REDD Methodological Module

"Estimation of baseline carbon stock changes and greenhouse gas emissions from unplanned deforestation" – BL-UP

Version – February 2010

I. SCOPE, APPLICABILITY, DATA REQUIREMENTS AND OUTPUT PARAMETERS

Scope

This module allows for estimating carbon stock changes and GHG emissions related to unplanned deforestation in the baseline case (VCS eligible category AUDD[1]). Degradation is not considered under this module. The module is mandatory for the unplanned deforestation category.

Applicability

The module is applicable for estimating baseline emissions from unplanned deforestation (conversion of forest land to non-forest land in the baseline case) . The following required and exclusionary conditions must be met to apply this module. The forest landscape configuration can be either mosaic, transition or frontier[2]

Required conditions

1 **Avoiding Unplanned Deforestation and Degradation (AUDD)** reduces GHG emissions by stopping deforestation/degradation of degraded to mature forests at the frontier that are been expanding historically, or will expand in the future, as result of improved forest access (frontier configuration) or occurring under the mosaic configuration (mosaic deforestation).

2 According to the VCS-AFOLU Guidance Document, the forest frontier configuration is where humans and their infrastructure are encroaching into areas with relatively little human activity. The forest mosaic configuration is where human populations and associated agricultural activities and infrastructure (roads, towns, etc.) are spread out across the landscape and most areas of forest are within such a configured region or country are accessible. (cf. Brown, S., M. Hall, K. Andrasko, F. Ruiz, W. Marzoli, G. Guerrero, O. Masera, A. Dushku, B. DeJong, and J. Cornell, 2007. Baselines for land-use change in the tropics: application to avoided deforestation projects. Mitigation and Adaptation Strategies for Global Change, 123 86):1001-1026).
Here Mosaic configurations are defined as any landscape in which no forest patch exceeds 1000 ha in area and more than 75% of the patches' perimeters are surrounded by lands anthropogenically deforested. Frontier configurations are defined as any landscape in which there is no current direct physical connection with areas anthropogenically deforested. Transition configurations are defined as any landscape that is neither mosaic or frontier.
Transition configurations are defined as any landscape that is neither mosaic nor frontier

- The module shall be applied by all projects with a baseline of unplanned deforestation only[3].
- The module shall be applied to all project activities where the baseline agents of deforestation; (i) clear the land for settlements, crop production (agriculturalist) or ranching, where such clearing for crop production or ranching does not amount to large scale industrial agriculture activities[4]; (ii) have no documented and uncontested legal right to deforest the land for these purposes; and (iii) are either resident in the region (reference region—cf. section 1 below) or immigrants.
- It shall be demonstrated that post-deforestation land use shall not constitute reforestation
- The resulting baseline must be renewed every 10 years after the start of the project except where forests in the project area are undergoing degradation in the baseline and the estimated difference in carbon stocks between the baseline and project is greater than a de minimus[5]. In this situation the baseline must be revised every 5 years

Exclusionary conditions

- If deforestation is legal or sanctioned, this module shall not be used.

Output parameters

This module provides procedures to determine the following parameters:

Parameter	SI Unit	Description
$\Delta C_{BSL,unplanned}$	tCO_2-e	Net CO_2 equivalent emissions in the baseline from unplanned deforestation
$\Delta C_{BSL,LK,unplanned}$	tCO_2-e	Sum of baseline carbon stock changes from unplanned deforestation in the Leakage Belt up to year *t**
$A_{BSL,PA,unplanned,t}$	ha yr^{-1}	Projected area of unplanned baseline deforestation in the Project Area at year *t*
$A_{BSL,LK,unplanned,t}$	ha yr^{-1}	Projected area of unplanned baseline deforestation in the Leakage Belt Area at year *t*

II. PROCEDURE

The methodology is divided into three parts:

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3 This module is only applicable to determine an unplanned deforestation baseline and not to carbon losses by degradation—see module BL-DFW for degradation and M-EXP for ex-post regrowth in project area.

4 Small-scale / Large-scale agriculture to be defined and justified by the project

5 According to the VCS standards the de minimus is 5% or less of the total difference

Baseline shall be revisited at fixed 10 year intervals except where a baseline revision has been triggered. See REDD-MF for triggers for baseline revision[6].

PART 1. ESTIMATION OF ANNUAL AREAS OF UNPLANNED DEFORESTATION

The procedure is implemented by applying the following six steps:

STEP 1.1 Definition of boundaries

STEP 1.2 Analysis of historical deforestation

STEP 1.3 Analysis of agents and proxy drivers of deforestation

STEP 1.4 Selection of the most appropriate baseline approach

STEP 1.5 Analysis of deforestation constraints

STEP 1.6 Estimation of the annual areas of unplanned baseline deforestation in the reference region

STEP 1.1 Definition of spatial/geographic boundaries

The analytical domain from which information on the historical deforestation rate is extracted and projected into the future must be delineated by spatial and temporal boundaries.

1.1.1 Definition of the spatial boundaries of the analytical domain

The boundaries of the following spatial features must be defined:

1.1.1.1 Reference region

1.1.1.2 Project area

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[6] Although baselines must be revised on a fixed 10-year schedule there also exist triggers that will lead to an immediate baseline revision. The following will trigger baseline revision for BL-UP:

- Construction and / or paving of a road through the project and / or leakage belt, or within 500 m of project geographic boundary
- A rate of population growth that differs by ≥ 15% from official government projections made prior to the start of the baseline period
- Forest scarcity relative to the baseline deforestation rate

1.1.1.3 Leakage belt

For each spatial feature, the criteria used to define their geographic boundaries must be described and justified. Vector or raster files, maps, GPS coordinates or any other locational information that allows the identification of the boundaries unambiguously must be available.

1.1.1.1 Reference region

The boundary of the reference region is the spatial delineation of the analytic domain from which information about regional rates and spatial patterns of deforestation are obtained, projected into the future and monitored. The reference region shall be representative of the general patterns of unplanned deforestation that are influencing the project area and its leakage belt as defined below. The reference region does not need to be contiguous with or encompass the project area.

The minimum size of the reference region (MREF) will depend on the area of the project and must be calculated as follows[7]:

$$MREF = RAF \times PA \quad (1)$$

$$RAF = \left(9000 * PA^{-0.7}\right) \quad (2)$$

Where:

MREF Minimum size of the reference region, ha

PA Project area, ha

RAF Reference Area Factor. Factor to multiply project area by to get minimum reference area, dimensionless

The boundary of the reference region must be defined using the following criteria:

a) **The main agent(s) of deforestation** in the reference region during a 10 year period prior to start of the project, must be the same as those expected to cause deforestation in the project area during the project term[8]. Such determination can be accomplished by:

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7 The relationship was developed from data on reference area and project area in Brown et al. 2007. Baselines for land-use change in the tropics: application to avoided deforestation projects. Mitigation and Adaptation Strategies for Climate Change, 12:1001-1026), from practical experience with pilot projects, and from expert opinion.

8 For instance, if deforestation pressure on the project area is linked to population growth of small farmers practicing subsistence agriculture on land that is considered marginal for commercial agriculture, areas outside the project boundary that are subject to deforestation by large cattle ranchers and cash-crop growers should not be included in the reference region. However, if the forest land within the project boundary is suitable for deforestation agents that have not encroached into the project area historically (e.g. large cattle

- a qualitative assessment, opinion of local experts or literature sources to demonstrate the proportion of agriculturalist versus ranchers is the same ±20% in the reference region as in the project area,
- rapid assessment techniques for determination of lack of legal rights to use land is the same in the reference region as in the project area, and
- rapid assessment techniques for determination of proportion of agents resident in the local area (lived in area > 5yr) versus immigrants (lived in area < 5 yr) is the same ±20% in the reference region as in the project area.

b) **Landscape factors** of forest types, soil types, slope and elevation classes: These factors can be determined by analysis of spatial data bases (e.g. vegetation map, soil suitability map, DEM [Digital Elevation Model] for slope and elevation) in a GIS for both the project area and reference region.

- Forest classes[9] must be present in the reference region in the same proportion as in the project area (+/- 20%).
- Soil types that are suitable for the land-use practice used by the main agent(s) of deforestation in the project area must be present in the reference region in the same proportion as the project area (+/- 20%).
- The ratio of slope classes "gentle" (slope<15%) to "steep" (slope ≥15%) in the project area shall be (+/- 20%) the same as the ratio in the reference region.
- Elevation classes (500m classes) in the reference region shall be in the same proportion as in the project area (+/- 20%).

c) Transportation networks and human infrastructure, such as roads, navigable rivers and settlements, that increase the likelihood of deforestation and that exist historically in the reference region must be directly comparable to those that are expected to exist within the project area during the project term.

The following conditions shall be met :

- Where navigable rivers are present in the project area, navigable river/stream density (m/km^2) is the same (+/-20%) for the reference region and the project area.
- Road density (m/km^2) is the same (+/-20%) for the reference region as for the projected density (in the baseline period) for the project area (including a buffer around the project area of at least 1 km and up to the total project area).

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ranchers and cash-crop growers) but that may do so during the project term, then the reference region must include areas where such agents have been deforesting during the historical reference period.

9 Defined as the broad classes that are observable in remote sensing imagery from differences in spectral characteristics that can be confirmed on the ground. The same classes shall be used throughout Parts 1 and 2 of BL-UP

- Settlement density (settlements/km^2) is the same (+/-20%) for non-forested areas in a 1km buffer around the project area at the start of the baseline period as in 1 km buffer zones around forested areas in the reference region at the start of the historical reference period

d) **Policies and regulations** having an impact on land-use change patterns within the reference region and the project area must be of the same type or have the same effect, taking into account the current level of enforcement. This means that where sub-national administrative units are governed by a different set of land-use regulations, it is necessary to ensure that the boundary of the reference region does not cross into another sub-national unit that does not have equivalent policies or regulations.

e) **Exclusion of planned deforestation**. Areas of planned deforestation shall be excluded from the reference region boundaries where evident.

1.1.1.2 Project area

The project area is the discrete(s) parcel(s) of land that are under threat of deforestation on which the project developers will undertake the project activities and that are forest land at the start date of the REDD project activity. Lands on which the REDD project activities will not be undertaken or that have not entered in the baseline assessment are not to be included in the project area .

The VCS requires all REDD projects (including AUPD), to submit boundary data in a KML file. The VCS Program Update – 21 January 2010, section 3.g and section 7 clarify this and provides the specifications for submissions on the website.

1.1.1.3 Leakage Belt

Depending on the methods chosen to address leakage due to activity displacement, a leakage belt may have to be defined in the surroundings or immediate vicinity of the project area. See the Module "Estimation of emissions from activity shifting for avoided unplanned deforestation" (LK-ASU) to decide whether a leakage belt is required.

If a leakage belt is defined, a baseline deforestation rate must be estimated for it using the procedures described in this module.

At a minimum the Leakage Belt must have a minimum area equal to the project area (+/- 10%) and must be contiguous with the project area . The leakage belt must at a minimum be accessible and reachable by project baseline deforestation agents with consideration of agent mobility. The belt must not be spatially biased in terms of distance of edge of belt from edge of project area without justification based on agent mobility or criteria for landscape and transportation listed below. The Leakage Belt must conform with the following criteria:

A) Landscape factors - These factors can be determined by analysis of spatial data bases (e.g. vegetation map, soil suitability map, DEM [Digital Elevation Model] for slope and elevation) in a GIS for both the project area and reference region.

- Forest types must be present in the leakage belt in the same proportion as in the project area (+/- 20%).
- Soil types that are suitable for the land-use practice used by the main agent(s) of deforestation in the project area must be present in the leakage belt in the same proportion as the project area (+/- 20%).
- The ratio of slope classes "gentle" (slope<15%) to "steep" (slope ≥15%) in the project area shall be (+/- 20%) the same of the ratio in the leakage belt.
- Elevation classes (500m classes) in the leakage belt shall be in the same proportion as in the project area (+/- 20%).

B) Transportation factors -

The following conditions shall be met :

- Where navigable rivers/streams are present in the project area, navigable river/stream density (m/km^2) is the same (+/-20%) for the leakage belt and the project area.
- Road density (m/km^2) is the same (+/-20%) for the leakage belt as for the projected density (in the baseline period) for the project area (including a buffer around the project area of at least 1 km and up to the total project area).
- Settlement density ($settlements/km^2$) is the same (+/-20%) for non-forested areas in a 1km buffer around the project area as in 1 km buffer zones around forested areas in the leakage belt

1.1.2 Temporal boundaries

The following temporal boundaries must be defined (see also the "REDD Methodology Framework" – REDD-MF):

- **Start date and end date of the historical reference period**[10]
- **Start date and end date of the REDD crediting period.**
- **Date at which the project baseline will be revisited**

Note: Any definitions or guidance of the VCS that are or will become inconsistent with the definitions of this module shall out-rule the definitions in this module.

STEP 1.2 Analysis of historical deforestation

10 Historical reference period shall always end ≤ 2 years prior to project start date

This step is to quantify the historical deforestation rate during the historical reference period within the reference region and project area. This is performed by implementing the following sub-steps:

1.2.1 Collection of appropriate data sources

1.2.2 Mapping of historical deforestation

1.2.3 Calculation of the historical deforestation rate

1.2.4 Map accuracy assessment

1.2.1 Collection of appropriate data sources

Collect the data that will be used to analyze deforestation during the historical reference period within the reference region. This should be done for at least three time points, at least 3 years apart to obtain sufficient data for calibrating and testing the goodness of fit of a deforestation model[11] with historical deforestation data.

As a minimum requirement:

- Collect medium resolution remotely sensed spatial data[12] (30m x 30m resolution or less, such as Landsat, Resourcesat-1 or Spot sensor data) for three points in time of no less than 3 years apart covering no more than 12 years (with the first point in time being no more than 2 years from the project start date). Three time points over a maximum of 12 years must be included, however, additional points either within or beyond the 12 year period may be added to enhance the deforestation analysis.
- For the first point in time from the project start date, collect high-resolution data from remote sensors (< 5 x 5 m pixels) and/or from direct field observations for ground-truthing the medium resolution data collected in previous step. These data must be of sufficient quantity to produce a map that has an accuracy of no less than 80% in the classification of forest vs non-forest as per Step 1.2.4 .

Where already interpreted data of adequate spatial and temporal resolution and accuracy are available and they meet the requirements defined in this module, these can be used instead of collecting new original data.

[11] This is required for PART 2 - Location and quantification of the threat of unplanned baseline deforestation.

[12] Guidance on the selection of data sources (such as remotely sensed data) can be found in Chapter 3A.2.4 of the IPCC 2006 GL AFOLU and in GOFC-GOLD. (2008), Section 3.2.4.

1.2.2 Mapping of historical deforestation[13]

Using the data collected in Step 1.2.1 divide the reference region into polygons[14] representing "forest" land and "non-forest" land at different dates in the past (Forest Cover Maps) as well as "deforested" land (Deforestation Maps) at different time periods in the past. Deforestation Maps showing areas of deforestation with paired data shall be prepared and available for the time periods between each historic image.

Given the heterogeneity of methods, data sources, and software, no specific methodology is prescribed for forest land and deforestation mapping. However, good practice of remote sensing analysis has to be followed in any case[15]. Mapping methods for each map type (forest / deforestation) have to be able to generate consistent data sets.

Consistent with the applicability condition, areas of planned deforestation shall be identified and excluded from both the Forest Cover Maps and the Deforestation Maps.

1.2.3 Calculation of the historical deforestation rate

The outcome of the calculations must be the area of forest and the number of hectares deforested for each year of the historical reference period.

Calculating the rate of deforestation when maps have gaps due to cloud cover is a challenge. The use of multiple-date images for the same 12 month period can significantly reduce cloud cover, and the cloud cover in the final images must be no more than 10% of any image. If there are clouds in either date in question in the area for which the rate is being calculated, then the rate should come from areas that were cloud free in *both* dates in question. This should be estimated in % per year. Then, a maximum possible forest cover map should be made for the most recent date. The historical rate in % per year should be multiplied by the maximum forest cover area at the start of the period for estimating the total area of deforestation during the period.

1.2.4 Map accuracy assessment

A verifiable accuracy assessment of the maps (AA_U) produced in the previous sub-step is necessary to produce a credible estimate of the historical deforestation rate[16].

The minimum map accuracy should be 80% for both the "forest" class and the "non-forest" class.

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13 Note: For the purpose of this module, mapping forest and non-forest land is sufficient. However, project participants may consider to divide these two classes in sub-classes representing different carbon densities, as long as such classes can be accurately mapped using the data collected in Step 2.1 and such mapping is useful for other methodology steps.

14 Data formats can be either raster or vector (line, point, or polygon); data in raster format can be converted to vector formats and vice versa.

15 For example, Sourcebook on REDD (GOFC-GOLD 2008).

16 See Chapter 5 of IPCC 2003 GPG, Chapter 3A.2.4 of IPPC 2006 Guidelines for AFOLU, and Section 3.2.4 of Sourcebook on REDD (GOFC-GOLD, 2008) for guidance on map accuracy assessment.

If the classification accuracy is less than 80% then the map is not acceptable for further analysis. More remote sensing data and ground truthing data will be needed to produce a product that reaches the 80% minimum mapping accuracy.

Where interpretation of historical remote sensing products is included in this step, it may not be possible to perform an accuracy assessment of the past image(s). If field data, aerial photographs or high resolution imagery (resolution ≤ 4m) are available for the applicable time period these shall be used. If no field data, aerial photographs or high resolution images exist it is assumed that the classification algorithm used for the most recent image to achieve the 80% or more accuracy of the map product is applicable to the past images and will achieve the same accuracy.[17]

STEP 1.3 Estimation of the annual areas of unplanned baseline deforestation in the reference region

The rate of deforestation in the reference region ($A_{BSL,RR,unplanned,t}$) shall be calculated based on the area deforested in the historical reference period. The approach requires a regression of deforested area against time. If five or more points in time in the analysis then a non-linear regression may be used, if there are less than five points the regression shall be linear. To be applied any regression must be significant ($p \leq 0.05$).

$A_{BSL,RR,unplanned,t}$ Projected area of unplanned baseline deforestation in the reference region at year t; ha yr^{-1}

If no significant regression results the mean rate across the historical reference period shall be used.

Where regression analysis is insignificant:

$$A_{BSL,RR,unplanned,t} = A_{RR,unplanned,hrp} / T_{hrp} \quad (3)$$

Where:

$A_{BSL,RR,unplanned,t}$ Projected area of unplanned baseline deforestation in the reference region at year t; ha yr^{-1}

$A_{RR,unplanned,hrp}$ Total area deforested during the historical reference period in the reference region; ha

T_{hrp} Duration of the historical reference period in years; yr

t A year of the proposed project term.

STEP 1.4 Estimation of annual areas of unplanned baseline deforestation

17 This is standard remote sensing practice and given that the algorithm is designed to distinguish between forest and non forest, and that the maximum time period over which the algorithm is assumed to applicable is 3-5 years, this is a valid assumption.

The projected rate of unplanned baseline deforestation in the Project Area is estimated as follows:

$A_{BSL,PA,unplanned,t} = A_{BSL,RR,unplanned,t} * P_{PA}$ (4)

Where:

$A_{BSL,PA,unplanned,t}$ Projected area of unplanned baseline deforestation in the Project Area at year *t;* ha yr^{-1}

$A_{BSL,RR,unplanned,t}$ Regional area of unplanned baseline deforestation in the reference region at year *t;* ha yr^{-1}

P_{PA} Project Area as a proportion of the forested area in the reference region estimated at ≤ 2 years of the start date of the crediting period; %

t A year of the proposed project term.

The annual area of unplanned baseline deforestation in the leakage belt is estimated as follows:

$A_{BSL,LK,unplanned,t} = A_{BSL,RR,unplanned,t} * P_{LK}$ (5)

Where:

$A_{BSL,LK,unplanned,t}$ Projected area of unplanned baseline deforestation in the Leakage Belt Area at year *t;* ha yr^{-1}

$A_{BSL,RR,unplanned,t}$ Regional area of unplanned baseline deforestation in the reference region at year *t;* ha yr^{-1}

P_{LK} Forested area within the leakage belt as a proportion of the forested area within the reference region estimated at ≤ 2 years of the start date of the crediting period; %

t A year of the proposed project term.

$$A_{BSL,PA,unplanned} = \sum_{t=1}^{t*} A_{BSL,PA,unplanned,t} \quad (6)$$

$$A_{BSL,LK,unplanned} = \sum_{t=1}^{t*} A_{BSL,LK,unplanned,t} \quad (7)$$

Where:

$A_{BSL,PA,unplanned}$ Total area of unplanned baseline deforestation in the Project Area; ha

$A_{BSL,LK,unplanned}$ Total area of unplanned baseline deforestation in the Leakage Belt; ha

$A_{BSL,PA,unplanned,t}$ Annual area of unplanned baseline deforestation in the Project Area at year t; ha yr^{-1}

$A_{BSL,LK,unplanned,t}$ Annual area of unplanned baseline deforestation in the Leakage Belt at year t; ha yr^{-1}

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

STEP 1.5 Analysis of deforestation constraints

Annual deforestation rates can only be credible within the context of constraints to further deforestation in the reference region. This will be the case if it can be demonstrated that forest land suitable for the conversion to non-forest land is still available in sufficient quantity as defined in 1.5.2 below. A baseline revision shall be triggered in any situation where remaining forest area can be perceived as a limiting factor for ongoing deforestation.

1.5.1 Identification of land-use constraints

Identify the biophysical and infrastructural constraints (soil, climate, elevation, slope, distance to roads, etc.) that limit the geographical area where deforestation agents could expand their land-use activities in current forest land. Consider the constraints as they are perceived by the main groups of deforestation agents. The criteria and maps developed to model the spatial location of deforestation can be used in this step (see PART 2)

1.5.2 Identification of forest land that is suitable for deforestation

Using the constraints identified in Step 1.5.1, map the forest land that is suitable for the further expansion of non-forest land in the project area ($A_{e.d.PA}$).

$$A_{e.d.PA} = \left(PA - \left(\sum_{t=1}^{t^*} A_{BSL,PA,unplanned,t} \right) \right) \quad (8)$$

Where:

$A_{e.d.PA}$ Area of forest suitable for expansion of non-forest land in the project area; ha

$A_{BSL,PA,unplanned,t}$ Projected area of unplanned baseline deforestation in the Project Area at year *t;* ha yr^{-1}

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

A baseline revision shall be triggered under the following scenario where:

$A_{e.d.PA} \leq 50 * A_{BSL,PA,unplanned,t}$

PART 2. LOCATION AND QUANTIFICATION OF THREAT OF UNPLANNED DEFORESTATION

The procedure is based on the assumption that deforestation is not random but a phenomenon that occurs at locations that have a combination of bio-geophysical and economic attributes that is particularly attractive to the agents[18] of deforestation. For example, a forest located on fertile soil, flat land, and near roads and markets for agricultural commodities is likely to be at greater risk of deforestation than a forest located on poor soil, steep slope, and far from roads and markets. Locations at higher risk are assumed to be deforested first.

The basic steps needed to perform the analysis described above are:

STEP 2.0 Determination of whether location analysis is required

STEP 2.1 Preparation of spatial variable data sets

STEP 2.2 Preparation of risk maps for deforestation

STEP 2.3 Selection of the most accurate deforestation risk map using an acceptable validation metric

STEP 2.4 Mapping of the locations of future deforestation

STEP 2.0 Determination of whether location analysis is required

Whether or not a location analysis is required[19] is determined by the initial configuration of the landscape[20]:

a) Mosaic Configuration

In the case of a mosaic configuration, location analysis is not required. Location analysis can still be elected to avoid the conservative approach with regard to carbon stocks. If location analysis is not elected, proceed directly to Step 2.4.

[18] Deforestation agents are the social groups (farmers, ranchers etc.) that are converting forest land to non-forest land. and that will continue to do so in absence of the proposed REDD project activity.

[19] Where no location analysis is conducted, a conservative approach in the use of carbon stocks or areas deforested in the baseline is required. Specifically, the stratum with the lowest carbon stocks shall be deforested first followed sequentially by the next highest carbon stock stratum ad infinitum (see Step 2.4.1)

[20] Mosaic configurations are defined as any landscape in which no forest patch exceeds 750 ha in area and more than 75% of the patches' perimeters are surrounded by lands anthropogenically deforested. Frontier configurations are defined as any landscape in which there is no current direct physical connection with areas anthropogenically deforested. Transition configurations are defined as any landscape that is neither mosaic nor frontier

b) Transition Configuration

In the case of a transition configuration location analysis is not required where it can be shown that ≥ 25% of the project geographic boundary is within 50m of land that has been anthropogenically deforested within the 10 years prior to the project start date. If this criterion is not met location analysis is always required. Location analysis may always be elected to avoid the conservative approach with regard to carbon stocks. If location analysis is neither required nor elected proceed directly to Step 2.4.

c) Frontier Configuration

In the case of a frontier configuration location analysis is always required.

STEP 2.1 Preparation of spatial variable data sets

2.1.1 Requirements of spatial models

Project proponents must identify the model/software that will be used to analyze where deforestation is most likely to happen in future periods. The model/software used must:

- Be peer-reviewed

- Be transparent (no "black box" calculations such as neural networks)

- Incorporate spatial datasets correlated with deforestation (both raster and vector)

- Be able to project location of future deforestation

In addition, to the above the models shall conform with the requirements and analyses detailed in Steps 2.1.2, 2.2, 2.3 and 2.4.2.

2.1.2 Preparation of spatial datasets

Identify the spatial variables that most likely explain the pattern of deforestation in the reference region. The following key categories must be considered – landscape factors, accessibility factors, antropogenic factors and factors related to land tenure and management. Within these categories at a minimum the following factors shall be considered:

1. **Landscape factors**, vegetation type, soil fertility, slope, elevation
2. **Accessibility factors,** distance to navigable rivers, distance to water bodies, distance to roads (primary and secondary alone or in combination), distance to settlements, distance to railroads
3. **Anthropogenic factors**, distance to sawmills, settlements, already cleared land, forest edge, and
4. **Actual land tenure and management**, private land, public land, protected land, logging concession, etc.

The final analysis shall use a minimum of one variable from each of the four classes of variables given above, and create digital maps representing the Spatial Features of each variable (i.e. the shape files representing the point, lines or polygon features or the raster files representing surface features). Models are required to produce Distance Maps from the mapped features (e.g. distance to roads or distance to already cleared lands) or maps representing continuous variables (e.g. slope classes) and categorical variables (e.g. soil quality classes). For simplicity, these maps are called "Factor Maps".

STEP 2.2 Preparation of *deforestation* risk maps

A Risk Map shows, for each pixel location *l*, the risk, or "suitability", for deforestation as a numerical scale (e.g. from 0 = minimum risk to some upper limit representing the maximum.

Models use different techniques to produce Risk Maps and algorithms may vary among the different modeling tools. Algorithms of internationally peer-reviewed modeling tools are eligible to prepare deforestation risk maps provided they are shown to conform with the methodology at time of validation.

STEP 2.3 Selection of the most accurate deforestation risk map

Confirming the model output (generally referred to as model validation in the modeling community) is needed to determine which of the deforestation risk maps is the most accurate. A good practice to confirm a model output (such as a risk map) is "calibration and validation", referred to here as "calibration and confirmation" (so as not to be confused with validation as required by the VCS).

Model calibration and confirmation:

Divide the reference region into an even number of equal area tiles and randomly select half of the tiles for the calibration data set and the other half for the confirmation set. There are no clear rules on the number of tiles needed or their area, instead the number of tiles created is a function of the area of the reference region and the expertise of the modeler—the larger the area the greater number of tiles can be generated, but in general the number does not exceed 6-8.

Prepare for each Risk Map a Prediction Map of the deforestation in the confirmation period. Overlay the predicted deforestation with locations that were actually deforested during the confirmation period. Select the Prediction Map with the best fit and identify the Risk Map that was used to produce it. Prepare the final Risk Map using the data from the calibration and the confirmation tiles.

The map with the best fit will be the map that best reproduced actual deforestation in the confirmation period. The best fit is assessed by use of the "Figure of Merit" (FOM) that confirms the model prediction in statistical manner (Pontius *et al*. 2008; Pontius et al. 2007[21]). The FOM is a ratio of the intersection of the observed change (change between the reference maps in time 1 and time 2) and the predicted change (change between the reference map in time 1 and simulated map in time 2) to the union of the observed change and the predicted change (9). The FOM ranges from 0%, where there is no overlap between observed and predicted change, to 100% where there is a perfect overlap between observed and predicted change. The highest percent FOM and least number of drivers used for creating the deforestation risk map must be used as the criteria for selecting the most accurate deforestation risk map to be used for predicting future deforestation.

$$FOM = CORRECT/(CORRECT+Err_A+Err_B) \quad (9)$$

Where,

CORRECT	Area correct due to observed change predicted as change; ha
Err_A	Area of error due to observed change predicted as persistence; ha
Err_B	Area of error due to observed persistence predicted as change; ha

The minimum threshold for the best fit as measured by the Figure of Merit (FOM) must be 40% for frontier configuration, 80% for mosaic configuration, and 60% for transition configuration.[22] Where these minimum standards are not met the project shall be considered ineligible.

STEP 2.4 Mapping of the locations of future deforestation

2.4.1 Where location analysis is not conducted

Where no location analysis is conducted (for eligibility see Step 2.0) the following conservative approach is mandatory:

Future deforestation is assumed to happen first in the strata with the lowest carbon stocks.

- Select the stratum with the lowest carbon stock (see Step 3.2.1);
- Where deforestation in year x (plus the deforestation already accounted in previous years) exceeds the area of the lowest carbon stock stratum proceed to the next lowest carbon stock stratum;

21 R G Pontius Jr, W Boersma, J-C Castella, K Clarke, T de Nijs, C Dietzel, Z Duan, E Fotsing, N Goldstein, K Kok, E Koomen, C D Lippitt, W McConnell, A Mohd Sood, B Pijanowski, S Pithadia, S Sweeney, T N Trung, A T Veldkamp, and P H Verburg. 2008. Comparing input, output, and validation maps for several models of land change. Annals of Regional Science, 42(1): 11-47. R G Pontius Jr, R Walker, R Yao-Kumah, E Arima, S Aldrich, M Caldas and D Vergara. 2007. Accuracy assessment for a simulation model of Amazonian deforestation. Annals of Association of American Geographers, 97(4): 677-695.)

22 Based on data for seven case studies in Belize, Bolivia, Brazil, Mexico, and Kalimantan (Brown et al. 2007; Harris et al. 2008, op. cit.)

- Repeat the above procedure for each successive project year (or monitoring period).

2.4.2 Where location analysis (Steps 2.1, 2.2, 2.3) has been conducted

Future deforestation is assumed to happen first at the pixel locations with the highest deforestation risk value.

To determine the locations of future deforestation do the following:

- In the Deforestation Risk Map select the pixels with the highest value whose total area is equal to the area expected to be deforested in project year one (or first baseline period). The result is the Map of Baseline Deforestation for Year 1 (or first baseline period, respectively).
- Repeat the above pixel selection procedure for each successive project year (or baseline period) to produce a Map of Baseline Deforestation for each future project year (or monitoring period). Do this at least for the upcoming baseline period and, optionally, for the entire project duration.
- Add all yearly (or periodical) baseline deforestation maps in one single map showing the expected Baseline Deforestation for the Baseline Period and, optionally, Project Duration.
- Prepare a table showing the number of hectares that will be deforested each year in the baseline case for the baseline period. In addition, prepare a Crediting Period Baseline Deforestation Map showing the hectares projected to be deforested in each year in the fixed (10 year) baseline period.

PART 3. ESTIMATION OF CARBON STOCK CHANGES AND GREENHOUSE GAS EMISSIONS

The methodology procedure is divided in the following five steps:

STEP 3.1 Stratification of the total area subject to deforestation

STEP 3.2 Estimation of carbon stocks and carbon stock changes per stratum

STEP 3.3 Estimation of the sum of baseline carbon stock changes

STEP 3.4 Estimation of the sum of baseline greenhouse gas emissions

STEP 3.5 Calculation of net CO_2 equivalent emissions

STEP 3.1 Stratification

Pre-deforestation strata (forest strata)

If the baseline carbon stock changes resulting from land use activity and project activity are not homogeneous across the project area, stratification must be carried out. The Module X –STR shall be used to stratify the total area subject to deforestation in the Project Area ($A_{BSL,PA,unplanned}$)and Leakage Belt area ($A_{BSL,LK,unplanned}$)in M_F Forest Strata.

Post-deforestation land-uses (non-forest land uses)

The areas expected to be deforested ($A_{BSL,PA,unplanned}$ and $A_{BSL,LK,unplanned}$) shall be separated into post-deforestation land uses. The long-term average carbon stock for post-deforestation land-uses shall be determined in Step 3.2.2. The land uses shall be justified taking into account current land uses in the reference region and observed land-uses in areas deforested during the historical reference period.

STEP 3.2 Estimation of carbon stocks and carbon stock changes per stratum

3.2.1 Forest carbon stocks

Each forest stratum will be represented by one forest class with the carbon stock estimated within 2 years before the project start date, for simplicity referred to here as stocks at t=0 (see module CP-AB).

Use the methods described in the carbon pool modules to determine the carbon stock of each forest stratum. In the situation where the baseline includes harvesting of long-lived wood products the harvested wood products carbon pool shall be included.

Forest strata (forest classes):

(10)

Where:

$C_{TOT-FOR,iF}$	Carbon stock in all carbon pools in the forest stratum *iF*; t CO_2-e ha^{-1}
$C_{AB,iF}$	Carbon stock in aboveground biomass in the forest stratum *iF*; t CO_2-e ha^{-1}
$C_{BB,iF}$	Carbon stock in belowground biomass in the forest stratum *iF*; t CO_2-e ha^{-1}
$C_{DW,iF}$	Carbon stock in dead wood in the forest stratum *iF*; t CO_2-e ha^{-1}
$C_{LI,iF}$	Carbon stock in litter in the forest stratum *iF*; t CO_2-e ha^{-1}
$C_{SOC,iF}$	Carbon stock in soil organic carbon in the forest stratum *iF*; t CO_2-e ha^{-1}
iF	1, 2, 3 … M_F forest strata
	Note: the time index *t* is omitted as in these strata stocks are assumed to be constant

Carbon pools excluded from the project can be counted as zero. For determining which carbon pools shall be included in the calculations as a minimum, see tool T-SIG.

3.2.2 Estimation of post-deforestation carbon stocks

Post-deforestation carbon stocks are assumed to be the long-term average stocks on the land following deforestation (time-weighted average of stocks in a given cyclical post-deforestation land-uses systems such as shifting agriculture with fallow). These stocks depend on the assumed land-uses after deforestation in each post-deforestation land-uses.

Two options are available to determine the carbon stocks of these land-uses:

Option 1 – Simple approach: A list of likely post-deforestation land uses shall be established taking into account land uses on areas deforested in the reference region during the historical reference period. The land uses with the highest long-term carbon stocks are conservatively considered representative of future post-deforestation land use classes. A carbon stock is calculated from the highest carbon stock land-use class and used as a proxy for all post-deforestation carbon stocks in that land use during the project term. Note that in cyclical post-deforestation land-use systems the time-weighted average of stocks in a cycle[23] shall be used.

Option 2 – Historical area-weighted average: The historical land-use matrix will refer to post-deforestation land uses initiated during the historical reference period. An historical mix of post-deforestation land-uses is assumed to be representative of future changes. The area-weighted average of the mature carbon stock for each land use is calculated from the historical land-use change matrix and is assumed to represent all post-deforestation carbon stocks in that land use during the project term. Note that in cyclical post-deforestation land-use systems the

[23] If a land-use cycle exceeds 14 years in length then the maximum stock over the cycle shall be used

time-weighted average of stocks in a cycle[24] shall be used. The historical reference period used to calibrate the deforestation model (see PART 1) shall be used as the time-frame reference.

Post-deforestation carbon stocks of the selected land-use classes shall be obtained from local studies and, where examples of mature vegetation for a particular land-use do not exist in the reference area then data shall be obtained from credible and representative literature sources (e.g. IPCC GL 2006 or other credible literature sources). The local study areas shall include sites that represent the conditions and the land management practices identified as the most likely post-deforestation baseline conditions. Local data shall be based on a sampling scheme that produces conservative estimates of the carbon stocks[25]. Where stocks accumulate through time, the mature stock shall be used and where stocks are in a cycle such as in shifting cultivation, the time-weighted average of C stocks in a cycle shall be used in option 1 and 2.

$$C_{TOT-post,iPD} = C_{AB,iPD} + C_{BB,iPD} + C_{DW,iPD} + C_{LI,iPD} + C_{SOC,iPD} \quad (11)$$

Where:

$C_{TOT-post,iPD}$	Carbon stock in all pools in the post-deforestation land use *iPD*; t CO_2-e ha^{-1}
$C_{AB,iPD}$	Carbon stock in aboveground biomass in the post-deforestation land use *iPD*; t CO_2-e ha^{-1}
$C_{BB,iPD}$	Carbon stock in belowground biomass in the post-deforestation land use *iPD*; t CO_2-e ha^{-1}
$C_{DW,iPD}$	Carbon stock in dead wood in the post-deforestation land use *iPD*; t CO_2-e ha^{-1}
$C_{LI,iPD}$	Carbon stock in litter in the post-deforestation land use *iPD*; t CO_2-e ha^{-1}
$C_{SOC,iPD}$	Carbon stock in soil organic carbon in the post-deforestation land use *iPD*; t CO_2-e ha^{-1}
iPD	1, 2, 3 … M_{PD} post-deforestation land uses

Carbon pools excluded from the project can be accounted as zero. For the determination which carbon pools shall be included in the calculations as a minimum, see tool T-SIG.

STEP 3.3 Estimation of the sum of baseline carbon stock changes

The sum of baseline carbon stock changes is estimated as follows:

$$\Delta C_{TOT} = C_{TOT-For} - C_{TOT-post} - C_{TOT-wp} \quad (12)$$

$$C_{TOT-For} = \sum_{t=1}^{t*} \sum_{iF}^{MF} ((C_{TOT-FOR,iF}) * A_{unplanned,iF,t}) \quad (13)$$

24 If a land-use cycle exceeds 14 years in length then the maximum stock over the cycle shall be used

25 It is possible that the post-deforestation vegetation is variable and a conservative estimate would be obtained by selectively sampling the vegetation to represent the maximum C stocks present.

(14)

$$C_{TOT-hp} = \sum_{t=1}^{t*} \sum_{iF}^{MF} (C_{HP,t} * A_{unplanned,iF,t}) \quad (15)$$

Where:

ΔC_{TOT}	Sum of the baseline carbon stock change in all pools up to time $t*$; t CO_2-e (calculated separately for the project area [PA] and the leakage belt [LB]
$C_{TOT\text{-}For}$	Total forest carbon stock in areas deforested up to time $t*$; t CO_2-e
$C_{TOT\text{-}Post}$	Total post-deforestation carbon stock in areas deforested up to time $t*$; t CO_2-e
$C_{TOT\text{-}wp}$	Total carbon stock in harvested wood products up to time $t*$; t CO_2-e
$C_{TOT\text{-}FOR,iF,t}$	Carbon stock in all carbon pools in the forest stratum *iF*at year t; t CO_2-e ha^{-1}
$C_{TOT\text{-}FOR,iF}$	Carbon stock in all carbon pools in the forest stratum *iF*(at project start); t CO_2-e ha^{-1}
$A_{unplanned,iF,t}$	Area of unplanned deforestation in forest stratum *iF* at year *t*; ha
$C_{TOT\text{-}post,iPD}$	Carbon stock in all carbon pools in the post-deforestation stratum *iPD*; t CO_2-e ha^{-1}
$A_{unplanned,iPD,t}$	Area of unplanned deforestation in post deforestation stratum *iPD* at year *t*; ha
$C_{HP,iF,t}$	Carbon stock sequestered in wood products from forest stratum *iF*at the year *t* = *td* when deforestation occurs; t CO_2-e ha^{-1}
t	1, 2, 3, … t^* years elapsed since the projected start of the REDD VCS project activity
iF	1, 2, 3 … M_F forest strata
iPD	1, 2, 3 … M_{PD}post-deforestation strata

For calculation of carbon stock sequestered in wood products, see Module CP-W.

STEP 3.4 Estimation of the sum of baseline greenhouse gas emissions

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

$$GHG_{BSL,unplanned} = \sum_{t=1}^{t^*} ET_{FC,t} + E_{BiomassBurn,t} + N_2O_{direct-N,t} \quad (16)$$

Where:

$GHG_{BSL,E}$	Greenhouse gas emissions as a result of deforestation activities within the project boundary in the baseline stratum *i* at project year *t*; t CO_2-e
$ET_{FC,t}$	CO_2 emission from fossil fuel combustion during year *t* in the baseline; t CO_2-e $year^{-1}$
$E_{BiomassBurn,t}$	Non-CO_2 emissions due to biomass burning as part of deforestation activities during the year *t* in the baseline; t CO_2-e $year^{-1}$
$N_2O_{direct-N,t}$	Direct N_2O emission as a result of nitrogen application on the alternative land use within the project boundary in year *t* in the baseline; t CO_2-e $year^{-1}$
t	*1, 2, 3 …t** years elapsed since the start of the REDD VCS project activity

For detailed information regarding the calculation of $ET_{BSL,FC,t}$, $E_{BSL,\ BiomassBurn,t}$ and $N_2O_{BSL,direct-N,t}$ see the VCS-approved Modules "Estimating emissions from fossil fuel combustion in REDD project activities (E-FFC)", "Estimating non-CO_2 emissions from biomass burning in REDD project activities (E-BB)" and the latest A/R CDM tool "Estimation of direct nitrous oxide emission from nitrogen fertilization"[26].

GHG emission sources excluded from the project boundary can be neglected, i.e. accounted as zero. For the determination which sources of emissions must be included in the calculations as a minimum, see tool T-SIG.

STEP 3.5 Calculation of net CO_2 equivalent emissions

$$\Delta C_{BSL,unplanned} = \Delta C_{BSL,PA,unplanned} + GHG_{BSL,unplanned} \quad (17)$$

$$\Delta C_{BSL,PA,unplanned} = \Delta C_{TOT,PA} \quad (18)$$

$$\Delta C_{BSL,LK,unplanned} = \Delta C_{TOT,LB} \quad (19)$$

Where:

$\Delta C_{BSL,unplanned}$	Net CO_2 equivalent emissions in the baseline from unplanned deforestation; t CO_2-e
$\Delta C_{BSL,PA,unplanned}$	Net CO_2 equivalent emissions in the baseline from unplanned deforestation in the project area; t CO_2-e

[26] http://cdm.unfccc.int/EB/033/eb33_repan16.pdf

$\Delta C_{BSL,LK,unplanned}$	Net CO_2 equivalent emissions in the baseline from unplanned deforestation in the leakage belt; t CO_2-e
$GHG_{BSL,unplanned}$	Sum of baseline greenhouse gas emissions from unplanned deforestation up to time t^*; t CO_2-e
$\Delta C_{TOT,PA}$	Sum of the baseline carbon stock change in all pools up to time t^* in the project area; t CO_2-e
$\Delta C_{TOT,LB}$	Sum of the baseline carbon stock change in all pools up to time t^* in the leakage belt; t CO_2-e
t	$1, 2, 3 \ldots t^*$ years elapsed since the start of the project activity

III. DATA AND PARAMETERS MONITORED FOR BASELINE RENEWAL

Data / parameter:	Any spatial feature included in the spatial model that is subject to changes over time (Factor Maps)
Data unit:	Depending on the spatial features selected
Used in equations:	
Description:	Factor Maps
Source of data:	
Measurement procedures (if any):	Update of digital maps
Any comment:	Must be updated each time the baseline is revisited (at least every 10 years)

Data / parameter:	Risk Maps
Data unit:	
Used in equations:	
Description:	A Risk Map shows, for each pixel location *l*, the risk, or "suitability", for deforestation as a numerical scale (e.g. from 0 = minimum risk to some upper limit representing the maximum).
Source of data:	
Measurement procedures (if any):	Update of digital maps
Any comment:	Must be updated each time the baseline is revisited (at least every 10 years)

Data / parameter:	Baseline Deforestation Maps
Data unit:	
Used in equations:	
Description:	Maps showing the location of deforested hectares in each year of the baseline period
Source of data:	
Measurement	Update of digital maps

procedures (if any):	
Any comment:	Must be updated each time the baseline is revisited (at least every 10 years)

Data / parameter:	AA_U
Data unit:	%
Used in equations:	Part 1, Section 2.4
Description:	The accuracy assessment of the rate of unplanned deforestation (equals 20% or less)
Source of data:	Existing maps or models, expert consultation, literature
Measurement procedures (if any):	Multi-criteria analysis implemented in a Geographical Information System
Any comment:	Reassessed once every 10 years (when the baseline is revisited)

Data / parameter:	*Correct*
Data unit:	ha
Used in equations:	9
Description:	Area correct due to observed change predicted as change
Source of data:	Spatial model of deforestation location
Measurement procedures (if any):	
Any comment:	Must be updated each time the baseline is revisited (every 10 years)

Data / parameter:	Err_A
Data unit:	ha
Used in equations:	9
Description:	Area of error due to observed change predicted as persistence
Source of data:	Spatial model of deforestation location
Measurement procedures (if any):	
Any comment:	Must be updated each time the baseline is revisited (every 10 years)

Data / parameter:	Err_B
Data unit:	ha
Used in equations:	9
Description:	Area of error due to observed persistence predicted as change
Source of data:	Spatial model of deforestation location
Measurement procedures (if any):	
Any comment:	Must be updated each time the baseline is revisited (every 10 years)

Data / parameter:	*FOM*
Data unit:	
Used in equations:	
Description:	Figure of Merit
Source of data:	Calculated using equation 9.
Measurement procedures (if any):	
Any comment:	Must be updated each time the baseline is revisited (every 10 years)

Data / parameter:	*LB*
Data unit:	Ha
Used in equations:	
Description:	Leakage belt area
Source of data:	GPS coordinates and/or remote sensing data
Measurement procedures (if any):	
Quality Assurance / Quality Control	Where leakage belt boundaries have not been derived using GPS on-the-ground measurements quality control shall be carried out. A minimum of 30 locations on the leakage belt boundary, each separated by at least 1km, shall be visited. If a systematic bias is detected in the original boundaries and/or if >10% of locations differ by >50m then the entire boundary shall be resurveyed

Any comment:	Must be updated each time the baseline is revisited (at least every 10 years) Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / parameter:	*PA*
Data unit:	Ha
Used in equations:	1,2
Description:	Unplanned deforestation project area
Source of data:	GPS coordinates and/or remote sensing data
Measurement procedures (if any):	
Quality Assurance / Quality Control	Where project boundaries have not been derived using GPS on-the-ground measurements quality control shall be carried out. A minimum of 30 locations on the project boundary, each separated by at least 1km, shall be visited. If a systematic bias is detected in the original boundaries and/or if >10% of locations differ by >50m then the entire boundary shall be resurveyed
Any comment:	Must be updated each time the baseline is revisited (at least every 10 years) Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / parameter:	P_{LK}
Data unit:	%
Used in equations:	5
Description:	Forested area within the leakage belt as a proportion of the forested area within the reference region estimated at ± 2 years of the start date of the crediting period
Source of data:	
Measurement procedures (if any):	Calculated from the result of remotely sensed data analysis
Any comment:	Monitored once every 10 years (when the baseline is revisited)

	Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / parameter:	P_{PA}
Data unit:	%
Used in equations:	4
Description:	Project Area as a proportion of the forested area in the reference region estimated at ± 2 years of the start date of the crediting period
Source of data:	
Measurement procedures (if any):	Calculated from the result of remotely sensed data analysis
Any comment:	Monitored once every 10 years (when the baseline is revisited) Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / parameter:	*RA*
Data unit:	Ha
Used in equations:	
Description:	Geographic boundaries of the reference area
Source of data:	GPS coordinates and/or remote sensing data
Measurement procedures (if any):	
Quality Assurance / Quality Control	
Any comment:	Must be updated each time the baseline is revisited (at least every 10 years) Shall be estimated at time zero, this estimate shall be used for ex-ante purposes

Data / parameter:	T_{hrp}
Data unit:	Yr
Used in equations:	3

Description:	Duration of the historical reference period in years
Source of data:	
Measurement procedures (if any):	
Any comment:	Should be between 10 and 15 years

IV. PARAMETERS ORIGINATING IN OTHER MODULES

Data / parameter:	$A_{RR,unplanned,hrp}$
Data unit:	Ha
Used in equations:	3
Description:	Total area deforested during the historical reference period in the reference region
Module parameter originates in:	M-EXP
Any comment:	

Data / parameter:	$C_{AB,tree,i}$
Data unit:	t CO_2-e ha^{-1}
Used in equations:	10,11
Description:	Carbon stock in aboveground biomass in trees in the baseline in stratum *i*
Module parameter originates in:	CP-AB
Any comment:	

Data / parameter:	$C_{BB,tree,i}$
Data unit:	t CO_2-e ha^{-1}
Used in equations:	10,11
Description:	Carbon stock in belowground biomass in trees in the baseline in stratum *i*
Module parameter originates in:	CP-AB

Any comment:	

Data / parameter:	$C_{nontree,i,}$
Data unit:	t CO_2-e ha^{-1}
Used in equations:	10,11
Description:	Carbon stock in non-tree vegetation in the baseline in stratum *i*
Module parameter originates in:	CP-AB
Any comment:	Herbaceous vegetation considered *de minimis* in all instances

Data / parameter:	$C_{BSL,DW,i}$
Data unit:	t CO_2-e ha^{-1}
Used in equations:	10,11
Description:	Carbon stock in dead wood in the baseline in stratum *i*
Module parameter originates in:	CP-W
Any comment:	

Data / parameter:	$C_{LI,i}$
Data unit:	t CO_2-e ha^{-1}
Used in equations:	10,11
Description:	Carbon stock in litter in the baseline in stratum *i*
Module parameter originates in:	CP-L
Any comment:	

Data / parameter:	$C_{SOC,i}$
Data unit:	t CO_2-e ha^{-1}
Used in equations:	10,11
Description:	Carbon stock in soil organic carbon in the baseline in stratum *i*
Module parameter	CP-S

originates in:	
Any comment:	

Data / parameter:	$C_{WP,i}$
Data unit:	t CO_2-e ha^{-1}
Used in equations:	10,11
Description:	Carbon stock in wood products in the baseline in stratum *i*
Module parameter originates in:	CP-W
Any comment:	

Data / parameter:	$E_{BiomassBurn,t}$
Data unit:	t CO_2-e $year^{-1}$
Used in equations:	16
Description:	Non-CO_2 emissions due to biomass burning as part of degradation activities during the year *t* in the baseline; t CO_2-e
Module parameter originates in:	E-BB
Any comment:	

Data / parameter:	$ET_{FC,t}$
Data unit:	t CO_2-e $year^{-1}$
Used in equations:	16
Description:	CO_2 emission from fossil fuel combustion during year *t* in the baseline; t CO_2-e
Module parameter originates in:	E-FFC
Any comment:	

Data / parameter:	$N_2O_{direct-N,t}$
Data unit:	t CO_2-e $year^{-1}$
Used in equations:	16

Description:	Direct N_2O emission as a result of nitrogen application on the alternative land use within the project boundary in year *t* in the baseline; t CO_2-e year^{-1}
Module parameter originates in:	E-NA
Any comment:	

Data / parameter:	*Regional Forest Cover / Non-Forest Cover Benchmark Map*
Data unit:	
Used in equations:	
Description:	Map showing the location of forest land within the reference region at the beginning of the crediting period
Module parameter originates in:	M-EXP
Any comment:	

Data / parameter:	*Project Forest Cover Benchmark Map*
Data unit:	
Used in equations:	
Description:	Map showing the location of forest land within the project area at the beginning of each monitoring period. If within the Project Area some forest land is cleared, the benchmark map must show the deforested areas at each monitoring event
Module parameter originates in:	M-EXP
Any comment:	

Data / parameter:	*Leakage Belt Forest Cover Benchmark Map*
Data unit:	
Used in equations:	
Description:	Map showing the location of forest land within the leakage belt area at the beginning of each monitoring period. Only applicable where leakage is to be monitored in a leakage belt
Module parameter	M-EXP

originates in:	
Any comment:	