood debris for multiple attributes in extensive resource inventories. Ecological Indicators 1: 139-153. This method may be used in place of Steps 1 to 3.

[15] Warren, W.G. and Olsen, P.F. (1964) A line intersect technique for assessing logging waste. *Forest Science* 10: 267-276.

[16] Van Wagner, C.E. (1968). The line intersect method in forest fuel sampling. *Forest Science* 14: 20-26.

$D_{DW,dc}$ Basic wood density of dead wood in the density class – sound (1), intermediate (2), and rotten (3); t d.m. m^{-3}

A_i Area of stratum i; ha

i 1, 2, 3 … M_{PS} strata in the project scenario

t 1, 2, 3 … t years elapsed since the start of the IFM project activity

8.5.1.3   Wood Products (if selected in Table 1)

The Wood Products pool is calculated through the following general steps for each harvest period h:

Step 1: Calculate the carbon in harvested timber removed from the project site based on wood densities and standard carbon conversions from biomass volumes

Step 2: Calculate the total carbon in harvested timber that will enter the wood products pool based on mill efficiencies and product disposition percentages

Step 3: Calculate the total carbon that will be stored for the short lived (≤3 years), medium lived (>3 years to 100 years) and long lived (100+ years)

The annual change in carbon stored in wood products is given in the following equation:

$$\Delta C_{WP,t1,t2} = \frac{C_{WP,t2} - C_{WP,t1}}{T}$$

(28)

where:

$\Delta C_{WP,t1,t2}$ Annual carbon stock change in wood products between time t1 and t2, (averaged over a monitoring period); t C yr^{-1}

$C_{WP,t2}$ Carbon stock of wood products at time $t=2$; t C

$C_{WP,t1}$ Carbon stock of wood products at time $t=1$; t C

T Number of years between monitoring $t2$ and $t1$ ($T = t2-t1$); yr

t 1, 2, 3 … t years elapsed since the start of the IFM VCS project activity

To calculate wood products two methods are available. The direct (*1605b*) method is only applicable within the 48 contiguous United States and for limited vegetation types. The less direct (*Winjum et al.*) method can be applied to any vegetation types throughout the world.

1.   **Method 1:** 1605b Method

The method uses the Forestry Appendix of the Technical Guidelines of the US Department of Energy's Voluntary Reporting of Greenhouse Gases Program (known as Section 1605(b)).[17] All harvested wood will be categorized by species and wood product (sawnwood or pulpwood). Wood density values for each species in the project area will be used to determine carbon volume for each cubic volume of wood delivered to processing facilities. Regional data supplied in Table 1.4 and Table 1.5 of the 1605(b) document provide values to determine the percentage of harvested softwoods and hardwoods that will be converted to sawnwood and pulpwood.

Step 1: Calculate the total carbon in harvested timber removed from the project site. This is calculated by taking the biomass of the total volume extracted from the start of the project to date from within the project area with extracted timber differentiated into hardwood, softwood, sawnwood and pulpwood classes (if necessary convert volumes in ft^3 to m^3 by multiplying by 0.0283):

$$EXC_{WP,ty} = \sum_{h=1}^{H_{PS}} \sum_{j=1}^{S_{PS}} (V_{ex,h,s|p,j} * D_j * CF_j)$$

(29)

where:

$EXC_{WP,ty}$	The summed stock of extracted biomass carbon from within the project area by wood product disposition (hardwood sawnwood/hardwood pulpwood/softwood sawnwood/softwood pulpwood) *ty*; t C
$V_{ex,h,s|p,j,}$	The volume of timber extracted from within the project area during harvest *h* by species *j* and wood product disposition *ty*; m^3
D_j	Basic wood density of species *j*; t d.m. m^{-3}
CF_j	Carbon fraction of biomass for tree species *j*; t C t^{-1} d.m. (IPCC default value = 0.5 t C t^{-1} d.m.)
h	*1, 2, 3 …*number of harvests since the start of the IFM project activity
j	*1, 2, 3 … S$_{PS}$* tree species in the baseline scenario
s|p	Wood product disposition – defined here as sawnwood or pulpwood

Step 2: Calculate the total carbon that will enter the wood products pool. All projects must calculate the total carbon in harvested biomass that enters the wood products pool after deducting harvest slash left on site, bark biomass and waste calculated through mill efficiencies. For the purposes of this protocol Tables 1.4, 1.5 and 1.6 can be used to estimate these values for different regions within the United States. Examples 1.4 and 1.5 are given on

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[17] http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf Also available as a US Forest Service General Technical Report at:
http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf

pages 25-27 of the 1605(b) document which demonstrate the methods that can be followed with different existing data sets.

Step 3: Calculate the total amount of carbon stored in short lived, medium lived and long lived wood products. For the purposes of this methodology the proportion of harvested carbon stored in wood products is equivalent to the proportion listed in the "In Use" column of Table 1.6 of the 1605(b) document for any given year after harvest. Each year's harvested carbon volume must be categorized into one of the following categories:

- Short lived wood products: harvested wood products and wood waste that will decay within 3 years.
- Medium lived wood products: harvested wood products and wood waste that will be retired between 3 and 100 years from the date of harvest.
- Long lived wood products: harvested wood products and wood waste that may be considered permanent (stored for 100 years or more).

To determine the proportion of harvested wood products that fall into each category, refer to the "In Use" column in the appropriate regional version of Table 1.6 of the 1605(b) document. For each harvested wood type (hardwood/softwood/pulpwood/sawnwood), two values are taken from the table: $P_{3\text{-year}}$, the percentage of total carbon stored in wood products after 3 years; and $P_{100\text{-year}}$, the proportion of harvested wood stored for 100 years. Three different values are calculated from this data, the short lived fraction (P_{SLF}), medium lived fraction (P_{MLF}), and long lived fraction (P_{LLF}):

$$P_{SLF} = 1 - P_{3\text{-year}}$$

$$P_{MLF} = P_{3\text{-year}} - P_{100\text{-year}}$$

$$P_{LLF} = P_{100\text{-year}}$$

Each category of wood products will store carbon according to the following rules:

- Short lived wood products – immediate loss of all carbon upon harvest
- Medium lived wood products – no loss of carbon upon harvest, but carbon stored will decrease by 1/20th for the next 20 years after harvest
- Long lived wood products – no loss of carbon

$$C_{WP,t,ty} = \sum_{h=0}^{t} ((C_{Mill,ty,h} * P_{LLF}) + [(C_{Mill,ty.h} * P_{MLF}) * ((20 - h)/20)]$$

(30)

Where:

$C_{WP,t,ty}$ The total carbon removed from the project site that remain stored in harvested wood products at Year t for harvest category ty (hardwood, softwood, sawnwood, pulpwood)

$C_{Mill,\,ty,h}$ the total carbon volume stored in wood products for harvest h, after deducting for mill efficiencies and product dispositions

h Year of harvest

$P_{SLF,MLF,LLF}$ The proportion of carbon stored in sawn hardwood/softwood or pulp hardwood/softwood "In Use" for the appropriate term. For short lived wood products this is 0. For medium lived wood products

this must be reduced by 1/20 for 20 years after harvest. 20 years after harvest the medium lived term becomes zero. Long lived storage proportion is 1 for the 100 years of the project life.

2. **Method 2:** The Winjum et al. Method

Step 1: Calculate the biomass of the total volume extracted from the start of the project to date from within the project area (if necessary convert volumes in ft^3 to m^3 by multiplying by 0.0283).

$$EXC_{WP,ty} = \sum_{h=1}^{H_{PS}} \sum_{j=1}^{S_{PS}} (V_{ex,h,ty,j} * D_j * CF_j)$$

(31)

where:

$EXC_{WP,ty}$ — The summed stock of extracted biomass carbon from within the project area class of wood product *ty*; t C

$V_{ex,h,ty,j,}$ — The volume of timber extracted from within the project area during harvest *h* by species *j* and wood product class *ty*; m^3

D_j — Basic wood density of species *j*; t d.m.m^{-3}

CF_j — Carbon fraction of biomass for tree species *j*; t C t^{-1} d.m. (IPCC default value = 0.5 t C t^{-1} d.m.)

h — *1, 2, 3 …number of harvests since the start of the IFM project activity*

j — *1, 2, 3 … S_{PS} tree species in the baseline scenario*

ty — Wood product class – defined here as sawnwood, wood-based panels, other industrial roundwood, paper and paper board, and other

Step 2: Calculate the total carbon in harvested timber that will enter the wood products pool based on mill efficiencies and product disposition percentages. All factors are derived from Winjum et al.1998.[18]

$$C_{Mill,ty} = \sum_{s,w,oir,p}^{ty} EXC_{WP,ty} * (1 - WW)$$

(32)

Where:

$C_{Mill,ty}$ — Carbon in wood products after milling for category *ty*

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[18] Winjum, J.K., Brown, S. and Schlamadinger, B. 1998. Forest harvests and wood products: sources and sinks of atmospheric carbon dioxide. *Forest Science* 44: 272-284

$EXC_{WP,ty}$ Total extracted wood volumes over all types ty

WW Wood waste fraction based on mill efficiency

s,w,oir,p Wood product categories: sawnwood, woodbase panels, other industrial roundwood, paper and paperboard

Wood waste fraction (WW):

Winjum et al indicate that the proportion of extracted biomass that is oxidized (burning or decaying) from the production of commodities to be equal to 19% for developed countries, 24% for developing countries. WW is therefore equal to $EXC_{WP,ty}$ multiplied by 0.19 for developed countries and 0.24 for developing countries (Winjum et al., p. 278).

Step 3: Calculate the total carbon that will be stored for the short lived (≤3 years), medium lived (>3 years to 100 years) and long lived (100+ years).

Each year's harvested carbon volume must be categorized into one of the following categories:

- Short lived wood products: harvested wood products and wood waste that will decay within 3 years.

- Medium lived wood products: harvested wood products and wood waste that will be retired between 3 and 100 years from the date of harvest.

- Long lived wood products: harvested wood products and wood waste that may be considered permanent (stored for 100 years or more).

For each year's harvests, the calculation of carbon in wood products follows this formula:

$$C_{WP,ty} = \sum_{s,w,oir,p}^{ty} \left(\left(C_{Mil,ty} - SLF \right) - OF \right)$$

$$\cancel{C_{WP,ty} = \sum_{s,w,oir,p}^{ty} \left(\left(\left(C_{Mill,ty} \right) - SLF \right) + MLF \right)}$$

(33)

where:

$C_{WP,ty}$ Total carbon for all wood product categories

$C_{Mill,ty}$ The summed stock of carbon remaining in wood products after milling from within the project area by class of wood product ty; t C

SLF   Fraction of wood products that will be emitted to the atmosphere within 3 years of timber

                      harvest, t C

OF   Carbon emitted due to decay or burning of medium lived wood products calculated for the

                      20 years after each harvest and summed by product type and year.

ty   Wood product class – defined here as sawnwood, wood-based panels, other industrial

                      roundwood, paper and paper board

t   1, 2, 3 … t years elapsed since the start of the IFM project activity

Short-lived fraction (SLF)

Winjum et al., 1998 defines the following proportions as the amount of carbon that each product category will lose over the first 5 years after harvest (applicable internationally):

Sawnwood	0.2
Woodbase panels	0.1
Other industrial roundwood	0.3
Paper and Paperboard	0.4

Assuming a linear decay rate, convert these values to annualized proportions as follows:

Sawnwood	0.04 annually
Woodbase panels	0.02 annually
Other industrial roundwood	0.06 annually
Paper and paperboard	0.08 annually

To convert this to 3 year percentage reductions as required by the AFOLU Requirements we multiply the annual values by 3 to come up with the final value for "short lived proportion" for each product category.

Sawnwood	0.12
Woodbase panels	0.06
Other industrial roundwood	0.18
Paper and paperboard	0.24

The methodology makes the assumption that this proportion of wood and all other classes of wood products are 100% oxidized immediately.

Therefore SLF will be equal to:

$$SLF = \left(C_{Mill,ty} \right) * slp \tag{34}$$

where:

SLF   Fraction of wood products that will be emitted to the atmosphere within 3 years of timber harvest; t C

$C_{WP,ty}$ The summed stock of extracted biomass carbon from within the project area by class of wood product *ty*;

          t C

slp   Short-lived proportion -

ty   Wood product class – defined here as sawnwood, wood-based panels, other industrial roundwood, paper

          and paper board, and other

Medium lived fraction (MLF)

Winjum et al., 1998 gives annual oxidation fractions for each class of wood products split by forest region (boreal, temperate and tropical). This methodology projects these fractions over 97 years to give the additional proportion that is oxidized between the 3rd and 100th years after initial harvest (Table 3):

Table 3: Proportion of remaining wood products oxidized between 3 and 100 years after initial harvest by wood product class and forest region (MLF)

Wood Product Class	*OF*		
	Boreal	**Temperate**	**Tropical**
Sawnwood	0.39	0.62	0.86
Woodbase panels	0.62	0.86	0.98
Other industrial roundwood	0.86	0.98	0.99
Paper and paperboard	0.39	0.62	0.99

To reflect a 20-year linear decay as required by the VCS AFOLU Requirements~~, the~~, 1/20th of these proportions must be deducted from the harvested wood products pools each year after harvest. 20 years after harvesting, the MLF term will be equal to zero.

~~However, for the first twenty years after each harvest cycle, the value of MLF for that harvest is therefore equal to~~ The timeframe for short-lived wood products is defined as less than three years to meet VCS ~~AFOLU~~Methodology Requirements ~~section 4.5.3.4. a.~~

The portion of wood products stored in medium lived wood products to be emitted to the atmosphere between 3 and 100 years was estimated using the oxidation fractions found in Table 2 of Winjum et al. 1998.

However, Table 2 of Winjum et al. specifies oxidation fractions for long lived wood products, defined as 5 years or greater. Additionally, the paper requires a separate oxidation rate for the first five years (0.2 for sawnwood and 0.4 for pulp).

To account for this, split the medium lived fraction into two portions: $MLF_{3,5}$ to account for the years that Winjum et al. defines as short lived and $MLF_{5,100}$ for the remaining 95 years. For the first portion, $MLF_{3,5}$

$$\cancel{MLF = \left(\left(C_{Mill,ty}\right) - SLF\right) * \left((20 - h)/20\right) * fo}$$

$$MLF_{3,5} = C_{mill,ty} \times slp_{adj}$$

_____(35)

where:

Calculated values of slp_{adj} ~~adj~~ can be found in the Table 4.

Table 4. Proportion of short-lived wood products by product class.

Product	Winjum et al. slp (<5 years)	VM0003 Version 1.32 slp (<3 years)	sSlp$_{adj}$ (Years 3 to 5)
Sawnwood	0.2	0.12	0.08
Pulp	0.4	0.24	0.16

MLF$_{3,5}$ — Fraction of wood products that is considered stored for the medium term for the period t= 3 years to t= 5 years; t C

$C_{Mill,ty}$ — The summed stock of extracted biomass carbon after milling from within the project area by class of wood product *ty*; t C

slp$_{adj}$ — short lived proportion for the period t=3 years to t= 5 years

MLF — Fraction of wood products that is considered stored for the medium term and will be emitted to the atmosphere each year after harvest for twenty year; t C

For MLF$_{5,100}$, the project proponents used the following equation:

$$MLF_{5,100} = (C_{mill,ty} - SLF - MLF_{3,5}) \times 0.615 \hspace{4cm} (36)$$

MLF$_{5,100}$ — Fraction of wood products that is considered stored for the medium term for the period t= 5 years to t= 100 years; t C

$C_{Mill,ty}$ — The summed stock of extracted biomass carbon after milling from within the project area by class of wood product *ty*; t C

SLF — Fraction of wood products that will be emitted to the atmosphere within 3 years of timber harvest; t C

fo — Fraction oxidized – see Table 3 for defaults; t C t C^{-1}

ty — Wood product class – defined here as sawnwood, wood-based panels, other industrial roundwood, paper and paper board, and other

h — year after harvest

For the first twenty years after each harvest cycle, the value of MLF for that harvest is therefore equal to

$$MLF = MLF_{3,5} + MLF_{5,100}$$

$$MLF = MLF_{3,5} + MLF_{5,100} \hspace{4cm} (37)$$

MLF — Fraction of wood products that is considered stored for the medium term and will be emitted to the atmosphere each year after harvest for twenty year; t C

MLF$_{3,5}$ — Fraction of wood products that is considered stored for the medium term for the period t= 3 years to t= 5 years; t C

MLF$_{5,100}$ — Fraction of wood products that is considered stored for the medium term for the period t= 5 years to t= 100 years; t C

8.5.2   Estimation of GHG emissions within the project area

The change in GHG emissions as a result of the implementation of the proposed IFM‑ project activity within the project area can be estimated as:

$$GHG_{PS,E} = \sum_{t=1}^{t^*} \left(E_{PS,BiomassBurn,t} \right)$$

(3~~8~~<u>6</u>)

where:

$GHG_{PS,E}$	Greenhouse gas emissions as a result of forest management activities within the project area in the project scenario; t CO_2-e
$E_{PS,\,BiomassBurn,t}$	Non-CO_2 emissions due to biomass burning as part of forest management during the year t in the project scenario; t CO_2-e
t	1, 2, 3 …t^* years elapsed since the start of the IFM project activity

The monitoring of emissions by sources is only required if significant; if insignificant, evidence must be provided (e.g. as relevant part of the monitoring of the project implementation) that the assumptions for the exclusion made in the *ex-ante* assessment still hold in the *ex-post* situation.

8.5.2.1   Estimation of non-CO2 emissions due to biomass burning

The non-CO_2 emissions due to biomass burning as part of forest management ($E_{BiomassBurn}$) shall be estimated by:

$$E_{BiomassBun,t} = E_{BiomassBun,CH_4,t}$$

(3~~9~~<u>7</u>)

where:

$E_{BiomassBurn,t}$	Non-CO_2 greenhouse gas emission at time t as a result of biomass burning due to forest management; t CO_2-e
$E_{BiomassBurn,CH4,t}$	CH_4 emissions at time t as a result of forest management; t CO_2-e

Estimation of CH_4 emissions is based on the carbon stock loss from biomass burning during forest management is based on the biomass of logging slash burned, *BS* calculated using equation 30. This is multiplied by factors that adjust for the mass of CH_4 versus carbon released, and for the global warming potential of CH_4.

$$E_{BiomassBurn,CH_4,t} = BS_{PS,t} * ER_{CH_4} * \frac{16}{12} * GWP_{CH_4}$$

(3~~8~~<u>40</u>)

where:

$E_{BiomassBurn,CH,t}$	CH_4 emissions at time t as a result of forest management; t CO_2-e
$BS_{PS,t}$	Carbon stock in logging slash subject to burning as part of forest management in the project scenario; t C

ER_{CH4} Emission ratio for CH4 (if local data on combustion efficiency is not available or if

combustion efficiency can not be estimated from fuel information, use IPCC default value,

0.012^{19}); kg C as CH_4 (kg C burned)$^{-1}$

GWP_{CH4} Global warming potential for CH4 (IPCC default: 21 for the first commitment period of the

Kyoto Protocol); t CO_2-e (t CH_4)$^{-1}$

16/12   Ratio of molecular weights of CH_4 and C; mol mol^{-1}

t   1, 2, 3, … t years elapsed since the start of IFM project activities

If logging slash is not burned as part of forest management, then:

$$BS_{PS,t} = 0$$, otherwise:

$$BS_{PS,t} = \sum_{j=1}^{S_{PS}} \sum_{l=1}^{N_{j,t}} \left(\left(\left(f_j\left(DBH,H\right) \right) - \left(V_{l,j,t} * D_j \right) \right) * CF_j \right)$$

(~~39~~41)

where:

$BS_{PS,t}$ Carbon stock in logging slash subject to burning as part of forest management; t C

$V_{l,j,t}$ Harvested merchantable volume of tree l of species j at time t, m^3

D_j Basic wood density of species j; t d.m.m^{-3}

$f_j(DBH,H)$ Allometric equation for species j linking diameter at breast height (DBH) and

possibly height (H) to above-ground biomass of living trees; t d.m. tree^{-1}

CF_j Carbon fraction of biomass for tree species j; t C t^{-1} d.m. (IPCC default value = 0.5

t C t^{-1} d.m.)

l Sequence number of trees harvested

j *1, 2, 3 … S$_{PS}$ tree species in the project scenario*

t   1, 2, 3, … t years elapsed since the start of IFM project activities

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

8.6   Leakage

Under the applicability conditions of this methodology the type of leakage emissions to be calculated is: GHG emissions due to market effects resulting from a shift in harvest through time.[20]
Therefore, leakage shall be estimated as follows:

$$LK = LK_{MarketEffets}$$

(4~~2~~0)

where:

LK   Total GHG emissions due to leakage; t CO_2–e

$LK_{MarketEffects}$ Total GHG emissions due to impacts of project on timber supply and demand; t CO_2-e

Note: In this methodology the equation above is used to estimate leakage for the period of time elapsed between project start (t=1) and the year t=t^*, t^* being the year for which actual net greenhouse gas removals by sinks are estimated.

8.6.1   Leakage due to Activity Shifting

As per the applicability conditions there may be no leakage due to activity shifting.

If the project is able to demonstrate that any decrease in wood products produced by the project relative to the baseline is less than 5% and any temporal displacement in the total production of wood products is less than 5 years, then:

$$LK_{ActivityShifting} = 0$$

(4~~3~~1)

If the project decreases wood product production by >5% relative to the baseline then the project proponent and all associated land owners must demonstrate that there is no leakage within their operations – i.e., on other lands they manage/operate outside the bounds of the IFM project. Such a demonstration may include:

Historical records showing trends in harvest volumes paired with records from the with-project time period showing no deviation from historical trends forest management plans prepared ≥24 months prior to the start of the project showing harvest plans on all owned/managed lands paired with records from the with-project time period showing no deviation from management plans.

Leakage due to market effects is equal to the baseline emissions from logging multiplied by a leakage factor:

$$LK_{MarketEffets} = LF_{ME} * \left(\Delta C_{ACTUAL} - \Delta C_{BSL} \right)$$

(4~~4~~2)

Where:

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[20] GHG emissions through fossil fuel use outside the boundaries of the project are not considered based on guidance from the CDM Executive Board: http://cdm.unfccc.int/EB/044/eb44rep.pdf

$LK_{MarketEffects}$ Total GHG emissions due to market- effects leakage through decreased timber harvest; t CO_2-e

LF_{ME} Leakage factor for market-effects calculations; dimensionless

ΔC_{ACTUAL} Actual net greenhouse gas removals by sinks; t CO2-e

ΔC_{BSL} Baseline net greenhouse gas removals by sinks; t CO2-e

The leakage factor is determined by considering where in the country logging will be increased as a result of the decreased supply of the timber caused by the project. If the areas liable to be logged have a higher carbon stock than the project area it is likely that the proportional leakage is higher and vice versa:

LF_{ME} = 0, where it can be demonstrated that no market-effects leakage will occur within national boundaries, (e.g. if no new concessions are being assigned AND annual extracted volumes cannot be increased within existing national concessions AND illegal logging is absent (or *de minimis*) in the host country); or,
Where the project is able to demonstrate that any decrease in wood products produced by the project relative to the baseline is less than 5% and any temporal displacement in the total production of wood products is less than 5 years.

LF_{ME} = 0.1, where rotations are moderately extended (5-10 years) leading to a shift in harvests across time periods but a change in total timber harvest equal to ≤25% over the project lifetime[21]

Where rotations are extended by >10 years and/or harvest is decreased by >25% over the project lifetime as per VCS AFOLU Requirements.

The amount of leakage is determined by where harvesting would likely be displaced to. If in the forests to which displacement would occur a lower proportion of forest biomass in commercial species is in merchantable material than in project area , then in order to extract a given volume higher emissions should be expected as more trees will need to be cut to supply the same volume. In contrast if a higher proportion of the total biomass of commercial species is merchantable in the displacement forest than in the project forests then a smaller area would have to be harvested and lower emissions would result.

Each project thus shall calculate within each stratum the proportion of total biomass in commercial species that is merchantable (PMP_i). This shall then be compared to mean proportion of total biomass that is merchantable for each forest type (PML_{FT}).

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[21] Defined here as the minimum project lifetime elected by project proponents in their project description document. If the project is extended beyond this time period harvests may not be decreased by more than 25% across through each additional crediting/baseline period

Merchantable biomass is defined as: "Total gross biomass (including bark) of a tree 5 inches (12.7 cm) DBH or larger from a 1 foot (30.48 cm) stump to a minimum 4 inches top DOB of the central stem" *Definition from US Forest Service FIA Program*

The following deduction factors (LF_{ME}) shall be used:

Where:

PML_{FT} *is equal (± 15%) to PMP_i, $LF_{ME} = 0.4$*

PML_{FT} *is > 15% less than PMP_i $LF_{ME} = 0.7$*

PML_{FT} *is > 15% greater than PMP_i, $LF_{ME} = 0.2$*

Where:

PML_{FT}	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type; % (default values see parameter table)
PMP_i	Merchantable biomass as a proportion of total aboveground tree biomass for stratum *i* within the project boundaries; %
LF_{ME}	Leakage factor for market-effects calculations; dimensionless

8.7 Summary of the GHG Emission Reduction and/or Removals

The net anthropogenic GHG removals by sinks is the actual net GHG removals by sinks minus the baseline net GHG removals by sinks minus leakage, therefore, the following general formula can be used to calculate the net anthropogenic GHG removals by sinks of a IFM -project activity (C_{IFM}) in t CO_2-e.

$$C_{IFM} = \Delta C_{ACTUAL} - \Delta C_{BSL} - LK$$

(453)

where:

C_{IFM}	Net anthropogenic greenhouse gas removals by sinks; t CO_2-e
ΔC_{ACTUAL}	Actual net greenhouse gas removals by sinks; t CO_2-e
ΔC_{BSL}	Baseline net greenhouse gas removals by sinks; t CO_2-e
LK	Total GHG emissions due to leakage; t CO_2–e

8.7.1 Calculation of Uncertainty

Estimated carbon emissions and removals arising from AFOLU activities have uncertainties associated with the uncertainties associated with measures/estimates of: area or other activity data, carbon stocks, biomass growth rates,

expansion factors, and other coefficients. It is assumed that the uncertainties associated with the estimates of the various input data are available, either as default values given in IPCC Guidelines (2006), IPCC GPG-LULUCF (2003), or estimates based of sound statistical sampling. Uncertainties arising from the measurement and monitoring of carbon pools and the changes in carbon pools shall always be quantified.

Indisputably conservative estimates can also be used instead of uncertainties, provided that they are based on verifiable literature sources. In this case the uncertainty is assumed to be zero. However, this module provides a procedure to combine uncertainty information and conservative estimates resulting in an overall project uncertainty.

Uncertainty at all times is defined as the 90% confidence interval as a percentage of the mean.

Planning to Diminish Uncertainty

It is important that the process of project planning consider uncertainty. Procedures including stratification, and the allocation of sufficient measurement plots can help ensure that low uncertainty results and ultimately full crediting can result.

It is good practice to consider uncertainty at an early stage to identify the data sources with the highest uncertainty to allow the opportunity to conduct further work to diminish uncertainty.

Estimation of Uncertainty for Pools and Emissions Sources

For each measurement pool calculate both the mean and the 90% confidence interval   . In all cases uncertainty should be expressed as the 90% confidence interval as a percentage of the mean.

For modeled results use the confidence interval of the input inventory data.

For wood products use the confidence interval of the stocks of extracted timber.

For biomass burning emissions use the confidence interval of the preburning stocks.

For both the baseline and the with-project case the total uncertainty is equal to the square root of the sum of the squares of each component uncertainty.

Total Uncertainty of the IFM Project

The total project uncertainty is calculated at the time of reporting through propagating the error in the baseline stocks and the error in the project stocks:

$$C_{IFM\_ERROR} = \sqrt{\text{Uncertainty}_{BSL}{}^2 + \text{Uncertainty}_P{}^2}$$

(464)

Where:

CIFM_ERROR   Total uncertainty for IFMProject; %

UncertaintyBSL   Total uncertainty in baseline scenario; %

UncertaintyP   Total uncertainty in the with-project scenario; %

The uncertainty in the baseline and in the project should be defined as the square root of the summed errors in each of the measurement pools. The errors in each pool can be weighted by the size of the pool so that projects may reasonably target a lower precision level in pools that only form a small proportion of the total stock.

8.7.2   Uncertainty Deduction

If CIFMS_ERROR ≤ 10% of CIFM- then no deduction should result for uncertainty

If CIFM-_ERROR > 10% of CIFM- then the modified value for CIFM- to account for uncertainty should be:

= CIFM x (1 – Discount factor)   _____
(475)

Where:

CIFM: Net anthropogenic greenhouse gas reductions and removals by sinks; t CO2-e

CIFM_ERROR: Total uncertainty for IFMProject, aggregated to the project level: tCO2-e.

Discount factor: Discount factor to be applied for calculating the conservativeness deduction; %

Determine the Discount factor using the following equation:

$$Discount\ factor = \frac{CIFM\_ERROR}{t10\%\ x\ t66.6\%}$$ (468)

Discount factor: Discount factor to be applied for calculating the conservativeness deduction, %.

CIFM_ERROR: Total uncertainty for IFMProject, aggregated to the project level: tCO2-e.

%$t10\%$: t-value for the two-sided 90% confidence interval, approximately 1.6449; dimensionless

$t66.6\%$: t-value for a one-sided 66.67% confidence interval, approximately 0.4307; dimensionless

Where:

CIFM-   Net anthropogenic greenhouse gas removals by sinks; t CO2-e

CIFM-_ERROR   Total uncertainty for IFMProject; %

8.7.3   Calculation of VCUs

To estimate the amount of VCUs that can be issued at time $t=t2$ (the date of verification) for monitoring period $T=t2-t1$, this methodology uses the following equation:

$$VCUs = \left(C_{IFM,t2} - C_{IFM,t1}\right) - BRR$$

(4~~7~~9)

where:

VCUs	Number of Verified Carbon Units
CIFM-,t2	Net anthropogenic greenhouse gas removals by sinks, as estimated for t*=t2; t CO2-e
CIFM-,t1	Net anthropogenic greenhouse gas removals by sinks, as estimated for t*=t1; t CO2-e
BRR	Portion of carbon credits to be withheld as a buffer reserve

Buffer reserve should be calculated using *VCS Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination*.

The number of VCUs eligible for crediting in any one monitoring period may not exceed the ex-ante projected total number of VCUs for the defined project lifetime unless it can be demonstrated the ex-ante estimate created through modeling has been conservatively underestimated (e.g. through growth rates in excess of projection or increases in harvest efficiency/decreases in harvest volumes).[22]

9   MONITORING

9.1   Data and Parameters Not Monitored

In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

In choosing key parameters or making important assumptions based on information that is not specific to the project circumstances, such as in use of existing published data, project proponents must 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 must be selected.

Data / parameter:	$A_{BSL,i}$
Data unit:	Ha
Used in equations:	Implicitly used in Section 4.1
Description:	Area of baseline stratum, *i*
Source of data:	GPS coordinates and/or Remote Sensing data and/or legal parcel records
Measurement procedures (if any):	N/A
Any comment:	

Data / parameter:	*BEF*
Data unit:	Dimensionless
Used in equations:	15

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[22] This requirement ensures through forest management rotations with growth and harvesting projects are not overcredited. Crediting should not occur to the peaks of growth if harvest is going to immediately follow.

Description:	Biomass expansion factor for conversion of annual net increment (including bark) in stem biomass to total above-ground tree biomass increment for species *j*
Source of data:	The source of data shall be chosen with priority from higher to lower preference as follows: (a) Existing local and forest type-specific; (b) National and forest type-specific or eco-region-specific (e.g. from national GHG inventory); (c) Forest type-specific or eco-region-specific from neighboring countries with similar conditions. Sometimes (c) might be preferable to (b); (d) Globally forest type or eco-region-specific (e.g. IPCC literature: Table 3A.1.10 of GPG-LULUCF)
Measurement procedures (if any):	
Any comment:	- BEFs are age dependent, and use of average data may result in significant errors for both young and old stands – as BEFs are usually large for young stands and quite small for old stands.

Data / parameter:	*CF*
Data unit:	t C t^{-1} d.m.
Used in equations:	9, 10, 19, 29, 31, ~~39~~41
Description:	Carbon fraction of dry matter
Source of data:	Default value 0.5 t C t^{-1} d.m. can be used, or species specific values from the literature
Measurement procedures (if any):	
Any comment:	

Data / parameter:	*D*
Data unit:	t d.m. m^{-3}
Used in equations:	9, 29, 31, ~~41~~39
Description:	Basic wood density
Source of data:	The source of data shall be chosen with priority from higher to lower preference as follows: (a) National and species-specific or group of species-specific (e.g. from National GHG inventory); (b) Species-specific or group of species-specific from neighboring countries with similar conditions. Sometimes (b) may be preferable to (a); (c) Globally species-specific or group of species-specific (e.g. IPCC GPG-LULUCF).
Measurement procedures (if any):	N/A
Any comment:	

Data / parameter:	*D$_{DW}$*
Data unit:	t d.m. m^{-3}
Used in equations:	27

Description:	Basic wood density of dead wood in the density class – sound (1), intermediate (2) and rotten (3)
Source of data:	The source of data shall be chosen with priority from higher to lower preference as follows: (a) Research publications relevant to the project area; (b) National and species-specific or group of species-specific (e.g. from National GHG inventory); (c) Species-specific or group of species-specific from neighboring countries with similar conditions. Sometimes (b) may be preferable to (a); (d) Globally species-specific or group of species-specific (e.g. IPCC GPG-LULUCF).
Measurement procedures (if any):	Project-specific determination of density is most likely necessary
Any comment:	

Data / parameter:	$f_j(DBH,H)$
Data unit:	t d.m. tree^{-3}
Used in equations:	9, 19, 41~~39~~
Description:	Allometric equation for species j linking diameter at breast height (DBH) and possibly height (H) to above-ground biomass of living trees
Source of data:	Whenever available, use allometric equations that are species-specific or group of species-specific, provided the equations have been derived using a wide range of diameters and heights, based on datasets that comprise at least 20 trees. Otherwise, default equations from IPCC literature, national inventory reports or published peer-reviewed studies may be used – such as those provided Tables 4.A.1 to 4.A.3 of the GPG-LULUCF (IPCC 2003).
Measurement procedures (if any):	

Any comment:	It is necessary to verify the applicability of equations used.
	Allometric equations can be verified by both:
	    2. Verification of equation conditions:
	Justification should be provided for the applicability of the equation to the project locations. Such justification should include identification of climatic, edaphic, geographical and taxonomic similarities between the project location and the location in which the equation was derived. Any equation used should have an r^2 value of greater than 0.5 (50%) and a p value that is significant (<0.05 at the 95% confidence level).
	    3. Additional field verification
	For field verification either of the two methods below may be used:
	A. Destructive Sampling
	▪ Selecting at least 5 trees covering the range of DBH existing in the project area, and felling and weighting the above-ground biomass to determine the total (wet) weight of the stem and branch components;
	▪ Extracting and immediately weighing subsamples from each of the wet stem and branch components, followed by oven drying at 70ºC to determine dry biomass;
	▪ Determining the total dry weight of each tree from the wet weights and the averaged ratios of wet and dry weights of the stem and branch components.

	B. Limited Measurements
	▪ Select at least 10 trees per species distributed across the age range (but excluding trees less than 15 years old for which there is rarely a great relative inaccuracy in equations)
	▪ Calculate volume of tree from basal and top diameters and tree height. Multiply by species-specific density to gain biomass of bole. Add an additional percentage to approximately cover biomass of branches: 15% for spruce/fir, 5% for pines and 20% for broadleaf forests[23]
	If the biomass of the harvested trees is within ±10% of the mean values predicted by the selected default allometric equation, and is not biased – or if biased is wrong on the conservative side (i.e., use of the equation results in under- rather than over-estimate of project net anthropogenic removals by sinks) – then mean values from the equation may be used.

Data / parameter:	*OF,, WW*
Data unit:	kg kg^{-1}.
Used in equations:	32
Description:	WW = Fraction of extracted biomass effectively emitted to the atmosphere during production
Source of data:	The source of data is the published paper of Winjum et al. 1998[24]
Measurement procedures (if any):	
Any comment:	

Data / parameter:	*PML$_{FT}$*
Data unit:	%
Used in equations:	Leakage Section 6.2
Description:	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type
Source of data:	The source of data shall be chosen with priority from higher to lower preference as follows: 1. Peer-reviewed published sources (including carbon/biomass maps or growing stock volume[25] maps with a scale of at least 1km) 2. Official Government data and statistics 3. Original field measurements The forest types considered shall be only those relevant for the specific market effects leakage ie. only forest types with active timber production.

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[23] Calculated conservatively from the biomass expansion factors used to calculate total tree biomass from the biomass of the bole in IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (2003), Table 3A.1.10.

[24] Winjum, J.K., Brown, S. and Schlamadinger, B. 1998. Forest harvests and wood products: sources and sinks of atmospheric carbon dioxide. *Forest Science* 44: 272-284

[25] Volumes shall be converted to merchantable biomass using wood densities/specific gravities. A weighted wood density shall be used to convert multi-species data on growing stock volume to merchantable biomass

An appropriate source of data will be Government records on annual allowable cuts for the areas of commercial forests.

Where volumes are used the source of data wood density is required to convert to merchantable biomass. The source of data on wood densities shall be chosen with priority from higher to lower preference as follows:

1. Knowledge on commercial species and thus an appropriately weighted wood density derived from the density of these species
2. A region-specific mean wood density as given e.g. in Brown 1997[26]

For the lower 48 US States the following defaults have been calculated[27] from the US Forest Service Forest Inventory Analysis Database and shall be used where appropriate:

Forest Type Group	Merchantable Biomass as Proportion of Total Biomass
White Red Jack Pine	77%
Spruce Fir	58%
Longleaf Slash Pine	73%
Loblolly Shortleaf Pine	73%
Ponderosa Pine	64%
Oak Pine	71%
Oak Hickory	73%
Oak Gum Cypress	72%
Elm Ash Cottonwood	73%
Maple Beech Birch	76%
Aspen Birch	61%
Douglas Fir	70%
Western White Pine	62%
Fir-Spruce/Mountain Hemlock	62%
Lodgepole Pine	64%
Hemlock/Sitka Spruce	67%
Western Larch	66%
Redwood	43%
Western Oak	69%

Measurement procedures (if any):	
Any comment:	

Data / parameter:	R
Data unit:	kg kg^{-1}.
Used in equations:	16, 20
Description:	Root-shoot ratio appropriate for biomass increment of forest type / biome
Source of data:	The source of data shall be chosen with priority from higher to lower preference as follows:

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[26] Brown, S. 1997. Estimating biomass and biomass change of tropical forests: a Primer. FAO Forestry Paper 134. http://www.fao.org/docrep/W4095E/W4095E00.htm

[27] The FIA mapmaker program (http://www.ncrs2.fs.fed.us:4801/fiadb/fim30/wcfim30.asp) was used. For the lower 48 states the total biomass and merchantable biomass by forest type were downloaded in order to calculate the proportions given here

	(a) Research publications relevant to the project area;
	(b) National and forest type-specific or eco-region-specific (e.g. from National GHG inventory); Sometimes (b) may be preferable to (a)[28]
	(c) Forest type-specific or eco-region-specific from neighboring countries with similar conditions.;
	(d) Globally forest type-specific or eco-region-specific (e.g. IPCC GPG-LULUCF).
Measurement procedures (if any):	
Any comment:	Guidelines for Conservative Choice of Default Values:
	1. If in the sources of data mentioned above, default data are available for conditions that are similar to the project (same vegetation genus; same climate zone; similar forest type), then mean values of default data may be use d and considered conservative.
	2. Global values may be selected from Table 3A.1.8 of the GPG-LULUCF (IPCC 2003), or equivalently Table 4.4 of the AFOLU Guidelines (IPCC 2006), by choosing a climatic zone and species that most closely matches the project circumstances.

Data / parameter:	*SLF*
Data unit:	unitless
Used in equations:	30, 33, 34, 3~~6~~5
Description:	Short lived fraction - proportion of wood products that oxidize immediately in the first three years after harvesting
Source of data:	The Forestry Appendix of US Department of Energy's Technical Guidelines for The Voluntary Reporting of Greenhouse Gas Program (Section 1605b)
	http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf
	Also available as a US Forest Service General Technical Report at:
	http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf
	Winjum et al,. 1998
Measurement procedures (if any):	
Any comment:	

Data / parameter:	*MLF*
Data unit:	unitless
Used in equations:	30, 33, 35~~, 36, 37~~
Description:	Medium lived fraction -- Proportion of wood products that decay over a 20 year period after harvest
Source of data:	The Forestry Appendix of US Department of Energy's Technical Guidelines for The Voluntary Reporting of Greenhouse Gas Program (Section 1605b)
	http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf

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[28] (b) shall only be used instead of (a) when the dataset is significantly larger and the relationship between root and shoot tighter for National and forest type-specific or eco-region-specific (b). For example projects may elect to use IPCC defaults in the 2006 Guidelines for National Greenhouse Gas Inventories: Volume 4 AFOLU – Table 4.4. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf

	Also available as a US Forest Service General Technical Report at: http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf Winjum et al., 1998
Measurement procedures (if any):	
Any comment:	

Data / parameter:	*LLF*
Data unit:	unitless
Used in equations:	30
Description:	Long lived fraction - proportion of wood products that remain stored for 100 years after harvest
Source of data:	The Forestry Appendix of US Department of Energy's Technical Guidelines for The Voluntary Reporting of Greenhouse Gas Program (Section 1605b) http://www.eia.doe.gov/oiaf/1605/Forestryappendix[1].pdf Also available as a US Forest Service General Technical Report at: http://www.fs.fed.us/ne/durham/4104/papers/ne_gtr343.pdf Winjum et al., 1998
Measurement procedures (if any):	
Any comment:	

9.2   Description of Monitoring Plan

All data collected as part of monitoring must be archived electronically and be kept at least for 2 years after the end of the project. 100% of the data must be monitored if not indicated otherwise in tables below. All measurements must be conducted according to relevant standards. In addition, the monitoring provisions in the tools referred to in this methodology apply.

9.2.1   Monitoring of Project Implementation

Information shall be provided, and recorded in the project description, to establish that:
i.   The geographic position of the project area is recorded for all areas of land;
- The geographic coordinates of the project area (and any stratification inside the boundary) are established, recorded and archived. This can be achieved by field survey (e.g., using GPS), or by using georeferenced spatial data (e.g., maps, GIS datasets, orthorectified aerial photography or georeferenced remote sensing images).
ii.   Commonly accepted principles of forest inventory and management are implemented;
- Standard operating procedures (SOPs) and quality control / quality assurance (QA/QC) procedures for forest inventory including field data collection and data management shall be applied. Use or adaptation of SOPs already applied in national forest monitoring, or available from published handbooks, or form the *IPCC GPG LULUCF 2003*, is recommended;
- The forest management plan, together with a record of the plan as actually implemented during the project shall be available for validation and verification, as appropriate.

9.2.2   Sampling Design and Stratification

Stratification of the project area into relatively homogeneous units can either increase the measuring precision without increasing the cost unduly, or reduce the cost without reducing measuring precision because of the lower variance within each homogeneous unit. Project proponents must present in the project description an *ex-ante* stratification of the project area or justify the lack of it. The number and boundaries of the strata defined *ex-ante* may change during the project crediting period (*ex-post*).
Updating of strata
The *ex-post* stratification shall be updated due to the following reasons:
   ▪ Unexpected disturbances occurring during the project crediting period (e.g. due to fire, pests or disease outbreaks), affecting differently various parts of an originally homogeneous stratum;
   ▪ Forest management activities (cleaning, planting, thinning, harvesting, coppicing, re-planting) may be implemented in a way that affects the existing stratification.
Established strata may be merged if reasons for their establishing have disappeared.

9.2.3   Sampling framework

To determine the sample size and allocation among strata, this methodology uses the latest version of the UNFCCC tool for the "Calculation of the number of sample plots for measurements within A/R CDM project activities" (see section References) approved by the CDM Executive Board. The targeted precision level for biomass estimation across the project is +/- 10% of the mean at a 90% confidence level. In contrast to the CDM tool note that temporary plots are permissible under this methodology.

9.2.4   Data and Parameters Monitored

The following parameters must be monitored 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 proponents shall provide transparent estimations for the parameters that are monitored during the project crediting period. These estimates shall be based on measured or existing published data where possible and project proponents must 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 must be selected. Future developments may allow remote sensing of carbon stocks and changes in carbon stocks, however, a new version of this methodology will be necessary to accommodate the currently unknown components of such future technology.

Data / parameter:	A_i
Data unit:	ha
Used in equations:	17, 22, 27
Description:	Area of stratum *i*
Source of data:	Monitoring of strata and stand boundaries shall be done preferably using a Geographic Information System (GIS), which allows for integrating data from different sources (including GPS coordinates and Remote Sensing data).
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	

Any comment:	It shall be assumed ex-ante that stand boundaries and strata areas shall not change through time

Data / parameter:	*Ap*
Data unit:	m²
Used in equations:	14
Description:	Area of sample plot
Source of data:	Recording and archiving of size of sample plots
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	Ex-ante the size of plots shall be defined and recorded in the monitoring plan

Data / parameter:	$D_{n,i,t}$
Data unit:	cm
Used in equations:	26
Description:	Diameter of piece *n* of dead wood along the transect in stratum *i*, at time *t*
Source of data:	Field measurements in sample plots
Measurement procedures (if any):	Lying dead wood must be sampled using the line intersect method (Harmon and Sexton 1996[29]). Two 50-meter lines are established bisecting each plot and the diameters of the lying dead wood (≥ 10 cm diameter) intersecting the lines are measured. Minimum measurement diameter for all sites must not be less than 10 cm.
Monitoring frequency:	
QA/QC procedures:	
Any comment:	Ex-ante the change in carbon stocks in all applicable pools will be modeled following the requirements in Section 4.1

Data / parameter:	*DBH*
Data unit:	cm
Used in equations:	9, 19, ~~38~~41
Description:	Diameter at breast height of tree
Source of data:	Field measurements in sample plots
Measurement procedures (if any):	Typically measured 1.3m above-ground. Measure all trees above some minimum *DBH* in the sample plots that result from the IFM project activity. The minimum *DBH* for all sites must not be more than 20cm.
Monitoring frequency:	
QA/QC procedures:	
Any comment:	Ex-ante the change in carbon stocks in all applicable pools will be modeled following the requirements in Section 4.1

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[29] Harmon, M.E. and J. Sexton. (1996) Guidelines for measurements of woody detritus in forest ecosystems. US LTER Publication No. 20. US LTER Network Office, University of Washington, Seattle, WA, USA.

Data / parameter:	H
Data unit:	m
Used in equations:	9, 19, ~~38~~41
Description:	Height of tree
Source of data:	Field measurements in sample plots
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	Ex-ante the change in carbon stocks in all applicable pools will be modeled following the requirements in Section 4.1

Data / parameter:	L
Data unit:	m
Used in equations:	26
Description:	Length of the transect to determine volume of lying dead wood (default 100 m)
Source of data:	Field measurements
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	Ex-ante the change in carbon stocks in all applicable pools will be modeled following the requirements in Section 4.1

Data / parameter:	N
Data unit:	Dimensionless
Used in equations:	26
Description:	Total number of wood pieces intersecting the transect
Source of data:	Field measurements
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	Ex-ante the change in carbon stocks in all applicable pools will be modeled following the requirements in Section 4.1

Data / parameter:	PMP_i
Data unit:	%
Used in equations:	Leakage section 6.2
Description:	Merchantable biomass as a proportion of total aboveground tree biomass for stratum i within the project boundaries
Source of data:	Within each stratum divide the summed merchantable biomass (defined as "Total gross biomass (including bark) of a tree 5" (12.7 cm) DBH or larger from a 1' (30.48 cm)

	stump to a minimum 4" (10.2 cm) top DOB of the central stem") by the summed total aboveground tree biomass
Measurement procedures (if any):	
Monitoring frequency:	At least every five years at the time of verification
QA/QC procedures:	
Any comment:	Ex-ante a time zero measurement shall be made of this factor

Data / parameter:	*T*
Data unit:	yr
Used in equations:	18, 23, 24, 28
Description:	Number of years between monitoring time *t* and *t1* ($T = t2 - t1$)
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	Ex-ante the monitoring plan shall detail the planned monitoring intervals through the project life

9.2.5 Conservative Approach and Uncertainties

To help reduce uncertainties in accounting of emissions and removals, this methodology uses, whenever possible, the proven methods from the GPG-LULUCF, GPG-2000, the IPCC's Revised 2006 Guidelines and the tools and methodologies of the CDM Executive Board. Tools and guidance from the CDM Executive Board on conservative estimation of emissions and removals are also used. Despite this, potential uncertainties still arise from the choice of parameters to be used. Uncertainties arising from, for example, biomass expansion factors (*BEFs*) or wood density, would result in uncertainties in the estimation of both baseline net GHG removals by sinks and the actual net GHG removals by sinks – especially when global default values are used.

It is recommended that project proponents identify key parameters that would significantly influence the accuracy of estimates. Local values that are specific to the project circumstances must then be obtained for these key parameters, whenever possible. These values must be based on:

- Data from well-referenced peer-reviewed literature or other well-established published sources[30]; or
- National inventory data or default data from IPCC literature that has, whenever possible and necessary, been checked for consistency against available local data specific to the project circumstances; or
- In the absence of the above sources of information, expert opinion may be used to assist with data selection. Experts will often provide a range of data, as well as a most probable value for the data. The rationale for selecting a particular data value must be briefly noted in the project description. For any data provided by experts, the project description shall also record the expert's name, affiliation, and principal qualification as an expert (e.g., that they are a member of a country's national forest inventory technical advisory group) – plus inclusion of a 1-page summary CV for each expert consulted, included in an annex.

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[30] Typically, citations for sources of data used should include: the report or paper title, publisher, page numbers, publication date, etc. (or a detailed web address). If web-based reports are cited, hardcopies should be included as Annexes in the project description if there is any likelihood such reports may not be permanently available

In choosing key parameters of making important assumptions based on information that is not specific to the project circumstances, such as in use of default data, project proponents must select values that will lead to an accurate estimation of net GHG removals by sinks, taking into account uncertainties. If uncertainty is significant, project proponents must choose data such that it tends to under-estimate, rather than over-estimate, net GHG removals by sinks.

10   REFERENCES

Articles

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UNFCCC Reports

UNFCCC CDM Additionality Tests (available at: http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf)

UNFCCC "Tool for testing significance of GHG emissions in A/R project activities" (available at: http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-04-v1.pdf)

UNFCCC tool for the "Calculation of the number of sample plots for measurements within A/R CDM project activities" (available at: http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.pdf)

UNFCCC Executive Board of the Clean Development Mechanism 42nd Meeting Report (available at http://cdm.unfccc.int/EB/042/eb42rep.pdf)

UNFCCC Executive Board of the Clean Development Mechanism 44th Meeting Report (available at http://cdm.unfccc.int/EB/044/eb44rep.pdf)

DOCUMENT HISTORY

Version	Date	Comment
v1.0	13 May 2010	Initial version released. The initial version was developed by Ecotrust Forest Management, Inc., and assigned version '4 May 2010' for development purposes and assessed as version 4 May 2010 for reference in the first and second assessment reports. It has been redesignated version 1 for the purposes of finalization and approval by the VCSA.
v1.1	20 Nov 2012	The methodology was revised to account for the decay of carbon from the harvested wood products pool and to make explicit that the decay of the dead wood pool shall not be assumed to be immediate. Revisions were made to Section 8.5.1.3. Other minor updates have also been incorporated into the methodology. Specifically, the applicability conditions were revised to clarify the types of forest management techniques which are eligible activities under this methodology and a modification was made with respect to the timing by which FSC certification must be in place to allow projects to achieve certification by the start of the project crediting period.
v1.2	29 Aug 2013	Clarified Section 6.3 with respect to selection of the most plausible baseline scenario.
v1.3	21 Nov 2022	Modified Section 4 to expand access to non-certified lands that are to become FSC certified. Modified Section 5 to improve accuracy of wood products accounting in accordance with auditors' assessments and findings. Updated Section 8 to conform with the most recent VCS requirements for the quantification of uncertainty.