Carbon Accounting Methodology for Project Activities that Reduce Emissions from Mosaic Deforestation and Degradation

A methodology for the Voluntary Carbon Standard

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October, 2010

Definitions

The definitions below are consistent with or complement the definitions in the VCS AFOLU guidance (VCS 2007.1, 2008 p 40-43). The definitions set forward by the VCS in future guidance documents shall always have precedence over the definitions introduced in this section.

Greenhouse Gases, Sources, and Sinks

Net anthropogenic Emission Reductions (NERs) are the net GHG benefits generated by the REDD project. The Voluntary Carbon Units (VCUs) are the NERs that are released after transferring the adequate amount of NERs to a buffer account according to before discounting credits according to the VCS AFOLU non-permanence risk analysis.

Geographical boundaries

This methodology uses three geographical distinctions for land.

The **project area** is the geographical area where the project participants will implement activities to reduce deforestation. The project area may be contiguous or consist of multiple smaller adjacent and non-adjacent project areas (referred to as **discrete project area parcels**) and conforms to the definition of "forest" under this methodology.

Leakage is the net change in carbon stocks and/or the increase in permanent GHG emissions occurring outside the project area but that are attributable to the REDD project activity. Leakage occurs when GHG emissions increase outside of the project area as a result of project measures. This increase in GHG emissions can be due to increased deforestation, increased forest degradation, or the increased emission of non-biomass GHG emissions. Leakage can occur on both forest land and non-forest land, such as woodland or grassland. The area where leakage occurs around an individual discrete project area parcel is referred to as a **leakage belt**. Adjacent discrete project parcels will share a leakage belt. The **leakage area** is the sum individual leakage belts. The leakage area does not have to be contiguous.

The **reference region** is the region from which historical and current deforestation and forest degradation quantities and trends are obtained. This information is required to predict future deforestation and degradation quantities in the absence of project activities (i.e. baseline scenario). Before the start of the project (i.e. during the historical reference period) the reference region includes the project and leakage areas. After the project has started (i.e. during the crediting period) the reference region excludes the project and leakage areas to serve as a reference for determining deforestation and forest degradation rates in the absence of project activities.

Scenarios

The **baseline scenario** represents the hypothetical situation in which the proposed project activities are not implemented; the baseline scenario refers to the business-as-usual situation in absence of the proposed REDD project activity.

The **project scenario** represents the situation in which the proposed project activities are implemented according to the proposed project actions. The emission reductions generated by the REDD project area are calculated by subtracting the net GHG emissions under the baseline scenario from the net GHG emissions under the project scenario and subsequently subtracting GHG emissions from leakage.

Temporal Boundaries

The **historical reference period** is a fixed time period preceding the starting date of the proposed REDD project or the time at which the baseline is updated during which the magnitude of deforestation in the reference region is quantified, and the agents and drivers of deforestation are identified. This analysis is the basis for the estimation of future deforestation trends and is used to calculate the baseline GHG emissions for the first baseline validation period. The historical reference period must end at the start date of the project or the time at which the baseline is updated. The duration shall range between 10 and 15 years.

The project actions and conditions must be monitored and compiled in monitoring reports. Only after a third party **verification** of a monitoring report, can VCUs be issued. The frequency and years of verification must be fixed for the duration the baseline is valid and must be included in the PD or in a monitoring report if the baseline is updated.

The **baseline validation period** is the period during which the *ex-ante* calculation of net GHG emissions under the baseline scenario is valid. After the baseline validation period expires, a new *ex-ante* baseline needs to be calculated and validated by a VCS verifier.

Land Use and Land Cover (LULC) Classes and Forest Strata

In this methodology units of land are allocated to different **land use and land cover** (LULC) classes. The forest LULC classes are further divided into more narrow forest strata according to biomass density, forest type or management. These definitions are consistent with the IPCC GPG-LULCF 2003 and the requirements of Articles 3.3 and 3.4 of the Kyoto Protocol. The following definitions are in accordance with Chapter 2 of the IPCC GPG-LULUCF 2003.

Under this methodology, a **forest** is defined as following[1]:

- If the Designated National Authority (DNA) of the country where the REDD project activity will be implemented has set the thresholds for defining a forest according to decisions 11/CP.7 and 11/CP.9, these should be followed by the project proponents. The DNA definition can be checked on the CDM UNFCCC website at http://cdm.unfccc.int/DNA/index.html.

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[1] Any forest definition used for a VCS project that is different to the national forest definitions applied by authorities in charge for carbon accounting in a mandatory scheme (i.e. national schemes such as the KP) may cause non-compatibility with this scheme and therefore not allow solution on the avoidance of double counting when this may become necessary.

- If the DNA has not formally decided on a forest definition, the FAO definition should be used

> *Forest includes natural forests and forest plantations. It is used to refer to land with a tree canopy cover of more than 10 percent and area of more than 0.5 ha. Forests are determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 m.*

(http://www.fao.org/DOCREP/004/Y1997E/y1997e1m.htm#bm58)

Note that the minimum mapping unit for assessing forest area should be identical as the minimum size set forward in the forest definition.

Temporarily un-stocked forests are areas that have previously met the criteria for forest land, do not meet these criteria at present, but are expected to regenerate and become forest land again. Such land includes harvested areas in managed forests or forest land that was affected by a fire or a hurricane, on the condition that this land will regenerate to forest land (and meet the forest definition criteria again) within a pre-defined period referred to as the **maximal period of temporarily un-stocked**. See IPCC GPG LULUCF 2003, Chapter. 4.2.6.2.1 for further reference.

The forest LULC class is further sub-divided into more narrow **forest strata** according to the carbon stock density, native forest type, past and future management, landscape position, biophysical properties, and the degree of past disturbance.

Cropland includes arable and tillage land and agro-forestry systems where vegetation does not the meet the forest definition.

Grassland includes managed and unmanaged rangeland, pasture land, wild land, recreational areas, and silvo-pastoral systems that do not meet the forest definition. Non-forest land with woody shrubs may be classified as **sparse woodland** to distinguish it from land that is dominated by grass species.

Settlements include all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.

Wetland includes land that is covered or saturated by water for all or part of the year and that does not fall into the forest land, cropland, grass land or settlements LULC classes. Examples include peat lands, reservoirs, and rivers.

Other land includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories.

The process of dividing land into one of the LULC classes is defined as **LULC classification**, while the process of sub-dividing the forest LULC class into more narrow forest strata is defined as **forest stratification**.

Land transition

Land use or cover changes over time; land transitions from one LULC class or forest stratum into another. This methodology considers four main categories of transitions.

Deforestation (DF)[2], per section 4.2.6.2 of the IPCC GPG-LULUCF 2003, is the process taking place on land the meets the following conditions:

- Meets the definition of forest at the beginning of the historical reference period, or 10 years before project start date, whichever is earliest.
- Does not meet the definition of forest anymore at some time after the start of the historical reference period (or 10 years before project implementation) as the result of direct human-induced interventions.
- Will not meet the definition of forest within the period of time used to define temporarily un-stocked.

Forest degradation (DG) refers to the gradual loss of carbon on forest land as a consequence of direct human intervention (e.g., logging, fuel-wood collection, or human-induced fire) but still remains forest land. In absence of a definition set forward by the VCS, the suggested definition of the IPCC (2003b) is adopted:

> *A direct, human-induced, expected to be long term (persisting for minimum of x years) decrease of at least y% of forest carbon stock* [and forest values] *for t-year time period and not qualifying as deforestation.*

x, y, and t must be set at validation by the project proponents and must remain fixed until the baseline update. The minimum thresholds for x, y and t are 10 years, 10% and 3 years respectively. Note that the minimum mapping unit set forward in the forest definition should also be applied to forest strata. Therefore, the minimum mapping unit for assessing forest degradation will be identical to the minimum forest size set forward in the forest definition.

Forest regeneration (RG) refers to a gradual increase in carbon stock on forest land due to natural succession or human interventions. It is formally defined as the converse of forest degradation:

> *A direct, expected to be long term (persisting for minimum of x years increase of at least y% of forest carbon stock* [and forest values] *for a t-year time period and not qualifying as reforestation.*

The same threshold values of x, y, and t, as the ones selected for forest degradation must be used for forest regeneration. Analogously as for forest degradation, the minimum mapping unit for assessing forest regeneration will be identical to the minimum forest size set forward in the forest definition.

Increased forest cover is the transition of non-forest land into forest land, and encompasses both reforestation and natural succession.

[2] The minimum mapping unit for assessing forest strata should be identical as the minimum size set forward in the forest definition.

- **Reforestation (RF)** is the human-induced conversion of non-forest land back to forest land (e.g., from cropland to forest, or grassland to forest). Reforestation is excluded from this methodology as a project activity for generating carbon credits.
- **Natural succession** is the natural increase in forest cover without any human interventions. Natural succession is included in the baseline and project scenarios. Natural succession and increase in forest cover are likely results of decrease in deforestation rate due to project activities.

Other definitions relevant within the scope of this methodology

Timber harvesting for local and domestic use. The extraction of timber wood for direct use within the project area and by the households that are living within the project area, without on-sale of the timber

Commercial timber harvesting. The extraction of timber wood for further sale on regional/global timber markets outside of the project area or transferred to non-project participants (see VCS 2007.1, 2008, point 25 p 23).

Participating community. A local community of individuals and households who are permanently living adjacent to the project area, and who are participating in project activities and directly benefit from project activities through increased livelihoods and improved forest resources.

Assisted natural regeneration (ANR). Human-induced forest regeneration by ways of silvicultural activities inducing or accelerating an increase in forest biomass stock density compared to natural regeneration rates. Silvicultural activities include thinning to stimulate tree growth, removal of invasive species, coppicing, and enrichment planting.

Section I: Summary and Applicability of Baseline & Monitoring Methodology

I.1 Sources

This methodology uses different elements from several approved methodologies and tools. More specifically, this methodology is based on elements from the following methodologies (latest version):

- Approved CDM Methodology - AR ACM0001 Afforestation and reforestation of degraded land
- Approved CDM Methodology - AR AM0002 Restoration of degraded lands through afforestation/reforestation
- Approved CDM Methodology – AR AM0004 Reforestation or afforestation of land currently under agricultural use.
- Approved CDM Methodology - AR AM0006 Afforestation/Reforestation with Trees Supported by Shrubs on Degraded Land
- Approved VCS Methodology VM0003 Methodology for Improved Forest Management through Extension of Rotation Age

This methodology also refers to the latest approved versions of the following tools:

- VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities. (Available at http://www.v-c-s.org/tool_VT0001.html)
- AR AMTOOL03 Calculation of the number of sample plots for measurements within A/R CDM project activities. (Available at https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.pdf
- AR AM Tool 07 Estimation of direct nitrous oxide emission from nitrogen fertilization. (Available at http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-07-v1.pdf)
- ARM Methodological Tool – Estimation of GHG emissions related to displacement of grazing activities in A/R CDM project activity. (Available at http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-09-v2.pdf)

Projects that meet the applicability criteria of this methodology will conform to all relevant applicability criteria associated with each of these individual methodologies and tools.

I.2 Summary of Methodology

This methodology sets out the project conditions and carbon accounting procedures for activities aimed at reducing unplanned anthropogenic deforestation and forest degradation of the mosaic type. The main methodological aspects of the methodology are:

- REDD credits are calculated by subtracting *ex-ante* changes in baseline carbon stocks, *ex-post* monitored emissions from leakage, and *ex-post* monitored emission sources from the *ex-post* monitored changes in carbon stocks in the project areas

- Baseline emissions in the project area are calculated based on historical deforestation or forest degradation rates in a reference region that is similar to the project area.
- Net emission reductions from avoided deforestation and avoided forest degradation are treated separately. When changes in forest biomass cannot be measured with sufficient accuracy, credits from avoided forest degradation must be excluded. Credits from avoided deforestation may still be included.
- The quantification of baseline deforestation/degradation rates is based on field-calibrated remote sensing analyses over a historical reference period. Credits from avoided deforestation are discounted based on the accuracy of observing forest vs. non-forest. Credits from avoided degradation are discounted based on the accuracy of observing individual forest biomass classes.
- Carbon stock densities are quantified by permanent sampling plots on forest lands and temporary sampling plots on non-forest lands (conservative default values may be used for non-forest lands). Net emission reductions are discounted based on the attained precision of the biomass measurements. If the forest biomass density cannot be measured with sufficient precision, the project is not eligible.
- Leakage is monitored and quantified using a leakage belt approach for geographically constrained drivers and by a factor approach for geographically unconstrained drivers. Market-effect leakage must be accounted for within each PD, according to the rules set forward within the VCS guidance. Note that the market-effect leakage section within the PD is subject to rigorous dual validation.
- While reforestation is not allowed under the VCS AFOLU guidance for REDD projects, increased forest cover through natural regeneration and assisted natural regeneration must be included in the baseline and project scenarios. This is achieved by applying the empirically observed baseline regeneration rates in the reference region to the project and baseline scenarios. Note that (human-induced) assisted natural regeneration activities are allowed as a leakage prevention activity, but only to the extent that it increases the baseline natural regeneration rate.

Projects may include assisted natural regeneration activities on degraded areas. However, the quantification of the GHG benefits from assisted natural regeneration follows a different and more detailed procedure than for the quantification of GHG benefits from areas without assisted natural regeneration. The accounting of the carbon changes always must follow the relevant sections of the most updated CDM-approved methodology AR-ACM0001. The baseline for areas on which assisted natural regeneration (ANR) is executed has two aspects (1) the natural regeneration rate without assistance, and (2) the loss of forest biomass due to deforestation and forest degradation.

I.3 Criteria for Applicability of this Methodology

Project proponents must demonstrate that project conditions meet the following list of criteria.

Criteria related to conditions on the land before project implementation:

1. Land in the project area, consisting of either one contiguous area or multiple discrete project parcels (see definition of project area), has qualified as forest at least 10 years before the project start date (VCS 2007.1, 2008 p 16). Note that in case the project area consists of multiple discrete project parcels, each of the discrete parcels must meet all the applicability criteria of this methodology.
2. The project area would be deforested in absence of the REDD project activity, as evidenced by the presence of deforestation agents and drivers near the project area (see the following criterion), and a minimal deforestation rate in the reference region of 0.5% during the historical reference period. In addition, the deforestation in the reference region[3] must follow the mosaic typology; the presence of a mosaic typology must be verified using the criteria for mosaic deforestation set forward by the VCS[4].
3. Areas that have been legally sanctioned for logging where the primary activity would be stopping such logging must be excluded from the project area.
4. Deforestation and forest degradation in the project area occurs due to one or more of the following categories of drivers[5] (see section II.1.3)
    - Driver 1: Conversion of forest land to crop-land or grazing land for subsistence and small-scale farming.
    - Driver 2: Conversion of forest land to settlements
    - Driver 3: Logging of timber for commercial sale
    - Driver 4: Logging of timber for local and domestic use
    - Driver 5: Fuel-wood collection or charcoal production
    - Driver 6: Forest fires[6]

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[3] A procedure to delineate the reference region is included further in the methodology.

[4] The risk of overestimating credits due to an incorrect or insufficient deforestation type definition is deemed very small for mosaic deforestation methodologies. More specifically, if a methodology for mosaic deforestation is used while the deforestation type was actually frontier, credits will be conservatively estimated because the baseline deforestation rate calculated according to the methodology is going to be smaller than the true baseline deforestation rate in the frontier deforestation case. This is because the historical deforestation rate in areas under frontier deforestation is small, and usually not representative for future deforestation rates.

[5] A driver of deforestation is the immediate activity executed by agents of deforestation/degradation that leads to deforestation/ degradation. An agent of deforestation or degradation is the social group, community, or other entity involved in deforestation or forest degradation.

[6] Forest fires are often an integral part of natural ecosystem dynamics, and in many cases even essential for regeneration. However, in many cases, forest fires occur with more intensity and greater frequency than natural forest fires, and may be a significant driver of deforestation.

No other deforestation driver may be present in the project area[7]. Following the definition for degradation, degradation may only be included in the baseline if the observed decrease in biomass stocks follows the definition of degradation included in this methodology. More specifically, project proponent(s) must demonstrate that the degradation is long-term in nature and human induced.

5. Accurate data on past land use, land cover, and forest cover are available for at least four points in time in the reference region. More specifically:
    - It must be demonstrated that the reference region has similar characteristics as the project area and that the same drivers of deforestation are present in the reference region and in the project area according to the procedures included in this methodology.
    - At least one remote sensing image (i.e., data) from 0-1 years before the project start date, at least one image from 2-5 years before the project start date, at least one image from 6-9 before the project start date, and one image from 10-15 years before the project start date must be available. No images older than 15 years may be used for the historical reference period.
    - Broad LULC classes and forest strata (if forest degradation is included) must be recognized with a minimal accuracy of 70%[8]. The carbon accounting must be completely symmetrical: if degradation is included in the baseline, regeneration must be included as well. Likewise, deforestation is included in the baseline, and, therefore, increase in forest cover must be included in the baseline as well.
6. Subsequent to the removal or disappearance of carbon in the above ground live biomass pool, carbon in the below ground biomass pool is also removed or disappears within the duration of the project. The removal of the belowground biomass can be caused by anthropogenic activities such as digging, extraction of stump, and burning, or by the natural process of decay and decomposition.[9].

Criteria related to conditions on the land after project implementation

7. Emissions from deforestation and forest degradation in the project area must be reduced by implementing one or more of the following activities[10]:

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[7] Road construction is not interpreted as a true deforestation driver, but as a catalyst for other deforestation drivers such as encroachment, (illegal) logging, etc.

[8] Credits from avoided deforestation must be discounted based on the accuracy of LULC classification, which is minimally 70% per this applicability criterion. Section II.1.2.4.3 details how to determine the discounting factor. Equation 1 explains how to include the discounting factor within the overall net emission reductions.

[9] This must be justified using appropriate literature sources such as Chambers et al. (2000).

[10] Note that the carbon accounting for biomass related emissions is fully performance-based and not practice-based. In other words, only project activities that lead to an empirically demonstrable and fully verifiable conservation of biomass (and avoiding of

- Project activity 1: strengthening of land-tenure status and demarcating forest, tenure and ownership boundaries.
- Project activity 2: development of sustainable forest and land use management plans.
- Project activity 3: forest protection through patrolling of forests and forest boundaries, and social fencing through capacity building and creating mechanisms to communicate forest trespassing to law enforcers.
- Project activity 4: fire prevention activities through the construction of fire breaks and controlled burning.
- Project activity 5: decrease in the consumption of fuel-wood by introducing fuel-efficient wood-stoves and mosquito nets[11] for livestock.

Each of the project activities must follow the detailed description included in section II.2.1 of the methodology.

8. The magnitude of activity-shifting leakage by geographically constrained drivers from project activities is quantified through a rigorous monitoring plan consisting of rural appraisals, remote sensing analysis and biomass inventories in the project area and all leakage belts[12]. The exact procedures for doing so are included in this methodology.
9. All increases in CO_2, N_2O and CH_4 emissions from project or leakage prevention activities must be accounted for using the procedures included in this methodology[13]. In addition, as part of the validation, the project proponents shall demonstrate that no other significant emissions exist originating from any measure associated with the project.
10. No fossil-fuel based alternative fuel sources may be promoted by the project proponents as a leakage prevention activity[14].
11. No commercial production of timber, fuel-wood or charcoal from biomass within the project areas may be planned in the project areas after the project starts. Only

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emissions from deforestation/degradation) can generate carbon credits under this methodology. Project proponents may select one or more of these project and leakage prevention activities but can only achieve tradable emission reductions if the deforestation or forest degradation is reduced based on empirical evidence such as remote sensing data and biomass inventories.

[11] The burning of wood to generate smoke for the purpose of repelling mosquitoes around cattle and water buffalo enclosures consumes considerable amount of fuelwood. Covering livestock pens with large mosquito nets treated with insecticide reduces the amount of fuel-wood consumed.

[12] Geographically constrained drivers may induce leakage in the leakage belt, which is the area in the immediate vicinity of project areas. The methodology contains procedures to determine the location of the leakage belt.

[13] See Table 2 for a comprehensive overview of the potential secondary gases that are to be included in the carbon accounting.

[14] This includes the distribution, subsidizing or promotion in any form of propane stoves and kerosene stoves.

fuel-wood gathering for domestic use is allowed in project areas at a rate that is lower than the baseline fuel-wood and timber gathering rate.

12. The decrease in carbon stored in long-lived wood products due to avoiding logging for timber for commercial on-sale is less than 5% of the total credits and therefore insignificant (VCS 2007.1, 2008 p 19). The insignificance of the long-lived wood products pool must be explicitly tested using the procedure in section II.4.1.

13. The following conditions are met so that aboveground live non-tree biomass can be omitted as a carbon pool.
    - The project areas will be converted from forest to non-forest with final land cover of non perennial crop under the baseline scenario.
    - No oil palm plantations or short rotation woody crops are present under the baseline scenario within the reference region after deforestation. This is a necessary but not sufficient requirement to exclude aboveground live non-tree biomass.
    - Based on scientific studies or field observations, it can be demonstrated that the magnitude of change of the aboveground live pool upon deforestation is either positive or insignificant.

14. The following conditions are met so that soil organic carbon can be omitted as a carbon pool (see http://cdm.unfccc.int/EB/033/eb33_repan15.pdf):
    - The project areas shall not include organic soils (e.g., peat-lands), or wetlands
    - Removal of existing vegetation for assisted natural regeneration (ANR) or fire prevention measures shall be insignificant and not occur on more than 10% of the area on which ANR activities occur to avoid a decrease in soil carbon in the project scenario related to a decrease in plant biomass input into the soil.
    - Project activities will not remove any fine litter (woody twigs less than 2mm diameter, bark and leaves)
    - No mechanical soil disturbance such as tilling or soil cultivation is allowed in the project area.

14. Sufficient and appropriate data are available to quantify the carbon stored in long-lived wood products under the baseline scenario. Appropriate sources of data are listed within the methodology.

I.4 Requirements for Included Gases and Carbon Pools, Geographical Project Boundaries, and Project Duration

I.4.1 Gases

This methodology requires accounting of emissions of all three biogenic greenhouse gases (CO_2, N_2O and CH_4) from sources not related to changes in carbon pools, henceforward referred to as "emission sources" (Table 2)[15]. Project proponents may

[15] Nitrous oxide emissions from forest fires (excluding controlled burning as a silvicultural activity) are excluded from the GHG accounting.

omit certain emission sources, but only if they can prove that their contributions are insignificant. The VCS defines significant sources as those accounting for more than 5% of the total GHG benefits generated (VCS 2007.1, 2008 p 17). As explained in section 0, this methodology uses the procedure outlined in EB31 Appendix 16 (http://cdm.unfccc.int/EB/031/eb31_repan16.pdf) to calculate the significance of emission sources.

Table 1. GHG emissions from sources not related to changes in carbon pools ("emission sources") to be included in the GHG assessment. Project activity (PA) and leakage prevention activity (LPA) numbers refer to AC 4.

	Potential Emission Source	Gas	Include/Exclude	Justification/Explanation
Emissions under the baseline scenario	Baseline Deforestation and Forest Degradation	CO_2	Include CO2 emissions from changes in carbon pools.	Major source of CO2 emissions under the baseline scenario.
		CH_4	Exclude	Negligible
		N_2O	Exclude	N2O emissions from fire are conservatively excluded.
Emissions from project activities	Fossil fuel used for vehicles	CO_2	Include if PA 3 is implemented	Potentially major source
		CH_4	Exclude	Negligible
		N_2O	Exclude	Negligible
	Loss of biomass due to fire prevention activities	CO_2	Include if biomass is removed as a project activity	Major when biomass is removed through controlled burning
		CH_4	Include if controlled burning is used to remove biomass for fire prevention	Potentially major source
		N_2O	Exclude	N2O emissions from burning are insignificant
	Fertilizer used during enrichment planting for assisting natural regeneration	CO_2	Exclude	Not applicable
		CH_4	Excluded	Not applicable
		N_2O	Include when enrichment planting is done	Potentially major source
Emissions from leakage prevention activities	Increased area of rice production systems	CO_2	Exclude	Not applicable
		CH_4	Include if rice area is increased	Potentially major source
		N_2O	Exclude	Not applicable
	Increased fertilizer use	CO_2	Exclude	Not applicable
		CH_4	Exclude	Not applicable
		N_2O	Include if fertilizer rates are used to increased productivity	Potentially major source
	Increased emissions from increases in livestock stocking rates	CO_2	Exclude	Not applicable
		CH_4	Include if livestock stocking rates are increased	Potentially major source
		N_2O	Include if livestock stocking rates are increased	Potentially major source
	Removal of biomass to prepare assisted natural regeneration	CO_2	Include if biomass is removed for assisting natural regeneration	Potentially major source
		CH_4	Include if controlled burning is used to remove biomass for assisting natural regeneration	Potentially major source
		N_2O	Exclude	N2O emissions from burning are insignificant

Significance of the size of a pool is formally tested based on the CDM tool to test significance; the procedure to do so is repeated within this methodology.

I.4.2 Carbon Pools

Table 2 summarizes the carbon pools that must be included in projects following this methodology.

Table 2. Selected Carbon Pools

Carbon Pool	Included/Excluded	Justification/ Explanation of Choice
Above-ground tree biomass	Included	Major carbon pool affected by project activities
Above-ground non-tree biomass	Excluded	Change expected to be positive or insignificant under applicability criteria and therefore can be excluded.
Below-ground biomass	Included	Major carbon pool affected by project activities
Dead wood	Included	Major carbon pool affected by project activities
Litter	Excluded	Expected to decreases under the baseline scenario under the applicability criteria.
Soil organic carbon	Excluded	Change expected to be positive or insignificant under applicability criteria and therefore can be excluded.
Wood products	Included	Major carbon pool affected by project activities

I.4.3 Spatial Boundaries

The spatial boundaries of (1) the project area, (2) the leakage area and (3) the reference region must be unambiguously defined in the PD. The project area may be contiguous or consist of multiple adjacent or non-adjacent parcels, "discrete project area parcels". Around each discrete project area parcel, a leakage belt shall be defined. Before the start of the project, the reference region must include the project area and leakage area. After the start of the project, the reference region may not contain the project area and leakage belt.

I.4.4 Project Duration

Project duration is fixed and must minimally 20 years, and maximally 100 years (VCS 2007.1, 2008 p 17).

Reporting requirements in the PD
1. Evidence that each of the applicability conditions is met. 2. A list of specific sources of greenhouse gases that will be considered in the project based on Table 1.

I.5 Summary of Major Methodological Steps for the Baseline GHG Emissions, Project GHG Emissions, and Monitoring

Overview and General Principles

The PD contains the *ex-ante* annual net GHG emission reductions due to project activities (NERs) and an estimate of the *ex-ante* VCUs that are issued after transferring a portion of the NERs to the buffer pool according to the buffer withholding percentage (VCS 2007.1, 2008 p 22). The actual NERs and VCUs are calculated *ex-post* based on data collected during monitoring and reported in a monitoring report. The calculation of emission reductions is based on the following principles:

- This methodology separates emission reductions from avoided deforestation, emission reductions from avoided forest degradation, and carbon uptake through assisted natural regeneration.
- The calculation of NERs within this methodology is based on a classification and stratification of the land in discrete classes or forest strata according to the land use and land cover (LULC) or forest type and density. By analyzing a transition from one class or stratum to a different class or stratum, deforestation and forest degradation can be quantified. Deforestation is a transition from a forest class to a non-forest class. Forest degradation is formally defined as a direct, human-induced, expected to be long-term (persisting for 10 years or more) decrease of at least 10% of forest carbon stock for 3-years time period and not qualifying as deforestation (see "definition" section). In practice, under this methodology forests are divided into discrete forest strata in such a way that any transition of a forest stratum with higher biomass to a forest stratum with a lower biomass follows the definition of "degradation".
- Emission reductions from avoided deforestation (DF) are separated from emission reductions from avoided degradation (DG) because different accuracy thresholds and discounting procedures are imposed for deforestation and forest degradation. If the accuracy threshold for analyzing forest degradation is not met, only credits from avoided deforestation can be generated. However, if sufficient data becomes available during the crediting period, credits from avoided degradation may be included during the crediting period. Emission reductions from avoided deforestation or degradation are calculated by multiplying the size of the area on which the transition was averted, i.e. the activity data, by the emission factor related to this transition. The emission factor is the difference in carbon stocks between the "from" and "to" states of the transition. The size of the transition areas is estimated using a combination of remote sensing analysis and computer modeling, whereas the emission factors are quantified using a biomass inventory.
- All NERs must be discounted for conservativeness using a discounting factor for the uncertainty of the classification, $u_{classification}$ and a discounting factor for the uncertainty of the biomass inventory$\cdot$ $u_{inventory}(i)$.
- The accounting for greenhouse gas benefits from assisted natural regeneration (ANR) activities are calculated completely separated using the most recent version of the approved consolidated CDM methodology AR-ACM0001: "Afforestation and Reforestation of Degraded Land".
- Significant methane, nitrous oxide and fuel-CO_2 emissions from project and leakage prevention activities must be subtracted from the NERs. The significance of each of these emissions is tested according to the methodology provided in EB31 appendix 16 to determine whether it must be included (see section II.4.1).

The PD must include an estimate of the net anthropogenic emission reductions calculated for every year t of the crediting period. Equation (1) on the following page is used to calculate annual net emission reductions (NERs).

The procedure to calculate *ex-ante* NERs consists of three major parts: (1) calculation of the baseline scenario, (2) calculation of the project scenario and (3) estimation of leakage. The following section provides an overview of each of the individual parts. During the crediting period, all project actions and conditions in the project area must be monitored. A brief summary of monitoring is included.

GHG Sinks and Emissions under the Baseline Scenario

Under this methodology, the most plausible baseline scenario under the CDM modalities and procedures, paragraph 22 is option (a) (see section II.1). The calculation of the deforestation in the project area under the baseline scenario is based on a combination of remote sensing analysis of historical images and land-use change modeling. First, the total rate of deforestation and forest degradation in the project area is estimated based on the empirical land-use and forest cover changes in a reference region similar to the project area. Subsequently, a simple land use change model is used to divide the total rate into individual rates for every forest stratum. The procedure to calculate the baseline deforestation and forest degradation rates for every land class and forest stratum in the project area is explained in detail in section II.1. The calculation of the baseline deforestation and forest degradation rates in the leakage area follows a similar methodology and is completed once the size of the leakage area is determined, which is explained in section II.3.2.2.

GHG Emissions and Sinks under the Project Scenario in the Project Area

Ex-ante, the relative reduction in deforestation rates inside the project area is calculated by aggregating the expected effect of a project activity on each driver. The simple spatial model calibrated previously is then used to divide the total deforestation and forest degradation rates in the project scenario into forest-strata specific rates. Subsequently, emission sources from project activities are calculated. In a last step, GHG sinks from assisted natural regeneration activities are calculated based on the approved CDM methodology AR-ACM0001 version 3. A detailed procedure for each of these steps can be found section II.2.

GHG Emissions under the Project Scenario outside the Project Area (Leakage)

Under this methodology, leakage is calculated separately for every individual project action. GHG emissions due to primary leakage through activity-shifting attributable to the project activity must be accounted for under VCS 2007.1, 2008 p 23 point 23. This methodology assumes (1) that the amount of leakage can be estimated before project implementation, (2) that activity-shifting leakage related to drivers that are geographically constrained, e.g. forest fires, collection of fuel-wood, grazing and the production of charcoal are restricted to a geographical region around the discrete project area parcels, called the leakage belt, (3) that the location and the size of the leakage belts can be identified before the start of the project and (4) that the activity-shifting leakage related to activities that target drivers that are geographically unconstrained, e.g. illegal commercial timber harvesting can be conservatively estimated using a factor approach. Note that the methodology excludes commercial timber harvesting in the project area after project start through the applicability criteria.

Calculate Ex-ante NERs and VCUs

Once the individual steps above are performed, the significance of the different emission sources can be tested using the procedure described in II.4.3. Only the significant emissions need to be retained in the final calculations as long as the sum of insignificant emissions does not become significant. All calculated values are brought together and the net *ex-ante* NERs are calculated using [EQ1] on the next page.

VCUs are then calculated by discounting the NERs according to the buffer withholding percentage as determined using the VCS's tool for AFOLU non-permanence risk analysis and buffer determination ([EQ2]). These VCUs are valid after the completion of the positive evaluation of dual approval process on risk and leakage.

Net Emission Reductions =

ΔGHG from avoided deforestation ❶ + ΔGHG from deforestation due to leakage ❷ + ΔGHG from avoided degradation ❸ + ΔGHG from degradation due to leakage ❹ + GHG from leakage by unconstrained geographic drivers ❺ + ΔGHG from assisted natural regeneration ❻ + ΔGHG from changes in long-lived wood products ❼ + GHG from improved cookstoves ❽ + GHG from sources ❾ [1]

Voluntary Carbon Units =

Net Emission Reductions - *buffer* × (ΔGHG from avoided deforestation ❶ + ΔGHG from avoided degradation ❸ + GHG from assisted natural regeneration ❻ + ΔGHG from changes in long-lived wood products ❼) [2]

where:

$$❶ = \sum_{i=1}^{nrFNFtransitions} \left(u_{classification} \cdot \left(\begin{matrix} +\Delta area_{projectAreaWithoutANR,projectScenario}(t,i) \\ -\Delta area_{projectAreaWithoutANR,baselineScenario}(t,i) \end{matrix} \right) \cdot u_{inventory}(i) \cdot EF(i) \right)$$

$$❷ = \sum_{i=1}^{nrFNFtransitions} \left(u_{classification} \cdot \left(\begin{matrix} +\Delta area_{leakageArea,projectScenario}(t,i) \\ -\Delta area_{leakageArea,baselineScenario}(t,i) \end{matrix} \right) \cdot u_{inventory}(i) \cdot EF(i) \right)$$

$$❸ = \sum_{i=1}^{nrStrataTransitions} \left(u_{stratification} \cdot \left(\begin{matrix} +\Delta area_{projectAreaWithoutANR,projectScenario}(t,i) \\ -\Delta area_{projectAreaWithoutANR,baselineScenario}(t,i) \end{matrix} \right) \cdot u_{inventory}(i) \cdot EF(i) \right)$$

$$❹ = \sum_{i=1}^{nrStrataTransitions} \left(u_{stratification} \cdot \left(\begin{matrix} +\Delta area_{leakageArea,projectScenario}(t,i) \\ -\Delta area_{leakageArea,baselineScenario}(t,i) \end{matrix} \right) \cdot u_{inventory}(i) \cdot EF(i) \right)$$

$$❺ = -\, GHG_{otherLeakageSources}(t)$$

$$❻ = \frac{44}{12} \cdot \sum_{i=1}^{nrStrata} \Delta C(t,i) - \left(\begin{matrix} + \frac{44}{12} \cdot CF \cdot \sum_{i=1}^{nrStrata} NAI(i) \cdot area_{projectAreaWithANR,baselineScenario}(t,i) \\ + \sum_{i=1}^{nrFNFtransitions} \left(u_{classification} \cdot \Delta area_{projectAreaWithANR,baselineScenario}(t,i) \cdot u_{inventory}(i) \cdot EF(i) \right) \end{matrix} \right)$$

$$❼ = \frac{44}{12} \cdot \left(C_{LWP,project,t} - C_{LWP,baseline,t} \right)$$

$$❽ = -GHG_{sources,projectArea}(t) - GHG_{sources,leakagePrevention}(t) - GHG_{sources,ANR}(t)$$

$$❾ = -ER_{cookstoves}(t)$$

Variable	Explanation
$NERs(t)$	Net emission reductions during year t. Section II.4.4. [tCO_{2}-eq]
$nrFNFtransitions$	Number of forest/non-forest transitions among land classes or forest strata, meaning transitions in which either the "from" or the "to" class are non-forests. Section II.1.2.3
$nrStrataTransitions$	Number of transitions among forest strata. Section II.1.2.3
$nrStrata$	Number of strata within the ANR area. Section II.1.2.3
$\Delta area_{projectAreaWithoutANR,projectScenario}(t,i)$	Hectares undergoing transition i within the project area, excluding the ANR area, under the project scenario for year t. [ha yr^{-1}]. Section II.2.2
$\Delta area_{projectAreaWithoutANR,baselineScenario}(t,i)$	Hectares undergoing transition i within the project area, excluding the ANR area, under the baseline scenario for year t. [ha yr^{-1}]. Section II.1.5.4
$\Delta area_{projectAreaWithANR,baselineScenario}(t,i)$	Hectares undergoing transition i within the ANR area under the baseline scenario for year t. [ha yr^{-1}]. Section II.2.4.3
$\Delta area_{leakageArea,projectScenario}(t,i)$	Hectares undergoing transition i within the leakage area under the project scenario for year t. [ha yr^{-1}]. Section II.3.2.3
$\Delta area_{leakageArea,baselineScenario}(t,i)$	Hectares undergoing transition i within the leakage area under the baseline scenario during year t. [ha yr^{-1}]. Section II.1.5.4
$\Delta area_{projectAreaWithoutANR,projectScenario}(t,i)$	The size of the area within the project area where no assisted natural regeneration (ANR) activities are planned of transition i during year t. [ha yr^{-1}] . Section II.2.2
$GHG_{otherLeakageSources}(t)$	GHG emissions from leakage by unconstrained geographic drivers at time t. [tCO_{2}-eq]
$EF(i)$	Emission Factor for transition i. Section II.1.4.6
CF	Carbon fraction of wood (use 0.5 by default).
$NAI(i)$	Net annual increment (baseline regeneration rate) on the "from" forest stratum of transition i. Section II.1.4.2
$area_{projectAreaWithANR,baselineScenario}(t,i)$	Size of strata i within the project area on which ANR activities are proposed for year t under the baseline scenario. Section II.2.4.3
$u_{stratification}$	Discounting factor for NERs from avoided degradation, based on the accuracy of stratification, i.e. dividing forest into individual forest biomass classes. Section II.1.2.4.3
$u_{classification}$	Discounting factor for NERs from avoided deforestation, based on the accuracy of classification, i.e. dividing land into broad land use types. Section II.1.2.4.3
$u_{inventory}(i)$	Discounting factor for all emission reductions, based on the uncertainty of biomass inventory related to transition i. Section
$\Delta C(t,i)$	Annual change in carbon stock in all selected carbon pools for forest stratum i and year t. Section II.2.4.3. [Mg C yr^{-1}]
$GHG_{sources,projectArea}(t)$	Emissions from sources of methane, nitrous oxide or fuel-CO_2 from activities within the project area for year t. Section II.2.3. [tCO_{2}-eq]
$GHG_{sources,leakagePrevention}(t)$	Emissions from sources of methane, nitrous oxide or fuel-CO_2 from leakage prevention activities for year t. Emission sources within the leakage area are included in Table 1. Section II.3.4. [tCO_{2}-eq]
$GHG_{sources,ANR}(t)$	Emissions of sources of methane, nitrous oxide or fuel-CO_2 from assisted natural regeneration activities for year t. Section II.2.4.5. [tCO_{2}-eq]

$ER_{cookstoves}(t)$	Emission reductions from reducing biomass use through improved cookstoves in case avoided degradation is excluded from the project. Section II.2.1, "Decrease the consumption of fuel-wood" [tCO_2-eq yr^{-1}]
$VCUs(t)$	Voluntary Carbon Units. [tCO_{2}-eq]
$buffer$	Buffer withholding percentage according to the VCS's tool for AFOLU non-permanence risk analysis and buffer determination. [-]
$C_{LWP,baseline,t}$	GHG sink in long-lived wood product under the baseline scenario during time t [Mg C]
$C_{LWP,project,t}$	GHG sink in long-lived wood product under project scenario during time t [Mg C]

Monitoring Methodology

During the crediting period, the monitoring variables must be recorded with the frequency specified in the methodology (see "Frequency of monitoring" field in the overview of the data and parameters to be monitored in section III.1.1). For verification, project proponents must compile all monitored data in a monitoring report and submit the monitoring report to a VCS verifier. A positive evaluation upon completion of dual approval process on risk and leakage will allow VCUs to be issued by the VCS. Monitoring has three components: (1) estimating transitions of LULC classes and forest strata, (2) measuring carbon stock densities per LULC class using field sampling techniques and (3) tracking all GHG emissions from emission sources.

- Changes in land and forest cover are monitored using a combination of remote sensing analysis and ground-truthing data. During the crediting period, project proponents must conduct regular mapping analysis in the project area, reference region, and leakage area to monitor deforestation and forest degradation rates in these areas.
- Carbon stock densities from the land and forest classes must be regularly updated by conducting a biomass inventory.
- All changes in GHG emissions that are not related to carbon pools and that are directly attributable to project activities, must be recorded. These include fuel CO_2 emissions due to patrolling of the forest, increased N_2O and CH_4 emissions from greater fertilizer use related to agricultural intensification, intensification of livestock management, and associated manure management. The quantification of the emission sources is done by duly recording all project activities and inputs and by conducting interviews or social appraisals. Applicable leakage prevention activities must comply with specific applicability criteria as defined further in the methodology. For example, the conditions under which agricultural intensification can be implemented are explained in the beginning of section II.3.4.1.

Section II: Description of the Methodology for *Ex-ante* Estimation of NERs and Additionality

II.1 *Ex-ante* Estimation of GHG Emissions and Changes in Sinks under the Baseline Scenario

Estimation of Ex-ante GHG Emission and Changes in Sinks under the Baseline Scenario follows the baselines rules as defined by VCS. Under this methodology, the most plausible baseline scenario under the CDM modalities and procedures, paragraph 22, is option (a):

> *Existing or historical, as applicable, changes in carbon stocks in the carbon pools within the project boundary.*

This option was selected because under the mosaic typology of deforestation, the historical changes in land-use are representative for the most likely future changes in land-use. The most appropriate future scenario is that historical rates, change in rate, and dynamics of deforestation and forest degradation will continue in the future. No new economically attractive course of action is expected in the future, therefore option (a) was selected, and not option (b).

The selected baseline shall be in compliance with all mandatory applicable legal and regulatory requirements, even if these laws and regulations have objectives other than GHG reductions, e.g. to mitigate local air pollution (EB 29, Annex 5) unless these applicable legal and regulatory requirements are generally not enforced.

The net GHG sources and sinks under the baseline scenario must be estimated ex-ante for each year of the crediting period. Once validated, the baseline is to be used for the calculation of actual NERs. Baseline calculations remain valid only for a limited period of time and must be updated following section II.1.1.5.

II.1.1 Step 1 – Select Spatial and Temporal Boundaries

This step includes the demarcation the project area and the reference region. Note that the demarcation of the leakage area is included in section II.3.2.2.

II.1.1.1 Step 1A – Describe Spatial Boundaries of the Discrete Project Area Parcels

Project proponents shall provide digital (vector-based) files of the discrete project area parcels in a common GIS software format. A clear description must accompany each file, and the metadata must contain all necessary projection reference data. In addition, as per VCS 2007.1, 2008 p 17, the PD must include a table containing the **name** of each discrete project area parcel , the **centroid coordinate** (latitude and longitude using a WGS1984 datum), the **total land area** in ha, **details of tenure/ ownership** and the relevant **administrative unit** belongs to (county, province, municipality, prefecture, etc.).

Following VCS 2007.1, 2008 p16-17, new discrete project area parcels (referred to as "new project area") may be integrated into an existing project with some limitation, the procedures to do so are described in the monitoring section, III.3.1.

II.1.1.2 Step 1B – Select Size of the Reference Region

Existing regional or national baselines that are spatially explicit and approved by the competent national authority must be adopted if they provide an equally or more accurate measure of the project's baseline compared to this methodology i.e., the pre-existing baseline needs to conform to the requirements of this methodology. If no such applicable regional or national baseline is available, a stratified regional baseline (Sathaye and Andrasko, 2007; Brown et al., 2008) must be developed in a reference region around the project area but much larger than the project area. The reference region must consist of both forest and non-forest land. The reference region typically consists of a watershed, a province or state, or sometimes the entire country. Information about deforestation agents and drivers and the rate of deforestation and forest degradation is calculated from the reference region which is used as a proxy for the baseline calculations within the project area. Note that before the project start date, i.e. during the historical reference period, the reference region must include the project and leakage areas. Note that the leakage areas must consist of both forest and non-forest land as well. However, after project start, the reference region may not include the project and leakage areas anymore.

The minimum size of the reference region is dependent on the size of the project area. Project proponents must use Table 3 to determine the minimal size of the reference region.

Table 3. Requirements for the minimal size of the reference region, relative to the size of the project area.

Size of the Project Area (ha)	Minimal size of the Reference Region relative to the Project Area (number of times larger)
< 25,000	20 ×
25,000 – 50,000	10 ×
50,000 – 100,000	5 ×
> 100,000	2 ×

The conditions in the discrete project area parcels must be similar to the conditions in the reference region (see below). A larger reference region is not necessarily more conservative. For example, if encroaching by migrants is the main deforestation driver in the project area, and the reference region is expanded to an area where land tenure enforcement prohibits encroachment, deforestation rates based on the total reference region will be underestimated. Use the following procedure to fix the location of the reference region.

II.1.1.3 Step 1C – Select Location of the Reference Region

The boundaries of the reference region must coincide with natural, geopolitical or watershed boundaries. However, in case the project area shares a border with a natural, geopolitical or watershed boundary, the boundary of the reference region may be extended outwards by applying a buffer around the project area. In addition, the reference region must exclude all areas on which the access by agents of deforestation is restricted, such as national parks, areas where REDD initiatives are effectively implemented, army bases, or land concessions. Before the start of the project the reference region includes the project and leakage areas. After the project has started (i.e. during the crediting period) the reference region excludes the project areas and leakage areas will serve as a reference for determining deforestation and forest degradation rates in the absence of project activities.

The project proponents must demonstrate that the reference region is similar to the project area with respect to a number of key variables, detailed in Table 4. First, demonstrate that the reference region does not contain areas where agents of deforestation have restricted access. Include maps where the reference region and the project area have been overlaid with maps of protected areas, including:

- National parks that are effectively protected
- Areas under conservation that are effectively protected
- Areas under a logging or economic land concession where access is effectively being restricted
- Large plantations that are effectively protected

In addition, the reference region must contain at least 25% forest cover at the beginning of the crediting period[16]. This condition must be explicitly checked using the classification that is developed under the remote sensing section of this methodology.

II.1.1.4 Step 1D – Demonstrate the similarity between project area and reference region

The procedure to compare reference region and project area follows VCS 2007.1, 2008 p 20. Compare the value of every key variable listed in Table 4 between reference region and project area according to the comparison procedure in the same table. Areas in the potential reference region where one or more of these variables differ from the project area must be excluded. Once these areas are excluded, the homogeneity must be re-evaluated. Therefore, determining the spatial boundaries of the reference region is an iterative process.

[16] Note that due to deforestation in the past, a much greater relative forest cover than 25% would have been present at the beginning of the historical reference period.

Table 4. Comparison variables to demonstrate similarity between project area and reference region.

Category	Variable	Comparison procedure	Explanation
Drivers of deforestation	Drivers of deforestation	All agents that were identified in the project area must be present in the reference region. A comparison of the existence of every driver between the project area and the reference region shall be carried out. The similarity between the project area and the reference region must be documented and sustained with relevant evidence.	Since the reference area will be used to determine baseline deforestation and degradation rates in the project area, the deforestation drivers must be similar in the reference area and the project area.
Landscape configuration	Distribution of native forest types	The proportion of each forest type of the reference region (see section II.1.2.2) must be within 10% from the proportion of this type in the project area. Percentages must be calculated relative to the total area of forests, not the total land area.	Deforestation and land-use change dynamics are highly dependent on geographical conditions. For example, if the project is to protect a mountain forest on the top of a watershed then low-land humid forests or dry forests on the planes at the bottom of the valley should not be used as a reference region.
	Elevation	Average elevation of the reference region shall be within 10% of the elevation of the project area.	
	Slope	Average slope of the reference region shall be within 10% of the average slope of the project area.	
	Extent of steep area	Relative area with slope > 10% in the reference region shall be within 10% of the relative area with slope > 10% in the project area.	
Socio-economic and cultural conditions	Land-tenure status	Demonstrate that the land-tenure system prevalent in the reference region is identical to the land-tenure system in the project area through peer-reviewed literature, reports, or expert's opinion.	The specific land tenure system impacts the rate of land use changes, and must therefore be similar between the project area and reference area.
	Policies and regulations	The reference region should be governed by an administrative unit that has comparable enforced policies, regulations and capacities as the administrative unit of the project area.	Different governing bodies may have a different legislative framework or capacity for enforcement. It has to be demonstrated that the forest is similar in the reference region and project area.
	Degree of urbanization	Proportion of urbanized vs. agriculture-based population within the reference region shall be within 10% of this proportion in the project area.	People living in urban areas have a significantly different relation to forest land compared to people that are agriculture-based.

II.1.1.5 Step 1E – Specify Temporal Boundaries of the Project

Project proponents must fix the following temporal boundaries

- The **historical reference period** with exact start date. The end of the historical reference period must occur within two years of the project start date. The duration of the historical reference period must be between 10 and 15 years.
- The **project crediting period** with exact start date and project ending date. The start of the crediting period is equal to the start of project date and is the date when the first project activity for which NERs are claimed is implemented. The duration of the crediting period must be between 20 and 100 years.
- Project proponents must seek third-party verification at least every five years. The **frequency of verification** may change during the crediting period (e.g., every two years during the first ten years of the crediting period, and every five years thereafter). The frequency and years of verification must be fixed for the duration the baseline is valid and must be specified in the PD or in a verification report if the baseline is updated.

Baselines must be updated at year five, ten and every ten years unless specific circumstances exist, in which case the baseline must be updated more frequently. These circumstances are outlined in the monitoring section.

Reporting Requirements in the PD
1. Maps for all project areas with the LULC classes and forest stratification. 2. Digital boundaries of the discrete project area parcels and the reference region[17]. All necessary meta-data to correctly display the files must be included. 3. Table of all the discrete project area parcels with their ID, name, coordinate centroid (latitude and longitude using a WGS1984 datum), total land area in ha, details of tenure/ownership, and the relevant administrative unit. 4. Overview map of the whole reference region with the location of the discrete project area parcels clearly indicated. 5. Evidence that areas with effective protection were excluded from the reference region, such as maps with the location of national parks or economic land concessions. 6. The size of the reference region relative to the size of the project area for comparison with the relative sizes in Table 3. 7. Demonstration of the similarity between reference region and project area based on the formal comparison of as listed in Table 4. 8. Description of the temporal boundaries: start and end of the historical reference period, start and end of the project crediting period, years during the baseline validation period when verification will be sought, and years during the crediting period when the baseline will be updated.

[17] Note that separate digital boundaries are also necessary for all individual forest strata per discrete project parcel where ANR activities are implemented, and must remain available for the duration of the project's crediting period. This is detailed in section II.2.4.5.

II.1.2 Step 2 – Analyze Historical Deforestation and Forest Degradation in the Reference Region

II.1.2.1 Step 2A – Describe Data Sources

The quantification of deforestation and forest degradation rates under this methodology is based in part on remote sensing and other spatial data. The selection of data sources must follow Chapter 3A.2.4 of the IPCC 2006 GL AFOLU and Brown et al. (2007), section 3.2.4. Table 5 lists the data that are minimally required. This table also outlines the information about these data that must be documented in the PD. At least four maps of forest cover are required during the historical reference period, a period between 10 and 15 years before the start of the crediting period: (1) at least one image from 0-1 year before project start date, (2) at least one image from 2-5 years before project start date, (3) at least one image from 6-9 years before project start date, and (4) at least one image from 10-15 years before project start date. No images older than 15 years may be used for the historical reference period.

Table 5. Information to be reported on the employed remote sensing and other spatial data for assessing deforestation and forest degradation.

Data Source	Main Use for Data	Information Needed about the Data Collected
High to medium resolution (< 30 m) **remote sensing data** are required for at least four time points: (1) at least one image from 0-1 years before project start date, (2) at least one image from 2-5 years before project start date, (3) at least one image from 6-9 years before project start date, and (4) at least one image from 10-15 years before project start date. No images older than 15 years may be used for the historical reference period.	• Historical analysis of deforestation and forest degradation	• Source • Type • Resolution (spatial and spectral) • Acquisition date • Coordinate system and pre-processing • If different sources of remote sensing data are used, a formal comparison of the sensors should be added to the monitoring report to ensure consistency.
Readily available **LULC maps which are already processed** are complementary	• Training of the automatic classification procedures • Independent verification of the analysis of historical images	• Minimum Mapping Unit (ha) • Description of method used to produce these data • Descriptions of the LULC classes and/or LULC-change categories • Information on how these classes may match with IPCC classes and categories
Recent (< 5 yr) **high resolution** (< 5 m) **remote sensing data** is required for at least part of the reference region at a time point coinciding with one of the medium-resolution remote sensing images.	• Ground-truthing and check of accuracy	• Source • Type • Resolution (spatial, spectral) • Acquisition date • Coordinate system and pre-processing
Direct field observations or visually interpreted locations from remote sensing images are required for calibration of the classification and stratification procedures and validation of the calibration and classification accuracy for at least two images or one third of the images (whichever is largest).	• Ground-truthing and check of accuracy	• Acquisition date • Type of data (classification system used) • coordinate system

II.1.2.2 Step 2B – Define LULC Classes and Forest Strata

The ultimate goal of a correct classification and stratification system is to divide the reference region into LULC classes or forest strata that have homogeneous carbon stock density in a cost-effective and practically feasible way. The LULC class or forest stratum represents the current *state* of the land; it does not reflect the future evolution of the land. The exact number and type of LULC classes and forest strata used is project-specific and dependent on local conditions. A number of iterations between the remote sensing image analysis and defining the LULC class and forest strata may be necessary before an optimal classification system can be attained.

The LULC classification and forest stratification must be applicable for both the reference region and the project area. The LULC classification and forest stratification must be documented separately for project area and the reference region and use the following procedures.

- For the **LULC classification**, include *at least* the six IPCC LULC classes (Forest Land, Crop Land, Grass Land, Wetlands, Settlements, and Other Land). The definition of these classes must be consistent with Chapter 2 of the IPCC GPG-LULUCF 2003. In cases where the country has defined more specific LULC classes than the IPCC classes, these definitions must be used if they are accurate enough for project-specific classification.
- To achieve the goal of defining classes that are homogeneous in carbon stock density, the forest LULC class shall be sub-divided into **forest strata**. Forest land is usually heterogeneous in terms of local climate, soil condition, forest canopy cover, and forest type. Forest stratification can help to increase the homogeneity in carbon stock density within classes and therefore increase the measurement precision without increasing the cost, or reduce the measurement cost without reducing precision due to lower variance within each homogeneous unit. If emissions from avoided degradation are included, appropriate forest strata representing regeneration must be included as well. Because emission reductions are discounted based on the uncertainty of the biomass inventory, stratifying forest area into classes may lead to a greater amount of emission reductions. The forest stratification is implemented using the following steps.

  Sub-Step 1: **Assess the key factors** that influence carbon stocks **in the above-** and below-biomass pools within the reference region. These factors should include soil features, local climate, landform (e.g., elevation, slope, and aspect), forest type and dominant tree species and project actions

  Sub-Step 2: Collect maps of key factors identified in step 1 within the reference region, including:
  - Local climate maps if significant climatic differences exist
  - Native forest type (such as evergreen, deciduous, broadleaved, mangrove, or coniferous)
  - Forest canopy cover maps (e.g., <20%, 20-40%,40-70%, >70%) based on the satellite image analysis (see below)
  - Soil types, parent rocks and preferably soil maps
  - Landform information and/or maps
  - Soil erosions intensity map
  - Forest management (e.g., age or time since last harvest)

- Human degradation intensity (e.g., distance to roads and distance to settlements)
- Regeneration stages

Data sources may include archives, records, statistics, study reports and publications of national, regional or local governments, institutes and/or agencies, and literature. Figure 1 shows an example of a hierarchical classification system.

Sub-Step 3: Preliminary stratification. The stratification shall be conducted by re-classifying the maps collected in step 2 into LULC classes and forest strata that have significant differences in carbon stock density. For example a raster map of slopes could be classified into four slope classes: <5 degrees, 5-10 degrees, 10-20 degrees, >20 degrees. A GIS platform must be used to overlay the re-classified maps. Managed forests must be divided into different forest strata according to the forest management regimes, unless the differences in management among regimes do not lead to significant differences in carbon density during the baseline validation period.

Sub-Step 4: Field survey. Conduct a biomass inventory on at least three plots for each preliminarily identified stratum. In each plot, record tree species, crown cover, and mean diameter at breast height (DBH) for every tree in the plot, and record the forest type of the plot.

Sub-Step 5: Final stratification. With the information from the field survey, evaluate the homogeneity of the carbon stock densities within each preliminary forest stratum. If necessary, adjust the stratification procedure to minimize the stratum heterogeneity, while including differences in management or degradation pressure. A stratum within which there is a significant variation in any of vegetation type, soils and project actions must be divided into two or more strata. On the other hand, strata with similar features shall be merged into one stratum. Distinct strata should differ significantly from each other in terms of how they impact the baseline and/or project carbon stock. For example, sites with different species and plantations with distinct age classes of trees shall form separate strata. Sites with a more intensive collection of fuelwood might also be a separate stratum. On the other hand, site and soil factors may not warrant a separate stratum as long as all lands have a baseline of continued degradation, with little to no vegetation growing, and with no human intervention, and as long as the carbon accumulation in above-ground and below-ground biomass is similar in the project scenario.

- Native Forest Type
  - Evergreen
    - Dense and inaccessible evergreen forests
    - Evergreen forest with some evidence of logging
    - Highly logged and accessible evergreen forests
  - Mixed
    - Dense and inaccessible mixed forest
    - Mixed forest with medium density and poor soil conditions
    - Highly degraded and accessible mixed forests
  - Deciduous
    - Deciduous forests with intermediate biomass density
    - Deciduous forests with low biomass density and high degradation pressure

Figure 1. Example of a forest stratification system.

Note that the result of forest stratification reflects the current *condition or state*, and not the *process* of change or future *evolution* of the specific forest class. A degraded forest class will regenerate if the deforestation drivers are restricted. In contrast, a low-density open forest might stay in a low-carbon state due to an impermeable clay layer in the soil, impeding root growth. Although their future evolution will be completely different, these two forest systems might both be in the same low-carbon density forest class.

- In addition, all **areas that will be subject to ANR activities within the project area**[18] must be further divided into forest strata according to the specific silvicultural management activities that will be employed on these areas. *Ex-post* adjustment of the stratification according to ANR activities is allowed until the first verification.
  - (a) Gather information on variables that influence biomass growth potential. These factors may include soil, climate, previous land use, existing vegetation type, degree of anthropogenic pressure in the baseline scenario, etc.
  - (b) Define the stand models to be implemented in the project area by specifying:
    - The species or species combination to be planted together in one single location and at the same date to create a so-called stand model
    - The growth assumptions for each species or combination of species in the stand model
    - Planting, fertilization, thinning, harvesting, protecting, coppicing, and replanting cycle scheduled for each stand model, by specifying:
      - The age class when the above management activities will be implemented
      - The quantities and types of fertilizers to be applied
      - The volumes to be thinned or harvested

[18] ANR activities are carried out only in areas that would otherwise be deforested as in baseline scenario which is different from Afforestation and Reforestation activities.

- The volumes to be left on site (harvest residues becoming dead wood) or extracted

(c) Define the establishment timing of each stand model by specifying:

- The planting date
- The area to be planted (ha)
- The geographical location for each stand model.

(d) Stratify the ANR area according to

- Existing LULC class
- Biomass growth potential
- Management (e.g., establishment year, treatment)

Delineate the boundary of each ANR stratum using GPS coordinates, and present maps of the stratified project areas in the PD.

A sound definition of the LULC classes and forest strata is crucial for a conservative carbon accounting. It shall be assessed and confirmed by the auditor at validation and whenever there are changes in classes that the distribution and width of the carbon content of the LULC classes and forest strata will not lead to a systematic overestimation of carbon losses and therefore the overall emission reductions attributed to the project. This assessment shall be done once biomass density values are available for each LULC class or forest stratum, as described in section II.1.4.5.

II.1.2.3 Step 2C – Define Land Transitions between LULC classes and Forest Strata

A **land transition** is a change from one LULC class or forest stratum into another LULC class or forest stratum. A land transition is a process and an evolution and not a condition or state. The main land transitions are deforestation, forest degradation, increased forest cover and regeneration. A list must be prepared of the transitions that are considered by the project proponents by analyzing a matrix combining all relevant LULC class and forest strata subject to deforestation, forest degradation, and increase forest cover and regeneration. Reforestation is not allowed under this methodology.

Land that only temporarily transitions from forest to non-forest and transitions back to forest after a short while is considered **temporarily unstocked forest** and may not be counted towards the total deforestation and increased forest cover rates. For every deforestation transition, select the maximal period that the “from” forest stratum can be out of forest cover and is temporarily unstocked. Use a default value of two years, unless project-specific conditions demand a different period.

By definition, degradation is a process that must have persisted for at least 3 years. In other words, forest land that transitions from a stratum with a larger carbon density stock to a stratum with smaller carbon density stock can only be degradation if it has persisted for 3 years.

Table 6. Example LULC and forest strata transition matrix showing all possible transitions.

To	From	Forest stratum						Non-forest LULC class					
		EG1	EG2	EG3	MX1	MX2	MX3	DGL	GRL	CRL	STL	WTL	OTL
Forest stratum	EG1		DGE21					RFDE1	RFGE1	RFCE1			
	EG2	RGE12		DGE32									
	EG3		RGE23										
	MX1					DGM21		RFDM1	RFGM1	RFCM1			
	MX2				RGM12		DGM32						
	MX3					RGM23							
Non-Forest LULC class	DGL	DFE1D	DFE2D	DFE3D	DFM1D	DFM2D	DFM3D						
	GRL												
	CRL	DFE1C	DFE2C	DFE3C	DFM1C	DFM2C	DFM3C						
	STL	DFE1S	DFE2S	DFE3S	DFM1S	DFM2S	DFM3S						
	WTL												
	OTL												

EG1-EG3 = evergreen forest classes with increasing carbon density, MX1-MX3 = mixed/deciduous forest classes with increasing carbon density, PL1-PL2 = plantation forest classes with increasing carbon density, DGL = degraded land, GRL = grassland, CRL = cropland, STL = settlement, WTL = wetland, OTL = other land

II.1.2.4 Step 2D – Analyze Historical LULC Class and Forest Strata Transitions

In this step, the following items are produced: (1) a series of LULC class and forest strata maps of the reference region from the historical reference period, (2) a forest cover benchmark map indicating forest cover status at project start, and (3) a table of historical deforestation and forest degradation rates. First, all images from the historical reference period must be classified according to the LULC class and forest strata definitions outlined in section II.1.2.2. Existing classification or stratification maps can be used if (1) the classes or strata in these maps can be matched to the LULC class and forest strata definitions developed according to this methodology and (2) the accuracy of these maps is quantified using the procedures in section II.1.2.4.3. The forest benchmark map clearly indicates which areas are forested and which are not following the relevant forest definition. The time series of historical LULC and forest strata maps is then used to produce a table of historical deforestation, increased forest cover, forest degradation, and natural regeneration rates.

A number of remote sensing products exist for LULC classification and forest stratification based on optical, RADAR, or LiDAR sources, and acquired from on airborne or satellite platforms. The most appropriate data product is dependent on project conditions and requirements. Therefore, a set of main methodological steps, rather than one specific data source is required within the methodology. The analysis of land cover change shall be performed by processing and analyzing remote sensing data in three steps:

(1) Pre-processing of remote-sensing data

(2) Classification and stratification

(3) Accuracy assessment using ground-truth data.

II.1.2.4.1 Pre-processing

Pre-processing includes:

1. **Geometric corrections** to ensure that images in a time series overlay properly to each other and to other GIS maps used in the analysis (i.e. for post-classification stratification). The average location error between two images (RMSE) must be less than one pixel.
2. **Cloud and cloud shadow removal** using additional sources of data (e.g., radar, aerial photographs, and field surveys). If clouds and cloud shadows cannot be removed, the following rules will be followed.
    a. Areas in the **reference region** covered by clouds or cloud shadows shall be masked out and excluded from the calculation of the deforestation rates. The maximally allowed cloud cover for use of any image is 20%, and the total loss of change date due to cloud cover must be less than 20%. Formally:

$$\begin{cases} \text{For all images } i\text{: } CloudCover(i) \leq 20\% \\ \dfrac{\sum_{i=1}^{nrImages-1} CloudCover(i+1) + CloudCover(i)}{nrImages - 1} \leq 20\% \end{cases}$$

    Where $CloudCover(i)$ is the percentage of cloud cover for image i, where images are ordered consecutively.

    b. It is essential to prove the forest cover status in the project areas near the start of the crediting period ("forest benchmark map") which is operationally defined is maximally one year before the start of the crediting period. Areas in the **project and leakage areas** for which no cloud-free or cloud-shadow-free imagery is available **within one year of the project start** must be excluded from the project area. They may only be added back to the project area at first verification following the rules around "Additions of New Project Area" in Section III.3.1.

c. When clouds or cloud shadows are present in the **project and leakage areas after the project has started**, the calculation of the GHG benefits from these areas must be postponed until cloud-free remote sensing data is available in a subsequent monitoring period. These temporarily halted NERs may be added to the NERs generated in the subsequent monitoring period. This is only allowed on areas for which the forest status was unambiguously demonstrated at the beginning of the crediting period (see previous point).

3. **Reduction of haze** using specialized software.
4. Apply **radiometric corrections** to ensure that identical objects have the same spectral response in multi-temporal datasets.

See Chapter 3 of the sourcebook on REDD (Brown et al., 2008) or consult experts and literature for further advice on pre-processing techniques. Duly record all pre-processing steps for later reporting.

II.1.2.4.2 LULC Classification and Forest Stratification

LULC classification and forest stratification must be done using widely accepted analysis techniques such as maximum likelihood, decision trees, or support vector machines. Since the most appropriate technique is dependent on project-specific conditions and requirements, this methodology does not prescribe one specific technique. Ancillary data may be included to boost the classification accuracy. The selection of the relevant ancillary data is project-specific, and cannot be prescribed here. Relevant ancillary data may include:

- **Biophysical data** (e.g., climate or ecological zone, soil and vegetation type, elevation, rainfall, aspect, etc.). The IPCC 2006 Guidelines for National GHG Inventories provide default climate and soil classification schemes in Annex 3A.5 and advice on classifying LULC areas in section 3.3.2,
- **Disturbance indicators** (e.g., vicinity to roads or settlements; concession areas),
- **Age** (in case of plantations and secondary forests),
- **Land management** categories (e.g., protected forest, logging concession, indigenous reserve, etc.).

Note that the minimum mapping unit for assessing forest strata should be identical as the minimum size set forward in the forest definition. Duly report all interpretation and classification steps, sources of ancillary data, and techniques in the PD.

II.1.2.4.3 Map Accuracy Assessment and Discounting Factor for Classification/Stratification

The accuracy by which broad LULC classes can be discerned is used to discount credits from avoiding deforestation; the accuracy of discerning forest strata is used to discount credits from avoiding forest degradation. The discounting factor for classification/stratification is calculated by multiplying a factor related to the accuracy, and a factor related to the number of images (see the table further in this section). Equation 2 indicates how to apply the discounting factors for the calculation of NERs. Because the fine classification of forest land into different carbon density classes is more challenging than the broad classification into forest types or forest/non-forest land (Brown et al., 2008), a different discounting factors must be calculated. A minimal accuracy of 70% is required for discerning LULC classes or forest strata.

The accuracy assessment of the LULC classification and forest stratification process must follow the best practices for remote sensing (e.g., Congalton 1991), and must be done separately for LULC classification and forest stratification. More specifically, the accuracy must be assessed by comparing predicted LULC classes or forest strata for a number of reference locations with independently determined LULC classes or forest strata. The LULC classes or forest strata for these reference locations must be identified using field observations, in-situ maps, remote sensing data, and other ground-truthing data. At least 50 reference locations per LULC class or forest stratum must be used. If the area of the class exceeds 500 km^2 or the number of classes is more than 12, then at least 75-100 reference locations per class must be used. The specification of the number of reference locations is based on recommendations by Congalton (1991), Hay (1979) and Fenstermaker (1991). The locations of reference locations within each LULC class must be systematically distributed to represent varying topography, parcels and other geographic features. The accuracy of historic images may be assessed using historical high resolution images, aerial photographs or local topographic maps existing at the time when the historic image was acquired.

Sub-Step 1: Determine the accuracy of LULC classification. The accuracy is calculated based on a database of locations and their corresponding correct classification (as determined by ground-surveys or through visual interpretation of higher resolution data). Subsequently, a confusion matrix must be created to assess the accuracy. Report the overall accuracy, and the commission and omission errors (see Congalton 1991 or Pontius 2000 for an in-depth explanation). Use the smallest accuracy of all maps to select the first discounting factor based on sub-step 2 in the table within this section. If the accuracy of broad classification is smaller than 70%, the project is not eligible under this methodology.

Sub-Step 2: Determine the accuracy of forest stratification. The accuracy is calculated by comparing the actual carbon density of all field sampling plots, with the predicted carbon density class from the forest stratification map. Report the proportion of the points which are classified conservatively, i.e. the proportion of points that have an actual carbon density higher or equal than the predicted carbon density, and the commission and omission errors. Use the smallest accuracy of all maps to select the first discounting factor based on step 2 in the table within this section. If the accuracy of broad classification is smaller than 70%, NERs from avoided degradation must be excluded. However, in the latter case, credits from avoided deforestation may still be claimed subject to the accuracy requirements explained in sub-step 1.

Sub-Step 3: Multiply the first factors from sub-steps 1 and 2 with the discounting factor based on the number of images in the historical reference period (sub-step 3 in the table). An absolute minimum of four images is required to quantify the historical deforestation and degradation rates. Credits must be further discounted by multiplying the factors from sub-steps 1 and 2 with a factor 0.9 when only four images are used. If five or more images are used, no additional discounting is required[19].

[19] Note that when baselines are updated during the crediting period, a similar procedure must be used to update baseline deforestation rates. The historical reference period always ends at the time of the baseline update. Therefore, gradually

Table 7. Accuracy discounting factors for LULC classification

	Discounting factor for emission reductions from avoided deforestation based on the accuracy of LULC classification $u_{classification}$	Discounting factor for emission reductions from avoided degradation based on the accuracy of forest stratification $u_{stratification}$
STEP 2: Choose first discounting factor based on empirically attained accuracy.		
Accuracy attained		
>85%	1	1
80-85%	0.8	0.8
75-80%	0.75	0.75
70-75%	0.7	0.7
<70%	Project is not eligible	0 (exclude emission reductions from avoided forest degradation)
STEP 3: Multiply the first factors from step 1 with a discounting factor based on number of images in historical reference period		
Number of images in historical reference period		
<4	Project is not eligible	Project is not eligible
4	0.9	0.9
>4	1	1

II.1.2.5 Step 2E – Summarize all Historical Land Transitions

For every pair of subsequent images in the historical reference period[20], calculate the area of each land transition (Table 8). Note that for deforestation, lands should have been without forest cover for longer than the period defined as temporarily un-stocked. Likewise, for degradation, lands must have been in the smaller carbon stock density stratum for at least 3 years. Apply an appropriate temporal filter to ensure that only land that meets the three-year condition is designated as degradation.

It is necessary to summarize these data in a LULC Change Matrix (see Table 8 for an example). In addition, the PD must contain a table which contains the overall areas (ha) of deforestation, increased forest cover, forest degradation, and regeneration for each sub-period. These data will be used to project future land use change (section II.1.5.1).

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more data points will become available during the crediting period, and eventually eliminate this discounting.

[20] Note that there are as much pairs of consecutive images as the number of images minus one.

Table 8. Example LULC and forest strata transition matrix from initial state (top row) to final state (left column).

To	From	Forest strata								
		EG1	EG2	EG3	MX1	MX2	MX3	PL1	PL2	...
Forest strata	EG1		50							
	EG2	10		20						
	EG3		20							
	MX1					30				
	MX2				5		20			
	MX3					8				
	PL1	10	5	5	25	30	25			
	PL2							10		
Non-forest LULC class	DGL	50	40	30	70	90	70			
	GRL									
	CRL	20	30	10	20	10	10			
	STL	5	5	7	4	8	4			
	...									

Values are in ha yr^{-1}. Empty cells indicate no or insignificant change.

Reporting Requirements in the PD

1. List of all spatial, remote sensing and field observation data sources with their characteristics as listed in Table 5.
2. Report on the stratification procedure, document separately for project area and reference region, where relevant.
    a. Variables were used to stratify the area.
    b. Detailed map of the stratification.
    c. In case of a forest stratum on which ANR activities are planned, a description of all the site preparation activities planned.
    d. Detailed management plan of all the activities planned.
3. Description of each LULC class and forest stratum, document separately for project area and reference region, where relevant.
    a. **Name** and code of the LULC class or forest stratum
    b. **General description** including leading species, canopy structure, typical tree density or basal area and typical carbon density
    c. **Criteria and thresholds** used to distinguish the LULC class or forest stratum from other classes or strata (spectral and other stratification criteria) for the reference region including the areas on which ANR activities are proposed.
    d. **Seasonality of biomass and thresholds:** include information on seasonality (leaf-off period) for deciduous trees.
    e. **Other aspects determining carbon stock differences in the landscape and over time**. List all relevant aspects for understanding carbon stock changes within each class such as rotation cycle duration or harvesting intensity.
4. Description of each land transition
    a. Rationale on which **transitions are included**. Summarize the included land transition categories in a land transition matrix (see Table 6).
    b. Rationale on the decision of the period of **temporarily un-stocked**, for every deforestation transition.
5. Remote sensing-based LULC classification
    a. Description of the **methodology** used for classification and stratification.
    b. **LULC class and forest stratum map** of each image in the historical reference period.
    c. **Confusion matrix** for every LULC class and forest stratum map, and values for the commission and omission errors.
    d. Tables containing the overall areas (ha) of deforestation, degradation, and regeneration for each sub-period.

II.1.3 Step 3 – Analyze the Agents and Drivers of Deforestation

An **agent** of deforestation is the social group, community, or other entity involved in deforestation or forest degradation. The **driver** of deforestation relates to the reason why they deforest or degrade the forest. Deforestation can be the result of a short-term process (e.g., forest clear-cutting) or a gradual progressive process referred to as forest degradation (see definitions). Therefore, agents/drivers of deforestation are often hard to distinguish from agents/drivers of forest degradation. As a consequence, throughout this document, the term deforestation agents/drivers is used for deforestation and degradation agents/drivers. This methodology allows the generation NERs from reducing biomass loss due to different categories drivers of deforestation.

1. Conversion of forest land to crop-land or grazing land for small-scale subsistence farming.
2. Conversion of forest land to settlements, villages, homesteads, or infrastructure
3. Logging of timber for commercial sale. See the definition section for further explanation on commercial timber harvesting
4. Logging of timber for local and domestic use. See the definition section for further explanation on local and domestic use of timber.
5. Fuel-wood collection or charcoal production
6. Forest fires

The PD must contain an analysis of the deforestation agents and drivers by performing the following four sub-steps (Angelsen and Kaimowitz, 1999; Chomitz et al., 2006).

1. Identification of **drivers** of deforestation and forest degradation
2. Assessing the relative importance of the drivers of deforestation and forest degradation
3. Identification of the **quantitative driving variables** related to the agents and drivers of deforestation and forest degradation

Note that if this analysis reveals that deforestation agents and drivers are not similar in the reference region compared to the project area, the size and location of the reference region has to be iteratively altered.

II.1.3.1 Step 3A – Identify Deforestation and Forest Degradation Agents and Drivers

For each of the six included categories of drivers covered by this methodology that are present in the reference region, the main agents must be identified. Agents of deforestation may include small-scale farmers, encroachers, hunters, ranchers, loggers, or plantation companies. In some cases, one or more of the six general drivers need to be sub-divided into separate individual drivers depending on the different agents using the driver. A qualitative narrative on the broader underlying forces determining the agents' motivations for deforestation and forest degradation must be included. Where relevant to a driver, the following aspects must be considered in this narrative:

- Population pressure
- Poverty
- War and other types of conflicts and their effects
- Changes in policies related to subsidies, payments for environmental services, and credits
- Property and land tenure regime
- Market forces influencing land and commodity prices

II.1.3.2 Step 3B – Assess the Relative Importance of the Deforestation Drivers

The relative contribution of each of the deforestation drivers to the total historical deforestation and forest degradation is estimated in two steps: (1) estimating the absolute annual carbon loss per driver, and (2) estimate the relative contribution of each driver to the total carbon loss from deforestation and degradation.

Sub-Step 1: **Estimating the *absolute* annual carbon loss per driver** using the formulas in Table 9, which are based on GPG-LULUCF.

Table 9. Formulas to calculate the absolute annual carbon loss per deforestation or forest degradation driver category

Nr.	Driver category	Annual carbon loss	
1	Fuel-wood collection or charcoal production	$L_1 = FW_{baseline} \cdot \rho_{wood} \cdot BEF_2 \cdot CF$ (Equation 3.2.8 from GPG-LULUCF)	[3]
2	Forest fires	$L_2 = \sum_{i=1}^{nrStrata} \Delta area_{baseline,fire}(i) \cdot E \cdot P \cdot C(i) \cdot CF$ (Equation 3.2.9 from GPG-LULUCF)	[4]
3	Conversion of forest land to crop-land	$L_3 = CF \cdot \sum_{i=1}^{nrStrata} \left(\Delta area_{baseline,cropland}(i) \cdot \left(C(i) - C(cropland)\right)\right)$ (Equation 3.3.8 from GPG LULUCF)	[5]
4	Conversion of forest land to settlements	$L_4 = CF \cdot \sum_{i=1}^{nrStrata} \left(\Delta area_{baseline,settlement}(i) \cdot \left(C(i) - C(settlement)\right)\right)$ (Equation 3.3.8 from GPG LULUCF)	[6]
5	Logging of timber for commercial on-sale	$L_5 = CT_{baseline} \cdot \rho_{wood} \cdot BEF_2 \cdot CF$ (Equation 3.2.7 from GPG-LULUCF)	[7]
6	Logging of timber for local and domestic use	$L_6 = DT_{baseline} \cdot \rho_{wood} \cdot BEF_2 \cdot CF$ (Equation 3.2.7 from GPG-LULUCF)	[8]

where:

L_i = Annual carbon loss associated with driver i. [Mg C yr^{-1}]

$FW_{baseline}$	=	Annual volume of fuelwood gathering in the baseline scenario, measured from the following sources (lower-ranked options may only be used if higher-ranked options are not available) (1) social assessments conducted by project proponents[21] if at least 1% of the households or 100 households (whichever is greatest) or focused group discussion with community representatives were included; (2) recent (<10 yr) peer-reviewed scientific literature conducted in the reference region, or (3) recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region within the same country. If emission reductions from avoided degradation were excluded due to insufficient accuracy and credits from introducing fuel-efficient woodstoves are included, $FW_{baseline}$ must be estimated based on social assessments in which at least 100 households or 5% of the households in the project area, whichever is smallest, are sampled. [m^3 yr^{-1}]
ρ_{wood}	=	Basic wood density, estimated using Table GPG-LULUCF 3A.1.9. [Mg DM m^{-3}]
BEF_2	=	Biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass (including bark), estimated using GPG-LULUCF Table 3A.1.10. [-]
CF	=	Carbon fraction of dry matter (default = 0.5). [Mg C (Mg DM)$^{-1}$]
$nrStrata$	=	Number of deforestation and forest degradation strata. [-]
$area_{baseline,fire}(i)$	=	Annual forest areas in the project area affected by disturbances from forest fires, measured from (lower-ranked options may only be used if higher-ranked options are not available) (1) recent (<10 yr) peer-reviewed scientific literature in the reference region, (2) recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region within the same country, (3) recent remote-sensing analyses [ha yr^{-1}]

[21] See Top et al. (2004) for an example of the use of social assessments to determine woodfuel volume. [Top et al. (2004) Variation in woodfuel consumption patterns in response to forest availability in Kampong Thom Province, Cambodia. Biomass and Bioenergy 27 (2004) 57 – 68]

E	=	Average combustion efficiency of the above-ground tree biomass (dimensionless). Use the following sources (lower-ranked options may only be used if higher-ranked options are not available): (1) project-specific measurements, (2) regionally valid estimates, (3) estimates from Table 3.A.14 of IPCC GPG LULUCF, (4) if no appropriate combustion efficiency can be used, the IPCC default of 0.5. [-]
P	=	Average proportion of mass burnt from the above-ground tree biomass; estimate from GPG-LULUCF Table 3A.1.13 relative to C_{class1} . [-]
$C(i)$	=	Average total carbon stock density for forest stratum i. [Mg C ha^{-1}]
$\Delta area_{baseline,cropland}(i)$	=	Forest area converted from forest stratum i to cropland at the beginning of the crediting period; measure from (lower-ranked options may only be used if higher-ranked options are not available) (1) remote sensing analyses in the reference region, (2) recent (<10 yr) peer-reviewed scientific literature in the reference region, (3) recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region within the same country. [ha yr^{-1}]
$C(i)$, $C(cropLand)$, and $C(settlement)$	=	Average total carbon stock density of forest stratum i, cropland, or settlement, respectively; measured using forest sampling plots. [Mg DM ha^{-1}]
$B_{cropland}$	=	Biomass stock density of cropland); measure using forest sampling plots. [Mg DM ha^{-1}]
$\Delta area_{baseline,settlement}(i)$	=	Average forest area converted from forest stratum i to settlement land; measure from (lower-ranked options may only be used if higher-ranked options are not available) (1) remote sensing analyses in the reference region, (2) recent (<10 yr) peer-reviewed scientific literature in the reference region, or (3) recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region within the same country, or (4) social assessments conducted by project proponents if at least 1% of the households or 100 households (whichever is greatest) were included. [ha yr^{-1}]
$B_{settlement}$	=	Biomass stock density of cropland); measure using forest sampling plots. [Mg DM ha^{-1}]

$CT_{baseline}$ = Annually extracted volume of harvested timber, roundwood for commercial on-sale; measure from (lower-ranked options may only be used if higher-ranked options are not available) (1) recent (<10 yr) peer-reviewed scientific literature in the reference region, (2) recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region within the same country, (3) recent (<10 yr) non peer-reviewed reports by local organizations or (4) social assessments conducted by project proponents if at least 1% of the households or 100 households (whichever is greatest) were included. [m^3 yr^{-1}]

$DT_{baseline}$ = Annually extracted volume of timber for domestic and local use, roundwood; measure from (lower-ranked options may only be used if higher-ranked options are not available) (1) recent (<10 yr) peer-reviewed scientific literature in the reference region, (2) recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region, or (3) recent (<10 yr) non peer-reviewed reports by local organizations, or (4) social assessments conducted by project proponents. [m^3 yr^{-1}]

Sub-Step 2: **Estimating the *relative* contribution of each driver** to the total carbon loss from degradation and deforestation. Carbon losses must be separated into losses from deforestation and losses from degradation. In case of conversion of forestland to cropland and settlements, all of the carbon loss is related to deforestation. However, drivers that have a more gradual carbon decrease (fuel-wood collection, wildfires, and logging) will first lead to forest degradation, and eventually deforestation when biomass density becomes smaller than the arbitrary threshold implied under the forest definition. For example, a loss of 25 Mg biomass per hectare on a well-stocked forest of 200 Mg biomass per hectare may, according to the forest definition, be categorized as forest degradation, while the same loss on a poorly-stocked forest of 50 Mg standing biomass per hectare could be deforestation, because the final tree cover has become smaller than the forest cover threshold in the forest definition. The proportion of the carbon loss from fuel-wood collection, wildfires, and logging that leads to deforestation versus forest degradation is estimated depending on specific conditions outlined in Table 10.

Table 10. Proportion of carbon loss leading to deforestation vs. forest degradation for different drivers.

Driver	$proportion_{DF}(i)$	$proportion_{DG}(i)$
Fuel-wood collection for immediate use or for charcoal production	5%	95%
Small ground fires	0%	100%
Large crown fires destroying most of the forest biomass.	100%	0%
Conversion of forest land to crop-land	100%	0%
Conversion of forest land to settlements	100%	0%
Logging for commercial on-sale by clear cutting[22].	100%	0%
Logging for commercial on-sale by high-grading (selective logging)	0%	100%
Logging for domestic use as clear cutting.	100%	0%
Logging for domestic use by high-grading (selective logging).	0%	100%

The total carbon loss due to deforestation versus forest degradation can be calculated as following:

$$\Delta C_{DF} = \sum_{i=1}^{nrDrivers} proportion_{DF}(i) \cdot L(i) \qquad [9]$$

$$\Delta C_{DG} = \sum_{d=1}^{nrDrivers} proportion_{DG}(d) \cdot L(i) \qquad [10]$$

where:

ΔC_{DF}	=	Total carbon loss due to deforestation. [Mg C yr^{-1}]
ΔC_{DF}	=	Total carbon loss due to degradation. [Mg C yr^{-1}]
$nrDrivers$	=	Number of drivers of deforestation or forest degradation. [-]
$proportion_{DF}(d)$ and $proportion_{DG}(d)$	=	Proportion of the gradual carbon loss that leads to deforestation or forest degradation, respectively, due to driver d. Estimate using the procedure detailed in Table 10.
$L(i)$	=	Annual carbon loss associated with driver i. [Mg C yr^{-1}]

[22] Clear-cutting is defined as removing more than 75% of the trees on an area that is at least the minimal required area of forest implied in the forest definition used.

The relative importance of the deforestation and forest degradation drivers can be calculated by combining the absolute carbon losses from Table 9 with the contributions from Table 10 using the formulas in Table 11.

Table 11. Formulas to calculate the relative importance of per deforestation and forest degradation driver to the total deforestation (DF) and forest degradation (DG)

Nr.	Driver Category	contribution to DF		contribution to DG	
1	Fuel-wood collection or charcoal production	$contribution_{DF}(1) = \frac{proportion_{DF}(1) \cdot L(1)}{\Delta C_{DF}}$	[11]	$contribution_{DG}(1) = \frac{proportion_{DG}(1) \cdot L(1)}{\Delta C_{DG}}$	[12]
2	Forest fires	$contribution_{DF}(2) = \frac{proportion_{DF}(2) \cdot L(2)}{\Delta C_{DF}}$	[13]	$contribution_{DG}(2) = \frac{proportion_{DG}(2) \cdot L(2)}{\Delta C_{DG}}$	[14]
3	Conversion of forest land to crop-land	$contribution_{DF}(3) = \frac{proportion_{DF}(3) \cdot L(3)}{\Delta C_{DF}}$	[15]		
4	Conversion of forest land to settlements	$contribution_{DF}(4) = \frac{proportion_{DF}(4) \cdot L(4)}{\Delta C_{DF}}$	[16]		
5	Logging of timber for commercial on-sale	$contribution_{DF}(5) = \frac{proportion_{DF}(5) \cdot L(5)}{\Delta C_{DF}}$	[17]	$contribution_{DG}(5) = \frac{proportion_{DG}(5) \cdot L(5)}{\Delta C_{DG}}$	[18]
6	Logging of timber for local and domestic use	$contribution_{DF}(6) = \frac{proportion_{DF}(6) \cdot L(6)}{\Delta C_{DF}}$	[19]	$contribution_{DG}(6) = \frac{proportion_{DG}(6) \cdot L(6)}{\Delta C_{DG}}$	[20]

where:

$contribution_{DF}(i)$ = Relative contribution of driver i to the total deforestation. [-]

$contribution_{DG}(i)$ = Relative contribution of driver i to the total forest degradation. [-]

$proportion_{DF}(i)$ = Proportion of the gradual carbon loss that leads to deforestation. [-]

$proportion_{DG}(i)$ Proportion of the gradual carbon loss that leads to degradation. [-]

ΔC_{DF} = Total carbon loss due to deforestation. [Mg C yr^{-1}]

ΔC_{DF} = Total carbon loss due to degradation. [Mg C yr^{-1}]

$L(i)$ = Annual carbon loss associated with driver i. [Mg C yr^{-1}]

II.1.3.3 Step 3C – Analyze of the Mobility of Each Deforestation and Forest Degradation Driver

The geographical extent of leakage is, in part, dependent on the mobility of each deforestation agent. It must be determined how far each deforestation agent is willing to go to acquire the forest resource or clear the land for cropland, grassland or settlement. In other words, how far are people expected to walk, bike or drive for collecting fuel-wood, logging, or charcoal production?

- For every driver of deforestation, report the main mode of transportation used by the main agent of deforestation of that driver: on foot, bike, scooter, motorcycle, car, or truck. Substantiate the choice with data from (lower-ranked options may only be used if higher-ranked options are not available) (1) social appraisals conduction by project proponents, (2) recent (< 10 yr) peer-reviewed scientific literature conducted among groups similar to the deforestation agents of the project, (3) communications by local socio-cultural and anthropological experts.
- Present a table of the average speed by which each identified mode of transportation can cross each of the LULC classes and forest strata and road categories, such as tracks, seasonally accessible small roads, and year-round accessible two-lane roads. Note the average speed on land with restricted access, such as national parks, as 0. Substantiate the choice with data from (lower-ranked options may only be used if higher-ranked options are not available) (1) social appraisals conducted by project proponents, (2) recent (< 10 yr) peer-reviewed scientific literature conducted among groups similar to the deforestation agents of the project, (3) communications by local socio-cultural and anthropological experts.
- Drivers that are less geographically constrained will still be confined to a "sphere of influence". For example, timber concessions might be granted by provincial officials. In this case, leakage will most likely not extend beyond the boundaries of the province, and the sphere of influence of the driver is provincial. However, if the granting of large economic land concessions occurs at a national level, the prevention of project areas being converted into economic land concessions may lead to an increase in economic land concessions elsewhere in the country. In this case, the sphere of influence of the driver is national.

II.1.3.4 Step 3D – Identify the Quantitative Driving Variables of Deforestation and Forest Degradation

For each identified driver, provide:

1. Non-spatial driving variables that explain the **quantity** of land cover change (to be used in section II.1.5.1). Project proponents must present the following variables in the PD:
    - Rural wages,
    - Prices and demand of agricultural products,
    - Costs of agricultural inputs,
    - Population density.
2. Spatial driving variables that explain the **location** of land cover change are also called "predisposing factors" (De Jong, 2007) (to be used in section II.1.5.2). Project proponents must select one or more of the following variables that potentially explain the location of deforestation and forest degradation
    - Access to forests (such as vicinity to existing roads, railroads, navigable rivers and coastal lines),
    - Slope,
    - Aspect,
    - Proximity to markets,

- Proximity to industrial facilities (e.g., sawmills, agricultural products processing facilities, etc.),
- Proximity to forest edges,
- Proximity to settlements,
- Soil fertility and rainfall,
- Management category of the land (e.g., national park, logging concession, indigenous reserve, etc.).

Reporting Requirements in the PD
For each deforestation driver, provide the following information: 1. **Name** of the agent or agent group (there may be multiple agents) causing the deforestation. 2. Brief description of the **main social, economic, cultural and other relevant features** of each agent, including the broader underlying motivation for deforestation and forest degradation. 3. Brief assessment of the most likely **development of the population size** of the identified agents in the reference region and project area. 4. Estimate of the **relative contribution** of this driver to the overall deforestation quantity, using the procedures outlined in this section. 5. **Mobility** of the agents: analysis of transportation mode, analysis of the relative time needed to reach the project area, sphere of influence. 6. For every deforestation driver, list the non-spatial and spatial **quantitative driving variables** for each deforestation driver. Demonstrate that the identified variables are in fact explaining deforestation.

Once the agents and drivers of deforestation have been identified, project proponents must re-assess the similarity between the project area and the reference region, according to the procedure in section II.1.1.2. If necessary, adjust the area and location of the reference region to ensure that the same drivers of deforestation are acting in both the reference region and the project area.

II.1.4 Step 4 – Determine Emission Factors for All Included Transitions

For each LULC class or forest stratum that could be subject to a transition as identified in section II.1.2.3, it is necessary to determine the average carbon stock density, based on **permanent sampling plots on forest LULC classes** and **non-permanent sampling plots on non-forest LULC classes**. Alternatively, conservative defaults gathered from scientific literature may be used to quantify the carbon stock density on non-forest land. The applicability of these default values shall be confirmed by the validator. The number of plots and their location must be determined in a stratified sampling design. The following steps are to be followed:

1. Identify the LULC classes and forest strata for which carbon stocks are to be quantified.
2. Review existing biomass and biomass increment data for comparison with field measurements.
3. Determine the sample size per LULC class or forest stratum.
4. Measure carbon density stocks of each LULC class or forest stratum.

5. Calculate emission factors for each land transition category.

II.1.4.1 Step 4A – Identify the LULC Classes and Forest Strata for which Carbon Stocks are to be Quantified.

Present a table of the LULC classes and forest strata that are likely to be subject to transitions within the project area or anticipated leakage area based on the land transition matrix.

II.1.4.2 Step 4B – Review Existing Data of Biomass Stock Densities and Biomass Net Annual Increments

Review existing data on biomass stock densities

For the purpose of sampling design and quality assurance of the measured values, all existing data on biomass stock densities must be reviewed. Sources that must be consulted include (lower-ranked options may only be used if higher-ranked options are not available): (1) peer-reviewed scientific literature conducted within the reference region, (2) peer-reviewed scientific literature from an area similar to the reference region, (3) non peer-reviewed reports or studies from the reference region or similar areas. Sources that contain a measure of the variation of the values (range, standard deviations, standard errors, or coefficients of variation) are specifically useful, since these can be used for preliminary determination of the number of sampling plots required during field sampling. For every data source used, note the following items (Brown et al., 2008):

- Methodology (field inventory, extrapolation from satellite imagery, ecosystem model, or GIS analysis).
- Number of measurement plots used.
- Whether all species are included in the sampling.
- The minimum DBH of measured trees in the biomass inventory.
- Region in which the samples were taken.

The carbon stock density on non-forest land may be quantified using conservative defaults gathered from scientific literature. The applicability of these default values shall be confirmed by the validator.

Review existing data on net annual increments of biomass

Whereas the GHG benefits from avoided deforestation and avoided forest degradation are based on observed transitions between LULC classes and forest strata, the GHG benefits from ANR activities are based directly on the empirically observed increases in biomass stock densities. Therefore, a correct accounting of the GHG benefits from ANR activities requires a sound baseline natural regeneration rate. Therefore, for accurate ex-ante estimates, all existing data on net annual increments of biomass carbon stocks must be reviewed. Sources that must be consulted include (lower-ranked options may only be used if higher-ranked options are not available): (1) values measured by the project proponents in the project area using the methods used for forest inventories discussed in this methodology, (2) national or local growth curves and tables that are usually used in national or local forest inventories, (3) values from peer-reviewed literature, report the items above, (4) values from GPG-LULUCF Table 3A.1.5. These values are representative for regeneration in well-managed forests, and will therefore be conservative.

These values must be reported as $NAI(i)$ for every stratum i on which ANR activities are planned.

II.1.4.3 Step 4C – Determine the Sample Size per LULC Class or Forest Stratum

The determination of the sample size (number of sampling plots) required per LULC class and forest strata that are identified in II.1.4.1 is dependent on (1) the required precision at a given confidence level and (2) the anticipated variance in the specific LULC class and forest strata. Extra measurement plots must be installed within the ANR areas to reliably estimate the increase in carbon density. The following steps are followed to determine a sampling design, which follow method I (sampling with replacement) of the CDM methodological tool "Calculation of the number of sample plots for measurements within A/R CDM project activities"[23].

Sub-Step 1: Select a preliminary sample plot size (AP), desired level of precision p (must be less than 15%), and confidence level (must be at least 95%).

Sub-Step 2: Calculate the areas of each LULC class or forest stratum in the project area based on the stratification in section II.1.2 (A_i).

Sub-Step 3: Calculate the maximum possible number of sample plots in the project area and the maximum possible number of sample plots in stratum i.

$$N = \frac{size_{projectArea}}{AP}; N_i = \frac{area(i,0)}{AP} \qquad [21]$$

where:

N	=	Maximum possible number of sample plots in the project area. [-]
$size_{projectAre}$	=	Total size of all strata, e.g. the total project area. [ha]
AP	=	Sample plot size (constant for all strata). [ha]
i	=	Index for stratum. [-]
N_i	=	Maximum possible number of sample plots in stratum i. [-]
$area(i,0)$	=	Total size of stratum i at the beginning of the crediting period. [ha]

Sub-Step 4: Estimate the approximate average value of the aboveground tree biomass stock Q_i, and the associated standard deviation st_i for each LULC classes and forest stratum i, based on (lower-ranked options may only be used if higher-ranked options are not available): (1) preliminary sampling by project proponents in approximately 5 plots per LULC class or forest stratum, (2) peer-reviewed scientific literature from identical forest systems as the ones in the reference region. Estimate the allowable error E_i based on the desired level of precision (at most 15%).

$$E_i = Q_i \cdot p \qquad [22]$$

where:

E_i = Allowable error of the aboveground tree biomass. [Mg DM ha^{-1}]

[23] http://cdm.unfccc.int/EB/031/eb31_repan15.pdf

Q_i = Approximate average value of the aboveground tree biomass of class or stratum i. [Mg DM ha^{-1}]
p = Desired level of precision (must be < 15%). [-]

Determine the total required number of sampling plots.

$$\begin{cases} n = \dfrac{\left(\sum_{i=1}^{nrStrata} N_i \cdot st_i \cdot \sqrt{cost_i}\right) \cdot \left(\sum_{i=1}^{nrStrata} N_i \cdot st_i / \sqrt{cost_i}\right)}{\left(N \dfrac{E_1}{z_{\alpha/2}}\right)^2 + \sum_{i=1}^{nrStrata} N_i \cdot st_i^2} \\ n_i = n \cdot \dfrac{N_i \cdot st_i / \sqrt{cost_i}}{\sum_{i=1}^{nrStrata} N_i \cdot st_i / \sqrt{cost_i}} \end{cases} \quad [23]$$

where:

n = Sample size (total number of sample plots required) in the project area. [-]
n_i = Sample size for stratum i. [-]
$z_{\alpha/2}$ = Value of the z-statistic; α must be smaller than 0.15 (implying a minimal confidence level of 95%); $z_{0.10/2}$=1.96.
st_i = Expected of the standard deviation of the aboveground biomass of class or stratum i. [Mg DM ha^{-1}]
$cost_i$ = Cost to sample stratum i. Set to 1 if costs are identical for all strata.

- **Sub-Step 5**: If the number of samples produced is impractical to collect, then the area of the sampling plots may be increased.

II.1.4.4 Step 4D – Select Sampling Plot Layout and Location

Further explanation on how to select the **layout of sampling plots** (form, nesting, etc.) can be found in Pearson et al. (2005).

For measuring and monitoring carbon density in the forest strata, a network of permanent forest sampling plots must be established. Due to the significant anthropogenic influence on non-forest land, it is not deemed feasible to install permanent sampling plots. Therefore, the average carbon stock density on non-forest LULC classes shall be assessed using non-permanent sampling plots. Alternatively, conservative defaults gathered from scientific literature may be used to quantify the carbon stock density on non-forest land. The applicability of these default values shall be confirmed by the validator.

Within a LULC class or forest stratum, the **location of sample plots** must be selected either systematically with a random start (see 2003 IPCC GPG-LULUCF) or randomly within a cell of a systematic grid (see Thompson, 2002). The randomization must be done *ex-ante* by a computer program. This is required to avoid subjective choice of plot locations. For each sample plot, record the observed LULC class, forest type, and estimated forest canopy closure.

Summarize the sampling framework following the guidance of section 4.3.3.4 of GPG LULUCF and the Sourcebook for LULUCF (Pearson et al., 2006) in the PD and provide a map and the coordinates of all sampling locations.

II.1.4.5 Step 4E – Measure Carbon Density Stocks

The total biomass stock density from a sampling plot is calculated by summing the aboveground, belowground, and dead-wood components of this plot:

$$B_{plot\text{-}wise}(i,p) = B_{AG,plot\text{-}wise}(i,p) + B_{BG,plot\text{-}wise}(i,p) + B_{LDW,plot\text{-}wise}(i,p) + B_{SDW,plot\text{-}wise}(i,p) \quad [24]$$

where:

$\boldsymbol{B_{plot\text{-}wise}(i,p)}$	=	Total biomass stock density of plot p within LULC class or forest stratum i. [Mg DM ha^{-1}]
$\boldsymbol{B_{AG,plot\text{-}wise}(i,p)}$	=	Aboveground tree biomass stock density of plot $\boldsymbol{p}$ within LULC class or forest stratum $\boldsymbol{i}$. [Mg DM ha^{-1}]
$\boldsymbol{B_{BG,plot\text{-}wise}(i,p)}$	=	Belowground tree biomass stock density of plot $\boldsymbol{p}$ within LULC class or forest stratum $\boldsymbol{i}$. [Mg DM ha^{-1}]
$\boldsymbol{B_{LDW,plot\text{-}wise}(i,p)}$	=	Lying dead-wood biomass stock density of plot $\boldsymbol{p}$ within LULC class or forest stratum $\boldsymbol{i}$. [Mg DM ha^{-1}]
$\boldsymbol{B_{SDW,plot\text{-}wise}(i,p)}$	=	Standing dead-wood biomass stock density of plot $\boldsymbol{p}$ within LULC class or forest stratum $\boldsymbol{i}$. [Mg DM ha^{-1}]

The biomass stock density of stratum $\boldsymbol{i}$ and associated statistics are calculated on the plots $\boldsymbol{p}$ within LULC class or forest stratum $\boldsymbol{i}$.

$$B(i) = average\left(B_{plot\text{-}wise}(i,p)\right) \quad [25]$$

$$stdev\big(B(i)\big) = stdev\left(B_{plot\text{-}wise}(i,p)\right) \quad [26]$$

$$stderr\big(B(i)\big) = \frac{stdev\big(B(i)\big)}{\sqrt{n_i}} \quad [27]$$

$$HCWI\big(B(i)\big) = t_{0.95,n-1} \cdot stderr\big(B(i)\big) \quad [28]$$

$\boldsymbol{B(i)}$	=	Average total biomass stock density of LULC class or forest stratum $\boldsymbol{i}$. [Mg DM ha^{-1}]
$\boldsymbol{B_{plot\text{-}wise}(i,p)}$	=	Total biomass stock density of plot $\boldsymbol{p}$ within LULC class or forest stratum $\boldsymbol{i}$. [Mg DM ha^{-1}]
$\boldsymbol{stdev\big(B(i)\big)}$	=	Standard deviation of the total biomass stock density of LULC class or forest stratum $\boldsymbol{i}$. [Mg DM ha^{-1}]
$\boldsymbol{stderr\big(B(i)\big)}$	=	Standard error of the average of the total biomass stock density of LULC class or forest stratum $\boldsymbol{i}$. [Mg DM ha^{-1}]

n_i	=	Number of sampling plots of LULC class or forest stratum i. [-]
$HWCI(B(i))$	=	Half-width of the confidence interval around the average of the total biomass stock density of LULC class or forest stratum i. [Mg DM ha^{-1}]

The average total carbon stock is calculated by multiplication with the carbon fraction:

$$C(i) = CF \cdot B(i) \quad [29]$$

where:

$C(i)$	=	Average total carbon stock density of LULC class or forest stratum i. [Mg C ha^{-1}]
CF	=	Carbon fraction of dry matter in wood (default = 0.5). [Mg C (Mg DM)$^{-1}$]
$B(i)$	=	Total biomass stock of LULC class or forest stratum i. [Mg C ha-1]

The exact measurement of above-ground and below-ground tree carbon must follow international standards (IPCC GPG LULUCF 2003). These measurements are explained in detail in Pearson et al. (2006) and CDM approved methodology AR-AM0002 "Restoration of degraded lands through afforestation/reforestation". A step-by-step Standard Operations Procedure for field measurements should be prepared ex-ante and contain a detailed, step-by-step explanation of all of the required field-work for both ex-ante and ex-post measurements. This document will ensure consistency during the crediting period by standardizing sampling procedures from year to year.

- **Aboveground biomass**, $B_{AG}(i,p)$. Measure the DBH of all trees with a DBH > 5 cm within the sampling plot. Record the species. In permanent sampling plots, all trees must be tagged. The above-ground carbon stocks per tree are estimated by relating the biomass to DBH using allometric equations applied to the tree and multiplying the carbon fraction of tree biomass. The applicability of the allometric equation used must be specifically verified using the procedures in section II.6, [EA 36]. Sometimes the allometric equation will not provide above-ground biomass, but rather commercial/merchantable timber volume. This can be calculated into above-ground biomass by multiplying with a density of the wood, and a biomass expansion factor (BEF). Values of wood density can be found in Table 3A.1.9 of the GPG LULUCF or Reyes et al. (1992). BEF values can be found in Table 3A.1.10 of IPCC GPG-LULUCF 2003. The allometric equations and the BEF values are fixed during a baseline validation period. During baseline validation, project proponents may replace previously used allometric equations, and BEF values by more accurate ones, if these would become available.

$$B_{AG,plot\text{-}wise}(i,p) = \frac{\sum_{t=1}^{nrTrees(i,p)} f_{allometric}\big(DBH(t,i,p)\big)}{AP \cdot \cos\big(\theta(i,p)\big)} \quad [30]$$

where:

$B_{AG,plot\text{-}wise}(i,p)$	=	Aboveground biomass in plot p of LULC class or forest stratum i. [Mg DM ha^{-1}]

$nrTrees(i, p)$	=	Number of trees in sample plot p of LULC class or forest stratum i. [-]
$f_{allometric}(y)$	=	Allometric relationship to convert DBH into biomass. Use the following hierarchy to select the most appropriate allometric equation. 1. Allometric equations developed by project proponents 2. Allometric equations developed locally by groups other than project proponents 3. Allometric equations developed for forest types that are similar to the ones in the project as found in found in Appendix C of Pearson et al. (2005), or Tables 4.A.1. and 4.A.2. of the GPG LULUCF
$DBH(t, i, p)$	=	DBH of tree t within plot p of LULC class or forest stratum i. [cm]
AP	=	Size of a sampling plot. [ha]
$\theta(i, p)$	=	Slope of the land of plot p of LULC class or forest stratum i. See section 8 in Pearson et al. (2005). [m m^{-1}]

- **Belowground biomass**, $B_{BG}(i, p)$. The below-ground biomass pool is estimated from the above-ground biomass using a relationship between aboveground and belowground biomass, such as a root-to-shoot ratio. Similar as to the constants for the aboveground biomass, the root-to-shoot ratio are fixed during a baseline validation period. During baseline validation, project proponents may replace a previously used root-to-shoot value by a more accurate one, if this would become available.

$$B_{BG,plot\text{-}wise}(i, p) = f_{belowground}\left(B_{AG,plot\text{-}wise}(i, p)\right) \quad [31]$$

where:

$B_{BG,plot\text{-}wise}(i, p)$	=	Belowground biomass in plot p of LULC class or forest stratum i. [Mg DM ha^{-1}]
$f_{belowground}(y)$	=	Relationship between aboveground and belowground biomass, such as a root-to-shoot ratio. Use (lower-ranked options may only be used if higher-ranked options are not available) 1. A relationship calculated from destructive sampling data obtained within the project area. 2. A relationship obtained from the local/national studies that closely reflect the conditions of the project activity. 3. Equations under section 8.2 of Pearson et al., 2005, or standard root-to-shoot ratios as found in Table 4.4 of the IPCC GPG-LULUCF 2003, and adapted by Brown et al., 2007.

$\boldsymbol{B_{AG,plot\text{-}wise}(i,p)}$	=	Belowground biomass in plot $\boldsymbol{p}$ of LULC class or forest stratum $\boldsymbol{i}$. [Mg DM ha^{-1}]

- **Lying dead-wood**, $\boldsymbol{B_{LDW}(i,p)}$. Lying deadwood should be sampled using the line intersect method (Harmon and Sexton, 1996). Two 50-meter lines are established bisecting each plot and the diameters of the lying dead wood (≥ 5 cm diameter) intersecting the lines are measured. The dead wood is then assigned to one of the three density states (sound, intermediate, and rotten). Dry matte in ying deadwood per unit area is calculated using the equation by Warren and Olsen(1964) and modified by Van Wagener (1968):

$$B_{LDW,plot\text{-}wise}(i,p) = \frac{\pi^2 . \sum_{d=1}^{nrDecompClasses} \sum_{wp=1}^{nrLyingWood} D(d,i,wp,p)^2 . \rho_{DW}(d)}{8. L . \cos(\theta(i,p))} \quad [32]$$

where:

$\boldsymbol{B_{LDW,plot\text{-}wise}(i,p)}$	=	Biomass of lying dead wood in sampling plot p of LULC class or forest stratum i. [Mg DM ha^{-1}]
$\boldsymbol{nrDecompClasses}$	=	Number of decomposition classes, default = 3 (1=sound, 2=intermediate, 3=rotten). [-]
$\boldsymbol{nrLyingWood}$	=	Number of wood pieces found in transect. [-]
$\boldsymbol{D(d,i,wp,p)}$	=	Diameter of piece $\boldsymbol{wp}$ of lying wood along the transect in decomposition class $\boldsymbol{d}$ (1=sound, 2=intermediate, 3=rotten) of sampling plot $\boldsymbol{p}$ of LULC class or forest stratum $\boldsymbol{i}$. [cm]
$\boldsymbol{L}$	=	Length of the transect. [m] (If transect line is longer than 50 m, appropriate adjustment must be made)
$\boldsymbol{\rho_{DW}(d)}$	=	Basic density of dead wood in the density class d. [kg DM m^{-3}]
$\boldsymbol{\theta(i,p)}$	=	Slope of the land of plot $\boldsymbol{p}$ of LULC class or forest stratum $\boldsymbol{i}$ (see section 8 in Pearson et al., 2005). [m m^{-1}]

- **Standing dead-wood**, $\boldsymbol{B_{SDW}(i,p)}$. Standing dead trees shall be measured using the same procedures used for measuring live trees with the addition of a decomposition class. 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:

1. Tree with branches and twigs that resembles a live tree (except for leaves)
2. Tree with no twigs but with persistent small and large branches
3. Tree with large branches only
4. Bole only, no branches

Biomass for dead trees in decomposition class 1 is estimated using the allometric equation for live trees.

Within the PD, report the average $B(i)$, standard deviation $stdev(B(i))$, number of observations n_i, standard error around the mean $stderr(B(i))$, and half-width of the 95%-confidence interval around the mean $HCWI(B(i))$ for every LULC class or forest stratum i.

II.1.4.6 Step 4F – Calculate Emission Factors and Check Compatibility with Degradation Definition

Emission factors only include the carbon pool-related sources due to changes in biomass between the LULC classes and forest strata. Since N_2O and CH_4 emissions from forest fires increase emissions, they can be conservatively omitted for baseline calculations[24].

Once the carbon stock densities are calculated, biomass carbon emission factors and their uncertainties for each LULC class or forest stratum transition are calculated as:

$$EF_{bio}(classStratum1 \rightarrow classStratum2) = \frac{44}{12} \cdot \left(C(classStratum2) - C(classStratum1)\right) \quad [33]$$

$EF_{bio}(classStratum1 \rightarrow classStratum2)$	=	Emission factor for change from LULC class or forest stratum 1 to 2. [tCO_2-eq ha^{-1}],
$classStratum1 \rightarrow classStratum2$	=	Land transition from LULC class or forest stratum 1 to 2.
$C(i)$	=	Carbon density of classes or forest stratum i. [Mg C ha^{-1}]

The combined error for a transition is:

$$\frac{44}{12} \cdot CF \cdot \frac{\sqrt{HWCI\left(B(classStratum1)\right)^2 + HWCI\left(B(classStratum2)\right)^2}}{EF_{bio}(classStratum1 \rightarrow classStratum2)}$$

If the combined error is smaller than 0.15, no deduction is applied and the discounting factor for uncertainty around biomass stock densities is set to 1:

$$u_{inventory}(classStratum1 \rightarrow classStratum2) = 1$$

However, if the combined error is greater than 0.15, the following deduction must be applied:

$$u_{inventory}(classStratum1 \rightarrow classStratum2) = \quad [34]$$

[24] Note that under the project scenario, N_2O emissions from controlled burning must be included in the carbon accounting.

$$1 - \frac{44}{12} \cdot CF \cdot \frac{\sqrt{HWCI\big(B(classStratum1)\big)^2 + HWCI\big(B(classStratum2)\big)^2}}{|EF_{bio}(classStratum1 \rightarrow classStratum2)|}$$

In the extreme case that $\sqrt{HWCI\big(B(classStratum1)\big)^2 + HWCI\big(B(classStratum2)\big)^2}$ is greater than $|EF_{bio}(classStratum1 \rightarrow classStratum2)|$, $u_{inventory}(classStratum1 \rightarrow classStratum2)$ must be set to 0, and no net emission reductions from this transition may be generated.

where:

$u_{inventory}(classStratum1 \rightarrow classStratum2)$	=	Discounting factor for the emission factor for the transition from LULC class or forest stratum 1 to class 2 according to the uncertainty of the biomass inventory. [-]
$HWCI\big(B(classStratum1)\big)$ and $HWCI\big(B(classStratum2)\big)$	=	Half-width of the 95% confidence interval around the mean carbon stock density of LULC classes or forest strata 1 and 2. [Mg DM ha^{-1}]

Note that a positive sign of EF_{bio} indicates a net sequestration of carbon, or an increase in the carbon stock, and a negative sign indications emission. List the estimated emission factors, the associated uncertainties, and the lower confidence limit per LULC class and forest strata category in a table in the PD (see Table 12 for an example). The inventory must be iteratively expanded until for every transition, $u_{inventory}(classStratum1 \rightarrow classStratum2)$ is greater than 0.70. This threshold serves to ensure a minimal accuracy of biomass inventories.

Table 12. Example look-up table for emission factors (all values in tCO_2-eq ha^{-1})

Transition			Carbon pool-related emission factor (EF_{bio})		
From	To	Code	average	HWCI	$uncertainty_{inventory}$ average
EG1	EG2	RGE12	75	15	
EG1	DGL	DFE1D			
EG1	CRL	DFE1C			
EG1	STL	DFE1S			
EG2	EG1	DGE21			
EG2	EG3	RGE23			
…	…	…			

HWCI = half-width of the 95% confidence interval,

Finally, it must be checked that all forest stratum transitions are compatible with the definition of degradation. More specifically, check that the difference in carbon density stock between forest strata is at least 10%.

PD Reporting requirements
1. Rationale on which LULC classes and forest strata are selected for quantification. 2. Table with existing data in carbon stock density measurements in the literature, including the methodology, number of sampling plots, whether all species were included, minimum DBH used, and region in which the samples were taken. 3. Table with baseline net annual increments due to natural regeneration rates. Report the same information on the data sources as for the previous PD requirement 4. Sample framework for collecting field data, including size, layout, and location. 5. Spreadsheet containing the calculations of carbon stock densities. 6. Statistical distributions (histograms) of all carbon stock measurements per LULC class and forest type. 7. Table with descriptive statistics on carbon stock densities per predicted LULC class or forest stratum i, including: • Average, $B(i)$ • Standard deviation, $stdev\big(B(i)\big)$ • Number of observations, n_i • Standard error around the mean, $stderr\big(B(i)\big)$ • Half-width of the 95%-confidence interval around the mean, $HCWI\big(B(i)\big)$. 8. Look-up table with emission factors per LULC class and forest type, similar to Table 12.

II.1.5 Step 5 – Estimate *Ex-ante* Land Transition Rates under the Baseline Scenario

The goal of this step is to calculate all land transitions, including deforestation and increased forest cover, and forest degradation and regeneration under the baseline scenario. The procedure below initially calculates the **total deforestation and forest degradation rates** by extrapolating historical observations using a beta regression. Subsequently, these total rates of deforestation and forest degradation are divided into **LULC class or forest stratum specific deforestation and forest degradation rates** using a geographical modeling approach, similar to the GEOMOD model[25]. Note that the geographical modeling approach is only used to calculate LULC class or forest stratum-specific deforestation and forest degradation rates, and not the exact *location* of future deforestation, even though the latter is calculated as an intermediate step.

[25] This approach is conservative since upon exhaustion of one forest stratum, the deforestation will be displaced to the stratum with the greatest likelihood of being deforested. In case stratum-specific deforestation rates were calculated up front, the displacement of deforestation to other forest strata would have been more challenging.

II.1.5.1 Step 5A – Calculate Total Rates of Deforestation and Forest Degradation in the Project Area

The total future deforestation and degradation rates are interpolated from past trends. However, land scarcity of land may decrease rates to values below the maximal rates interpolated on past trends. This is accounted for in sub-step 5D below.

Create a graph of the historical deforestation rates in the reference region (hectares per year) versus time (years) for each consecutive pair of images in the historical reference period. Create a similar graph of the historical degradation rates versus time. From these graphs, calculate the future deforestation and degradation rates using two beta regression[26] equations, one for deforestation and one for forest degradation:

$$D_{referenceRegion,baselineScenario,DF}(t) = BetaReg_{DF}(t) \quad [35]$$

$$D_{referenceRegion,baselineScenario,DG}(t) = BetaReg_{DG}(t) \quad [36]$$

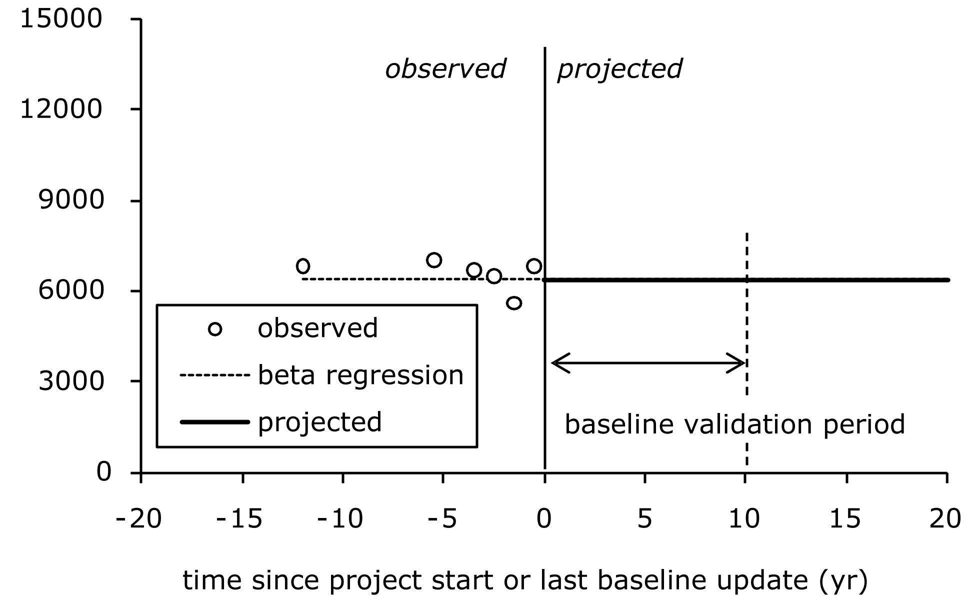
where:

$D_{baselineScenario,DF,referenceRegion}(t)$, $D_{baselineScenario,DG,referenceRegion}(t)$	=	Rate of deforestation/degradation within the reference region for year t. [ha yr^{-1}]
$BetaReg_{DF}(t)$ and $BetaReg_{DG}(t)$	=	Beta regression model describing the relationship between time and deforestation/degradation rate in the reference region during the historical reference period. [ha yr^{-1}]
t	=	Time since project start (negative before project start). [yr]

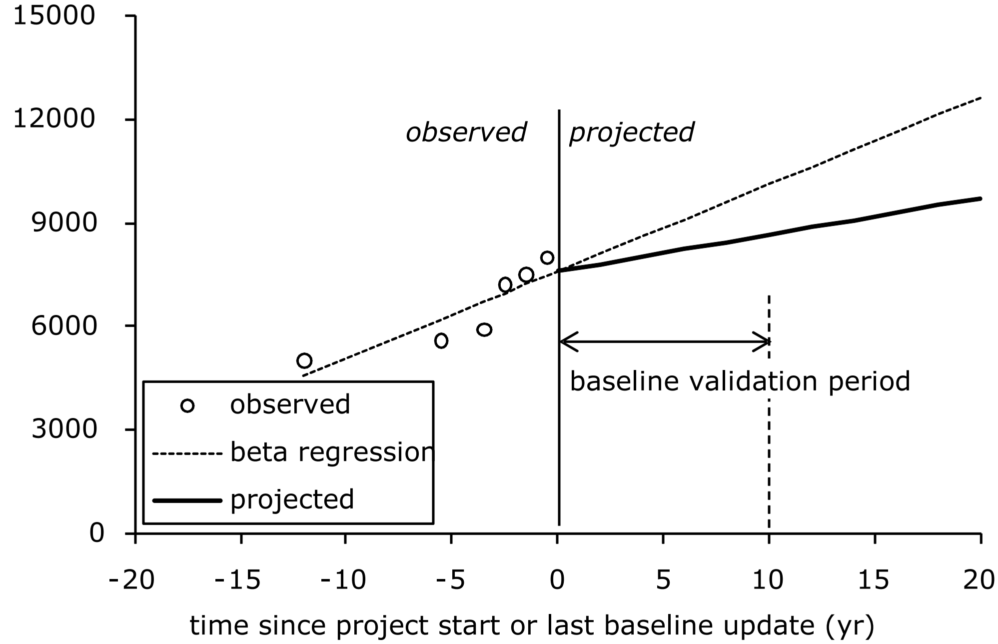
The future deforestation/ forest degradation quantity must be calculated as follows:

[26] Beta regression is commonly used to model variables that assume values in the standard unit interval (0; 1). Beta regression assumes that the dependent variable is beta-distributed and that its mean is related to a set of regressors through a linear predictor with unknown coefficients and a link function. Parameter estimation is performed by maximum likelihood. For a theoretical background as well as a computation example in the statistical package R, see Cribari-Neto and Zeileis (2010) at http://www.jstatsoft.org/v34/i02/paper

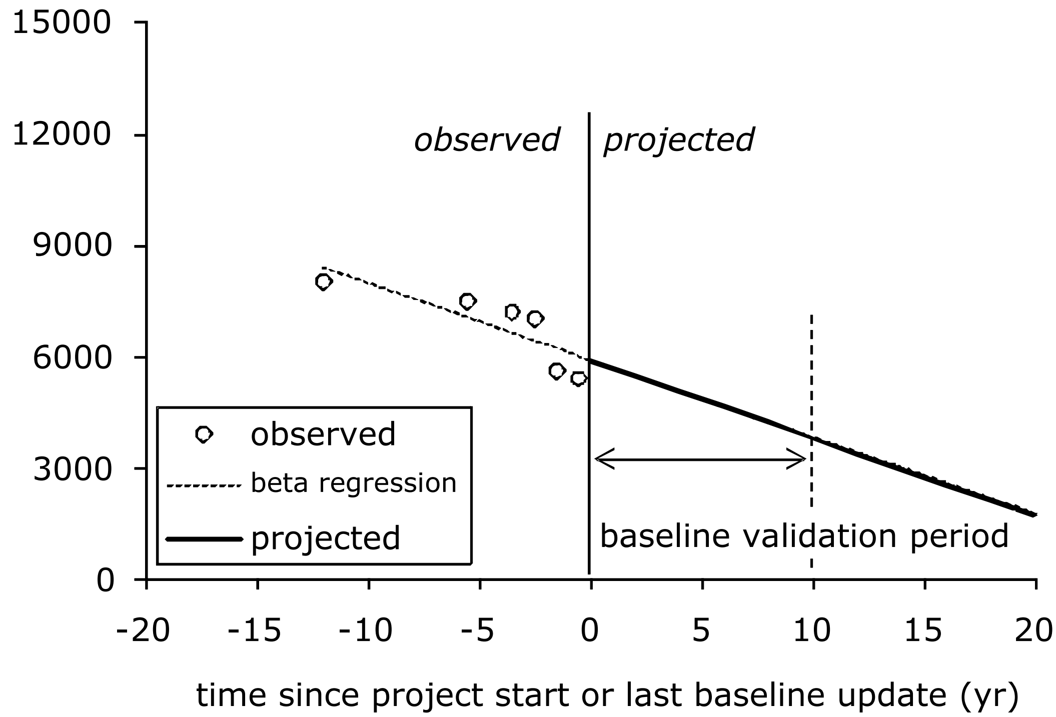
If the area of **deforestation/degradation is constant** (i.e. if the slope of the relation between deforestation/degradation quantities and time is not significantly different from 0 at the 95% confidence level), a constant future deforestation/degradation quantity is set as the mean of the observed deforestation/degradation amounts in the reference region.



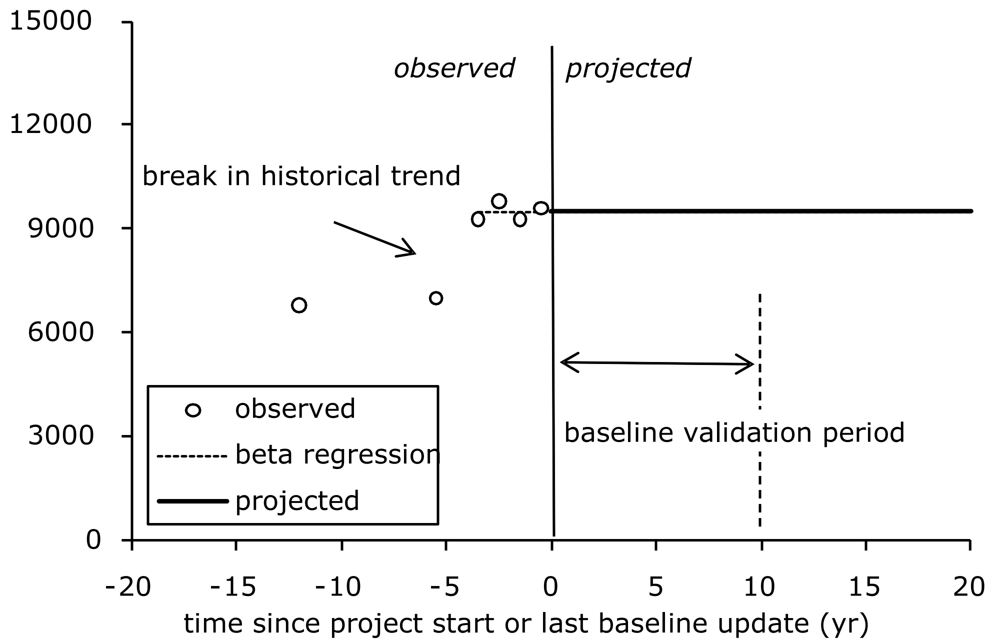
If the **deforestation/degradation quantity increases** (i.e. if the slope of the relation between deforestation/degradation quantities and time is significantly larger than 0 at the 95% confidence level), the lower 95% confidence interval of the beta regression model must be used.



If the **deforestation/degradation quantity decreases** (i.e. if the slope of the relation between deforestation/degradation quantities and time is significantly smaller from 0 at the 95% confidence level), the original beta regression model must be used.

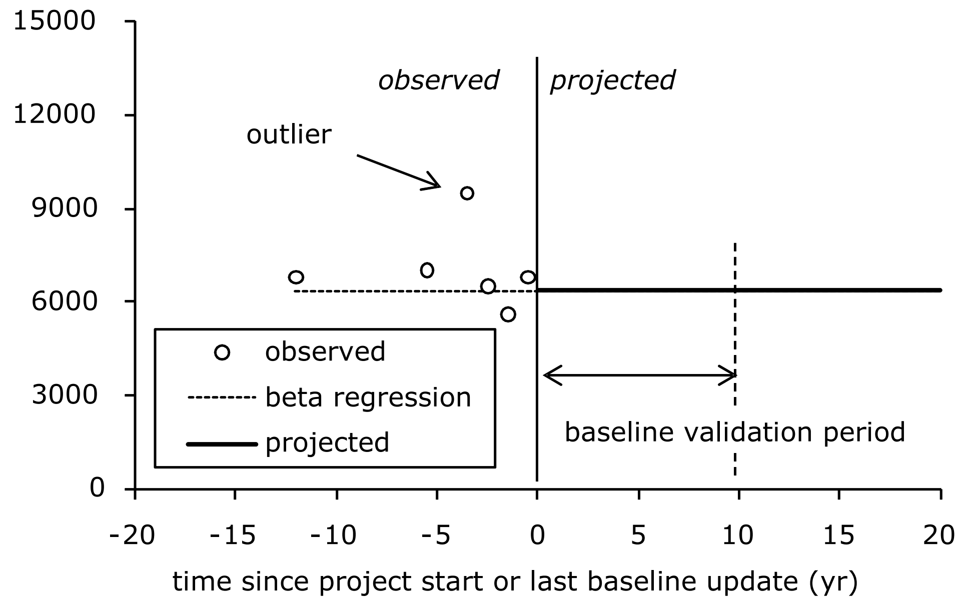

15000
12000
9000
6000
3000
0
observed
projected
observed
beta regression
projected
baseline validation period
-20
-15
-10
-5
0
5
10
15
20
time since project start or last baseline update (yr)

When there is a **clear break in the historical trend**, it is required to examine when the anomaly occurred, why it occurred, and whether the change is likely to be stable or not to determine whether to adjust the data points used in the beta regression. A break in the historical trend shall only be considered when at least six points in time are available[27]. A break in the historical trend usually indicates a technological breakthrough, a policy reform, or change in land use practice. If it is demonstrated that the reasons for a break in the trend continued into the future, omit the observations occurring before the break to project the future deforestation quantity. The projected deforestation rate must be determined from the period that goes back no farther than the appearance of the breakpoint (Sataye and Andrasko, 2007). Use one of the approaches above depending on the trend observed after the break.



Single outliers are most likely due to once-only anomalies (e.g., loss of forest land due to fire, hurricane or other natural disturbance). It is required that the cause of this single outlier be examined to determine if it may be removed. They may only be removed from the other points in the historical reference period if it is demonstrated that the occurrence of the outlier is due to specific conditions that are not present anymore (as would be the case for a natural disturbance). Use one of the approaches above depending on the trend observed after removing the outlier.

[27] Even though, often, only 3 or 4 data points will be available upon validation, increasingly more data points will become available during the crediting period. Therefore, when the baseline is updated, sufficient points may be available to detect a break.



Once the coefficients from the beta regressions are determined, calculate the baseline total deforestation and degradation rates in the project area as:

$$D_{projectArea,baselineScenario,DF}(t) = BetaReg_{DF}(t) \cdot \frac{size_{projectArea}}{size_{referenceRegion}} \quad [37]$$

$$D_{projectArea,baselineScenario,DG}(t) = BetaReg_{DG}(t) \cdot \frac{size_{projectArea}}{size_{referenceRegion}} \quad [38]$$

where:

$D_{projectArea,baselineScenario,DF}(t)$, and $D_{projectArea,baselineScenario,DG}(t)$	=	Baseline rate of deforestation/degradation within the project area for year t. [ha yr^{-1}]
$BetaReg_{DF}(t)$ and $BetaReg_{DG}(t)$	=	Beta regression model describing the relationship between time and deforestation/degradation rate in the reference region during the historical reference period. [ha yr^{-1}]
t	=	Time since project start (negative before project start). [yr]
$size_{projectArea}$	=	Total size of the project area. [ha]
$size_{referenceRegion}$	=	Total size of the reference region. [ha]

II.1.5.2 Step 5B – Calculate LULC Class or Forest Stratum-Specific Relative forest cover increase and Regeneration Rates

Although reforestation is not allowed as a project activity, the baseline scenario must include potential increases in forest cover or forest biomass that would have happened without project activities. There must be a full symmetry in carbon accounting: degradation in the baseline scenario may only be included if regeneration under the baseline is included as well. Likewise, deforestation in the baseline may only be included if natural forest establishment under the baseline is included as well.

The extent of increase in forest cover or forest regeneration that would have happened under the baseline scenario is quantified based on historical observations in the reference region during the historical reference scenario. For every land class or forest stratum that transitions into a different class with higher biomass, calculate the relative regeneration or forest cover increase rate by dividing the area of the transition by the area of the "from" class:

for every transition for which $C(CS_2) > C(CS_1)$:

$$RFRGrate(CS_1 \rightarrow CS2) = \frac{\Delta area_{historical}(CS_1 \rightarrow CS_2, t_1 \rightarrow t_2)}{area_{historical}(CS_1, t_1) \cdot (t_2 - t_1)} \quad [39]$$

where:

CS_1 and CS_2	=	Class or Stratum 1 and 2, respectively
$C(CS_1)$ and $C(CS_2)$	=	Carbon stock density of class or stratum 1 and 2, respectively. [Mg C ha^{-1}]
$RFRGrate(CS_1 \rightarrow CS_2)$	=	Relative annual forest cover increase and regeneration factor for the transition from class or stratum 1 to 2. [yr^{-1}]. Multiply with 100 to obtain a forest cover increase and regeneration rate in percentage per year.
$\Delta area_{historical}(CS_1 \rightarrow CS_2, t_1 \rightarrow t_2)$	=	Area of transition from class or stratum 1 to 2 from time 1 to 2 during the historical reference period. [ha]
$area_{historical}(CS_1, t_1)$	=	Total area of class or stratum 1 during time 1. [ha]
t_1 and t_2	=	Time 1 and time 2, respectively. [years]

Calculate the LULC class or forest stratum-specific regeneration or forest cover increase rates for every pair of subsequent images in the historical reference period, and report the averages in a table in the PD.

II.1.5.3 Step 5C – Calibrate and Validate a Spatial Model to Predict the Suitability for Deforestation and Degradation

Deforestation and degradation do not occur randomly within the forest area, but occur preferentially at specific locations where predisposing factors are present (De Jong 2007). These factors are referred to as *spatial driver variables* and were identified in section II.1.3.4. By examining the impact of spatial driver variables on historical land use change, the likelihood of land-use change can be quantified; this likelihood relation can be extrapolated into the future to predict the location of future land use change. Step 5C focuses on examining the relation between spatial drivers and historical land use change, while step 5D focuses on extrapolating this relation into the future. Spatial driver variables may be static, meaning that they will never change during model execution, such as slope or elevation, or non-static, meaning that they may change during project runs, such as distance to the nearest road, or forest density. In addition, they may be continuous, such as distance to the closest market, or categorical, such as soil type. Scientific evidence has demonstrated that logistic regression models can be used to quantify the suitability of deforestation and degradation, given that the values of the spatial driver variables are validated (Lambin 1997, Verburg et al. 2004 and Boer et al. 2006). It has been shown previously that the modeled suitability from logistic regression maps corresponds with actual future land-use changes. For example, Serneels and Lambin (2001) used the logistic model to identify the drivers of conversion to agriculture in Narok District, Kenya, and Williams et al. (2005) employed logistic regression models to understand the drivers of decline of native grasslands in Australia. To calculate a map of the suitability for deforestation and forest degradation, respectively, the following steps are to be followed once to create the deforestation model and once for the degradation model

1. For each pair of two subsequent LULC classification maps developed section in II.1.2.4[28]**, randomly select a large number (>10,000) of forested grid-cells/pixels** from the first image. Use the second image of the pair to determine whether these grid-cells/pixels were deforested, degraded, or showed no change during the period in between the two images. Since grid-cells are selected randomly from the baseline LULC maps, pixels will be selected from degrading, deforested, and no-change areas in an unbiased way.
2. Calculate the **value of each spatial driver variable** based on the first LULC map of the image pair for each of the points selected in the previous step. Create a list containing the location, land transition category, and all values of each of the spatial driver variable identified in section II.1.3.4. In case of non-static spatial driver variables[29], use a spatial driver at the time the first image was recorded. Deforestation and degradation usually occur in a clustered fashion. Therefore, include the distance to the forest edge, or forest fragmentation as spatial driver variables (Lambin et al., 1997).
3. Split this list randomly into a **calibration dataset and a (statistical) validation dataset**. The calibration data will be used to fit the deforestation and degradation logistic regression models and the validation data will be used to independently

[28] Note that all credits based on the forward-looking baseline model are discounted for based on the classification errors in these maps according to the procedure in section II.1.2.4.3 and Equation 1.

[29] Non-static variables refer to variables that change over time during modeling. Non-static variables can be either external or internal. The exact extent of the change for external non-static variables is known on beforehand. For example, when future road construction is known on beforehand, the distance-to-roads variable will change during the modeling. This change can be exactly calculated on beforehand. For internal non-static variables, in contrast, are dependent on the result of the previous model iteration. An example is the distance to the forest/non-forest edge, which shifts over time. This shift can only be calculated during model execution itself.

assess the quality of the model. 2/3 of the points should be used for calibration and 1/3 for validation.

4. **Calibrate a logistic regression model for deforestation** based on the values of spatial driver variables at the calibration point dataset. A logistic regression model predicts the suitability for deforestation for every location in the project area. If necessary, apply mathematical transformations to make the effect of the spatial driver variables linear. For instance, the influence of a road on deforestation will decrease exponentially with distance to the road, and a log-transformation should be applied,
5. **Calibrate a logistic regression model for degradation** based on the spatial driver variables defined in section II.1.4.3.
6. **Calibrate a logistic regression model for the LULC class of the new land use on cells selected for deforestation.** In case that there are more than two potential new LULC classes, use a multinomial logit model, which predicts a multi-level categorical variable based on the spatial driver variables.
7. **Quality assurance: significance and goodness-of-fit.** As a quality assurance step, report the significance of the overall logistic regression model (likelihood ratio test), and the significance of individual drivers of deforestation (t-tests). Both the full model and all individual drivers must be significant at the 95% confidence level. In addition, perform a goodness-of-fit test by predicting the new LULC classes and forest strata for the independent statistical validation data, and comparing the results with the measured data. Present a table of the empirically observed land-use change rates vs. the land-use change rate predicted using the logistic model. The difference in aggregated deforestation and forest degradation rates as well as forest stratum and LULC-class transition rates averaged over all the time periods (in between images of the reference period) between empirically observed and modeled rates may not be more than 10%. The capability of the model to adequately estimate likelihoods of deforestation and forest degradation shall be confirmed by the auditor.

II.1.5.4 Step 5D – Calculate All Class or Stratum-Specific Transition Rates.

Once the logistic regression models for deforestation and forest degradation, and the carbon density map are prepared, a simple cellular automata type model can be used to predict the future land use and land cover in each grid-cell and for each year of the crediting period. Even though the spatial model produces maps of the exact location of future deforestation, these maps are not used outside of the modeling step. The main output of the modeling step is a land-use change transition matrix. This matrix is calculated by aggregating the LULC class and forest stratum maps that are produced by the spatial model.

A similar approach, the combination of a logistic regression model with a cellular automata model is used by Echeverria et al. (2008) to elucidate which spatial driving variables led to forest fragmentation in southern Chile. This methodology employs a similar model as the GEOMOD model used by the latter authors, but with expanded transitions and land states. However, the model used in this methodology shares the following principles with the GEOMOD model (Pontius, 2006).

- **Neighborhood constraint**. Deforestation and forest degradation occur preferentially near already deforested land. Grid-cells that are within a certain distance to forest boundary will be preferentially deforested and degraded. This is incorporated by including the distance to the forest boundary as a spatial driver variable in the logistic regression model (see previous section).

- **Land suitability**. The logistic regression model calibrated in the previous section quantifies the suitability of a cell for deforestation and degradation. Deforestation and forest degradation is assigned first on land with the highest suitability.

In addition, the model incorporates the **forest scarcity principle**, the notion that deforestation rates decrease upon the gradual depletion of the native forest resources. It is well documented that deforestation rates decrease when forest areas are gradually disappearing. The "forest transition" theory (Mather and Needle, 1998[30]) explains how areas with vast forest areas which are initially characterized by rapid deforestation rates, stabilize their forest area after some time. To incorporate a decrease in deforestation rate upon a gradual depletion of forest resources, initial deforestation rates are multiplied with a "forest scarcity" factor, which is initially 1, but gradually decreases as the proportion of remaining forest decreases (Figure 2). This "scarcity factor" must be calibrated using scientific literature in an area close to the project area that has followed a more advanced deforestation route. Examples are neighboring countries, states or provinces that have undergone a more rapid deforestation course than the area where the project is located. Typically, deforestation rates start to decrease when around 50% of the original forest cover has disappeared. In addition, deforestation usually halts when around 80% of the forest area has disappeared. This pattern has been observed by Meyfroidt and Lambin (2008)[31] in Vietnam. Deforestation rates started decreasing when 50% of forest cover remained, and halted in 1991-1993 at around 25% forest cover. However, the specific values of the forest cover when deforestation will decrease are dependent on project conditions and should be analyzed and substantiated within the project document at validation.

[30] Mather AS, Needle CL (1998) The forest transition: a theoretical basis. Area, 30, 117–124.

[31] Meyfroidt P, Lambin EF (2008) Forest transition in Vietnam and its environmental impacts. Global Change Biology, 14 (6), 1319-1336

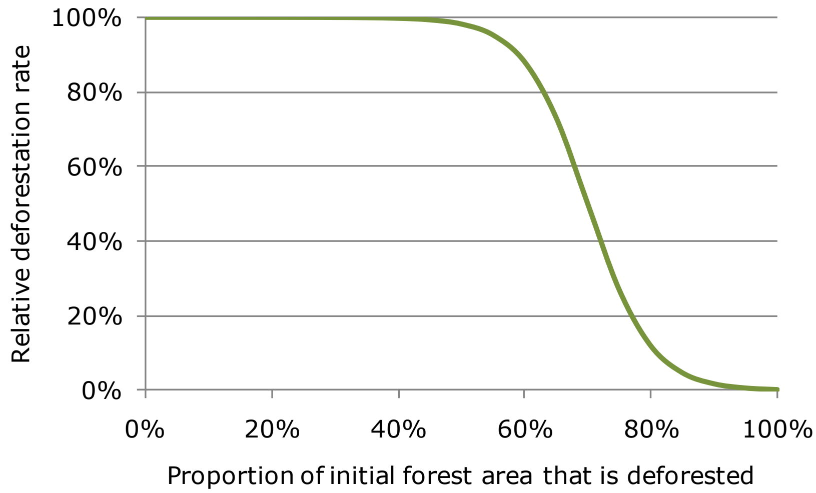


Figure 2. Example of "forest scarcity factor": the relative Deforestation Rate as a Function of Proportion of Initial Forest Area that is Deforested.

The following equation must be used to model the scarcity factor:

$$f_{scarcity}(t) = \frac{1}{1 + e^{sc_1\left(sc_2 - \frac{area(t,nonForest)}{size_{projectArea}}\right)}} \quad [40]$$

Where:

$f_{scarcity}(t)$	=	Forest scarcity factor used to reduce the historical deforestation rate. [-]
sc_1	=	First shape factor for the forest scarcity equation; steepness of the decrease in deforestation rate (greater is steeper). [-]
sc_2	=	Second shape factor for the forest scarcity equation; relative deforested area at which the deforestation rate will be 50% of the initial deforestation rate. [-]
$area(t, nonForest)$	=	Total area that is not forest within the project area at time t after project start. [ha]
$size_{projectArea}$	=	Total size of the project area. [ha]

The two shape factors sc_1 and sc_2 within this equation must be fitted using historical information in similar areas as the project area or data from peer-reviewed literature. Data sources that must be used are remotely sensed forest cover data in heavily deforested areas close to the project area such as neighboring provinces, states or countries. Values of sc_1 and sc_2 should be selected so that the carbon accounting is conservative. Lower values of sc_1 and higher values of sc_2 will result in lower deforestation, and are therefore more conservative. Project proponents must demonstrate that the source data used to fit this equation is appropriate.

Figure 3 outlines the steps followed by the land use change model.

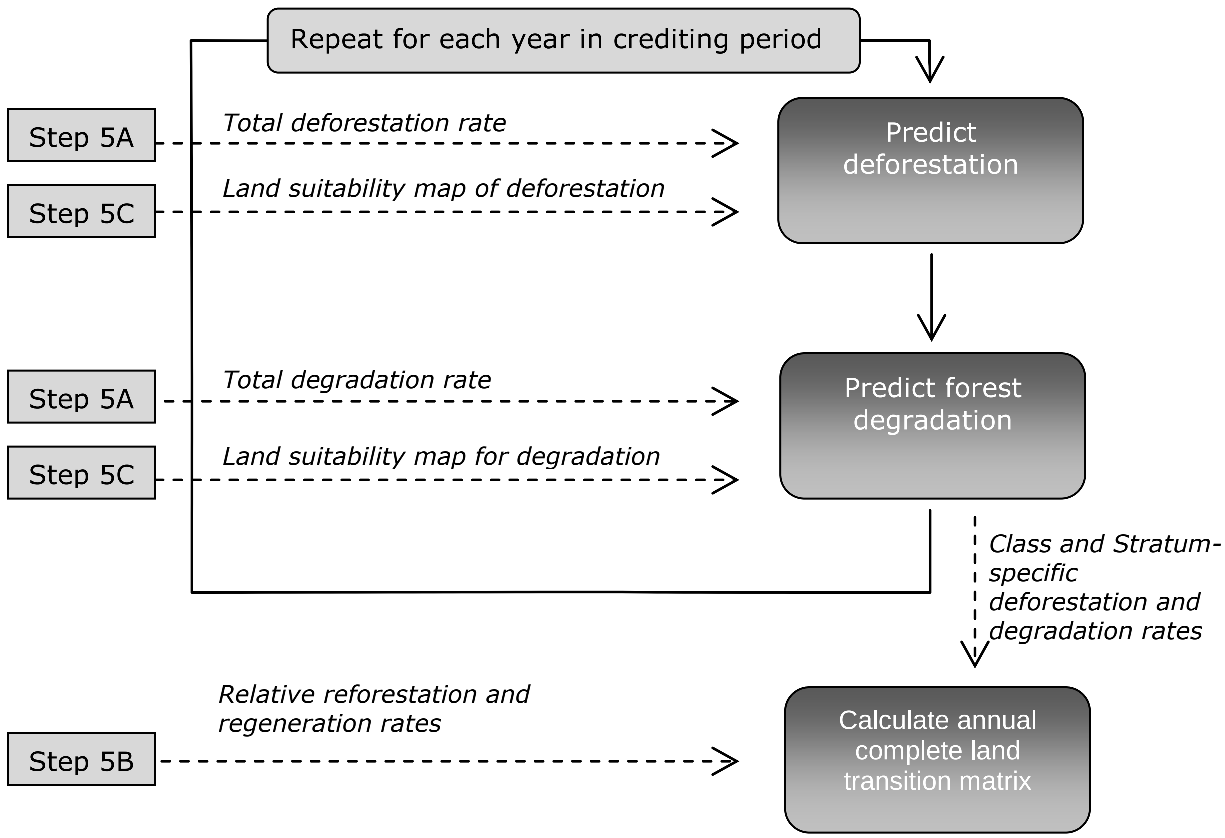


Figure 3. Outline of the procedure to calculate all land transitions

The following steps are followed for each year of the modeling period

1. Calculate the deforestation suitability for all forest cells using the logistic regression model.
2. Sort the forest cells according to their deforestation suitability from highest suitability to lowest suitability.
3. Set $D_{projectArea,baselineScenario,DF,remaining}(t)$ to $D_{projectArea,baselineScenario,DF}(t)$ multiplied with the forest scarcity factor based on the remaining forest cover. Start deforesting cells (in order of highest to lowest deforestation probability) until $D_{projectArea,baselineScenario,DF,remaining}(t)$ = 0. Every time a cell is deforested, update $D_{projectArea,baselineScenario,DF,remaining}(t)$ as $D_{projectArea,baselineScenario,DF}(t)$ minus the total amount of deforested cells and multiplied with the forest scarcity factor as a function of the remaining forest cover.
4. Calculate the suitability for a new non-forest LULC class on the cells that were selected for deforestation. Assign the LULC class with the highest suitability, according to the models calibrated in II.1.5.2, step B.

5. Repeat steps 1-4 for forest degradation on the forest cells that were not assigned for deforestation, and that are not in the forest strata or LULC class with the lowest carbon density. Degrade the cells selected for degradation by assigning them to the next-lower forest strata.
6. **For the area without ANR**, sum the areas for all transitions from the maps developed in the previous steps. Calculate the regeneration transitions from one class or stratum ("classStratum 1" in the equation below) to another class or stratum ("classStratum 2" in the equation below) by multiplying the total area of the first class or stratum with the relative regeneration rate for transitions from one class or stratum to another, in the following formula noted as class or stratum 1 to 2.

$$\Delta area(t, classStratum1 \rightarrow classStratum = RFRGrate(classStratum1 \rightarrow classStratum2) \cdot area(t, classStratum1) \quad [41]$$

where:

$\Delta area(t, classStratum1 \rightarrow classStratum2)$	=	Area of transition from class or stratum 1 to 2 from time t to $t+1$. [ha]
$RFRGrate(classStratum1 \rightarrow classStratum2)$	=	Relative annual regeneration rate for the transition from a class or stratum 1 to another, 2, from time t to $t+1$. [ha yr^{-1}]
$area(t, classStratum1)$	=	Total area of class or stratum 1 for time t of the crediting period. [ha]

All required values of $\Delta area_{projectAreaWithoutANR,baselineScenario}(t,i)$ have now been calculated for year t.

For the area with ANR, only sum the areas for the transitions between forest and non-forest classes, see section II.2.4.4. These are the only required values for $\Delta area_{projectAreaWithANR,baselineScenario}(t,i)$ for year t.

Reporting Requirements in the PD
1. Description of the approach followed to calculate the regression parameters in the calculation of the future deforestation and degradation rates. Justify the omission of outliers or the assumption of a break in the historical deforestation trend (if relevant). (see Step 5A) 2. Table with all relevant LULC class or forest stratum specific regeneration and forest cover increase rates, averaged over every pair of subsequent images. (see Step 5B) 3. Validation report of the logistic regression models with independent data. (see Step 5C) 4. A table with all land transitions under the baseline scenario separately for the area with and without ANR for every year through the crediting period according to the procedure in step 5D. For an example of such a table, see Table 17 in section II.4.1).

II.2 *Ex-ante* Estimation of GHG Emissions and Changes in Sinks under the Project Scenario inside the Project Area

II.2.1 Step 6 – Identify Project Activities and Estimate Total Deforestation and Degradation Rates under the Project Scenario

At least some or all of the deforestation drivers outlined in step 3 (section II.1.3) must be mitigated through specific project activities. Some activities may focus on increasing the livelihood options of local communities or prevention of leakage through e.g. increasing the land use intensity of already deforested land. The distinction between true REDD project activities and leakage prevention activities is often ambiguous within the context of mosaic deforestation, as any increase in livelihood of local communities will likely reduce deforestation and forest degradation both inside and outside of the project area. Therefore, leakage prevention activities are not considered separately in this section but treated as project activities.

The *ex-ante* estimation of the deforestation and forest degradation rates are based on a breakdown of the effectiveness of every project activity a in decreasing any deforestation driver d relative to that driver's contribution to deforestation and forest degradation, i.e. $effectiveness(a, d)$. For example, assume that the collection of fuel-wood leads to a degradation of 200 Mg C per year, and the introduction of fuel-efficient woodstoves decreases the emissions by 50 Mg C per year, and the development of biogas plants reduce the emissions by 100 Mg C per year. The effectiveness of fuel-efficient woodstoves to decrease degradation from fuel-wood collection $effectiveness(fuel\text{-}efficient\ stoves, fuel\text{-}wood\ collection)$ is 25%, whereas the effectiveness of biogas plants to reduce the degradation from fuel-wood collection is $effectiveness(fuel\text{-}efficient\ stoves, fuel\text{-}wood\ collection)$ is 50%. The values of the effectiveness must be estimated for every combination of project activities and drivers of deforestation and forest degradation. Note that the effectiveness values are only meant for *ex-ante* estimates of emission reductions. No actual *ex-post* VCUs are issued based on these values. The effectiveness values are often challenging to quantify, and depend on local conditions and the experience of the project proponent. However, the prediction of the volume of VCUs that a project will deliver crucially depends on the ability of the project proponents to predict effectiveness and refine these predictions through project monitoring.

Note that $effectiveness(a, d)$ should be interpreted as the maximal effectiveness, when all project conditions, such as adequate funding, the project's capacity, or the experience of the local communities, are optimal. Further in the text, it is explained how this maximal effectiveness is scaled down using a time-dependent factor for every project activity, i.e., $rate(a, t)$, to reflect that project activities will increase in effectiveness after a training period, or that project funding may be allocated in a phased manner.

The section below describes specific REDD project activities. Each activity description is followed by a table which outlines the procedure to quantify the maximal effectiveness for this project activity and each of the targeted drivers.

- **Strengthening the land-tenure status**.

  Legal agreements between the participating communities, landowners, project developers and the relevant government administrative levels are the necessary first step to protect the land. These legal agreements are particularly important when participating communities do not legally own the forest land, and the land-tenure status is unclear or obscured by a complex administrative hierarchy. The project proponents can assist local communities in securing their land tenure status. This can include developing legally binding community forestry agreements, purchasing or securing long-term conservation easements, or the revision of spatial plans and zoning laws. The establishment of these agreements will often require funds, which can be covered by the benefits from carbon trading. Strengthening the land-tenure status is essential to protect the land from encroachment by people other than participating communities and provide clarity on the allowed land use by the participating communities. Obviously, a legal protection of the land is not sufficient for a sound protection of the forest land. It must be complemented with an effective protection, social fencing, or patrolling system.

Target driver	*Maximal effectiveness quantification*
Logging of timber for commercial on-sale	$effectiveness < 5\%$ [42] Legal recognition of the land-tenure status will eliminate overlapping authorities of different administrations and reduce the potential that logging concessions are granted without explicit permission of participating communities. In addition, it is a necessary (but insufficient step) in reducing illegal logging of timber for commercial on-sale. Note that strengthening land-tenure alone usually does not directly lead to a reduction in deforestation.
Conversion of forest land to crop-land (by people other than participating communities)	$effectiveness < 5\%$ [43] Id.
Conversion of forest land to settlements (by people other than participating communities)	$effectiveness < 5\%$ [44] Id.

- **Development of sustainable forest and land use management plans**.

  Forest and land use management plans should be established in a participatory and democratic way. These plans can include the volumes of timber, fuel-wood or NTFP each community can sustainably harvest, the areas of livestock grazing, or the area of forest land that can be converted into settlements or cropland, and where the conversion must take place. The management plans must be based on current and future need for forest products and land. Such plans will increase the efficiency of the current land use and avoid the random conversion of forest patches which can accelerate forest degradation. The plans must be integrated and compatible with the land tenure and use rights. The plans must be long-term or permanent (where possible) in nature.

  The management plan is only binding for participating communities and will not affect the drivers of deforestation for which the agents are not participating in the project. The following table outlines the procedure to quantify the maximal effectiveness for this driver.

Target driver	*Maximal effectiveness quantification*
Conversion of forest land to crop-land by participating communities	$$effectiveness = \frac{\Delta area_{cropland,planned}}{\Delta area_{cropland,baseline}} \quad [45]$$ Forest and land-use plans usually explicitly indicate how much land can be converted from forest to crop-land. The baseline conversion rates must be estimated based on (lower-ranked options may only be used if higher-ranked options are not available) (1) remote sensing analysis, (2) social assessments.
Conversion of forest land to settlements by participating communities	$$effectiveness = \frac{\Delta area_{settlement,planned}}{\Delta area_{settlement,baseline}} \quad [46]$$ Id.
Logging of timber for local and domestic use by participating communities	$$effectiveness = \frac{H_{domestic,planned}}{H_{domestic}} \quad [47]$$ The baseline harvesting rate comes from (1) recent reports and studies within the project area, (2) peer-reviewed literature in regions similar to the reference region, (3) expert opinion.

- **Demarcating boundaries**

  The installation of fences, gates, boundary poles, and signage provides local communities a transparent, recognizable and fixed boundary of the project area. Because legal protection alone (project action 1, "Strengthening the land-tenure status") may be insufficient to prevent deforestation; often a physical boundary or signage is required to avoid deforestation, and support social fencing and patrolling. The boundaries of the discrete project area parcels must be clearly demarcated to be recognized by potential trespassers of the forest (hunters, loggers, or other encroachers). The following table outlines the procedure to quantify the maximal effectiveness for this driver.

Target driver	*Maximal effectiveness quantification*
Logging of timber for commercial on-sale	$$effectiveness < 10\%$$ [48] Demarcating boundaries does directly lead to only a minimal reduction in deforestation without patrolling or social fencing. This action is required but not sufficient for reductions in deforestation or forest degradation.
Conversion of forest land to crop-land by other people than participating communities	$$effectiveness < 10\%$$ [49] Demarcating boundaries does directly lead to only a minimal reduction in encroachment without patrolling or social fencing. This action is required but not sufficient for reductions in deforestation or forest degradation.
Conversion of forest land to settlements by other people than participating communities	$$effectiveness < 10\%$$ [50] Demarcating boundaries does directly lead to only a minimal reduction in conversion to settlements without patrolling or social fencing. This action is required but not sufficient for reductions in deforestation or forest degradation.

- **Protection, social fencing, and patrolling of boundaries.**

  The boundaries of the forest must be protected and patrolled. Often, there is a lack of official law enforcers to do this task, while communities are committed to defend their land-tenure and land use rights. Communities can be engaged in the regular patrolling of the forest area. It must be clarified with the local administration which actions can be taken in case of illegal trespassing (e.g., confiscating chainsaws, alerting local law enforcers, etc.). Improve synergies among local communities, law enforcement and other relevant agencies to support boundary protection. Other project actions include the creation of logistical plans to protect boundaries, social fencing, and the acquisition of equipment (e.g., small motorized vehicles) for patrolling and enforcement. The following table outlines the procedure to quantify the maximal effectiveness for this driver.

Target driver	*Maximal effectiveness quantification*
Logging of timber for commercial on-sale	$$50\% < effectiveness < 90\% \quad [51]$$ Patrolling and social fencing can be very effective in reducing illegal trespassing of the land. Set the value of effectiveness between the thresholds above based on (1) pilot experiments in the project area, (2) peer-reviewed studies in a similar area as the project area, or (3) advice from experts.
Conversion of forest land to crop-land by other people than participating communities	$$50\% < effectiveness < 90\% \quad [52]$$ Violations of a stakeholder-approved management plan can be effectively minimized by forest patrolling and social control. Set the value of effectiveness between the thresholds above based on (1) pilot experiments in the project area, (2) peer-reviewed studies in a similar area as the project area, or (3) advice from experts.
Conversion of forest land to settlements by other people than participating communities	$$50\% < effectiveness < 90\% \quad [53]$$ Violations of a stakeholder-approved management plan can be effectively minimized by forest patrolling and social control. Set the value of effectiveness between the thresholds above based on (1) pilot experiments in the project area, (2) peer-reviewed studies in a similar area as the project area, or (3) advice from experts.

- **Fire prevention.**

  If forest fires are threatening the project's forest, specific fire prevention measures could be taken. These include (1) installation of fire breaks, (2) cleaning of the forest from dead wood that can act as fuel for fires, especially around regenerating and young secondary forests, and (3) discouraging or eliminating (if possible) fire-based hunting techniques. Saplings and small trees are particularly vulnerable to forest fires. If this requires cutting down trees, or removing dead wood, the loss of carbon should be accounted for. The following table outlines the procedure to quantify the maximal effectiveness for this driver.

Target driver	*Maximal effectiveness quantification*	
Forest fires	$40\% < effectiveness < 60\%$ Fire prevention measures such as fire breaks together with education can effectively reduce fire-related deforestation and forest degradation with 50%. Set the value of effectiveness between the thresholds above based on (1) pilot experiments in the project area, (2) peer-reviewed studies in a similar area as the project area, or (3) advice from experts.	[54]

- **Providing alternative livelihoods to the agents of deforestation**.

  If deforestation agents can engage in alternative livelihoods that are not based on deforestation, they can secure their income without the need to further clear forests.

  - As far as possible, planned project activities should be **carried out by the local communities.** Engaging communities in forest patrolling, biomass inventory, fire prevention activities, installation of fences and boundary poles, and assisted natural regeneration activities. These activities will provide employment and a greater financial return flowing to the communities. In addition, the active involvement of the local communities will strengthen the project goals and decrease the risks of project failure.
  - Part of the forest can be made accessible for sustainable **eco-tourism**, which will create jobs and increase revenue.
  - The sustainable extraction of **non-timber forest products** can be further developed and commercialized. This includes the harvesting of honey, medicinal plants, fungi, and the extraction of resins. Clear harvesting plans need to be developed to ensure the sustainable extraction of these commodities.

  It is assumed that people will shift automatically towards a livelihood alternative that has a sufficiently greater return than their current livelihood. Therefore, the total effectiveness is calculated by dividing the income from alternative livelihoods by the total value of forest products that are harvested from the forest and sold on local markets. It is further assumed that alternative livelihood options must be 25% more economically attractive before people will switch to the alternative livelihoods. The total effectiveness thus becomes $0.75 \cdot \frac{(income\ through\ alternative\ livelihood)}{(total\ value\ of\ forest\ products)}$. This total effectiveness is then divided into individual values for the effectiveness for each of the different target drivers by multiplying with the respective relative financial contribution of the target driver to the total value of forest products. The following table outlines the procedure to quantify the maximal effectiveness for this driver.

Target driver	*Maximal effectiveness quantification*
Conversion of forest land to crop-land for crops that are sold on market	$effectiveness = 0.75 \cdot \frac{(income\ through\ alternative\ livelihood) \cdot (value\ of\ crops\ sold)}{(total\ value\ of\ forest\ products)^2}$ [55]
Logging of timber for sale by participating communities	$effectiveness = 0.75 \cdot \frac{(income\ through\ alternative\ livelihood) \cdot (value\ of\ timber\ sold)}{(total\ value\ of\ forest\ products)^2}$ [56] The "$value\ of\ timber\ sold$" parameter can be estimated by multiplying $H_{illegal}$ with the price for timber on the market.
Collection of fuel-wood and charcoal production for sale on markets	$effectiveness = 0.75 \cdot \frac{(income\ through\ alternative\ livelihood) \cdot (value\ of\ fuel\text{-}wood\ sold)}{(total\ value\ of\ forest\ products)^2}$ [57]

- **Intensification of agriculture.**

  Forest land is often deforested to make place for subsistence farming. Project activities that will increase productivity and agricultural yields on existing cropland and animal stocking rates on grazing lands minimize the need for further forest clearing. Such activities include increases in mechanization, installation of irrigation systems, increases in fertilizer use, the introduction of high-yielding crop varieties, and increase in livestock stocking rates. Only sustainable farming techniques should be promoted and any increases in GHG emissions due to these activities must be monitored, reported, and accounted for. Agriculture can be intensified through (1) sponsoring pilot and demonstration studies on sustainable agriculture and agro-forestry, (2) strengthening the relations with local agricultural extension services, colleges and universities, (3) establishing a system of small grants or micro-financing for local farmers to invest into agricultural equipment, infrastructure, seeds, or fertilizer. The adoption rate of the practices should be duly monitored to account for increases in GHG emissions.

  Intensification measures must be done on land that was already under agriculture or on land that is sanctioned to become agricultural land given the land-use plans. The following table outlines the procedure to quantify the maximal effectiveness for this driver.

Target driver	*Maximal effectiveness quantification*
Conversion of forest land to crop-land by project proponents	$$effectiveness = (maximal\ adoption\ rate) \cdot (increase\ in\ yield\ per\ hectare) \quad [58]$$ Estimate the maximal adoption rate based on the willingness of project participants to change their practices from (lower-ranked options may only be used if higher-ranked options are not available): (1) quantified in social assessments, or (2) expert opinion. Estimate the relative increase in yield from (1) field studies, (2) peer-reviewed literature, or (3) local agricultural extension experts.

- **Decrease the consumption of fuel-wood.**

  The collection of fuel-wood only leads to forest degradation if it is collected from live trees. A low-intensity collection of fuel-wood from downed dead wood may in fact have a positive effect on forest regeneration by decreasing the potential for forest fires. In cases where the collection of fuel-wood leads to forest degradation, the introduction of fuel-efficient wood-stoves will decrease the need for local consumption fuel-wood (Top et al., 2004). Adoption rates of these alternatives need to be monitored, together with the potential on-sale of fuel-wood on local markets, which can potentially annul the GHG benefits generated by the alternative stoves. Only fuel-wood gathering for domestic use is allowed in project areas. No on-sale of fuel-wood gathered in project areas is allowed.

  - In case **avoided forest degradation is included** in the project, the carbon accounting related to a decrease of consumption of fuel-wood is done through monitoring the changes in carbon stocks and the following table outlines the procedure to quantify the maximal effectiveness for this driver.

Target driver	*Maximal effectiveness quantification*
Fuel-wood collection or charcoal production	$$effectiveness = (maximal\ adoption\ rate) \cdot (increase\ in\ efficiency\ of\ stoves) \quad [59]$$ Estimate the maximal adoption rate based on the willingness of project participants to change their practices as (1) quantified in social assessments or (2) expert opinion. Estimate the relative increase in efficiency of stoves from (1) field studies, (2) peer-reviewed literature, or (3) local experts.

  - However, in case **avoided degradation is excluded** from the project, the ex-ante carbon accounting using effectiveness factors is not appropriate and carbon accounting must occur by setting the effectiveness to zero and the approved gold standard methodology “Indicative Programme, Baseline, and Monitoring Methodology for Improved Cook-Stoves and Kitchen Regimes”

(Currently V.02) must be followed for ex-ante estimates, baseline estimates, and project monitoring if the following additional applicability criteria are met:

- Credits from improved cook-stoves account for less than 10% of the total REDD credits.
- No fossil-fuel cookstoves may be supported by the project proponents.
- Regular fuel-wood harvesting does not lead to more than 25% of the total deforestation within the project.

When this methodology is followed, Kitchen Surveys must be conducted before validation, as explained in the methodology above. However, since fuel-efficient stoves may be introduced after start of the other REDD project activities, determining the empirical fuel consumption during "Kitchen Tests" for conventional and fuel-efficient stoves may be postponed until the monitoring report before the verification period during which credits from reduced fuel-wood use from improved cookstoves are sought. If the empirical fuel consumption is postponed, conservative values from the literature must be used for ex-ante estimates in the PD. The collection of fuel-wood will lead mostly to degradation compared to deforestation (see Table 10), therefore the potential for double counting by using the cookstove methodology in case only credits from deforestation are sought is low. However, to remain conservative, and eliminate any potential double counting, credits calculated using the cookstoves methodology must be discounted by multiplying with a discounting factor of 0.75:

$$ER_{cookstoves}(t) = 0.75 \cdot ER_{cookstoves,GS}(t) \quad [60]$$

where:

t	=	Time after project start. [yr]
$ER_{cookstoves}(t)$	=	Emission reductions from reducing biomass use through improved cookstoves discounted for double counting. [tCO_2-eq yr^{-1}]
$ER_{cookstoves,GS}(t)$	=	Emission reductions from reducing biomass use through improved cookstoves as calculated according to the gold standard methodology. [tCO_2-eq yr^{-1}]

The success of the implementation and on-going maintenance of these activities is critically dependent on the active involvement of all stakeholders in the planning and execution of these project activities. In particular, the local communities must be actively involved. Therefore, project management, advisory, oversight and consultative structures shall be developed to ensure an active involvement of all stakeholders. Through consultation with stakeholders, a transparent mechanism shall be set-up to ensure the equitable distribution of benefits from carbon benefits from the project.

A holistic approach should be taken towards meeting the various resource needs of local communities. For example, rather than excluding local communities from using any forest resources at all (and therefore necessarily forcing them to acquire these resources outside of the project area or purchase these on local or provincial markets, leading to outsource leakage), a sustainable (agro-)forestry management plan should be put in place that can meet local wood and agricultural needs.

The effectiveness of project actions may change during the crediting period, due to increased experience of project implementers or an increased allocation of funds during the crediting period. This time-dependent project activity rate is accounted for by integrating a factor $rate(a, d)$ for project activity a during year t. As was mentioned before, $effectiveness(a, d)$ thus represents the maximally attainable effectiveness given project conditions and capacity is optimal. As a consequence, $rate(a, d)$ must be 100% at least 1 year during the crediting period. The relative reduction in deforestation can be estimated *ex-ante* by integrating the relative proportion of each of the deforestation drivers with the effectiveness coefficients and the estimated adoption rates for each of the project activities.

$$RelativeDriverImpact_{DF}(t, d) = \sum_{a=1}^{nrActivities} \left(rate(a, t) \cdot effectiveness(a, d) \cdot contribution_{DF}(d)\right) \quad [61]$$

$$RelativeDriverImpact_{DG}(t, d) = \sum_{a=1}^{nrActivities} \left(rate(a, t) \cdot effectiveness(a, d) \cdot contribution_{DG}(d)\right) \quad [62]$$

$$RelativeProjectImpact_{DF}(t) = \sum_{d=1}^{nrDrivers} RelativeDriverImpact_{DF}(t, d) \quad [63]$$

$$RelativeProjectImpact_{DG}(t) = \sum_{d=1}^{nrDrivers} RelativeDriverImpact_{DF}(t, d) \quad [64]$$

where:

$RelativeDriverImpact_{DF}(t, d)$ and $RelativeDriverImpact_{DG}(t, d)$	=	Relative impact of a driver d on deforestation and forest degradation, respectively for year t of the crediting period. [-]
$RelativeProjectImpact_{DF}(t)$ and $RelativeProjectImpact_{DG}(t)$	=	Impact of all project activities on deforestation and forest degradation respectively, relative to the baseline deforestation and forest degradation rates during year t. [-]
$nrActivities$	=	Total number of project activities. [-]
$nrDrivers$	=	Total number of deforestation drivers. [-]
$rate(a, t)$	=	Adoption rate or relative degree of activity for activity a during year t. A value of 100% indicates that the activity cannot be more efficient in reducing deforestation or forest degradation. [-]
$effectiveness(a, d)$	=	The effectiveness of project action a to reduce deforestation driver d. [-]

$contribution_{DF}(d)$ and $contribution_{DG}(d)$	=	The relative importance of driver d in deforestation/degradation to the total /degradation. [-]

The absolute rate of deforestation in hectares per year in the project region under the project scenario can be calculated by multiplying the relative project impact with the total deforestation and forest degradation rates in the project region under the baseline scenario.

$$D_{projectArea,projectScenario,DF}(t) = RelativeProjectImpact_{DF}(t) \cdot D_{projectArea,baselineScenario,DF}(t) \quad [65]$$

$$D_{projectArea,projectScenario,DG}(t) = RelativeProjectImpact_{DG}(t) \cdot D_{projectArea,baselineScenario,DG}(t) \quad [66]$$

where:

$D_{projectArea,projectScenario,DF}(t)$ and $D_{projectArea,projectScenario,DG}(t)$	=	Rate of deforestation/degradation within the project area for year *t* under the project scenario. [ha yr^{-1}]
$RelativeProjectImpact_{DF}(t)$ and $RelativeProjectImpact_{DG}(t)$	=	Relative impact of all project activities on deforestation and forest degradation respectively during year t. [-]
$D_{projectArea,baselineScenario,DF}(t)$ and $D_{projectArea,baselineScenario,DG}(t)$	=	Baseline rate of deforestation/degradation within the project area for year *t.* [ha yr^{-1}]

II.2.2 Step 7 – Calculate Forest Strata-Specific Deforestation and Degradation Rates

Use the LULC model calibrated and validated in section in II.1.5 to divide the total *ex-ante* deforestation and forest degradation rates under the project scenario into individual rates for every forest stratum transition. The same logistic regression models may be used for calculating the stratum-specific rates under the project scenario. For every year of the crediting period, present a land transition table for the project areas under the project scenario similar to Table 17 in the projected land use change summary of section II.4.1.

Reporting Requirements in the PD	PD section
1. For every planned project activity:	2.4
a. Description of the activity, including which agents and drivers of deforestation are targeted.	1.8
b. Map of the planned location of the activities (if relevant).	1.8
c. Analysis of the labor/hours needed for the activity and who will implement.	1.9
d. Indication on how the involvement of all stakeholders and community levels will be ensured.	6
e. All risks involved in why the project activities may fail.	1.11
f. Estimate of the adoption rate $rate(a,t)$ per year t of the project activity.	1.9
g. A summary table of the effectiveness $effectiveness(a,d)$ for every action a and driver d. This quantity describes the impact of a project action on a targeted driver. Include a justification of the selection of an effectiveness factor based on data from the literature, pilot studies, or social assessments. Specify all underlying assumptions.	1.9
2. Table of $RelativeProjectImpact_{DF}(t)$ and $RelativeProjectImpact_{DF}(t)$ for every year t of the crediting period. This quantity is the relative reduction in the total amount of degradation and deforestation for every year of the crediting period.	2.4
3. Table with $D_{projectArea,projectScenario,DF}(t)$, the estimated total deforestation rate in the project area and $D_{projectArea,projectScenario,DG}(t)$, the estimated total forest degradation rate in the project area.	2.4
4. Land transition table under the project scenario for the project area for every year of the next crediting period (see Table 17 in section II.4.1).	4.3

II.2.3 Step 8 – Estimate GHG Emissions Sources

Project activities may lead to an increase in emissions in the project area, which are not related to carbon pools, named “emission sources”. This should be accounted for, and subtracted from the carbon pool-related emission reductions generated by the project activities. The emission sources from project activities within the project area can be calculated as:

$$GHG_{sources,projectArea} = E_{fireBreaks} \quad [67]$$

where:

$GHG_{sources,projectArea}$ = Emission sources from project activities within the forests of the project area. [tCO_2-eq yr^{-1}]

$E_{fireBreaks}$	=	Annual GHG emissions from implementation of fire-preventing actions as REDD project activities. [tCO_2-eq yr^{-1}]

In addition, as part of the validation, the auditor shall analyze that no other significant emissions exist originating from any measure associated with the project. The significance of these and other emissions is tested according to the methodology provided in EB31 appendix 16 to determine whether it must be included (see section II.4.1). If an emission source is found insignificant, it may be omitted.

II.2.3.1 Step 8B – Estimate GHG Emissions from Fire Breaks and Other Fire Prevention Measures ($E_{fireBreaks}$)

The carbon lost by removing woody biomass for fire prevention measures such as fire breaks must be accounted for[32]. This includes the emissions from fire breaks cleared by cutting or controlled burning woody biomass. In case controlled burning is used to remove woody biomass, all CH_4 emissions related to the burning must be included. The emissions from fire breaks can be calculated by:

$$E_{fireBreaks} = \frac{44}{12} \cdot \sum_{i=1}^{nrFireClasses} area_{biomassLoss}(i) \cdot C(i) + \sum_{i=1}^{nrClasses} area_{fireBiomassLoss}(i) \cdot C(i) \frac{16}{12} \cdot GWP_{CH4} \cdot ER_{CH4} \qquad [68]$$

where:

$E_{fireBreaks}$	=	Annual GHG emissions from implementation of fire-preventing actions as REDD project activities. [tCO_2-eq yr^{-1}]
$nrFireClasses$	=	Number of forest strata in which fire breaks were installed. [-]
$area_{biomassLoss}(i)$	=	Total annual area of forest stratum i that was cleared. [ha yr^{-1}]
$C(i)$	=	Carbon content in forest stratum i. It is conservatively assumed that all biomass is removed. [Mg C ha^{-1} yr^{-1}].
$area_{fireBiomassLoss}(i)$	=	Annual area of forest stratum i that was cleared by controlled burning. [ha yr^{-1}]
GWP_{CH4}	=	Global Warming Potential for CH_4 (IPCC default value = 21 for the first commitment period). [-]
ER_{CH4}	=	Emission ratio for CH_4 (IPCC default value = 0.012). See Table 3A.1.15 in IPCC GPG-LULUCF (2003). [-]

Add annual values of $E_{fireBreaks}$ to the summary table of all GHG emissions due to project activities (Table 18).

[32] Emissions from clearing herbaceous vegetation are insignificant.

PD Reporting requirements
1. List of the assumptions, data sources, and other information relevant to the calculation of the emissions for every source. 2. Summary of all individual emissions in Table 18.

II.2.4 Step 9 – Estimate the Net GHG Sequestration from Assisted Natural Regeneration Activities

II.2.4.1 Scope and Applicability

This methodology allows to generate carbon credits from silvicultural activities aimed at restoring degraded forest[33]. These ANR activities serve a triple goal: (1) increase the project area's overall GHG sink strength, (2) reduce activity-shifting, and (3) provide alternative livelihoods to local communities by employing local communities for executing the work. Implementing ANR activities is optional, but shall only be done if all of the following applicability criteria are met.

- ANR activities occur on degraded forest land within the project area. The conversion of non-forest land into forest land is not allowed under this methodology.
- Assisted natural regeneration activities must take place on degraded land on which no prior ANR activities have taken place.
- Assisted natural regeneration activities may consist of thinning, removal of invasive species, enrichment planting, and coppicing.
- The total size of the areas on which ANR activities are planned must be fixed in the Project Document and the exact location of the ANR activities must be identified before or at the first verification.

Assisted Natural Regeneration shall only be done by implementing one or more of the following measures:

- Removal of invasive understory species such as ferns or herbs to promote the growth of tree seedlings
- Thinning of over-stocked and stagnated forest stands to promote radial growth
- Removal of exotic and/or invasive tree species to promote the growth of native species
- Stem removal on trees with multiple shoots to promote the growth of a single stem
- Enrichment planting with trees of biodiversity or social value

A detailed ANR management plan with a detailed description of all activities including their location, must be included in the PD. An update to the management plan may be submitted at the first verification. However, after first verification, the management plan must be fixed.

[33] Note that per applicability criterion 2, ANR activities may only be carried out in areas that otherwise would be deforested under the baseline scenario.

II.2.4.2 General Quantification

The calculation of the GHG removals by sinks due to assisted natural regeneration activities is based on the CDM methodology AR-ACM0001 version 3. Wherever possible in this section, notation from AR-ACM0001 version 3 was retained. Combining and annualizing equations (33), (12), (13), and (14) from AR-ACM0001 version 3 yields:

$$C_{ANR}(t) = \frac{44}{12} \cdot \Delta C_{ANR}(t) - E_{ANR,biomassLoss}(t) - \Delta C_{ANR,BSL}(t) - LK_{ANR}(t) - GHG_{E,ANR}(t) \qquad [69]$$

where:

$C_{ANR}(t)$	=	Net anthropogenic greenhouse gas removals due to biomass increase in assisted natural regeneration. [tCO_2-eq]
$\Delta C_{ANR}(t)$	=	Annual change in carbon stocks in all selected carbon pools due to ANR for year t. [Mg C yr^{-1}]
$E_{ANR,biomassLoss}(t)$	=	Increase in CO_2 emissions from loss of existing woody biomass due to site-preparation (including burning), and/or to competition from forest (or other vegetation) planted as part of the ANR activities. [tCO_2-eq]
$GHG_{E,ANR}(t)$	=	Increase in GHG emissions as a result of the implementation of the proposed ANR activities during year t. [tCO_2-eq]
$\Delta C_{ANR,BSL}(t)$	=	Baseline greenhouse gas emissions or sources for year t. [Mg C yr^{-1}]
$LK_{ANR}(t)$	=	Total GHG emissions due to leakage for year t. [Mg C yr^{-1}]

- The procedure for calculating $\Delta C_{ANR}(t)$ is explained in section II.2.4.3.
- The procedure for calculating $\Delta C_{BSL}(t)$ is explained in section II.2.4.4.
- Report the difference $\Delta C_{ANR}(t) - \Delta C_{ANR,BSL}(t)$ in the overview table.
- The activity-shifting leakage from ANR activities is included in the total project's leakage, as explained in section II.3.
- The procedure for calculating $E_{ANR,biomassLoss}$ and $GHG_{ANR,E}(t)$ is explained in section II.2.4.5.

II.2.4.3 Step 9A – Estimate Carbon Stock Increase from Biomass

The procedure to calculate the carbon uptake by biomass due to assisted natural regeneration follows the CDM-approved methodology AR-ACM0001 version 3.

$$\Delta C_{ANR}(t) = \sum_{i=1}^{nrStrata} \Delta C(t,i) \qquad [70]$$

where:

$\Delta C_{ANR}(t)$	=	Annual change in carbon stocks in all selected carbon pools due to ANR for year t during the crediting period. [Mg C yr^{-1}]
$nrStrata$	=	Number of forest strata. [-]
$\Delta C(t,i)$	=	Carbon stock change for ANR stratum i for year t during the crediting period. [Mg C yr^{-1}]

As stated earlier, $\Delta C(t,i)$ is the sum of aboveground and belowground tree biomass. Similarly as in AR-ACM0001 version 3, changes in dead wood under the project scenario must be conservatively omitted for *ex-ante* calculations. The aboveground and belowground tree biomass is calculated using the "allometric method" following Equation (22) in AR-ACM0001 version 3:

$$\Delta C(t,i) = area_{projectAreaWithANR,projectScenario}(t,i) \cdot \frac{C(t_2,i) - C(t_1,i)}{t_2 - t_1} \quad [71]$$

where:

$area_{projectAreaWithANR,projectScenario}(t,i)$	=	Amount of land on which ANR activities are planned under the baseline scenario for year t and in stratum i. [ha]
$C(t_2,i)$ and $C(t_1,i)$	=	Aboveground carbon stock density during years t_2 and t_1 respectively and in stratum i. [Mg DM ha^{-1}]
$t_2 - t_1$	=	Duration between times 1 and 2. [year]

Ex-ante, values for biomass densities in ANR areas must be based on pilot projects or data on biomass increases in regenerating forests from the literature. *Ex-post*, this quantity must to be monitored for actual biomass according to a network of permanent sampling plots according to the procedures within this document. Select a sampling design with a confidence of minimally 95%. See section II.1.4.3 for instructions on determining sampling size. Use the same sampling layout as selected for section II.1.4.4.

II.2.4.4 Step 9B – Calculate Baseline Emissions or Sinks on Land on which Assisted Natural Regeneration Activities are Planned

Baseline emissions from land on which ANR activities are proposed are calculated analogously as for land without ANR activities except for the treatment of forest degradation and regeneration under the baseline scenario. To remain conservative, only the baseline scenario for ANR land only includes transitions between forest and non-forest LULC classes. In addition, regeneration under the baseline scenario is considered by using continuous "net annual increments" in Mg C ha^{-1} yr^{-1} which shall be specific for the forest strata. This departure from the previous approach for land without ANR is necessary because (1) the combination of the discrete approach to account for changes in biomass by transitions among forest strata for the baseline and the continuous carbon accounting approach from latest version of AR-ACM0001 for the scenario will lead to unexpectedly discontinuous GHG benefits from ANR, (2) incases when forest degradation has been excluded due to low accuracy of remote sensing analysis, this procedure will still assume a baseline regeneration rate. The baseline emissions or sinks on land with ANR can be calculated using the following equation.

$$\Delta C_{ANR,BSL}(t) = \frac{44}{12} \cdot CF \cdot \sum_{i=1}^{nrANRStrata} NAI(i) \cdot area_{projectAreaWithANR,baselineScenario(t,i)} + \sum_{i=1}^{nrFNFtransitions} \left(u_{classification} \cdot \Delta area_{projectAreaWithANR,baselineScenario}(t,i) \cdot u_{inventory}(i) \cdot EF(i)\right) \quad [72]$$

where:

$\Delta C_{ANR,BSL}(t)$	=	Baseline greenhouse gas emissions or sources for year t. [Mg C yr^{-1}]
CF	=	Carbon fraction of woody material (use a default value of 0.5). [Mg C (Mg DM)$^{-1}$]
$nrANRStrata$	=	Number of strata within the project area on which ANR activities are proposed. [-]
$NAI(i)$	=	Net annual increment due to natural regeneration and succession for the "from" class of transition i, as reported in section II.1.4.2. [Mg DM ha^{-1} yr^{-1}]
$area_{projectAreaWithANR,baselineScenario(t,i)}$	=	Size of strata i within the project area on which ANR activities are proposed for year t under the baseline scenario. [ha]
$nrFNFtransitions$	=	Number of forest/non-forest transitions among land classes or forest strata, meaning transitions in which either the "from" or the "to" classes are non-forests. [-]
$u_{classification}$	=	Discounting factor for uncertainty of LULC classification. [-]
$\Delta area_{projectAreaWithANR,baselineScenario}(t,i)$	=	Hectares undergoing transition i within the ANR area under the baseline scenario for year t. [ha yr^{-1}]
$u_{inventory}(i)$	=	Discounting factor for uncertainty of biomass inventory related to transition i. [-]
$EF(i)$	=	Emission factor for transition i. [tCO_2-eq ha^{-1}]

II.2.4.5 Step 9C – Calculate Emission Sources from Assisted Natural Regeneration

Under this methodology, all emissions from the proposed ANR project activities, including, $GHG_E(t)$ and $E_{biomassLoss}(t)$, are combined in $GHG_{sources,ANR}$:

$$GHG_{sources,ANR}(t) = E_{biomassLoss,ANR}(t) + GHG_{E,ANR}(t) \quad [73]$$

where:

$E_{sources,ANR}(t)$	=	Emissions of sources from methane, nitrous oxide, fuel-CO_2 and biomass removal from ANR activities during year t. [tCO_2-eq]
$E_{biomassLoss,ANR}(t)$	=	Increase in CO_2 emissions from loss of existing woody biomass due to site preparation, and/or competition from forest (or other vegetation) planted as part of the ANR project activity. [tCO_2-eq]
$GHG_{E,ANR}(t)$	=	Increase in GHG emissions as a result of the implementation of the proposed ANR activity within the project boundary during year t. [tCO_2-eq]

- The **CO_2 emissions from loss of existing woody biomass** for land preparation, $E_{biomassLoss,ANR}(t)$, are calculated as following

$$E_{biomassLoss,ANR}(t) = \frac{44}{12} \cdot \sum_{i=1}^{nrANRstrata} area_{biomassLoss,ANR}(t,i) \cdot C(i) \quad [74]$$

where:

$E_{biomassLoss,ANR}(t)$	=	Increase in CO_2 emissions from loss of existing woody biomass due to site preparation, and/or competition from forest (or other vegetation) planted as part of the ANR project activity. [tCO_2-eq]
$nrANRstrata$	=	Number of strata within the project area on which ANR activities are proposed. [-]
$area_{biomassLoss}(t,i)$	=	Area of biomass removed within ANR stratum i during year t. [ha]
$C(i)$	=	Carbon content in ANR stratum i. To remain conservative, it is assume that all biomass is removed. [Mg C ha^{-1} yr^{-1}]

- The **increase in GHG emissions as a result of the implementation of the proposed ANR activity**, $GHG_{E,ANR}(t)$ consists of CH4 emissions from controlled burning of woody biomass and is calculated as following:

$$\boldsymbol{GHG_{E,ANR}(t)} = \sum_{i=1}^{nrANRStrata} \boldsymbol{area}_{fireBiomassLoss,ANR}(t,i) \cdot C(i) \cdot \frac{16}{12} \cdot GWP_{CH4} \cdot ER_{CH4} \quad [75]$$

where:

$GHG_{E,ANR}(t)$	=	Annual GHG emissions from implementation of fire-preventing actions as REDD project activities. [tCO_2-eq yr^{-1}]
$nrANRStrata$	=	Number of strata within the project area on which ANR activities are proposed. [-]
$area_{fireBiomassLoss,ANR}(t,i)$	=	Area of biomass removed within ANR stratum i during year using controlled burning t. [ha]
$C(i)$	=	Carbon content in ANR stratum i. To remain conservative, it is assume that all biomass is removed. [Mg C ha^{-1} yr^{-1}]
GWP_{CH4}	=	Global Warming Potential for CH_4 (IPCC default value = 21 for the first commitment period). [-]
ER_{CH4}	=	Emission ratio for CH_4 (IPCC default value = 0.012). See Table 3A.1.15 in IPCC GPG-LULUCF (2003). [-]

Reporting Requirements in the PD

1. Digital boundaries of every individual stratum where ANR activities are planned, separately for every discrete project parcel. All necessary meta-data to correctly display the files must be included. The digital boundaries must remain available for the duration of the project's crediting period.
2. Estimates of biomass increases due to assisted natural regeneration activities based on literature data. Include the source, the methodology used, whether all species were included, the minimal DBH of measured trees, and the region in which the biomass increases were measured. This quantity may be reported separately for the different forest strata where relevant.
3. Summary table of $\frac{44}{12}\Delta C_{ANR}(t)$, the GHG benefits from assisted natural regeneration activities, $\Delta C_{ANR,BSL}(t)$, the baseline GHG changes on the land on which assisted natural regeneration activities are proposed.
4. Summary of the difference $\left(\frac{44}{12}\cdot\Delta C_{ANR}(t)-\Delta C_{ANR,BSL}(t)\right)$, the net GHG benefits from ANR without taking emission sources into account for every year t of the crediting period in the overview table.
5. List of the assumptions, data sources, and other information relevant to the calculation of the emissions for every source related to assisted natural regeneration.
6. Summary table of $E_{biomassLoss,ANR}(t)$, $E_{fire,ANR}(t)$, $E_{fertilization,ANR}(t)$ for every year t of the crediting period.
7. Summary of $E_{sources,ANR}(t)$, the sum of the GHG emissions sources related to assisted natural regeneration for every year t of the crediting period in the appropriate column of Table 18.

II.3 *Ex-ante* Estimation of GHG Emissions and Changes in Sinks under the Project Scenario outside the Project Area (Leakage)

II.3.1 Leakage Definitions and Inclusion in this Methodology.

Leakage has been cited as being a major obstacle for the development of avoided deforestation projects (e.g., Schlamadinger et al., 2005; Miles and Kapos, 2008). However, the mere potential for leakage does not necessarily negate the environmental integrity of an avoided deforestation project. Only in cases where potential leakage cannot be identified and quantified does leakage pose an insurmountable barrier. Project activities must incorporate measures to minimize leakage (see section II.2.1). The leakage emissions that cannot be avoided must be subtracted from the emission reductions. Under this methodology, leakage is estimated *ex-ante*, but actual NERs are based on actual leakage calculated with project monitoring data.

Leakage is the increase in GHG emissions outside of the project area directly attributable to the REDD project activities implemented inside of the project area. Leakage does not only occur on forest land outside of the project area, but also on non-forest land, such as woodlands or grassland. Depending on whether the increases in GHG emissions are directly attributable to the original deforestation agents, a distinction is made between primary leakage (directly attributable to the deforestation agents) and secondary leakage (not directly attributable to the deforestation agents) (Aukland et al., 2003).

Primary leakage occurs when the planned REDD project activities cause deforestation agents to engage in activities that increase GHG emissions outside of the project area. Primary leakage can be divided into the following sub-types:

> **Activity shifting**. Deforestation is not avoided, but merely displaced in whole or in part to an area outside of the project area. All activities that lead to deforestation under the baseline scenario and that are prevented under the project scenario will potentially lead to activity shifting leakage. Example 1: the protection of forest land from grazing inside the project area leads to the conversion of forest land into grazing land outside the project area. Example 2: closing down a forest for the collection of fuel-wood can increase fuel-wood collection in the immediate vicinity of the project area.
>
> **Outsourcing**. This occurs when REDD project activities lead to the purchase or contracting out of the services or commodities that were previously produced inside of the project area by the deforestation agents. For example, a logging company that was previously extracting timber within the project area, purchases timber from other operators to maintain an ongoing supply of timber to operate it’s sawmill. This differs from market effects (see below), since outsourcing is undertaken by the original deforestation agents and not by third parties.

Secondary leakage occurs when REDD project activities create incentives for people other than the original deforestation agents to increase GHG emissions elsewhere. Secondary leakage can be sub-divided into the following sub-types:

> **Market effects.** This occurs when REDD project activities lead to shifts in supply or demand of the products and services affected by the project actions, which will increase GHG emissions. For example, the protection of previously logged forest land might decrease the local supply of timber, thereby causing a rise in timber prices and an increase in logging activities by third parties. Market effect leakage

typically occurs in areas which were previously under commercial timber harvesting or commercial production of other forest-related commodities. It is less likely to occur in projects where deforestation is primarily driven by subsistence activities since these activities do not affect markets for the products involved. For reasons of consistency, any displacement of logging by a timber producing commercial entity is considered market leakage, even if it is the same commercial entity that has displaced their logging operations. The rationale behind this reasoning is that a commercial entity will always act as a response to changes in supply and demand and, therefore, displacement of commercial logging can be considered market effects rather than activity shifting.

Super-acceptance of alternative livelihood options occurs when the REDD project activities or livelihood options are not only adopted by the original deforestation agents, but also by other local actors. This may even cause an influx of people attracted into the general project area from regions outside of the original project boundaries. This may result in either positive or negative leakage:

Positive. If people other than the original deforestation agents switch from high-GHG-emitting activities to low-GHG-emitting livelihood options promoted by the project, there may be an overall reduction in GHG emissions.

Negative. People other than the original deforestation agents can adopt some of the REDD project activities that increase GHG emissions, such as using fertilizer to increase agricultural yields.

If the applicability criteria of this methodology are met, **activity shifting** is the main source of leakage. **Outsourcing** and **market-effect leakage** will be negligible because this methodology does not allow that timber from the project area is sold or transferred beyond the participating communities. Market-effect leakage must be accounted for within each PD. Note that the market-effect leakage section within the PD is subject to rigorous dual validation. GHG benefits from **positive super-acceptance** are not accounted for. Project proponents must track adoption rates and potential negative effects due to super-acceptance of alternative livelihoods in their monitoring plan.

The procedure to quantify leakage differs between drivers that are geographically constrained and geographically unconstrained drivers (see Table 13).

Table 13. Distinction between geographically constrained and geographically unconstrained drivers.

Geographically constrained driver categories	Geographically unconstrained driver categories
Fuel-wood collection or charcoal production	Logging of timber for commercial on-sale
Conversion of forest land to crop-land by local communities	Conversion of forest land to crop-land by migrants
Conversion of forest land to settlements	
Logging of timber for local and domestic use	
Forest fires[34]	

- *Ex-ante* activity-shifting leakage from the **geographically constrained drivers** uses a factor-approach based on rural appraisals and expert knowledge; *ex-post* leakage from these drivers is based on the remotely sensed deforestation/degradation rates in the leakage area.
- *Ex-ante* activity-shifting leakage from the **geographically unconstrained drivers** is based on a factor-approach based on rural appraisals and expert knowledge. *Ex-post* activity shifting leakage is based on a factor-approach using conservative assumptions.

II.3.2 Step 10 – Estimate Leakage from Geographically Constrained Drivers

Leakage from geographically constrained drivers is estimated *ex-ante* by calculating deforestation and forest degradation rates in the area adjacent to the project area subject to leakage, i.e. the leakage belts.

(1) First, calculate the leakage-induced increase in deforestation/degradation due to project activities.

(2) Subsequently, demarcate the location and the size of the leakage belts using a GIS analysis.

(3) Next, estimate forest strata-specific deforestation and forest degradation rates in the leakage belts. Calculate first the total deforestation and degradation rates in the leakage belts by adding the leakage-induced increases in deforestation/degradation to the baseline deforestation/ degradation rates in the leakage belts. Estimate then forest strata- specific deforestation and forest degradation rates using the land use model previously calibrated (section II.1.5) for every year of the crediting period.

[34] Not all forest fires are a source of leakage, only the forest fires caused by displaced agents such as hunters or beekeepers. The cause of the fire is not specified in the name of the leakage source, however, since, in practice, it is impossible to determine the source of fire. Any statistically significant increase in fire occurrence relative to a 10-yr baseline period must be considered as leakage.

II.3.2.1 Step 10A – Calculate the Leakage-Induced Increase in Deforestation and Forest Degradation Rates

$$\Delta D_{LK,DF}(t) = RelativeLeakageImpact_{DF}(t) \cdot D_{projectArea,baselineScenario,DF}(t) \quad [76]$$

$$\Delta D_{LK,DG}(t) = RelativeLeakageImpact_{DG}(t) \cdot D_{projectArea,baselineScenario,DG}(t) \quad [77]$$

where:

$\Delta D_{LK,DF}(t)$ and $\Delta D_{LK,DG}(t)$	=	Leakage-Induced Increase in deforestation and forest degradation rates for year t of the crediting period. [ha yr^{-1}]
$RelativeLeakageImpact_{DF}(t)$ and $RelativeLeakageImpact_{DG}(t)$	=	Total relative impact of leakage on the decrease in GHG emissions due to project activities for deforestation and forest degradation respectively for year t of the crediting period. [-]
$D_{projectArea,baselineScenario,DF}(t)$, and $D_{projectArea,baselineScenario,DG}(t)$	=	Baseline rate of deforestation/degradation within the project area for year t of the crediting period. [ha yr^{-1}]

The relative impact of leakage is quantified by *ex-ante* leakage cancellation factors, which express the driver-specific relative amount of leakage for the amount of deforestation or degradation that is avoided. This quantity describes the proportion of the (expected) gross emission reductions inside the project area that are lost again due to leakage outside of the project area. Only changes that are directly attributed to project activities shall be included in the cancellation rate. For example, if preventing illegal encroachment within the project area by patrolling saves 500 ha of forest per year, but directly leads to an increased deforestation outside of the project area of 300 ha, the cancellation rate of illegal encroachment prevention is 60%. Once the leakage cancellation rates $leakage(d)$ are fixed for every driver d, the $RelativeLeakageImpact$ can be calculated as following:

$$RelativeLeakageImpact_{DF}(t) = \sum_{d=1}^{nrCDrivers} leakage_{constrained}(d) \cdot RelativeDriverImpact_{DF}(t,d) \quad [78]$$

$$RelativeLeakageImpact_{DG}(t) = \sum_{d=1}^{nrCDrivers} leakage_{constrained}(d) \cdot RelativeDriverImpact_{DG}(t,d) \quad [79]$$

where:

$RelativeLeakageImpact_{DF}(t)$ and $RelativeLeakageImpact_{DG}(t)$	=	Total relative impact of leakage on the decrease in GHG emissions due to project activities for deforestation and forest degradation respectively. [-]
$nrCDrivers$	=	Number of geographically constrained drivers. [-]

$leakage_{constrained}(d)$	=	Leakage cancellation rate for avoiding deforestation/degradation of geographically constrained driver d. [-]
$RelativeDriverImpact_{DF}(t,d)$ and $RelativeDriverImpact_{DG}(t,d)$	=	Relative impact of a driver d on deforestation and forest degradation, respectively for year t of the crediting period. [-]

Every driver is assigned a leakage cancellation rate based expert knowledge, social assessments and past project experience.

- **Fuel-wood collection or charcoal production**. Estimate the leakage cancellation rate as:

$$leakage_{constrained}(fuel\text{-}wood) = \frac{FW_{project} - FW_{allowed}}{FW_{baseline} - FW_{allowed}} \quad [80]$$

where:

$leakage_{constrained}(fuel\text{-}wood)$	=	Leakage cancellation rate for avoiding deforestation/degradation of fuel-wood collection. [-]
$FW_{baseline}$	=	Biomass (dry matter) of fuel-wood collected by project participants under the baseline scenario. [m^3 yr^{-1}]
$FW_{project}$	=	Biomass (dry matter) of fuel-wood collected by project participants under the project scenario. [m^3 yr^{-1}]
$FW_{allowed}$	=	Biomass (dry matter) of allowed fuel-wood collection in the project area under the project scenario. This amount is typically fixed in a management plan. [m^3 yr^{-1}]

A number of project activities may be implemented to decrease the need for the resource either directly (e.g., the introduction of fuel-efficient woodstoves) or indirectly by providing alternative sources for the resource (e.g., propane stoves instead of woodstoves) must be used. Estimate $B_{projectScenario}$ as:

$$FW_{project} = \sum_{i=1}^{nrfuelWoodReductionActions} adoption(i) \cdot \left(1 - efficiency(i)\right) \cdot FW_{baseline} \quad [81]$$

where:

$nrfuelWoodReductionActions$	=	The number of project activities that reduce the need for fuel-wood. E.g., introduction of fuel-efficient wood-stoves, mosquito nets for livestock, biogas plants. [-]

$adoption(i)$ = Adoption rate of project activity i which reduces fuel-wood consumption. [-]

$efficiency(i)$ = Rate at which project activity i reduces fuel-wood consumption. [-]

$FW_{baseline}$ = Biomass (dry matter) of fuel-wood collected in the project area in the baseline scenario. [Mg DM yr^{-1}]

- **Conversion of forest land to settlements by local communities**

$$leakage_{constrained}(settlement\ conversion) = \frac{\Delta area_{settlement,project} - \Delta area_{settlement,allowed}}{\Delta area_{settlement,baseline} - \Delta area_{settlement,allowed}} \quad [82]$$

where:

$leakage_{constrained}(settlement\ conversion)$ = Leakage cancellation rate for avoiding deforestation/degradation due to conversion of forest land to settlements. [-]

$\Delta area_{settlement,baseline}$ = Area that would be converted to settlements by participating communities under the baseline scenario. [ha yr^{-1}]

$\Delta area_{settlement,project}$ = Area that will be converted to settlements by participating communities under the project scenario. [ha yr^{-1}]

$\Delta area_{settlement,allowed}$ = Area that will be converted to settlements after within the project area under the project scenario. This amount is fixed in a management plan. [ha yr^{-1}]

If the data are missing to calculate $leakage(settlement\ conversion)$, use a conservative rate of 0.9. This is allowed because no *ex-post* NERs are dependent on this rate estimated.

- Conversion of forest land to crop-land by participating communities

$$leakage_{constrained}(cropland\ conversion\ by\ participating\ communities) = \frac{\Delta area_{cropLand,project} - \Delta area_{cropLand,allowed}}{\Delta area_{cropLand,baseline} - \Delta area_{cropLand,allowed}} \quad [83]$$

where:

$leakage(cropland\ conversion)$	=	Leakage cancellation rate for avoiding deforestation/degradation due to conversion of forest land to settlements. [-]
$\Delta area_{cropLand,baseline}$	=	Area that would be converted to cropland by participating communities under the baseline scenario. [ha yr^{-1}]
$\Delta area_{cropLand,project}$	=	Area that will be converted to cropland by participating communities under the project scenario. [ha yr^{-1}]
$\Delta area_{cropLand,allowed}$	=	Area that will be converted to cropland after within the project area under the project scenario. This amount is fixed in a management plan. [ha yr^{-1}]

If the data are missing to calculate $leakage(cropland\ conversion)$, use a conservative rate of 100%. This is allowed because no *ex-post* NERs are dependent on this rate estimated.

- **Logging of timber for local and domestic use.** The timber needed for local and domestic use is non-elastic. Therefore, assume a leakage cancellation rate of 100 %

$$leakage_{constrained}(domestic\ timber) = 100\% \quad [84]$$

- **Forest fires induced by local communities.** Most forest fires that are avoided through fire prevention activities and education will not lead to increased occurrence of forest fires outside of the project area. Select a conservative leakage cancellation rate between 0-100% as fires induced by hunters or beekeepers may be partially or fully displaced by patrolling the project areas. Substantiate the selected rate based on rational arguments, field observations and scientific literature.

$$leakage_{constrained}(forest\ fires\ by\ participating\ communities) = 0 - 100\% \quad [85]$$

Combine all cancellation rates for avoided deforestation or avoided forest degradation in two separate tables such as Table 14.

Table 14. Example of a summary of deforestation rates in reference region, project area, and the leakage area according to the driver of deforestation, as identified in section II.1.3.1.

	Project Area				Leakage Area	
	Baseline Scenario		Project Scenario		Project Scenario	
Driver	Relative Contribution (%)	Deforested Area (ha)	Relative Change (%)	Deforested Area (ha)	Cancellation Rate (%)	Deforested Area (ha)
Agricultural expansion	50	651	25	163	10	49
Settlement expansion	10	130	50	65	50	33
Fire wood collection	10	130	25	33	75	73
Timber harvesting	20	260	10	26	100	234
Forest fires	10	130	10	13	90	105
TOTAL	100	1302		299	49	494

Note: Relative Contribution = the contribution of a driver of deforestation to the total deforestation under the baseline scenario. Relative Change = the relative degree to which the total of project actions reduces the deforestation caused by a driver of deforestation. Cancellation Rate = relative proportion of the GHG benefits from reducing deforestation within the project area lost through leakage outside of the project area.

II.3.2.2 Step 10B – Demarcate the Leakage Belts

Leakage from drivers that are geographically constrained will remain close to the project areas. Leakage from these drivers is monitored in an *ex-ante* fixed geographical region around each discrete project area parcel (a leakage belt). The leakage belts are identical for all geographically constrained drivers (see section II.3 and Table 13). A correct *ex-ante* demarcation of each leakage belt is crucial to accurately account for the GHG benefits of the REDD project since the leakage belt is the area where leakage from geographically constrained drivers will be monitored and deducted from the actual NERs. The size and location[35] of the leakage belts is determined using a cost-of-transportation-based GIS approach and social assessments. Use the following steps:

1) Determine the average "cost" to move across an LULC class, forest stratum, or road/track. The relative costs must be calculated by reciprocating the maximal speed for every class or road category and relevant mode of transportation, and therefore represent the fastest time it takes to cross a set distance. The speeds were analyzed in section II.1.3.3.
2) Using a GIS, generate a raster map of the reference region in which every pixel contains the cost to cross this pixel, based on the class or roads/tracks on this pixel. The cost to cross areas that are not accessible to deforestation agents must be set to an arbitrary large value. Examples of inaccessible areas include protected areas, national parks, economic land concessions, and large plantations. These must have been excluded already from the reference region.

[35] Note that the leakage belt encompasses both forest land and non-forest land.

3) This map must have an identical resolution as the remote sensing images of the historical reference period.
4) Using the cost map, generate a cost-distance map of the reference region in which every pixel contains the cost (time) to reach the nearest point of the project area.
5) For every agent of deforestation/degradation, estimate the extra time this agent is willing to take to move their deforestation activities from the project area to the nearest accessible forest. Determine this value using PRAs by asking what the extra time is that a single household would have to spend if the project area is not accessible anymore.
6) Select the area in the cost-distance map that is accessible from the boundary of the project area within the maximal time determined in the previous step. This area must contain both forest and non-forest land. Therefore, when different agents and drivers of deforestation are active, the **most mobile deforestation agent** shall determine the size of a leakage belt. Note that the leakage area should be fully encompassed within the reference region. Increase the size of the reference region, if necessary, to accommodate the defined leakage belts.

II.3.2.3 Step 10C – Calculate the Forest Strata-specific Deforestation and Degradation Rates in the Leakage Belts

- Once the leakage area is demarcated, the total deforestation/ degradation rates in the leakage belts are calculated using:

$$D_{leakageArea,baselineScenario,DF}(t) = D_{projectArea,baselineScenario,DF}(t)\frac{size_{leakageArea}}{size_{projectArea}} \quad [86]$$

$$D_{leakageArea,baselineScenario,DG}(t) = D_{projectArea,baselineScenario,DG}(t)\frac{size_{leakageArea}}{size_{projectArea}} \quad [87]$$

$$D_{leakageArea,projectScenario,DF}(t) = \Delta D_{LK,DF}(t) + D_{leakageArea,baselineScenario,DF}(t) \quad [88]$$

$$D_{leakageArea,projectScenario,DG}(t) = \Delta D_{LK,DG}(t) + D_{leakageArea,baselineScenario,DG}(t) \quad [89]$$

where:

$D_{leakageArea,baselineScenario,DF}(t)$ and $D_{leakageArea,baselineScenario,DG}(t)$	=	Baseline rate of deforestation/degradation within the leakage area for year t of the crediting period. [ha yr^{-1}]
$D_{projectArea,baselineScenario,DF}(t)$ and $D_{projectArea,baselineScenario,DG}(t)$	=	Baseline rate of deforestation/degradation within the project area for year t of the crediting period. [ha yr^{-1}]
$size_{leakageArea}$	=	Size of the leakage area. [ha]
$size_{projectArea}$	=	Size of the project area. [ha]

$D_{leakageArea,projectScenario,DF}(t)$ and $D_{leakageArea,projectScenario,DG}(t)$	=	Rate of deforestation/degradation within the leakage area under the project scenario for year t of the crediting period. [ha yr^{-1}]
$\Delta D_{LK,DF}(t)$ and $\Delta D_{LK,DG}(t)$	=	Leakage-Induced increase in deforestation and forest degradation rates for year t of the crediting period. [ha yr^{-1}]

- The total deforestation and forest degradation rates in the leakage area are calculated by adding the leakage-induced increase in deforestation/degradation rates to the baseline deforestation/ degradation rates. The baseline deforestation and forest degradation rates are calculated by taking the size-wise proportion of the deforestation/degradation rates in the project area under the baseline scenario. Add the total deforestation and forest degradation rates in the leakage area in two separate tables such as Table 15.
- Subsequently, estimate the forest strata- specific deforestation and forest degradation rates for every year of the crediting period using the land use model previously calibrated (section II.1.5).

II.3.2.4 Step 10D – Test Whether CH4 Emissions from Small-Scale Fires Must be Monitored

Losses of carbon in biomass due to small-scale fires other than from controlled burning in either the project area or leakage belts are accounted for through the stock change approach. However, emissions of CH_4 from small-scale fires other than from controlled burning in either the project area or leakage belts must still be accounted for during monitoring[36]. If the area is not prone to fire, emissions will be insignificant and emissions from small-scale forest fires do not have to be included in the monitoring plan. Therefore, the methodology allows to test at validation whether emissions from fire were significant in the past 5 years in the project area and leakage belts and therefore must be included in the monitoring plan. The project document must contain an analysis of whether small-scale fires have occurred in each forest stratum of every discrete project parcel and leakage belt in the five years before project start by either (1) conducting PRAs or (2) using a spatially explicit fire occurrence product based on a remote-sensing thermal sensor. If the remote-sensing data is used, the remote-sensing thermal sensor must acquire the number of fires at least once every two weeks, have a minimal resolution of 1 km[37], and must have at least 5 years of uninterrupted historical data. If the PRAs or the remote-sensing based fire occurrence product indicate that historical emissions from small-scale forest fires averaged over the five years preceding project start are insignificant on certain project parcels or forest strata, the calculation of emissions from fire during the monitoring period may be omitted until the next baseline update, at which the significance test must be repeated. However, if PRAs or the satellite-based analysis indicate that the area is fire prone and emissions are not insignificant for certain project parcels or forest strata,

[36] Methane emissions from large-scale fires occurring in the project area or leakage belts during the crediting period must always be accounted for, see monitoring section III.2.3.2

[37] An example of such a product is the University of Maryland's FIRMS product, based on the thermal sensors on board of the MODIS satellite.

emissions from fire must be included in the monitoring plan. A calculation method for emissions from forest fires due to leakage is included in section III.2.3.

II.3.3 Step 11 – Estimate Leakage from Geographically Unconstrained Drivers

Activity-shifting leakage from geographically unconstrained drivers is quantified using a factor approach in both the *ex-ante* and *ex-post* cases. All leakage from reducing commercial timber operations is considered through the VCS market leakage approach and is accounted for through the buffer withholding mechanics from the VCS, subject to dual validation. The only other geographically unconstrained driver is cropland clearing from migrants moving beyond the leakage belts. Conversion of forest land to crop-land by migrants or other people outside of the participating communities must be minimized with leakage prevention activities[38] such as the creation of alternative livelihoods and the intensification of land-use. A default leakage cancellation factor of 100% must be used to discount leakage from migrants clearing forests for crop land, unless a smaller cancellation factor can be substantiated (see further). The emissions from leakage are calculated by first quantifying the area of the leakage by multiplying the area of deforestation and degradation that is avoided with a leakage factor. Next, this area of leakage is multiplied with a maximal emission factor (EF_{max}) to calculate emissions from leakage by unconstrained drivers. This approach is fully conservative: in contrast to the deforestation by geographically constrained agents, it is not possible to predict in which forests the deforestation through leakage from unconstrained drivers will take place. To remain conservative, it is assumed that the leakage from unconstrained drivers happens in a forest with the highest average biomass stock density of the country. The following equation is to be used:

$$GHG_{otherLeakageSources}(t) = \\ +\frac{44}{12} \cdot EF_{max} \cdot D_{projectArea,baselinScenario,DF} \cdot leakage_{unconstrained}(cropland\ conversion) \cdot RelativeDriverImpact_{DF}(t, cropland\ conversion) \\ +\frac{44}{12} \cdot EF_{max} \cdot D_{projectArea,baselinScenario,DG} \cdot leakage_{unconstrained}(cropland\ conversion) \cdot RelativeDriverImpact_{DG}(t, cropland\ conversion)$$

[90]

where:

$GHG_{otherLeakageSources}(t)$	=	GHG emissions from leakage due to unconstrained geographic drivers for year t of the crediting period. [tCO_2-eq]

[38] A list of the allowed leakage prevention activities and the associated applicability criteria can be found in Step 12, section II.3.4.

EF_{max}	=	Maximal emission factor related to leakage. If comprehensive national-level statistics on biomass densities are available, EF_{max} must be calculated based on the maximal biomass of the country. Sources of the national-level statistics that are allowed are (1) academic research papers and (2) studies and reports published by the forestry administration or other organizations, including the FAO's Forest Resource Assessment reports, (3) the upper range of biomass in the GPG-LULUCF (2003) Table 3A.1.2. [tCO_2-eq]
$D_{projectArea,baselinScenario,DF}$ and $D_{projectArea,baselinScenario,DG}$	=	Baseline rate of deforestation and forest degradation respectively within the project area for year t of the crediting period, as calculated in section II.2.1, equations (63) and (64). [ha yr^{-1}]
$leakage_{unconstrained}(cropland\ conversion)$	=	Leakage cancellation rate for avoiding deforestation/degradation from migrants clearing forest area for cropland conversion, i.e. area of cropland conversion displaced beyond the leakage belts relative to the area of cropland conversion avoided within the project area. Assume a default rate of 100%, unless a smaller leakage rate can be substantiated by the project participants in the Project Document, the burden of proof lays with the project developer[39]. Valid sources to substantiate a smaller leakage rate include social assessments, scientific literature, and reports from civil society or governments. Sources have to be reliable and based on scientific methods and a good statistical design.
$RelativeDriverImpact_{DF}(t, cropland\ conversion)$ and $RelativeDriverImpact_{DF}(t, cropland\ conversion)$	=	Relative impact of the "clearing cropland by migrants" driver on deforestation and forest degradation, respectively for year t of the crediting period, as calculated in section II.2.1. [-]

Calculate values for $GHG_{otherLeakageSources}(t)$ for every year of the project crediting period and report in the overview table.

[39] For example, REDD Project participants can demonstrate that national measures to reduce leakage are effective. Evidence from other areas could be used to substantiate a smaller leakage rate after it is demonstrated that the circumstances are similar.

II.3.4 Step 12 – Estimate Applicability of and Emission sources from Leakage Prevention Activities

Leakage can be minimized by implementing a number of leakage prevention activities. Under this methodology, a number of potential leakage prevention activities are allowed (see further for a detailed specification). Note that the implementation of potential leakage prevention activities is optional. However, if leakage prevention activities are implemented, they must follow the specification and applicability criteria detailed in this section. In addition, as part of the validation, the auditor shall analyze that no other significant emissions exist originating from any measure associated with the project and intended to prevent leakage.

Any significant increase in GHG emissions due to the implementation of leakage prevention activities ($E_{sources,leakagePrevention}(t)$) must be subtracted from the project's overall GHG emissions according to the procedures included within this section. The following sources of GHG emissions are included in this methodology:

$$GHG_{sources,leakagePrevention}(t) = \Delta E_{fertilization}(t) + \Delta E_{flooded\ rice}(t) + \Delta E_{livestock}(t) \qquad [91]$$

where:

$GHG_{sources,leakagePrevention}(t)$	=	Emission sources from leakage prevention activities for year t of the crediting period. [tCO_2-eq]
$\Delta E_{fertilization}(t)$	=	Annual difference in GHG emissions due to increased use of N fertilizer as an agricultural intensification measure for year t of the crediting period. [tCO_2-eq]
$\Delta E_{flooded\ rice}(t)$	=	Annual difference in GHG emissions due to increased use of flooded rice production systems as agricultural intensification measures for year t of the crediting period. [tCO_2-eq]
$\Delta E_{livestock}(t)$	=	Annual difference in GHG emissions by enteric fermentation and manure management from increased animal stocking rates as an agricultural intensification measure for year t of the crediting period. [tCO_2-eq]

The significance of these and other emissions is tested according to the methodology provided in EB31 appendix 16 to determine whether it must be included (see section II.4.1). If an emission source is found insignificant, it shall be omitted.

II.3.4.1 Step 12A – Check Conditions and Quantify Emissions from Intensification of Annual Cropping Systems

Scope and Applicability

Intensification of annual crop production systems as a leakage prevention activity is optional, but shall only be introduced if all of the following conditions are demonstrated:

- The agricultural intensification measures are implemented only on land that is located within the leakage belt.
- The agricultural intensification measures are implemented only on land on which annual crop production systems are implemented.
- The agricultural intensification measures are implemented on land that is already under annual crop production systems at the time of validation.
- The agricultural intensification measures shall not be implemented on organic soils.
- In case irrigation is introduced for cropping systems other than rice, the irrigation systems may not significantly increase GHG emissions compared to non-irrigated conditions.

Intensification of annual crop production systems shall only be done by implementing one or more of the following measures:

- increasing synthetic or organic N inputs
- the use of fallow crops or shrubs
- replacing subsistence crops by cash crops
- replacing low-yielding crop varieties by higher-yielding, or less pest-sensitive crop varieties
- introduction of irrigation systems, except for flooded rice production systems

Emissions

Note that in case increased nitrogen fertilization is used as a way to intensify agriculture, increased emissions from N_2O respectively, must be accounted for using the CDM tool "Estimation of direct nitrous oxide emission from nitrogen fertilization"[40] to quantify emissions. The variable $N_2O_{direct-N,t}$ within this tool is equivalent to $\Delta E_{fertilization}(t)$ within this methodology. Add annual values of $\Delta E_{fertilization}(t)$ to the summary table of all GHG emissions due to project activities (Table 18).

All variables that are required to be reported ex-ante by the CDM tool must be included within the PD. All variables that are required to be monitored by the CDM tool must be included within the monitoring plan. For the purpose of this methodology, the following variables are specified in more depth than the specification provided within the CDM tool.

[40] http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-07-v1.pdf

$M_{\mathrm{SF}i,t}$ = Mass of synthetic fertilizer type i applied in year t. Value is the difference between the synthetic fertilizer applied during the project in year t and the synthetic fertilizer applied during the baseline. The mass of synthetic fertilizer used must be quantified for every cropping system that is part of the agricultural intensification of the REDD project both on fields that represent the baseline fertilization rate and fields that are part of the agricultural intensification. The mass of synthetic fertilizer used per cropping system and per project parcel under project activities must be monitored using social assessments before every verification.

$M_{\mathrm{OF}j,t}$ = Mass of organic fertilizer type j applied in year t. Value is the difference between the organic fertilizer applied during the project in year t and the organic fertilizer applied during the baseline. The mass of organic fertilizer used must be quantified for every cropping system that is part of the agricultural intensification of the REDD project both on fields that represent the baseline fertilization rate and fields that are part of the agricultural intensification. The mass of organic fertilizer used per cropping system must be monitored using social assessments before every verification.

II.3.4.2 Step 12B – Check Conditions and Quantify Emissions from Introduction of Flooded Rice Production

Scope and Applicability

The introduction of flooded rice production systems as a leakage prevention activity is optional, but shall only be introduced if all of the following conditions are demonstrated:

- Flooded rice production systems are implemented on land that is located within the leakage belt.
- Flooded rice production systems are implemented on land that is already under annual crop production systems at the time of validation.
- The flooded rice production systems will not be implemented on organic soils.
- The N2O emissions from flooded rice production systems are insignificant.

Emissions

A simple yet conservative estimate of the CH4 emissions from flooded rice fields is used to discount emission reductions. Emissions are calculated based on a maximal daily emission rate multiplied with the maximal length of the growing season determined by PRAs.

$$\Delta E_{flooded\ rice}(t) = GWP_{CH4} \cdot \Delta A_{rice}(t) \cdot t_{flooded,max} \cdot EF_{rice,max} \qquad [92]$$

where:

t = Time after project start. [yr]

$\Delta E_{flooded\ rice}(t)$ = Annual difference in GHG emissions due to increased use of flooded rice production systems as agricultural intensification measures for

		year t of the crediting period. [tCO_2-eq]
GWP_{CH4}	=	Global Warming Potentials for CH_4. Use IPCC default factor of 21. [-]
$\Delta A_{rice}(t)$	=	Annual increase in harvested area of rice due to leakage prevention measures. The area of rice cultivation must be quantified using social assessments [ha yr^{-1}].
$t_{flooded,max}$	=	Maximal period of time a field is flooded [days yr^{-1}]
$EF_{rice,max}$	=	Maximal emission rate for methane. By default, an emission rate of 36 kg CH4 ha^{-1} day^{-1} must be used, which is 25% greater than the maximal value found in a review study comparing 25 studies of CH4 fluxes in rice fields (Le Mer and Roger, 2001). Project proponents may use a smaller emission rate if it can be demonstrate that the rate remains conservative for the project conditions. [kg CH_4 ha^{-1} day^{-1}]

Add annual values of $\Delta E_{flooded\ rice}(t)$ to the summary table of all GHG emissions due to project activities (Table 18).

II.3.4.3 Step 12C – Estimate GHG Emissions from Increased Livestock Stocking Rates, $\Delta E_{livestock}$

Scope and Applicability

Increasing livestock stocking rates as a leakage prevention activity is optional, but shall only be introduced if all of the following conditions are demonstrated:

- Increase stocking only occurs within the leakage belts of the project area, see AR-AM0006 applicability criterion (i).
- If the proposed activity produces forage to feed livestock, all forage shall have a similar nutritional value and digestibility, and will support only a single livestock group with a single manure management system, see AR-AM0006 applicability criterion (k).
- If the stocking rate is increase for animals that are already in a zero-grazing system or are moved to a zero-grazing system then the grazing activity that is monitored is the production of fodder, see Displacement of Grazing CDM tool Point 5.
- Increased stocking rates shall only occur on Identified Forest land, Identified Cropland, Identified Grassland, and Unidentified land, see Displacement of Grazing CDM tool Point 6.
- Increased stocking rates shall not occur on Settlements, Wetlands, or Other lands – as defined by the GPG LULUCF (i.e. bare soil, rock, ice, and all unmanaged land areas that do not fall into category of forest land, cropland, grassland, settlements or wetlands), see Displacement of Grazing CDM tool Point 5.

Livestock stocking rates shall be increased through either or both of the following measures:

- Increasing the stocking density of livestock on existing grazing land.
- Moving of cattle to a zero-grazing system, defined as a system of feeding cattle or other livestock in which forage is brought to animals that are permanently housed instead of being allowed to graze.

Quantification and Monitoring of Emissions from Increased Stocking rates

Use the most recent version of approved CDM methodology AR-AM0006[41], section 8, "Leakage" to determine the $CH4$ and $N2O$ emissions from livestock, as well as the CDM AR tool "Estimation of GHG emissions related to displacement of grazing activities in A/R CDM project activity"[42]. The sum of variable $LK_{FFL,t}$ within AR-AM0006 and $LK_{Displacement,t}$ within the CDM tool is equivalent to $\Delta E_{livestock}(t)$ within this methodology. Add annual values of $\Delta E_{livestock}(t)$ to the summary table of all GHG emissions due to project activities (Table 18).

Use the variables list of default parameters and parameters to be monitored from AR-AM0006 and the CDM tool for displacement of grazing activities. Livestock population increases must be quantified using social assessments or peer-reviewed literature, and re-evaluated after every baseline update. Livestock population increases must be monitored using social assessments or peer-reviewed literature.

[41] This tool can be found at http://cdm.unfccc.int/UserManagement/FileStorage/T05CO1LWYIJ7EHD9GBVAKZPUSQ2N8X. This tools has been approved for A/R CDM projects, but is applicable to REDD projects. All references to "A/R CDM" within this tool should be interpreted as "REDD".

[42] This tool can be found at http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-09-v2.pdf. This tool has been approved for A/R CDM projects, but is applicable to REDD projects. All references to "A/R CDM" within this tool should be interpreted as "REDD".

PD Reporting requirements

1. Justification and assumptions made to obtain the leakage cancellation rates $leakage(d)$ for every geographically constrained deforestation driver d.
2. Summarizing table of the leakage cancellation rates $leakage(d)$ for each deforestation driver d.
3. Table with $RelativeLeakageImpact_{DF}(t)$ and $RelativeLeakageImpact_{DG}(t)$, the total relative impact of leakage on the decrease in GHG emissions due to project activities for deforestation and forest degradation respectively, together with $\Delta D_{LK,DF}(t)$ and $\Delta D_{LK,DG}(t)$, for every year t of the crediting period.
4. Decision criteria, data sources, field information, and maps used to demarcate the leakage belt.
5. A map of the leakage area with a clear indication which areas were excluded due to inaccessibility.
6. Table with $D_{projectArea,baselineScenario,DF}(t)$, $D_{projectArea,baselineScenario,DG}(t)$, $D_{leakageArea,projectScenario,DF}(t)$ and $D_{leakageArea,projectScenario,DG}(t)$ the absolute deforestation and forest degradation rates for the project and leakage areas under baseline and project scenarios for every year t of the crediting period.
7. Table with all land transitions for the leakage area under the baseline and project scenarios for every year of the next baseline validation period, use Table 17 in section II.4.1 as an example.
8. Justification and assumptions made to obtain the leakage cancellation rates $leakage(d)$ for every geographically unconstrained deforestation driver d.
9. Table with $GHG_{otherLeakageSources}(t)$ for every year t of the crediting period.
10. List of the assumptions, data sources, and other information relevant to the calculation of the emissions for sources $\Delta E_{rice}(t)$, $\Delta E_{fertilization}(t)$, and $\Delta E_{livestock}(t)$ from leakage prevention measures.
11. A report of $\Delta E_{rice}(t)$, $\Delta E_{fertilization}(t)$, and $\Delta E_{livestock}(t)$ in the relevant columns of Table 18 for every year t of the crediting period.

II.4 Step 13 – *Ex-ante* Estimation of NERs

II.4.1 Step 13A – Estimate carbon in long-lived wood products

This methodology considers the carbon in long-lived wood products (C_{LWP}) sequestered for over 100 year as permanently sequestered carbon. The net change in carbon in long-lived wood products is calculated by subtracting the carbon in long-lived wood products under the baseline scenario and the project scenario:

$$\Delta C_{LWP,t} = C_{LWP,project,t} - C_{LWP,baseline,t} \quad [93]$$

where:

$\Delta C_{LWP,t}$	=	Net carbon stock change in long-lived wood products during time t [Mg C]
$C_{LWP,baseline,t}$	=	Carbon stock in long-lived wood products under the baseline

		scenario during time t [Mg C]
$C_{LWP,Project,t}$	=	Carbon stock in long-lived wood products under the project scenario during time t [Mg C]

Equations [EQ 94] and [EQ 95] must be used to quantify the carbon stock in long-lived wood products under both the baseline scenario as well as the project scenario. The following steps must be used to quantify carbon in long-lived wood products.

Sub-step 1. Calculate carbon in harvested wood products.

The carbon in harvested wood products is calculating based on the volume of timber extracted within the project area in both the baseline scenario and the project scenario.

$$C_{HWP,project,ty} = \sum_{h=1}^{H_{PS}} \sum_{j=1}^{S_{PS}} \left(V_{ex,project,h,ty,j} \cdot \rho_j \cdot CF_j \right) \quad [94]$$

$$C_{HWP,baseline,ty} = \sum_{h=1}^{H_{PS}} \sum_{j=1}^{S_{PS}} \left(V_{ex,baseline,h,ty,j} \cdot \rho_j \cdot CF_j \right)$$

where:

$C_{HWP,project,ty}$ and $C_{HWP,baseline,ty}$	=	Total carbon stock in long-lived wood products within the project boundary for class ty of wood product in the project and baseline scenario, respectively [Mg C]
$V_{ex,project,h,ty,j}$ and $V_{ex,baseline,h,ty,j}$	=	The volume of timber extracted from within the project boundary during harvest h by species j and wood product class ty in the project and baseline scenario, respectively [m^3].
ρ_j	=	Wood density of species j [Mg m^{-3}]
h	=	1, 2, 3, …, H_{PS} number of harvests [-]
j	=	1, 2, 3, …, S_{PS} harvested tree species [-]
ty	=	Wood product class – defined here as sawn wood (sw), wood-based panels (wp), other industrial roundwood (oir), and paper and paper board (ppb).
CF	=	Carbon fraction of wood [Mg C (Mg DM)$^{-1}$] (default value = 0.5)

- Under the baseline scenario $V_{ex,baseline,h,ty,j}$, must be calculated as the sum of $DT_{baseline}$ and $CT_{baseline}$ (see section II.1.3.2 and Table 9). The uncertainty around the estimates of $DT_{baseline}$ and $CT_{baseline}$ must be estimated and/or justified with appropriate methods, such as reported uncertainties from scientific literature, or calculated uncertainties when social assessments are used. In situations when uncertainty cannot be estimated, the most conservative estimate must be used.

- For the ex-ante project case, $V_{ex,project,h,ty,j}$ must be calculated using the procedures in section II.2.1.
- Ex-post, $V_{ex,project,h,ty,j}$ must be monitored and quantified using forest operation records (i.e., log books kept as part of forest management plan). The uncertainty around the monitored volume of timber must be explicitly reported.

In case the uncertainty, as quantified by the half-width of the confidence interval, is less than 15% of the volume of timber extracted, no adjustment for uncertainty must be applied. If, however, the uncertainty is greater than 15% of the volume of timber extracted, $C_{HWP,baseline,ty}$ must be adjusted upwards with its associated uncertainty and $C_{HWP,project,ty}$ must be adjusted downwards with its associated uncertainty.

Sub-step 2. Calculate the carbon in long-lived wood products.

Carbon in long-lived wood products is defined as being sequestered for at least 100 years. Instead of tracking annual emissions through retirement, burning and decomposition, the methodology calculates the proportion of wood products that have not been emitted to the atmosphere 100 years after harvest and assumes that this proportion is permanently sequestered. All factors are derived from Winjum et al. (1998).

$$C_{LWP,project,t} = \sum_{s,wp,ppb,oir}^{ty} C_{HWP,project,ty} \cdot (1 - wwf)(1 - slp)\,(1 - fo)$$
$$C_{LWP,baseline,t} = \sum_{s,wp,ppb,oir}^{ty} C_{HWP,baseline,ty} \cdot (1 - wwf)(1 - slp)\,(1 - fo) \quad [95]$$

where:

$C_{LWP,project,t}$ and $C_{LWP,baseline,t}$	=	Carbon stock of long-lived wood products at time t in the project and baseline scenario, respectively. [Mg C]
$C_{HWP,project,ty}$ and $C_{HWP,baseline,ty}$	=	Total biomass carbon harvested within the project boundary by wood class ty in the project and baseline scenario, respectively [Mg C]
wwf		Fraction of carbon in harvested wood products that are emitted immediately because of mill inefficiency. This can be estimated by multiplying the applicable fraction to the total amount of carbon in different harvested wood product category. The default applicable fraction is 24% and 19% respectively for developing and developed countries (Winjum et al. 1998).
slp	=	Proportion of short lived products. These fractions are 0.2, 0.1, 0.4 and 0.3 respectively for sawnwood, wood-based panel, paper and paper boards and other industrial round woods as described in Winjum et al. (1998). The methodology assumes that all other classes of wood products are emitted within 5 years.
fo	=	Fraction of carbon that will be emitted to the atmosphere between

5 and 100 years of harvest. See Table 15. [-]

t	=	*1, 2, 3…..* t years elapsed since the start of the project. [yr]
ty	=	Wood product class – defined here as sawnwood (sw), wood-based panels (wp), other industrial round wood (oir), and paper and paper board (ppb)

Table 15. Proportion of remaining wood products oxidized between 5 and 100 years after initial harvest by wood product class and forest region

Wood product category	Forest region		
	Boreal	Temperate	Tropical
Sawnwood	0.36	0.60	0.84
Wood base panel	0.60	0.84	0.97
Other industrial round wood	0.84	0.97	0.99
Paper and paperboard	0.36	0.60	0.99

Source: Winjum et al. 1998

II.4.2 Step 13B – Summarize the projected land use change

- Present a table with the total deforestation and degradation rates under the baseline and project scenarios for the project area and leakage area for every year of the project duration (see Table 16 for an example).
- Present tables with the LULC class and forest-strata specific land transitions for the project and leakage area under the baseline and project scenarios (see Table 17 for an example).
- Subtract the land transition changes under the baseline scenario from the changes under the project scenario in Table 17, and multiply with the difference of the appropriate emission factor and baseline net annual increment from Table 12 and apply all uncertainty discounting factors (see Equation 2). Perform these calculations separately for deforestation and forest degradation, report these values in columns [1] to [4] of the overview table.
- Calculate values for $GHG_{otherLeakageSources}(t)$ from the procedure in II.3.3 and report in column [5] of the overview table.
- Calculate the difference $\frac{44}{12} \cdot \left(\Delta C_{ANR}(t) - \Delta C_{ANR,BSL}(t)\right)$ the net GHG benefits from ANR without taking emission sources into account for every year t of the crediting period. Report this difference to column [6] of the overview table.

Table 16. Example of a summary of deforestation and forest degradation rates in the baseline and project scenarios of the project and leakage areas

	Deforestation				Forest Degradation			
	Baseline Scenario		Project Scenario		Baseline Scenario		Project Scenario	
Year	Project Area [ha]	Leakage Area [ha]	Project Area [ha]	Leakage Area [ha]	Project Area [ha]	Leakage Area [ha]	Project Area [ha]	Leakage Area [ha]
1	1302	13020	299	13500	1302	13020	299	13500
2	1315	13150	302	13650	1315	13150	302	13650
3	1328	13280	305	13700	1328	13280	305	13700
4	1341	13411	308	13750	1341	13411	308	13750
5	1354	13541	311	13890	1354	13541	311	13890
…								
29	1667	16666	383	13910	1667	16666	383	13910
30	1680	16796	386	13930	1680	16796	386	13930
SUM	44724	447237	10286	485234	44724	447237	10286	485234

Table 17. Example of a table summarizing the projected land use change in the project area under the baseline scenario (all values are ha yr^{-1})

Land transition rates in the project area under the baseline scenario [ha yr-1]																	
	Forest Degradation				Deforestation to Plantation						Deforestation to Degraded land						
year	DGE21	DGE32	DGM21	DGM32	DFE1P1	DFE2P1	DFE3P1	DFM1P1	DFM2P1	DFM3P1	DFE1D	DFE2D	DFE3D	DFM1D	DFM2D	DFM3D	…
1		75															
2	22		38														
3		33															
4					42												
…				8		24											
n					16												

II.4.3 Step 13C – Test the Significance of GHG Emissions

In this step, the significance of emission sources is determined. This test has to be carried out at validation for every year until the next baseline update. All insignificant emissions can be omitted from the *ex-ante* calculation of the NERs. This methodology follows the "Tool for testing significance of GHG emissions in A/R CDM project activities" from EB31 appendix 16.

The sum of increases in emissions that may be excluded must be less than 5% of the emission reductions. If it is determined that a specific GHG emission source will never reach this threshold and will never become significant, it may be omitted from the monitoring plan.

Follow this procedure for each year of the project duration:

1. Include a table with all emission sources for every year of the project duration (see Table 18). Prepare a spreadsheet and calculate the sum of the emissions for every year of the project. Include annual estimates of the GHG benefits from project activities without taking emissions into account, i.e. the sum of [1] through [9] in Equation (1) to the columns of the spreadsheet.

Table 18. Estimation of GHG emissions due to project activities (all values in tCO_2-eq)

Year	Boundary poles $E_{fencing}$	Emissions from Vehicles $E_{vehicle}$	Fire Breaks $E_{fireBreaks}$	Biomass loss from ANR $E_{biomassLoss,A}$	GHG emissions loss from ANR burning $E_{fire,ANR}$	GHG emissions from ANR fertilization $E_{fertilization,ANR}$	Increased emissions from rice ΔE_{rice}	Increased emissions from fertilizer $\Delta E_{fertilization}$	Increased emissions from livestock $\Delta E_{livestock}$
1									
2									
3									
4									
…									
n									

2. Calculate the relative contributions of the project GHG emissions by sources and emissions by leakage activities according to the following equation (IPCC 2003, Eq. 5.4.1):

$$relativeContribution(E_i) = \frac{E_i}{\sum_{i=1}^{nrEmissions} E_i} \quad [96]$$

where:

$relativeContribution(E_i)$	=	Relative contribution of each source of GHG emissions i to the sum of GHG emissions. [-]
E_i	=	GHG emissions by sources of project and possible decreases in carbon pools and leakage emissions i. [Mg DM ha^{-1}]
$nrEmissions$	=	Total number of sources of GHG emissions considered. [-]

3. Rank the project and the leakage emissions in descending order of their relative contributions $relativeContribution(E_i)$ and order them according to their ranks (i.e. the lowest emission get the highest rank and occupy the last position in the ordered sequence of emissions).
4. Start calculating the cumulative sum of the relative contributions $relativeContribution(E_i)$ (ordered according to the step 3) beginning with the lowest rank. Mark each individual GHG emission source as it is included in the summation. Cease the summation when the cumulative sum reaches the threshold of 95%.
5. The GHG emissions by sources, possible decreases in carbon pools and leakage emissions not marked in the step 4 are considered insignificant if their sum is lower than 5% of net anthropogenic removals by sinks. Otherwise, the procedure described in the step 4 shall be continued beyond the threshold of 95% until the above condition is met.

II.4.4 Step 13D – Estimate *Ex-ante* NERs

Use Equation (1) to estimate the *ex-ante* NERs; only use the significant GHG sources as determined in step 2. Prepare a table with all the individual terms of Equation (1). Calculate the *ex-ante* NERs for every year of the crediting period. After NERs are calculated, use Equation [EQ2] to calculate the VCUs.

Cumulative credits from ANR activities must account for less than 20% of the cumulative credits generated by the project. For every year of the crediting period, divide [6] by the total NERS in the overview table, and confirm that the result is less than 20%. Note that NERs are only validated until the next baseline update (i.e., 10 years after validation), but must be reported for the entire crediting period.

PD Reporting requirements
1. GHG benefits from avoided deforestation in the project and leakage area in the overview table. 2. GHG benefits from avoided forest degradation in the project and leakage area in the overview table. 3. Annual values for $GHG_{otherLeakageSources}(t)$ in the overview table. 4. The difference $\left(\frac{44}{12}\cdot \Delta C_{ANR}(t) - \Delta C_{ANR,BSL}(t)\right)$, the net GHG benefits from ANR without taking emission sources into account for every year t of the crediting period in the overview table. 5. Table with all emissions for every year of the project duration, their relative contribution, and the cut-off value used to determine which emissions were considered insignificant, see Table 18 for an example. 6. A list of all the significant emissions from project and ANR activities in the overview table. 7. Overview table of the total GHG.

II.5 Step 14 – Demonstrate the Additionality Requirements

Projects are subject to the additionality rules and tests by the VCS. Therefore, use the latest approved version of the "Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities" to demonstrate additionality.

PD Reporting requirements
1. Demonstration on how the project is additional using the additionality tools from the CDM.

II.6 Overview of Data and Parameters Required for *Ex-ante* Estimates

II.6.1 General Data and Parameters

Data/parameter [EA 1]:	$nrFNFtransitions$
Data unit:	Count
Used in equations:	[EQ1], [EQ72]
Description:	Number of forest/non-forest transitions among land classes or forest strata, meaning transitions in which either the "from" or the "to" class are non-forests
Sources of data:	Field measurement
Measurement procedures:	Select based on the analysis of drivers in the reference region.
Any comment:	To be updated at baseline update.

Data/parameter [EA 2]:	$\Delta area_{projectAreaWithoutANR,projectScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1]
Description:	Hectares undergoing transition i within the project area, excluding the ANR area, under the project scenario for year t
Sources of data:	Land-use change model
Measurement procedures:	Calculate using the land use change model as detailed in section II.2.2
Any comment:	To be updated during monitoring.

Data/parameter [EA 3]:	$\Delta area_{projectAreaWithoutANR,baselineScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1], [EQ71]
Description:	Hectares undergoing transition i within the project area, excluding the ANR area, under the baseline scenario for year t
Sources of data:	Land-use change model
Measurement procedures:	Calculate using the classification and stratification procedures based on remote sensing data from the historical reference period as detailed in section II.1.5.4
Any comment:	To be updated at baseline update.

Data/parameter [EA 4]:	$\Delta area_{projectAreaWithANR,baselineScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1]
Description:	Hectares undergoing transition i within the leakage area under the project scenario for year t.
Sources of data:	Land-use change modeling
Measurement procedures:	Follow the procedures described in section II.1.5.4
Any comment:	To be updated at baseline update

Data/parameter [EA 5]:	$\Delta area_{leakageArea,projectScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1]
Description:	Hectares undergoing transition i within the leakage area under the project scenario for year t
Sources of data:	Land-use change modeling
Measurement procedures:	Follow the procedures described in section II.1.2.4
Any comment:	In case credits from avoided degradation are included, this parameter will provide the data required to calculate the activity data to estimate the emissions from both deforestation and forest degradation. To be updated during monitoring.

Data/parameter [EA 6]:	$\Delta area_{leakageArea,baselineScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1]
Description:	Hectares undergoing transition i within the leakage area under the baseline scenario during year t
Sources of data:	Land-use change modeling
Measurement procedures:	Follow the procedures described in section II.1.5.4
Any comment:	To be updated at baseline update

Data/parameter [EA 7]:	$nrANRstrata$
Data unit:	Count
Used in equations:	[EQ1], [EQ72], [EQ74]
Description:	Number of strata within the project area on which ANR activities are proposed
Sources of data:	Field measurement
Measurement procedures:	The number of ANR strata is dependent on the ANR management plan designed by the project proponents
Any comment:	May be updated until first verification

Data/parameter [EA 8]:	$NAI(i)$
Data unit:	[Mg DM ha^{-1} yr^{-1}]
Used in equations:	[EQ1], [EQ72]
Description:	Net annual increment due to natural regeneration and succession for the "from" class of transition i
Sources of data (*):	1. Values measured by the project proponents in the project area 2. National or local growth curves and tables 3. Values from peer-reviewed literature 4. Values from GPG-LULUCF Table 3A.1.5. These values are representative for regeneration in well-managed forests, and will therefore be conservative
Measurement procedures:	Further described in section II.1.4.2
Any comment:	Only to be included if ANR activities are planned. To be updated during monitoring.

*: lower-ranked options may only be used if higher-ranked options are not available

Data/parameter [EA 9]:	Locations of discrete project parcels
Data unit:	Digital boundaries
Used in equations:	
Description:	Locations of all individual discrete project parcels in electronic format
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	All necessary meta-data to correctly display the files must be included. Fixed after the first verification

Data/parameter [EA 10]:	Geographical location of reference region
Data unit:	Digital boundaries
Used in equations:	
Description:	Geographical locations of the reference region in electronic format
Sources of data:	GIS analysis

Measurement procedures:	Use the procedure in section II.1.1.3
Any comment:	All necessary meta-data to correctly display the files must be included. Fixed for the entire crediting period.

Data/parameter [EA 11]:	Description of LULC classes and forest strata
Data unit:	Narrative
Used in equations:	
Description:	Detailed description of the LULC classes and forest strata used for classification, including criteria and thresholds used, pictures, seasonality, and any other aspect determining the carbon stock differences
Sources of data:	Field survey, literature
Measurement procedures:	Use the procedure in section II.1.2.2 and II.1.1.3
Any comment:	To be updated at baseline update

Data/parameter [EA 12]:	Description of drivers of deforestation
Data unit:	Narrative
Used in equations:	
Description:	Detailed description of the drivers of deforestation, including the agents of deforestation, main socio-economic features, underlying motivation, population size and future development of population size, and driving variables
Sources of data:	Field survey, literature
Measurement procedures:	Use the procedure in section II.1.3
Any comment:	To be updated before every verification

Data/parameter [EA 13]:	Historical LULC and forest strata transition matrix
Data unit:	[ha yr^{-1}]
Used in equations:	
Description:	Matrix of historical land transition rates between LULC classes and forest strata
Sources of data:	Remote sensing analysis
Measurement procedures:	Use the procedure in section II.1.2.4
Any comment:	An uncertainty analysis must be carried out and a confusion matrix must be presented in the PD according to the procedures in the methodology. To be updated annually for the project area and leakage belts, and before every verification for the reference region.

Data/parameter [EA 14]:	$FW_{baseline}$
Data unit:	[m^3 yr^{-1}]
Used in equations:	[EQ3],[EQ81]
Description:	Annual volume of fuelwood gathered in the baseline scenario
Sources of data (*):	1. Participatory rural appraisals conducted by project proponents. 2. Recent (<10 yr) peer-reviewed scientific literature in the reference region, or 3. Recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region.
Measurement procedures:	
Any comment:	If emission reductions from avoided degradation were excluded due to insufficient accuracy, in which case $u_{classification} = 0$, and emission reductions from fuel-efficient woodstoves are included,

	$FW_{baseline}$ may only be measured using the first option, social assessments. To be updated during baseline update

Data/parameter [EA 15]:	ρ_{wood}
Data unit:	[Mg DM m^{-3}]
Used in equations:	[EQ7], [EQ8], [EQ94]
Description:	Basic wood density.
Sources of data:	GPG-LULUCF Table 3A.1.9.
Measurement procedures:	
Any comment:	May be updated before a baseline update

Data/parameter [EA 16]:	BEF_2
Data unit:	[-]
Used in equations:	[EQ7], [EQ8]
Description:	Biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass (including bark).
Sources of data:	Literature
Measurement procedures:	
Any comment:	May be updated before a baseline update

Data/parameter [EA 17]:	CF
Data unit:	[Mg C (Mg DM)$^{-1}$]
Used in equations:	[EQ3], [EQ4], [EQ5], [EQ6], [EQ7], [EQ8][EQ29], [EQ34], [EQ94]
Description:	Carbon fraction of dry matter in wood
Sources of data:	Default value of 0.5
Measurement procedures:	
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 18]:	$area_{baseline,fire}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ4]
Description:	Forest area in the project area affected by disturbances from forest fires in forest stratum i
Sources of data (*):	1. Participatory rural appraisals conducted by project proponents 2. Recent (<10 yr) peer-reviewed scientific literature in the reference region 3. Recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region 4. Expert opinion.
Measurement procedures:	
Any comment:	To be updated at baseline update

Data/parameter [EA 19]:	E
Data unit:	
Used in equations:	[EQ4]
Description:	Average combustion efficiency of the above-ground tree biomass
Sources of data (*):	1. Project-specific measurements 2. Regionally valid estimates

	3. Estimates from Table 3.A.14 of IPCC GPG LULUCF 4. If no appropriate combustion efficiency can be used, use the IPCC default of 0.5
Measurement procedures:	
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 20]:	P
Data unit:	
Used in equations:	[EQ4]
Description:	Average proportion of mass burnt from the above-ground tree biomass.
Sources of data:	GPG-LULUCF Table 3A.1.13
Measurement procedures:	
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 21]:	$\Delta B_{forestFires}$
Data unit:	[Mg DM ha^{-1}]
Used in equations:	
Description:	Biomass consumption for forest fires
Sources of data:	GPG-LULUCF Table 3A.1.13
Measurement procedures:	
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 22]:	$\Delta area_{baseline,cropland}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ5]
Description:	Forest area converted from forest stratum i to cropland in the project area under baseline conditions at the start of the project
Sources of data (*):	1. Remote sensing analyses in the reference region, see section II.1.2.5 2. Participatory rural appraisals conducted by project proponents; 3. Recent (<10 yr) peer-reviewed scientific literature in the reference region, or 4. Recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region
Measurement procedures:	
Any comment:	To be updated at baseline update

Data/parameter [EA 23]:	$\Delta area_{baseline,settlement}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ6]
Description:	Average forest area converted from forest stratum i to settlements in the reference region under baseline conditions
Sources of data (*):	1. Remote sensing analyses in the reference region, see section II.1.2.5 2. Participatory rural appraisals conducted by project proponents; 3. Recent (<10 yr) peer-reviewed scientific literature in the reference region, or 4. Recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region
Measurement procedures:	
Any comment:	To be updated at baseline update

Data/parameter [EA 24]:	$CT_{baseline}$
Data unit:	[m^3 yr^{-1}]
Used in equations:	[EQ7]
Description:	Annually extracted volume of harvested timber roundwood for commercial on-sale
Sources of data (*):	1. Participatory rural appraisals conducted by project proponents, 2. Recent (<10 yr) peer-reviewed scientific literature in the reference region, 3. Recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region, or 4. Recent (<10 yr) non peer-reviewed reports by local organizations
Measurement procedures:	
Any comment:	To be updated during monitoring.

Data/parameter [EA 25]:	$DT_{baseline}$
Data unit:	[m^3 yr^{-1}]
Used in equations:	[EQ8]
Description:	Annually extracted volume of timber for domestic and local use, roundwood
Sources of data (*):	1. Participatory rural appraisals conducted by project proponents, 2. Recent (<10 yr) peer-reviewed scientific literature in the reference region, 3. Recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region, or 4. Recent (<10 yr) non peer-reviewed reports by local organizations
Measurement procedures:	
Any comment:	To be updated during monitoring.

Data/parameter [EA 26]:	$nrDrivers$
Data unit:	Count
Used in equations:	[EQ9], [EQ10], [EQ93]
Description:	Number of drivers of deforestation or forest degradation
Sources of data:	Selection procedure in section II.1.3, "Analyze the Agents and Drivers of Deforestation"
Measurement procedures:	
Any comment:	To be updated during the baseline update

Data/parameter [EA 27]:	$size_{projectArea}$
Data unit:	[ha]
Used in equations:	[EQ21]
Description:	Total project area
Sources of data:	Field measurement
Measurement procedures:	
Any comment:	Fixed after the first verification

Data/parameter [EA 28]:	AP
Data unit:	[ha]
Used in equations:	[EQ21], [EQ32]
Description:	Sample plot size (constant for all strata)

Sources of data:	GPG-LULUCF 2003 , local biomass inventory protocols or Pearson et al. (2006)
Measurement procedures:	
Any comment:	To be updated during baseline update.

Data/parameter [EA 29]:	$area(i,t)$
Data unit:	[ha]
Used in equations:	
Description:	Total area of class or stratum $\boldsymbol{i}$ during time t
Sources of data:	Remote sensing analysis and stratification procedure
Measurement procedures:	
Any comment:	To be updated during monitoring.

Data/parameter [EA 30]:	Q_i
Data unit:	[Mg DM ha^{-1}]
Used in equations:	[EQ22]
Description:	Approximate average value of the aboveground tree biomass of class or stratum i
Sources of data:	Peer-reviewed literature
Measurement procedures:	See section II.1.4.2
Any comment:	To be updated during monitoring.

Data/parameter [EA 31]:	p
Data unit:	
Used in equations:	[EQ22]
Description:	Desired level of precision
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	Value must be smaller than 10% To be updated during monitoring.

Data/parameter [EA 32]:	α
Data unit:	
Used in equations:	[EQ23]
Description:	Minimal confidence level for the biomass stock density measured with a biomass inventory
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	Select a value of at least 95% To be updated during monitoring.

Data/parameter [EA 33]:	st_i
Data unit:	[Mg DM ha^{-1}]
Used in equations:	[EQ23]
Description:	Ex-ante expected standard deviation of the aboveground biomass of class or stratum i
Sources of data:	Peer-reviewed literature, reports, or preliminary measurements
Measurement procedures:	Use procedure in section II.1.4.2

Any comment:	To be updated during monitoring.

Data/parameter [EA 34]:	$cost_i$
Data unit:	[-]
Used in equations:	[EQ23]
Description:	Cost to sample stratum i
Sources of data:	Estimated from preliminary sampling in different forest strata
Measurement procedures:	
Any comment:	Set to 1 if costs are identical for all strata Fixed for the entire crediting period.

Data/parameter [EA 35]:	$nrTrees(i,p)$
Data unit:	Count
Used in equations:	[EQ30]
Description:	Number of trees in sample plot $\boldsymbol{p}$ of LULC class or forest stratum $\boldsymbol{i}$
Sources of data:	Field measurements
Measurement procedures:	Measure in sampling plots; count trees only if the tree is above a certain minimum DBH, see $DBH(t,i,p)$ parameter
Any comment:	To be updated during monitoring.

Data/parameter [EA 36]:	$f_{allometric}(y)$
Data unit:	Equation
Used in equations:	[EQ30]
Description:	Allometric relationship to convert DBH into biomass
Sources of data (*):	1. Allometric equations developed by project proponents 2. Allometric equations developed locally by groups other than project proponents 3. Allometric equations developed for forest types that are similar to the ones in the project as found in found in Appendix C of Pearson et al. (2005), or Tables 4.A.1. and 4.A.2. of the GPG LULUCF
Measurement procedures:	
Any comment:	To be updated during baseline update. The applicability of the selected allometric relationships must be verified using the following criteria: 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 at the 95% confidence level. Field verification A. Destructive Sampling • Selecting at least 5 trees covering the range of DBH existing in the project area, and felling and weighing the above-ground biomass to determine the total (green) weight of the stem an branch components • Extracting and immediately weighing subsamples from each of the green stems and branch component, followed by oven drying at 70°C to determine dry biomass.

	• Determine the total dry weight of each tree from the green 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 project area • 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 20 percentage of weight to approximately cover biomass of branches[43]. 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 towards the conservative side (i.e., equation underestimates of the project net anthropogenic removals by sinks), then mean values from the equation may be used.

Data/parameter [EA 37]:	$DBH(t,i,p)$
Data unit:	[cm]
Used in equations:	[EQ30]
Description:	DBH of tree t within plot p of LULC class or forest stratum i
Sources of data:	Field measurements
Measurement procedures:	Measure in sampling plots if the tree is above a certain minimum DBH. Typically measured 1.3 m above the ground. The minimum value varies on tree species and climate. In arid climates, the minimum DBH may be as small as 2.5 cm, whereas it could be up to 10 cm for humid climates
Any comment:	To be updated during monitoring The carbon stock density on non-forest land may be quantified using conservative defaults gathered from scientific literature.

Data/parameter [EA 38]:	$\theta(i,p)$
Data unit:	Degrees
Used in equations:	[EQ30], [EQ32]
Description:	Slope of the land of plot $\boldsymbol{p}$ of LULC class or forest stratum $\boldsymbol{i}$ (see section 8 in Pearson et al., 2005).
Sources of data:	Field measurement
Measurement procedures:	Measure in sampling plots
Any comment:	To be updated during monitoring.

Data/parameter [EA 39]:	$f_{belowground}(y)$
Data unit:	Equation
Used in equations:	[EQ31]
Description:	Relationship between aboveground and belowground biomass, such as a root-to-shoot ratio
Sources of data (*):	1. A relationship calculated from destructive sampling data obtained within the project area 2. A relationship obtained from the local/national studies that closely reflect the conditions of the project activity 3. Equations under section 8.2 of Pearson et al., 2005, or standard root-to-shoot ratios as found in Table 4.4 of the IPCC GPG-LULUCF

[43] Calculated conservatively from the biomass expansion factors used to calculate total 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.

	2003, and adapted by Brown et al., 2007
Measurement procedures:	
Any comment:	To be update at baseline update

Data/parameter [EA 40]:	$nrDecompClasses$
Data unit:	1=sound; 2=intermediate; 3=rotten
Used in equations:	[EQ32]
Description:	Number of decomposition classes
Sources of data:	Field observations
Measurement procedures:	Select the appropriate decomposition class. If no information is recorded, use a default value of 3
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 41]:	$D(d,i,p)$
Data unit:	[m]
Used in equations:	[EQ32]
Description:	Sum of diameters in biomass class d of sampling plot p of LULC class or forest stratum i
Sources of data:	Field measurements
Measurement procedures:	Measure in sampling plots
Any comment:	To be updated during monitoring.

Data/parameter [EA 42]:	L
Data unit:	[m]
Used in equations:	[EQ32]
Description:	Length of the transect
Sources of data:	Project design decision
Measurement procedures:	Standard operations procedure for field sampling for the line intersect method (Harmon and Sexton, 1996). The standard length of this is 50 m.
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 43]:	$\rho_{DW}(d)$
Data unit:	[kg.DM m^{-3}]
Used in equations:	[EQ32]
Description:	Basic density of dead wood in the density class d
Sources of data:	GPG LULUCG Tables 3A.1.9-1 and 3A.1.9-2
Measurement procedures:	
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 44]:	$D_{referenceRegion,baselineScenario,DF}(t)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ35]
Description:	Rate of deforestation within the reference region for year t.
Sources of data:	Linear interpolation of remote sensing data
Measurement procedures:	Follow procedures of section II.1.5.1
Any comment:	To be updated at baseline update

Data/parameter [EA 45]:	$D_{referenceRegion,baselineScenario,DG}(t)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ36]
Description:	Rate of forest degradation within the reference region for year t.
Sources of data:	Linear interpolation of remote sensing data
Measurement procedures:	Follow procedures of section II.1.5.1
Any comment:	To be updated at baseline update

Data/parameter [EA 46]:	GWP_{N2O}
Data unit:	
Used in equations:	
Description:	Global Warming Potentials for N_2O
Sources of data:	IPCC default value of 310
Measurement procedures:	
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 47]:	GWP_{CH4}
Data unit:	
Used in equations:	[EQ68], [EQ75], [EQ93]
Description:	Global Warming Potentials for CH_4
Sources of data:	IPCC default value of 21
Measurement procedures:	
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 48]:	ER_{N2O}
Data unit:	Proportion
Used in equations:	
Description:	Emission ratios for N_2O
Sources of data:	Table 3A.1.15 in IPCC GPG-LULUCF 2003
Measurement procedures:	Use IPCC default value of 0.007
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 49]:	ER_{CH4}
Data unit:	Proportion
Used in equations:	[EQ68], [EQ75]
Description:	Emission ratios for CH_4
Sources of data:	Table 3A.1.15 in IPCC GPG-LULUCF 2003
Measurement procedures:	Use IPCC default value of 0.012
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 50]:	r
Data unit:	Proportion
Used in equations:	
Description:	Carbon-to-Nitrogen ratio of the wood
Sources of data (*):	1. A measured value based on leaf litter analyses, 2. A conservative value of 100
Measurement procedures:	

Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 51]:	$size_{referenceRegion}$
Data unit:	[ha]
Used in equations:	[EQ37], [EQ38]
Description:	Total size of the reference region
Sources of data:	Project design decision
Measurement procedures:	Use procedure in section II.1.1.2
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 52]:	$\Delta area_{historical}(CS_1 \rightarrow CS_2, t_1 \rightarrow t_2)$
Data unit:	[ha]
Used in equations:	[EQ39]
Description:	Area of transition from LULC class or forest stratum 1 to 2 from time 1 to 2 during the historical reference period
Sources of data:	Remote sensing analysis
Measurement procedures:	Use classification and stratification procedures in section II.1.2.5
Any comment:	To be updated at update

Data/parameter [EA 53]:	$area_{historical}(CS_1, t_1)$
Data unit:	[ha]
Used in equations:	[EQ39]
Description:	Total area of LULC class or forest stratum 1 during time 1
Sources of data:	Remote sensing analysis
Measurement procedures:	Use classification and stratification procedures in section II.1.2.5
Any comment:	To be updated at baseline update

Data/parameter [EA 54]:	$f_{scarcity}(t)$
Data unit:	
Used in equations:	[EQ40]
Description:	Forest scarcity factor used to reduce the historical deforestation rate as a function of remaining forest cover. [-]
Sources of data:	Calculated
Measurement procedures:	Use procedure from section II.1.5.4
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 55]:	sc_1
Data unit:	
Used in equations:	[EQ40]
Description:	First shape factor for the forest scarcity equation; steepness of the decrease in deforestation rate (greater is steeper).
Sources of data:	Statistical fitting procedure. Using remotely sensed forest cover data in heavily deforested areas close to the project area such as neighboring provinces, states or countries
Measurement procedures:	Use procedure from section II.1.5.4
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 56]:	sc_2

Data unit:	
Used in equations:	[EQ40]
Description:	Second shape factor for the forest scarcity equation; relative deforested area at which the deforestation rate will be 50% of the initial deforestation rate.
Sources of data:	Statistical fitting procedure. Using remotely sensed forest cover data in heavily deforested areas close to the project area such as neighboring provinces, states or countries
Measurement procedures:	Use procedure from section II.1.5.4
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 57]:	$area(t, nonForest)$
Data unit:	[ha]
Used in equations:	[EQ40]
Description:	Total area that is not forest within the project area at time t after project start.
Sources of data:	Remote sensing analysis
Measurement procedures:	
Any comment:	To be updated during monitoring

Data/parameter [EA 58]:	$effectiveness_{DG}(a, d)$
Data unit:	
Used in equations:	[EQ61], [EQ62]
Description:	The relative effectiveness of project action a in reducing the forest degradation caused by driver d
Sources of data:	Pilot projects, social assessments
Measurement procedures:	Estimate based on the allocated funds, the capacity of implementing organization, and the motivation of participating communities
Any comment:	To be updated at baseline update

Data/parameter [EA 59]:	$nrActivities$
Data unit:	Count
Used in equations:	[EQ61], [EQ62]
Description:	Total number of project activities
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 60]:	$rate(a, t)$
Data unit:	Count
Used in equations:	[EQ61], [EQ62]
Description:	Adoption rate or relative degree of activity for activity a during year t. A value of 100% indicates that the activity cannot be more efficient in reducing deforestation or forest degradation than estimated
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	Assume that some time is required to train local communities before full efficiency of project activities is reached. Integrate the phased spending of funds for project activities, if relevant. To be updated at baseline update

Data/parameter [EA 61]:	$nrFireClasses$
Data unit:	Count
Used in equations:	[EQ68]
Description:	Number of forest strata in which fire breaks were installed
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	To be updated at baseline update

Data/parameter [EA 62]:	$area_{biomassLoss}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ68]
Description:	Total annual area of forest stratum i that was cleared
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	To be updated during monitoring.

Data/parameter [EA 63]:	$area_{fireBiomassLoss}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ68]
Description:	Annual area of forest stratum i that was cleared by using controlled burning
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	To be updated during monitoring.

Data/parameter [EA 64]:	$nrStrata$
Data unit:	Count
Used in equations:	[EQ70]
Description:	Number of forest strata
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	To be updated at baseline update

Data/parameter [EA 65]:	$area_{projectAreaWithANR,projectScenario}(t,i)$
Data unit:	[ha]
Used in equations:	[EQ71]
Description:	Amount of land on which ANR activities are planned under the baseline scenario for year $\boldsymbol{t}$ and in stratum i
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	Only to be included if ANR activities are implemented. To be updated during monitoring.

Data/parameter [EA 66]:	Locations of ANR activities
Data unit:	Digital boundaries
Used in equations:	
Description:	Locations of all individual parcels on which ANR activities are planned in electronic format

Sources of data:	Project design decision
Measurement procedures:	
Any comment:	Only to be included if ANR activities are implemented. All necessary meta-data to correctly display the files must be included. Fixed after the first verification

Data/parameter [EA 67]:	$area_{biomassLoss,ANR}(t,i)$
Data unit:	[ha]
Used in equations:	[EQ74]
Description:	Area of biomass removed within ANR stratum i during year t
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	Only to be included if ANR activities are implemented. To be updated during monitoring.

Data/parameter [EA 68]:	$area_{fireBiomassLoss,ANR}(t,i)$
Data unit:	[ha]
Used in equations:	[EQ75]
Description:	Area of biomass removed using controlled burning within ANR stratum i during year t
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	Only to be included if ANR activities are implemented. To be updated during monitoring.

Data/parameter [EA 69]:	$nrCDrivers$
Data unit:	Count
Used in equations:	[EQ78], [EQ79]
Description:	Number of geographically constrained drivers
Sources of data:	Literature/ Participatory rural appraisals
Measurement procedures:	Select based on the analysis of the drivers of deforestation and forest degradation
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 70]:	$leakage_{constrained}(d)$
Data unit:	
Used in equations:	[EQ78], [EQ79], [EQ90]
Description:	Leakage cancellation rate for avoiding deforestation/degradation of driver $\boldsymbol{d}$ from geographically constrained drivers
Sources of data:	Calculation
Measurement procedures:	Estimate using the "leakage cancellation rate" procedure in section II.3.2.1
Any comment:	To be updated at baseline update

Data/parameter [EA 71]:	$FW_{baseline}$
Data unit:	[m^3 yr^{-1}]
Used in equations:	[EQ3], [EQ94]
Description:	Biomass (dry matter) of fuel-wood collected by project participants under the baseline scenario

Sources of data (*):	1. Social appraisals in the project area before start of the crediting period. 2. Peer-reviewed literature from a similar area as the project area
Measurement procedures:	
Any comment:	To be updated at baseline update

Data/parameter [EA 72]:	$FW_{allowed}$
Data unit:	[m^3 yr^{-1}]
Used in equations:	[EQ81]
Description:	Biomass (dry matter) of allowed fuel-wood collection in the project area under the project scenario
Sources of data:	Management plans
Measurement procedures:	
Any comment:	Fixed for the entire crediting period.

Data/parameter [EA 73]:	$nrfuelWoodReductionActions$
Data unit:	Count
Used in equations:	[EQ81]
Description:	The number of project activities that reduce the need for fuel-wood. E.g., promotion of fuel-efficient wood-stoves, mosquito nets for livestock, biogas plants
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	Only to be included if activities that reduce fuel-wood consumption are implemented. Fixed for the entire crediting period.

Data/parameter [EA 74]:	$adoption(i)$
Data unit:	
Used in equations:	[EQ81]
Description:	Adoption rate of project activity i which reduces fuel-wood consumption
Sources of data:	Literature/ pilot studies
Measurement procedures:	Estimate based on a prediction of the willingness of local communities to adopt the alternative practice
Any comment:	Only to be included if activities that reduce fuel-wood consumption are implemented. To be updated during monitoring.

Data/parameter [EA 75]:	$efficiency(i)$
Data unit:	
Used in equations:	[EQ81]
Description:	Rate at which project activity i reduces fuel-wood consumption
Sources of data:	Literature/ pilot studies
Measurement procedures:	
Any comment:	Only to be included if activities that reduce fuel-wood consumption are implemented. To be updated during monitoring.

Data/parameter [EA 76]:	$\Delta area_{settlement,baseline}$
Data unit:	[ha yr^{-1}]

Used in equations:	[EQ82]
Description:	Area that would be converted to settlements by participating communities under the baseline scenario
Sources of data (*):	1. Remote sensing analysis in the project area before start of the crediting period 2. Social appraisals in the project area before start of the crediting period 3. Peer-reviewed literature 4. Country experts
Measurement procedures:	
Any comment:	To be updated at baseline update

Data/parameter [EA 77]:	$\Delta area_{settlement,project}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ82]
Description:	Area that will be converted to settlements by participating communities under the project scenario
Sources of data:	Literature
Measurement procedures:	Estimate the area that will be converted to cropland based on an understanding of the area required per household dwelling when participatory land use plans are in place and the anticipated population increase
Any comment:	To be updated during monitoring.

Data/parameter [EA 78]:	$\Delta area_{settlement,allowed}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ82]
Description:	Area that will be converted to settlements after within the project area under the project scenario
Sources of data:	Project design decision
Measurement procedures:	
Any comment:	To be updated at baseline update

Data/parameter [EA 79]:	$\Delta area_{cropLand,baseline}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ83]
Description:	Area that would be converted to cropland by participating communities under the baseline scenario
Sources of data (*):	1. Remote sensing analysis in the project area before start of the crediting period 2. Social appraisals in the project area before start of the crediting period 3. Peer-reviewed literature 4. Country experts
Measurement procedures:	
Any comment:	To be updated at baseline update

Data/parameter [EA 80]:	$\Delta area_{cropLand,project}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ83]
Description:	Area that will be converted to cropland by participating communities under the project scenario

Sources of data:	Literature/pilot studies
Measurement procedures:	Estimate based on an understanding of the cropland area required per household when support for agricultural intensification is provided and anticipated population increase
Any comment:	To be updated during monitoring.

Data/parameter [EA 81]:	$\Delta area_{cropLand,allowed}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ83]
Description:	Area that will be converted to cropland after within the project area under the project scenario
Sources of data:	Project design decision
Measurement procedures:	N/R
Any comment:	To be updated at baseline update

Data/parameter [EA 82]:	Geographical location of the leakage belts
Data unit:	shapefile
Used in equations:	
Description:	Exact geographical location of the leakage belt(s) in electronic form
Sources of data:	GIS
Measurement procedures:	Determine based on the procedure in section II.3.2.2 (step 10B)
Any comment:	May be updated after the first verification for the discrete project parcels that have been added to the project. Fixed after first verification.

Data/parameter [EA 83]:	$size_{leakageArea}$
Data unit:	[ha]
Used in equations:	[EQ86], [EQ87]
Description:	Size of the leakage area
Sources of data:	
Measurement procedures:	Select based on the procedure in section II.3.2.2
Any comment:	May be updated after the first verification for the discrete project parcels that have been added to the project. Fixed after first verification.

Data/parameter [EA 84]:	Historical fire significance of emissions from small-scale fires
Data unit:	Narrative
Used in equations:	
Description:	Test whether the CH4 emissions from fires were significant during the past five years in the project area and leakage belts.
Sources of data:	Social appraisals or remote sensing analysis
Measurement procedures:	Test the significance of historical emissions from fire either through: 1. Social appraisals 2. A spatially explicit fire occurrence product based on a remote-sensing thermal sensor. The remote-sensing thermal sensor must acquire the number of fires at least once every two weeks, have a minimal resolution of 1 km, and must have at least 5 years of uninterrupted historical data.
Any comment:	If the PRAs or the remote-sensing based fire occurrence product indicate that emissions from forest fires are insignificant on certain project parcels or forest strata, the calculation of emissions from fire

	may be omitted until the next baseline update, at which the significance test must be repeated. However, if PRAs or the satellite-based analysis indicate that the area is fire prone and emissions are not insignificant. To be updated at baseline update

Data/parameter [EA 85]:	$leakage_{unconstrained}(cropland\ conversion)$
Data unit:	Proportion
Used in equations:	[EQ90], [EQ91]
Description:	Leakage cancellation rate for avoiding deforestation/degradation from migrants clearing forest area for cropland conversion [-]
Sources of data:	Project area circumstances
Measurement procedures:	Assume a default rate of 100%, unless a smaller leakage rate can be substantiated by the project participants in the Project Document, the burden of proof lays with the project developer[44]. Valid sources to substantiate a smaller leakage rate include social assessments, scientific literature, and reports from civil society or governments. Sources have to be reliable and based on scientific methods and a good statistical design
Any comment:	To be updated at baseline update

Data/parameter [EA 86]:	$nrEmissions$
Data unit:	Count
Used in equations:	[EQ99]
Description:	Total number of sources of GHG emissions considered
Sources of data:	Project area circumstances
Measurement procedures:	
Any comment:	Fixed for the entire crediting period

Data/parameter [EA 87]:	Description of event, condition, or circumstance affecting land-use dynamics
Data unit:	Narrative
Used in equations:	
Description:	A description of a potential change affecting the land-use
Sources of data:	Literature
Measurement procedures:	Describe any potential event, condition, or circumstance in the project area that is not covered in the list in section III.4 and that would trigger a baseline update.
Any comment:	This potential change must be set at validation and remains fixed until the next baseline update.

Data/parameter [EA 88]:	x
Data unit:	Year
Used in equations:	
Description:	Number of years of long term persistent increase/decrease in forest carbon stock used in definition of forest degradation, and forest regeneration.

[44] For example, REDD Project participants can demonstrate that national measures to reduce leakage are effective. Evidence from other areas could be used to substantiate a smaller leakage rate after it is demonstrated that the circumstances are similar.

Sources of data:	Theoretical thresholds, currently 10 years.
Measurement procedures:	Use values from standards (such as VCS) if available or select remaining conservative.
Any comment:	This parameter must be set at validation and remains fixed until the next baseline update.

Data/parameter [EA 89]:	y
Data unit:	
Used in equations:	
Description:	Minimum percentage of change in forest carbon stock used in definition of forest degradation, and forest regeneration.
Sources of data:	Theoretical threshold, currently 10%.
Measurement procedures:	Use values from standards (such as VCS) if available or select remaining conservative.
Any comment:	This parameter must be set at validation and remains fixed until the next baseline update.

Data/parameter [EA 90]:	t
Data unit:	Year
Used in equations:	
Description:	Measurement time period for estimating persistent increase/decrease in forest carbon stock used in definition of forest degradation, and forest regeneration.
Sources of data:	Theoretical thresholds, currently 10 years.
Measurement procedures:	Use values from standards (such as VCS) if available or select remaining conservative.
Any comment:	This parameter must be set at validation and remains fixed until the next baseline update.

Data/parameter [EA 91]:	$V_{ex,h,ty,j}$
Data unit:	[Mg C]
Used in equations:	[EQ94]
Description:	The volume of timber extracted from within the project boundary during harvest *h* by species *j* and wood product class *ty* [m^3]
Sources of data:	Annually extracted wood volume. (Lower ranked options are used only if higher ranked options are not available) (1) Recent literature (peer reviewed publications, national/regional/local inventory and analysis reports (2) Social assessments conducted by project proponents (3) Forest operations log books (for update)
Measurement procedures:	
Any comment:	To be updated at baseline update. Under the baseline scenario, $V_{ex} = CT_{baseline} + DT_{baseline}$ Under the project scenario, V_{ex} is estimated from forest management plans and operation records by the project proponent during project activity.

Data/parameter [EA 92]:	$\boldsymbol{nrLyingWood}$
Data unit:	[-]
Used in equations:	[EQ32]
Description:	Total number of lying dead wood pieces in transect line within a sample plot.
Sources of data:	Field measurement

Measurement procedures:	Count the lying dead wood intersecting the transect lines of 50 m length within the sample plot.
Any comment:	

II.6.2 Data and Parameters related to reduced wood consumption through the use of Fuel-Efficient Woodstoves

The use of fuel-efficient woodstoves is optional. However, if fuel-efficient stoves are included and avoided degradation is excluded from the project[45] (section II.2.1), the carbon accounting following the approved gold standard methodology "Indicative Programme, Baseline, and Monitoring Methodology for Improved Cook-Stoves and Kitchen Regimes" (Currently V.02) must be followed for ex-ante estimates, baseline estimates, and project monitoring as is explained in section II.2.1 under the heading "Decrease the consumption of fuel-wood".

All ex-ante data and parameters from this methodology must be included within the REDD PD. However, since fuel-efficient stoves may be introduced after start of the other REDD project activities, determining the empirical fuel consumption during "Kitchen Tests" for conventional and fuel-efficient stoves may be postponed until the monitoring report before the verification period during which credits from reduced fuel-wood use from improved cookstoves are sought. If the empirical fuel consumption is postponed, conservative values from the literature must be used in the PD.

II.6.3 Data and Parameters related to Nitrous Oxide Emissions from Nitrogen Fertilization

If increased nitrogen fertilization is used as an agricultural intensification for leakage prevention, all data and parameters required for ex-ante estimates from the latest version of the approved CDM tool "Estimation of direct nitrous oxide emission from nitrogen fertilization" (EB33 Annex 16) must be included. More specifically, all data and parameters in the section "Data and parameters not monitored" must be included in the PD and collected according to the procedures described within this tool, as well as an ex-ante estimate of the items in the "Data and parameters monitored" table.

II.6.4 Data and Parameters related to Methane Emissions from Flooded Rice Production

The following data and parameters must be available in the PD if conversion to flooded rice production is introduced as a leakage prevention measure:

Data/parameter [EA 93]:	$\Delta A_{rice}(t)$
Data unit:	[ha]
Used in equations:	[EQ92]
Description:	Annual increase in harvested area of rice due to leakage prevention measures.
Sources of data:	Project design decision
Measurement procedures:	

[45] If avoided degradation is included in the project, emission reductions from fuel-efficient cookstoves are accounted for using the stock-change approach which is included within this methodology.

Any comment:	Only to be included if rice production is increased as a leakage prevention measure. To be updated during monitoring

Data/parameter [EA 94]:	$t_{flooded,max}$
Data unit:	[days yr^{-1}]
Used in equations:	[EQ92]
Description:	Maximal period of time a field is flooded
Sources of data:	Participatory rural appraisals
Measurement procedures:	
Any comment:	Only to be included if rice production is increased as a leakage prevention measure. To be updated during monitoring

Data/parameter [EA 95]:	$EF_{rice,max}$
Data unit:	[kg CH_4 ha^{-1} day^{-1}]
Used in equations:	[EQ92]
Description:	Maximal emission factor for methane
Sources of data:	Literature
Measurement procedures:	By default, an emission rate of 36 kg CH4 ha^{-1} day^{-1} must be used, which is 25% greater than the maximal value found in a review study comparing 23 studies of CH4 fluxes in rice fields (Le Mer and Roger, 2001). Project proponents may use a smaller emission rate if it can be demonstrated that the rate remains conservative for the project conditions.
Any comment:	Only to be included if rice production is increased as a leakage prevention measure. May be updated during baseline update

II.6.5 Data and Parameters related to GHG Emissions from Increased Livestock Stocking

If livestock stocking rates are increased as a leakage prevention measure, appropriate data and parameters from table 5 ("Data/parameter, their vintage, geographical scale and possible data sources") of section II. 11 ("Data needed for ex ante estimations") must be included in the PD for ex-ante estimates. More specifically, variables $LK_{FFL,t}$ until $Frac_{gas}$ must be included in the PD at validation according to the procedures described in this CDM methodology.

In addition, all data and parameters from the latest version of the approved CDM A/R methodological tool "Estimation of GHG emissions related to displacement of grazing activities in A/R CDM project activity" (EB39, Annex 12), section 1 and 2 of the "List of parameters and variables" part of Appendix A ("Defaults" and "Data and parameters estimated for the ex ante and monitored for ex post calculations.") must be included in the PD at validation according to the procedures described in this CDM methodological tool.

Section III: Monitoring Methodology Description

This methodology requires the following monitoring components for calculating actual NERs

- Monitoring of deforestation drivers, project activities and emission sources related to REDD project activities inside and outside of the project area.
- Monitoring LULC class and forest strata transitions in the project area, leakage area, and reference region using remote-sensing technologies, and validated with ground-truthing data.
- Monitoring carbon stock densities in LULC classes and forest strata.
- Monitoring carbon stock increases in the area on which ANR are performed.
- Monitoring of natural disturbances.

A monitoring report is produced which contains all of the information above, and which outlines the calculations for actual NERs generated. This monitoring report is the basis for verification by VCS-accredited verifiers. The actual VCUs are released upon verification and positive evaluation of a monitoring. The VCS requires that verification takes place minimally every five years. Project proponents may choose to seek verification more frequently, especially in the beginning of the crediting period. The PD must contain a fixed time schedule of when verification will be sought during the full duration of the crediting period.

At every verification time, project proponents must check that no other land-based carbon projects registered under the CDM or under any other carbon trading scheme (both voluntary and compliance-oriented) are present in the project area. A formal statement on the lack of any other carbon project in the project area must be included in the monitoring report.

Note that any natural disturbance is fully accounted as part of the on-going monitoring during the crediting period. Any loss of biomass during the credited period is monitored and accounted for regardless of the cause of the loss.

III.1 Overview of the Data that Must be Recorded and Monitored

III.1.1 Monitoring of Deforestation Drivers, Project Activities and Emission Sources

The table below contains a list of all the information to be recorded about the actions that occurred in the project and leakage areas, depending on the project activities implemented.

Duly record and justify any deviation from the planned activities as described in the PD. Record any activity that may cause an increase of GHG emissions, which was unforeseen in the PD.

The same procedure as outlined in section II.1.4.5 should be followed for on-going monitoring of already established permanent forest sampling plots. It is crucial that the procedure used to perform the biomass inventory is consistent throughout the project duration. The Standard Operations Procedure for biomass inventory developed in section II.1.4.5 should be meticulously followed. The results of the biomass inventory should be analyzed and checked for consistency and the emission factors in Table 12 should be updated following section II.1.4.

Data/parameter [MN 1]:	Locations of discrete project parcels
Data unit:	Digital boundaries

Used in equations:	
Description:	Locations of all individual discrete project parcels in electronic format
Sources of data:	Project design decision
Procedures/ comments:	All necessary meta-data to correctly display the files must be included.
Frequency of monitoring:	To be updated before first verification. Fixed after first verification.

Data/parameter [MN 2]:	$size_{projectArea}$
Data unit:	[ha]
Used in equations:	[EQ21]
Description:	Total project area
Sources of data:	Field measurement
Procedures/ comments:	
Frequency of monitoring:	May be adjusted before first verification, but fixed after the first verification

Data/parameter [MN 3]:	Historical LULC and forest strata transition matrix
Data unit:	[ha yr^{-1}]
Used in equations:	
Description:	Matrix of historical land transition rates between LULC classes and forest strata
Sources of data:	Remote sensing analysis
Procedures/ comments:	Use the procedure in section II.1.2.4 and II.1.1.3 . An uncertainty analysis must be carried out and a confusion matrix must be presented in the PD according to the procedures in the methodology.
Frequency of monitoring:	Annually for project area and leakage belts, and at least every five years or once before every verification (whichever is more frequent) for the reference region.

Data/parameter [MN 4]:	$\Delta area_{projectAreaWithoutANR,projectScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1]
Description:	Hectares undergoing transition i within the project area, excluding the ANR area, under the project scenario for year t. [ha yr^{-1}].
Sources of data:	Remote sensing analysis
Procedures/ comments:	Follow the procedures described in section II.1.2.4. In case credits from avoided degradation are included, this parameter will provide the data required to calculate the activity data to estimate the emissions from both deforestation and forest degradation.
Frequency of monitoring:	Annually

Data/parameter [MN 5]:	$\Delta area_{projectAreaWithoutANR,baselineScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1]
Description:	Hectares undergoing transition i within the project area, excluding the ANR area, under the baseline scenario for year t. [ha yr^{-1}].
Sources of data:	Land-use change modeling
Procedures/ comments:	Follow the procedures described in section II.1.5.4

Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 6]:	$\Delta area_{projectAreaWithANR,baselineScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1]
Description:	Hectares undergoing transition i within the leakage area under the project scenario for year t.
Sources of data:	Land-use change modeling
Procedures/ comments:	Follow the procedures described in section II.1.5.4
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 7]:	$\Delta area_{leakageArea,projectScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1]
Description:	Hectares undergoing transition i within the leakage area under the project scenario for year t
Sources of data:	Remote sensing analysis
Procedures/ comments:	Follow the procedures described in section II.1.2.4. In case credits from avoided degradation are included, this parameter will provide the data required to calculate the activity data to estimate the emissions from both deforestation and forest degradation.
Frequency of monitoring:	Annually

Data/parameter [MN 8]:	$\Delta area_{leakageArea,baselineScenario}(t,i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ1]
Description:	Hectares undergoing transition i within the leakage area under the baseline scenario during year t
Sources of data:	Land-use change modeling
Procedures/ comments:	Follow the procedures described in section II.1.5.4
Frequency of monitoring:	Annually

Data/parameter [MN 9]:	Household count
Data unit:	Count
Used in equations:	
Description:	Number of households in the project area
Sources of data:	Literature/ official records/ social appraisals
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 10]:	Household size
Data unit:	Count
Used in equations:	
Description:	Average size of a household in the project area
Sources of data:	Literature/ official records/ social appraisals
Measurement procedures:	
Frequency of monitoring:	Annually

Data/parameter [MN 11]:	$FW_{baseline}$
Data unit:	[m^3 yr^{-1}]
Used in equations:	[EQ3],[EQ81]
Description:	Annual volume of fuelwood gathering in the baseline scenario
Sources of data (*):	1. Participatory rural appraisals 2. Recent (<10 yr) literature in the reference region 3. Recent (<10 yr) literature in an area similar to the reference region
Procedures/ comments:	If emission reductions from avoided degradation were excluded due to insufficient accuracy, in which case $u_{classification} = 0$, and emission reductions from fuel-efficient woodstoves are included, $FW_{baseline}$ may only be measured using the first option, social assessments.
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

*: lower-ranked options may only be used if higher-ranked options are not available

Data/parameter [MN 12]:	ρ_{wood}
Data unit:	[Mg DM m^{-3}]
Used in equations:	[EQ7], [EQ8], [EQ97]
Description:	Basic wood density.
Sources of data:	GPG-LULUCF Table 3A.1.9.
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 13]:	BEF_2
Data unit:	[-]
Used in equations:	[EQ7], [EQ8]
Description:	Biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass (including bark).
Sources of data:	Literature
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 14]:	$area_{baseline,fire}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ4]
Description:	Forest area in the project area affected by disturbances from forest fires in forest stratum i
Sources of data (*):	1. Participatory rural appraisals 2. Recent (<10 yr) literature in the reference region. 3. Recent (<10 yr) literature in an area similar to the reference region
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 15]:	$\Delta area_{baseline,cropland}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ5]
Description:	Forest area converted from forest stratum i to cropland in the project area under baseline conditions at the start of the project
Sources of data (*):	1. Remote sensing analyses in the reference region 2. Participatory rural appraisals 3. Recent (<10 yr) literature in the reference region

	4. Recent (<10 yr) peer-reviewed scientific literature in an area similar to the reference region
Procedures/ comments:	For remote sensing procedure, use procedures in section II.1.2.5
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 16]:	$\Delta area_{baseline,settlement}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ6]
Description:	Average forest area converted from forest stratum i to settlements in the reference region under baseline conditions
Sources of data (*):	1. Remote sensing analyses in the reference region, 2. Participatory rural appraisals conducted by project proponents. 3. Recent (<10 yr) literature in the reference region 4. Recent (<10 yr) literature in an area similar to the reference region
Procedures/ comments:	See section II.1.2.5 for further guidance on remote sensing
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 17]:	$CT_{baseline}$
Data unit:	[m^3 yr^{-1}]
Used in equations:	[EQ7]
Description:	Annually extracted volume of harvested timber round-wood for commercial on-sale
Sources of data (*):	1. Participatory rural appraisals conducted by project proponents. 2. Recent (<10 yr) literature in the reference region 3. Recent (<10 yr) literature in an area similar to the reference region 4. Recent (<10 yr) non peer-reviewed reports by local organizations
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 18]:	Timber price
Data unit:	Local currency
Used in equations:	7
Description:	Prices of timber on local markets
Sources of data:	Field measurement/survey
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 19]:	$DT_{baseline}$
Data unit:	[m^3 yr^{-1}]
Used in equations:	[EQ8]
Description:	Annually extracted volume of timber for domestic and local use, roundwood
Sources of data (*):	1. Participatory rural appraisals conducted by project proponents 2. Recent (<10 yr) literature in the reference region 3. Recent (<10 yr) literature in an area similar to the reference region 4. Recent (<10 yr) non peer-reviewed reports by local organizations
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 20]:	$nrDrivers$
Data unit:	Count

Used in equations:	[EQ9], [EQ10], [EQ93]
Description:	Number of drivers of deforestation or forest degradation
Sources of data:	Selection procedure in section II.1.3, "Analyze the Agents and Drivers of Deforestation"
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 21]:	$area(i,t)$
Data unit:	[ha]
Used in equations:	[EQ21]
Description:	Total area of class or stratum i during time t
Sources of data:	Remote sensing analysis
Procedures/ comments:	Calculate based on a (preliminary) stratification and classification from a remote sensing analysis detailed in section II.1.2
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 22]:	$nrTrees(i,p)$
Data unit:	Count
Used in equations:	[EQ30]
Description:	Number of trees in sample plot $\mathbf{p}$ of LULC class or forest stratum $\mathbf{i}$
Sources of data:	Measure in sampling plots
Procedures/ comments:	Count trees only if the tree is above a certain minimum DBH, see $\mathrm{DBH(t,i,p)}$ parameter
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 23]:	$DBH(t,i,p)$
Data unit:	[cm]
Used in equations:	[EQ30]
Description:	DBH of tree t within plot p of LULC class or forest stratum i
Sources of data:	Measure in sampling plots
Procedures/ comments:	Measure only if the tree is above a certain minimum DBH. Typically measured 1.3 m above the ground. The minimum value varies on tree species and climate. In arid climates, the minimum DBH may be as small as 2.5 cm, whereas it could be up to 10 cm for humid climates
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 24]:	$\theta(i,p)$
Data unit:	degrees
Used in equations:	[EQ30]
Description:	Slope of the land of plot $\mathbf{p}$ of LULC class or forest stratum $\mathbf{i}$
Sources of data:	Measure in sampling plots
Procedures/ comments:	See section 8 in Pearson et al., 2005
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 25]:	$f_{allometric}(y)$
Data unit:	

Used in equations:	[EQ30]
Description:	Allometric relationship to convert DBH into biomass
Sources of data (*):	1. Allometric equations developed by project proponents 2. Allometric equations developed locally by groups other than project proponents 3. Allometric equations developed for forest types that are similar to the ones in the project as found in found in Appendix C of Pearson et al. (2005), or Tables 4.A.1. and 4.A.2. of the GPG LULUCF
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 26]:	$D(d,i,wp,p)$
Data unit:	[cm]
Used in equations:	[EQ32]
Description:	Diameter of piece wp of lying wood along the transect in decomposition class d (1=sound, 2=intermediate, 3=rotten) of sampling plot p of LULC class or forest stratum i.
Sources of data:	Measure in sampling plots
Procedures/ comments:	Diameter is measured the point where lying wood intersects the transect line
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 27]:	$\Delta area_{historical}(CS_1 \rightarrow CS_2, t_1 \rightarrow t_2)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ39]
Description:	Area of transition from LULC class or forest stratum 1 to 2 from time 1 to 2 during the historical reference period
Sources of data:	Remote sensing analysis
Procedures/ comments:	Calculate based on the remote sensing-based classification and stratification procedures detailed in section II.1.2
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 28]:	$area_{historical}(CS_1, t_1)$
Data unit:	[ha]
Used in equations:	[EQ39]
Description:	Total area of LULC class or forest stratum 1 during time 1
Sources of data:	Remote sensing analysis
Procedures/ comments:	Calculate based on the remote sensing-based classification and stratification procedures detailed in section II.1.2
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 29]:	$D_{referenceRegion,baselineScenario,DF}(t)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ35]
Description:	Rate of deforestation within the reference region for year t.
Sources of data:	Linear interpolation of remote sensing data
Procedures/ comments:	Follow procedures of section II.1.5.1
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 30]:	$D_{referenceRegion,baselineScenario,DG}(t)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ36]
Description:	Rate of forest degradation within the reference region for year t.
Sources of data:	Linear interpolation of remote sensing data
Procedures/ comments:	Follow procedures of section II.1.5.1
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 31]:	$area(t, nonForest)$
Data unit:	[ha]
Used in equations:	[EQ40]
Description:	Total area that is not forest within the project area at time t after project start.
Sources of data:	Remote sensing analysis
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 32]:	$effectiveness_{DG}(a, d)$
Data unit:	
Used in equations:	[EQ61], [EQ62]
Description:	The relative effectiveness of project action a in reducing the forest degradation caused by driver d
Sources of data:	Pilot projects, social assessments
Procedures/ comments:	Estimate based on the allocated funds, the capacity of implementing organization, and the motivation of participating communities
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 33]:	$rate(a, t)$
Data unit:	Count
Used in equations:	[EQ61], [EQ62]
Description:	Adoption rate or relative degree of activity for activity a during year t. A value of 100% indicates that the activity cannot be more efficient in reducing deforestation or forest degradation than estimated
Sources of data:	Project design decision
Procedures/ comments:	Assume that some time is required to train local communities before full efficiency of project activities is reached. Integrate the phased spending of funds for project activities, if relevant.
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 34]:	Forest patrolling labor
Data unit:	[hrs]
Used in equations:	
Description:	Labor hours used for forest patrolling
Sources of data:	Records of implemented activities
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 35]:	Description of fire prevention measures

Data unit:	text
Used in equations:	
Description:	Information on fire prevention measures
Sources of data:	Records of implemented activities
Procedures/ comments:	Record dates of implementation of fire prevention measures, type of activity, and location (lat/lon coordinates)
Frequency of monitoring:	Annually

Data/parameter [MN 36]:	$area_{biomassLoss}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ68]
Description:	Total annual area of LULC class i that was cleared
Sources of data:	Records of implemented activities
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 37]:	$area_{fireBiomassLoss}(i)$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ68]
Description:	Annual area of forest stratum i that was cleared by using controlled burning
Sources of data:	Records of implemented activities
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 38]:	$nrStrata$
Data unit:	Count
Used in equations:	[EQ70]
Description:	Number of forest strata
Sources of data:	Project design decision
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 39]:	$adoption(i)$
Data unit:	Proportion
Used in equations:	[EQ81]
Description:	Adoption rate of project activity i which reduces fuel-wood consumption
Sources of data:	social assessments
Procedures/ comments:	Estimated in the project area during the crediting period. Only to be included if activities that reduce fuel-wood consumption are implemented.
Frequency of monitoring:	Annually

Data/parameter [MN 40]:	$efficiency(i)$
Data unit:	Proportion
Used in equations:	[EQ81]
Description:	Rate at which project activity i reduces fuel-wood consumption

Sources of data:	Field measurements
Procedures/ comments:	Measure efficiency in at least 10 randomly selected households. Only to be included if activities that reduce fuel-wood consumption are implemented.
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 41]:	$\Delta area_{settlement,baseline}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ82]
Description:	Area that would be converted to settlements by participating communities under the baseline scenario
Sources of data:	Remote sensing analysis in the reference region after the start of the crediting period
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 42]:	Description of agricultural intensification
Data unit:	Narrative
Used in equations:	
Description:	Detailed description of the implemented agricultural intensification projects
Sources of data:	Records of implemented activities
Procedures/ comments:	Record the following items: • location of agricultural intensification practices (lat/lon) • crop species and varieties used • Dates of planting, cultivation, harvesting for agricultural intensification practices • Costs of inputs (seed, fertilizer, etc.) for agricultural intensification practices Only to be included if agricultural intensification activities are implemented.
Frequency of monitoring:	Annually

Data/parameter [MN 43]:	Area under agricultural intensification
Data unit:	[ha]
Used in equations:	
Description:	Size of the area of agricultural intensification separated for each agricultural intensification measure
Sources of data:	Participatory rural appraisals
Procedures/ comments:	Calculate based on areas of fertilized cropland in the leakage and project areas Only to be included if agricultural intensification activities are implemented.
Frequency of monitoring:	Annually

Data/parameter [MN 44]:	Yields under agricultural intensification
Data unit:	[Mg ha^{-1}]
Used in equations:	
Description:	Harvested yield for agricultural intensification practices

Sources of data:	Participatory rural appraisals
Procedures/ comments:	Only to be included if agricultural intensification activities are implemented.
Frequency of monitoring:	Annually

Data/parameter [MN 45]:	Agricultural outreach activity
Data unit:	Narrative
Used in equations:	
Description:	A detailed description of the different activities and meetings done for agricultural outreach
Sources of data:	Records of implemented activities
Procedures/ comments:	Provide dates and reports of demonstration meetings or agricultural outreach and extension activities for agricultural intensification practices
Frequency of monitoring:	Annually

Data/parameter [MN 46]:	Fuel-efficient stoves acquired
Data unit:	Count
Used in equations:	
Description:	Number of fuel-efficient stoves acquired per year
Sources of data:	Participatory rural appraisals.
Procedures/ comments:	Only to be included if fuel-efficient stoves are introduced.
Frequency of monitoring:	Annually

Data/parameter [MN 47]:	Fuel-efficient stoves used
Data unit:	Count
Used in equations:	
Description:	Number of fuel-efficient stoves effectively used by project participants
Sources of data:	Participatory rural appraisals.
Procedures/ comments:	Only to be included if fuel-efficient stoves are introduced.
Frequency of monitoring:	Annually

Data/parameter [MN 48]:	$nrANRstrata$
Data unit:	Count
Used in equations:	[EQ1], [EQ71], [EQ73]
Description:	Number of strata within the project area on which ANR activities are proposed
Sources of data:	Field measurement
Procedures/ comments:	The number of ANR strata is dependent on the ANR management plan designed by the project proponents. Only to be included if ANR activities are implemented.
Frequency of monitoring:	To be updated before first verification. Fixed after first verification.

Data/parameter [MN 49]:	Locations of ANR activities
Data unit:	Digital boundaries
Used in equations:	
Description:	Locations of all individual parcels on which ANR activities are planned in

	electronic format
Sources of data:	Project design decision
Procedures/ comments:	Only to be included if ANR activities are implemented.
Frequency of monitoring:	To be updated before first verification. Fixed after first verification.

Data/parameter [MN 50]:	Geographical location of the leakage belts
Data unit:	Digital boundaries
Used in equations:	
Description:	Exact geographical location of the leakage belt(s) in electronic form
Sources of data:	Project design decision/GIS analysis
Procedures/ comments:	Determine based on the procedure in section II.3.2.2**.**
Frequency of monitoring:	May be updated after the first verification for the discrete project parcels that have been added to the project. Fixed after first verification.

Data/parameter [MN 51]:	$size_{leakageArea}$
Data unit:	[ha]
Used in equations:	[EQ86], [EQ87]
Description:	Size of the leakage area
Sources of data:	
Procedures/ comments:	Select based on the procedure in section II.3.2.2
Frequency of monitoring:	May be updated after the first verification for the discrete project parcels that have been added to the project. Fixed after first verification.

Data/parameter [MN 52]:	Description of ANR activities
Data unit:	Narrative
Used in equations:	
Description:	Detailed description regarding the ANR activities, including dates and locations
Sources of data:	Records of implemented activities
Procedures/ comments:	Provide the following elements • Dates, locations (Digital boundaries), areas, and types of biomass removal (coppicing, removal of invasive species, thinning) • Dates, locations (Digital boundaries or geographic coordinates), areas, species, and planting density of enrichment planting Only to be included if ANR activities are implemented.
Frequency of monitoring:	Annually

Data/parameter [MN 53]:	$NAI(i)$
Data unit:	[Mg C ha^{-1} yr^{-1}]
Used in equations:	[EQ1], [EQ72], [EQ95]
Description:	Net annual biomass increment for forest stratum i under the baseline scenario.
Sources of data:	Estimate within the biomass inventory plots outside of the ANR area
Procedures/ comments:	Only to be included if ANR activities are implemented.
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 54]:	$\Delta C(t,i)$
Data unit:	[Mg C ha^{-1} yr^{-1}]
Used in equations:	[EQ70]
Description:	Increase in forest biomass in ANR forest stratum i at time t.
Sources of data:	Estimate within the biomass inventory plots inside of the ANR area
Procedures/ comments:	Only to be included if ANR activities are implemented.
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 55]:	ANR tree survival rate
Data unit:	proportion
Used in equations:	
Description:	Survival rate of planted or regenerating trees as an ANR activity
Sources of data:	Estimate within the biomass inventory plots inside of the ANR area
Procedures/ comments:	Only to be included if ANR activities are implemented.
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 56]:	$area_{fireBiomassLoss,ANR}(t,i)$
Data unit:	[ha]
Used in equations:	[EQ75]
Description:	Area of biomass removed by controlled burning within ANR stratum i during year t
Sources of data:	Records of implemented activities
Procedures/ comments:	Only to be included if ANR activities are implemented.
Frequency of monitoring:	Annually

Data/parameter [MN 57]:	$area_{biomassLoss,ANR}(t,i)$
Data unit:	[ha]
Used in equations:	[EQ74], [EQ75]
Description:	Area of biomass removed within ANR stratum i during year t, by coppicing, removing of invasive species, or thinning
Sources of data:	Records of implemented activities
Procedures/ comments:	Only to be included if ANR activities are implemented.
Frequency of monitoring:	Annually

Data/parameter [MN 58]:	$area_{projectAreaWithANR,projectScenario}(t,i)$
Data unit:	[ha]
Used in equations:	[EQ71]
Description:	Amount of land on which ANR activities are planned under the baseline scenario for year t and in stratum i
Sources of data:	Records of implemented activities
Procedures/ comments:	Only to be included if ANR activities are implemented.
Frequency of monitoring:	Annually

Data/parameter [MN 59]:	$nrFireClasses$

Data unit:	Count
Used in equations:	[EQ68]
Description:	Number of LULC classes in which fire breaks were installed
Sources of data:	Records of implemented activities
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 60]:	$size_{projectArea}$
Data unit:	[ha]
Used in equations:	[EQ21], [EQ38], [EQ40]
Description:	Total size of all strata, e.g. the total project area
Sources of data:	Project design decision
Procedures/ comments:	
Frequency of monitoring:	Fixed after first verification

Data/parameter [MN 61]:	Evidence of land-tenure strengthening
Data unit:	narrative
Used in equations:	
Description:	Information and data on land-tenure strengthening
Sources of data:	Records of implemented activities
Procedures/ comments:	Record the following aspects: 1. Dates and reports of all meetings with stakeholders regarding land-tenure status strengthening 2. Original agreements strengthening the land-tenure status 3. Dates when the land-tenure status strengthening agreements were signed 4. Dates and reports of all meetings with stakeholders regarding forest and land-use plans
Frequency of monitoring:	Annually

Data/parameter [MN 62]:	Fire prevention labor
Data unit:	[hrs]
Used in equations:	
Description:	Labor hours used to implement the measure fire prevention measure
Sources of data:	Records of implemented activities
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 63]:	NTFP harvest rate
Data unit:	[m^3 yr^{-1}] or [kg yr^{-1}]
Used in equations:	
Description:	Annual volumes of non-timber forest products extracted
Sources of data:	Participatory rural appraisals
Procedures/ comments:	Estimate among participating communities and communities living in the leakage area.
Frequency of monitoring:	Annually

Data/parameter [MN 64]:	Local NTFP price
Data unit:	local currency

Used in equations:	
Description:	Price of non-timber forest products on local markets
Sources of data:	Participatory rural appraisals
Procedures/ comments:	
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 65]:	Location of timber harvesting
Data unit:	Digital boundaries
Used in equations:	
Description:	Location of timber harvested within the project area
Sources of data:	Management plans and social assessments
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 66]:	Timber harvesting rate
Data unit:	[m^3]
Used in equations:	
Description:	Volume of timber harvested within the project area
Sources of data:	Participatory rural appraisals
Procedures/ comments:	Estimate among participating communities and communities living in the leakage area.
Frequency of monitoring:	Annually

Data/parameter [MN 67]:	Location of fuel-wood collection
Data unit:	Digital geographic coordinates
Used in equations:	
Description:	Location of fuel-wood collected within the project area
Sources of data:	Participatory rural appraisals
Procedures/ comments:	Estimate among participating communities and communities living in the leakage area.
Frequency of monitoring:	Annually

Data/parameter [MN 68]:	Wood harvested for charcoal
Data unit:	[m^3]
Used in equations:	
Description:	Volume of green wood harvested for charcoal production within the project area per forest stratum
Sources of data:	Participatory rural appraisals
Procedures/ comments:	Estimate using among participating communities and communities living in the leakage area.
Frequency of monitoring:	Annually

Data/parameter [MN 69]:	$leakage_{constrained}(d)$
Data unit:	
Used in equations:	[EQ78], [EQ79]. [EQ90]
Description:	Leakage cancellation rate for avoiding deforestation/degradation of driver $\boldsymbol{d}$
Sources of data:	Calculation

Procedures/ comments:	Estimate using the "leakage cancellation rate" procedure in section II.3.2.1
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 70]:	$leakage_{unconstrained}(cropland\ conversion)$
Data unit:	Proportion
Used in equations:	[EQ90], [EQ91]
Description:	Leakage cancellation rate for avoiding deforestation/degradation from migrants clearing forest area for cropland conversion [-]
Sources of data:	Project area circumstances
Procedures/ comments:	Assume a default rate of 100%, unless a smaller leakage rate can be substantiated by the project participants in the Project Document, the burden of proof lays with the project developer[46]. Valid sources to substantiate a smaller leakage rate include social assessments, scientific literature, and reports from civil society or governments. Sources have to be reliable and based on scientific methods and a good statistical design
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 71]:	$\Delta area_{settlement,project}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ82]
Description:	Area that will be converted to settlements by participating communities under the project scenario
Sources of data:	Literature
Procedures/ comments:	Estimate the area that will be converted to cropland based on an understanding of the area required per household dwelling when participatory land use plans are in place and the anticipated population increase
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 72]:	$\Delta area_{settlement,allowed}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ80]
Description:	Area that will be converted to settlements after within the project area under the project scenario
Sources of data:	Project design decision
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 73]:	$\Delta area_{cropLand,baseline}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ83]
Description:	Area that would be converted to cropland by participating communities under the baseline scenario
Sources of data (*):	1. Remote sensing analysis in the project area before start of the crediting period

[46] For example, REDD Project participants can demonstrate that national measures to reduce leakage are effective. Evidence from other areas could be used to substantiate a smaller leakage rate after it is demonstrated that the circumstances are similar.

	2. Social appraisals in the project area before start of the crediting period 3. Peer-reviewed literature 4. Country experts
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 74]:	$\Delta area_{cropLand,project}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ83]
Description:	Area that will be converted to cropland by participating communities under the project scenario
Sources of data:	Literature/pilot studies
Procedures/ comments:	Estimate based on an understanding of the cropland area required per household when support for agricultural intensification is provided and anticipated population increase
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 75]:	$\Delta area_{cropLand,allowed}$
Data unit:	[ha yr^{-1}]
Used in equations:	[EQ83]
Description:	Area that will be converted to cropland after within the project area under the project scenario
Sources of data:	Project design decision
Procedures/ comments:	
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 76]:	Description of natural disturbance (except for fire)
Data unit:	Narrative, maps of the areas
Used in equations:	
Description:	A detailed description of the circumstances and impacts of a natural disturbance
Sources of data:	Field observations
Procedures/ comments:	Provide the following items for every natural disturbance: 1. Type, i.e. flood/earthquakes/ pest/… 2. Date 3. Location and area affected (provide digital boundaries/geographic locations) 4. Area within the project area and leakage areas. Estimate of proportion of biomass lost during disturbance by comparing the maps of the areas with the LULC maps Record every time a natural disturbance decreasing the biomass in the project area is occurring.
Frequency of monitoring:	Annually

Data/parameter [MN 77]:	$\Delta area_{large\ scale\ fires}\ (t, i)$
Data unit:	[ha]
Used in equations:	[EQ101]
Description:	Area of large-scale fires detectable by medium-resolution satellite imagery in the project area or leakage belts
Sources of data:	Remote sensing analysis
Procedures/ comments:	

Frequency of monitoring:	Annually

Data/parameter [MN 78]:	Maps of the large-scale burned areas
Data unit:	Digital boundary
Used in equations:	
Description:	Maps of large-scale (10 ha) fires detectable by medium-resolution satellite imagery in the project area or leakage belts [ha]
Sources of data:	Remote sensing analysis
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 79]:	National, local and sectoral forest-use policies
Data unit:	Narrative
Used in equations:	
Description:	Describe any recent national, local and/or sectoral policies that are implemented that have affected or will affect allowable forest use
Sources of data:	legal documents, policy documents, etc.
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 80]:	Changes of political, social or economic nature
Data unit:	narrative
Used in equations:	
Description:	Describe significant changes of political, social or economic nature have occurred or will occur, making the current baseline estimates inaccurate
Sources of data:	Literature, Planning documents
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 81]:	Land-use opportunity cost
Data unit:	Narrative
Used in equations:	
Description:	The risk that alternative land uses on the land become much more attractive than the REDD project
Sources of data:	Literature, Planning documents
Procedures/ comments:	Describe and analyze market effects such as a significant price rising of timber and non-woody products, or the increase of prices of agricultural commodities would increase the deforestation pressure on the current forest land
Frequency of monitoring:	Annually

Data/parameter [MN 82]:	New Roads
Data unit:	Narrative
Used in equations:	
Description:	A description of the location and size of new roads that have been built since the last verification or roads that will be built before the following verification
Sources of data:	Literature, Planning documents
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 83]:	Other change affecting land-use
Data unit:	Narrative
Used in equations:	
Description:	A description of any potential change affecting the land-use in as set at validation or the previous baseline update
Sources of data:	Literature, Planning documents
Procedures/ comments:	
Frequency of monitoring:	Annually

Data/parameter [MN 84]:	Description of event, condition, or circumstance affecting land-use dynamics
Data unit:	Narrative
Used in equations:	
Description:	A description of a potential change affecting the land-use
Sources of data:	Literature
Procedures/ comments:	Describe any potential event, condition, or circumstance in the project area that is not covered in the list in section III.4 and that would trigger a baseline update.
Frequency of monitoring:	This potential change category must be set at validation in [EA 92] and must be adjusted Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 85]:	Historical significance of emissions from small-scale fires
Data unit:	Narrative
Used in equations:	
Description:	Test whether the CH4 emissions from fires were significant in the project area and leakage belts during the past five years.
Sources of data:	Participatory rural appraisals or remote sensing analysis
Procedures/ comments:	Test the significance of historical emissions from fire either through: 1. Participatory rural appraisals 2. A spatially explicit fire occurrence product based on a remote-sensing thermal sensor. The remote-sensing thermal sensor must acquire the number of fires at least once every two weeks, have a minimal resolution of 1 km, and must have at least 5 years of uninterrupted historical data. If the PRAs or the remote-sensing based fire occurrence product indicate that emissions from forest fires are insignificant on certain project parcels or forest strata, the calculation of emissions from fire may be omitted until the next baseline update, at which the significance test must be repeated. However, if PRAs or the satellite-based analysis indicate that the area is fire prone and emissions are not insignificant.
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

Data/parameter [MN 86]:	ER_{CH4}
Data unit:	
Used in equations:	[EQ68]
Description:	Emission ratio for CH_4
Sources of data:	Table 3A.1.15 in IPCC GPG-LULUCF (2003).
Procedures/ comments:	Use default value of 0.012.

Frequency of monitoring:	Only to be included if the historical fire emissions are significant (see before).

Data/parameter [MN 87]:	$\Delta C_{fire}(i)$
Data unit:	[tCO_2-eq ha^{-1}]
Used in equations:	[EQ98]
Description:	Biomass lost due to small-scale fires
Sources of data:	Field inventories
Procedures/ comments:	Calculate as the difference in carbon stock densities between the “from” and “to” class and stratum for transition i, or 10% of the carbon stock density of the “from” class of the transition, whichever is greatest. []. Only to be included if the historical fire emissions are significant (see before).
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 88]:	$fireExtent(t, i)$
Data unit:	
Used in equations:	[EQ98]
Description:	Proportion of project area and leakage belts that were affected by small-scale fires.
Sources of data:	Default factor or remote sensing analysis
Procedures/ comments:	By default, assume 100% or substantiate a smaller percentage using remote sensing data products, on the condition that the quantification is conservative. Only to be included if the historical fire emissions are significant.
Frequency of monitoring:	Annually

Data/parameter [MN 89]:	x
Data unit:	Year
Used in equations:	
Description:	Number of years of long term persistent increase/decrease in forest carbon stock used in definition of forest degradation, and forest regeneration.
Sources of data:	Theoretical thresholds, currently 10 years.
Measurement procedures:	Use values from standards (such as VCS) if available or select remaining conservative.
Frequency of monitoring:	This parameter must be set at validation and remains fixed until the next baseline update.

Data/parameter [MN 90]:	y
Data unit:	
Used in equations:	
Description:	Minimum percentage of change in forest carbon stock used in definition of forest degradation, and forest regeneration.
Sources of data:	Theoretical threshold, currently 10%.
Measurement procedures:	Use values from standards (such as VCS) if available or select remaining conservative.
Frequency of monitoring:	This parameter must be set at validation and remains fixed until the next baseline update.

Data/parameter [MN 91]:	t
Data unit:	Year
Used in equations:	
Description:	Measurement time period for estimating persistent increase/decrease in forest carbon stock used in definition of forest degradation, and forest regeneration.
Sources of data:	Theoretical thresholds, currently 10 years.
Measurement procedures:	Use values from standards (such as VCS) if available or select remaining conservative.
Frequency of monitoring:	This parameter must be set at validation and remains fixed until the next baseline update.

Data/parameter [MN 92]:	Forest definition consistency
Data unit:	
Used in equations:	
Description:	The consistency of the selected forest definition with applicable compliance REDD schemes must be regularly evaluated.
Sources of data:	
Measurement procedures:	
Frequency of monitoring:	The consistency must be re-evaluated every baseline update.

Data/parameter [MN 93]:	$V_{ex,h,ty,j}$
Data unit:	[Mg C]
Used in equations:	[EQ94]
Description:	The volume of timber extracted from within the project boundary during harvest *h* by species *j* and wood product class *ty* [m^3]
Sources of data:	Annually extracted wood volume. (Lower ranked options are used only if higher ranked options are not available) (1) Recent literatures (peer reviewed publications, national/regional/local inventory and analysis reports (2) Rural appraisals conducted by project proponents (3) Forest operations log books (for update)
Measurement procedures:	
Frequency of monitoring:	Annually

III.1.2 Data and Parameters related to reduced wood consumption through the use of Fuel-Efficient Woodstoves

The use of fuel-efficient woodstoves is optional. However, if fuel-efficient stoves are included and avoided degradation is excluded from the project[47] (section II.2.1), the carbon accounting following the approved gold standard methodology "Indicative Programme, Baseline, and Monitoring Methodology for Improved Cook-Stoves and Kitchen Regimes" (Currently V.02) must be followed as is explained in section II.2.1 under the heading "Decrease the consumption of fuel-wood".

[47] If avoided degradation is included in the project, emission reductions from fuel-efficient cookstoves are accounted for using the stock-change approach which is included within this methodology.

All monitoring data and parameters from this methodology must be included within the monitoring plan of the REDD project. Empirical values of fuel consumption determined using "Kitchen Tests" for conventional and fuel-efficient stoves must be available in the monitoring report before the verification period during which credits from reduced fuel-wood use from improved cookstoves are sought.

III.1.3 Data and Parameters related to Nitrous Oxide Emissions from Nitrogen Fertilization

If increased nitrogen fertilization is used as an agricultural intensification for leakage prevention, all data and parameters from the latest version of the approved CDM tool "Estimation of direct nitrous oxide emission from nitrogen fertilization" (EB33 Annex 16) must be included. More specifically, all data and parameters in the section "Data and parameters monitored" must be included and collected according to the procedures described within this tool.

For the purpose of this methodology, the following variables are specified in more depth than the specification provided within the CDM tool.

Data/parameter [MN 944]:	$M_{SFi,t}$
Data unit:	[kg N yr^{-1}]
Used in equations:	
Description:	Mass of synthetic fertilizer type i applied in year t.
Sources of data:	Social assessments
Procedures/ comments:	Value is the difference between the synthetic fertilizer applied during the project in year t and the synthetic fertilizer applied during the baseline. The mass of synthetic fertilizer used must be quantified for every cropping system that is part of the agricultural intensification of the REDD project both on fields that represent the baseline fertilization rate and fields that are part of the agricultural intensification. Only to be included if fertilizer input is increased in agricultural production systems as a leakage prevention measure.
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

Data/parameter [MN 95]:	$M_{OFj,t}$
Data unit:	[kg N yr^{-1}]
Used in equations:	
Description:	Mass of organic fertilizer type j applied in year t.
Sources of data:	Social assessments
Procedures/ comments:	Value is the difference between the organic fertilizer applied during the project in year t and the organic fertilizer applied during the baseline. The mass of organic fertilizer used must be quantified for every cropping system that is part of the agricultural intensification of the REDD project both on fields that represent the baseline fertilization rate and fields that are part of the agricultural intensification. Only to be included if fertilizer input is increased in agricultural production systems as a leakage prevention measure.
Frequency of monitoring:	Every 5 years or at least once before every verification, whichever is more frequent

III.1.4 Data and Parameters related to Methane Emissions from Flooded Rice Production

The following data and parameters must be available in the PD if conversion to flooded rice production is introduced as a leakage prevention measure:

Data/parameter [MN 96]:	$\Delta A_{rice}(t)$
Data unit:	[ha]
Used in equations:	[EQ93]
Description:	Annual increase in harvested area of rice due to leakage prevention measures.
Sources of data:	Project design decision
Procedures/ comments:	Only to be included if rice production is increased as a leakage prevention measure.
Frequency of monitoring:	Annually

Data/parameter [MN 97]:	$t_{flooded,max}$
Data unit:	[days yr^{-1}]
Used in equations:	[EQ93]
Description:	Maximal period of time a field is flooded
Sources of data:	Participatory rural appraisals
Procedures/ comments:	Only to be included if rice production is increased as a leakage prevention measure.
Frequency of monitoring:	Annually

Data/parameter [MN 98]:	$EF_{rice,max}$
Data unit:	[kg CH_4 ha^{-1} day^{-1}]
Used in equations:	[EQ93]
Description:	Maximal emission factor for methane
Sources of data:	Literature
Procedures/ comments:	By default, an emission rate of 36 kg CH4 ha^{-1} day^{-1} must be used, which is 25% greater than the maximal value found in a review study comparing 23 studies of CH4 fluxes in rice fields (Le Mer and Roger, 2001). Project proponents may use a smaller emission rate if it can be demonstrated that the rate remains conservative for the project conditions. Only to be included if rice production is increased as a leakage prevention measure.
Frequency of monitoring:	Every 10 years or every baseline update, whichever is more frequent

III.1.5 Data and Parameters related to GHG Emissions from Increased Livestock Stocking

If livestock stocking rates are increased as a leakage prevention measure, the appropriate data and parameters from the latest version of the approved CDM methodology AR-AM0006 must be included. More specifically, all data and parameters in Table 4 (“Data and information that will be collected in order to monitor leakage of the proposed A/R CDM project activity”) of section III.8 (“Data to be collected and archived for leakage”). Data and parameters monitored” must be included and collected according to the procedures described within this table and the relevant sections of this methodology.

In addition, all data and parameters from the latest version of the approved CDM A/R methodological tool "Estimation of GHG emissions related to displacement of grazing activities in A/R CDM project activity" (EB39, Annex 12), section 2 of the "List of parameters and variables" part of Appendix A ("Data and parameters estimated for the ex ante and monitored for ex post calculations.") must be included in the monitoring procedure according to the procedures described in this CDM methodological tool.

III.2 Calculation of *Ex-post* Actual Net GHG Emission Reductions

A monitoring report must contain the *ex-post* values of the actual net GHG emission reductions. Actual net NERs must be based on Equation [EQ1]; actual VCUs must be based on Equation [EQ2]. Update the parameters that are designated as "calculated *ex-post*" in Table 19 with the procedures in this section.

Table 19. Parameters required to calculate NERs, following Equation [EQ1] with the data source required for this parameter.

Parameter	Source
$\Delta area_{projectAreaWithoutANR,projectScenario}(t,i)$	Calculated *ex-post* based on remote sensing data gathered at the end of the monitoring period
$\Delta area_{projectAreaWithoutANR,baselineScenario}(t,i)$	Fixed *ex-ante*, no *ex-post* adjustment is allowed. Updated during baseline update.
$\Delta area_{projectAreaWithANR,baselineScenario}(t,i)$	Fixed *ex-ante*, no *ex-post* adjustment is allowed. Updated during baseline update.
$\Delta area_{leakageArea,projectScenario}(t,i)$	Calculated *ex-post* based on remote sensing data gathered at the end of the monitoring period
$\Delta area_{leakageArea,baselineScenario}(t,i)$	Fixed *ex-ante*, no *ex-post* adjustment is allowed. Updated during baseline update.
$u_{classification}$	Fixed *ex-ante*, no *ex-post* adjustment is allowed. Updated during baseline update.
$u_{inventory}(i)$	Fixed *ex-ante*, no *ex-post* adjustment is allowed. Updated in every monitoring report.
$EF(i)$	Fixed ex-ante, no ex-post adjustment is allowed. Updated in every monitoring report.
$GHG_{otherLeakageSources}(t)$	Calculated *ex-post* based on monitoring data
$\Delta C(t,i)$	Calculated ex-post based on monitoring data
$NAI(i)$	Fixed *ex-ante*, no *ex-post* adjustment is allowed. Updated in every monitoring report.
$u_{classification}$	Fixed ex-ante, no ex-post adjustment is allowed after first verification
$u_{stratification}$	Fixed *ex-ante*, no *ex-post* adjustment is allowed. Updated during baseline update.
$GHG_{otherLeakageSources}(t)$	Calculated *ex-post* based on monitoring data
$GHG_{sources,projectArea}(t)$	Calculated *ex-post* based on monitoring data
$GHG_{sources,leakagePrevention}(t)$	Calculated *ex-post* based on monitoring data

$GHG_{sources,ANR}(t)$	Calculated *ex-post* based on monitoring data
$C_{LWP,project,t}$	Calculated *ex-post* based on monitoring data

III.2.1 Calculation of *Ex-ante* GHG Emissions and Changes in Sinks under the Baseline Scenario

This section relates to the following parameters from Equation [EQ1]: $\Delta area_{projectAreaWithoutANR,baselineScenario}(t,i)$, $\Delta area_{leakageArea,baselineScenario}(t,i)$, $\Delta area_{projectAreaWithoutANR,baselineScenario}(t,i)$, $\Delta area_{leakageArea,baselineScenario}(t,i)$, $area_{projectAreaWithANR,baselineScenario(t,i)}$, $u_{classification}$, $u_{inventory}(i)$, $EF(i)$, $NAI(i)$, $u_{stratification}$

Annual baseline land transition rates, emission factors, and uncertainty discounting factors that were approved in the PD or in the latest baseline update must be used. No *ex-post* adjustments of these values are allowed.

III.2.2 Calculation of *Ex-post* GHG Emissions and Changes in Sinks under the Project Scenario inside the Project Area

This section relates to the following parameters from Equation [EQ1]: $\Delta area_{projectAreaWithoutANR,projectScenario}(t,i)$, $\Delta area_{projectAreaWithANR,projectScenario}(t,i)$, $\Delta C(t,i)$, $GHG_{sources,projectArea}(t)$, $GHG_{sources,ANR}(t)$, $C_{LWP,project,t}$

The changes in carbon sinks under the project scenario in the project area must be calculated based on remote sensing change analysis and field measurements.

- Carbon stock densities must be re-measured at least once before every verification event using ground-based biomass inventories, as described in section II.1.4.5. Updated values for the Emission Factors must be reported in the monitoring report based on the procedure in section II.1.4.

  The values used for baseline natural regeneration per forest stratum, $NAI(i)$, must be updated based on the measurements on the biomass inventory plots by using the following equation, similar to Equation [EQ71]:

$$NAI(i) = area_{projectAreaWithANR,projectScenario}(t,i) \cdot \frac{C(t_2,i) - C(t_1,i)}{t_2 - t_1} \qquad [97]$$

where:

$NAI(i)$	=	Net annual increment under the baseline scenario. [Mg C ha^{-1} yr^{-1}]
$area_{projectAreaW}$	=	Amount of land on which ANR activities are performed under the baseline scenario for year t and in stratum i.

$C(t_2, i)$ and $C(t_1, i)$	=	Aboveground carbon stock density during years t_2 and t_1 respectively from a stratum on which no ANR activities are planned, but that is similar in conditions as stratum i within the land on which ANR activities are performed. These quantities should be determined using biomass inventories. [Mg DM ha^{-1}]
$t_2 - t_1$	=	duration between times 1 and 2. [year]

Therefore, $NAI(i)$ is the empirically observed regeneration rate on strata that are similar to the ones on which ANR activities are performed.

- Acquire (a) remote sensing image(s) between validation or the last verification and the current date, and use the same procedure as used for the baseline to produce (a) land use, land cover, and forest cover map(s). As explained in section II.1.2.4.1, if any part of the project area is covered in clouds or cloud shadows, its GHG accounting should be postponed on that portion of the project area in this monitoring period until cloud-free imagery in this portion of the project area is available. The postponed NERs may be added to the NERs generated in the subsequent monitoring period. Note that if a different remote sensing data source is used than for the historical baseline analysis, the provisions in section III.4 must be followed.
- Execute an image classification on the acquired image according to the procedures in II.1.2.4. Perform an accuracy assessment as described in this section using data from field sampling and independent remote sensing data. Use the minimal accuracy of the three images of the historical reference period and the acquired images used for monitoring to base the ex-post discounting factor on.
- Compare the changes in between consecutive map(s) since the last time the project was verified and until the current map of land use, land cover, and forest cover. For the project area where no ANR activities were performed, produce (a) land transition matrix/matrices between the consecutive map(s) since the last verification.
- Annualize the land transition matrix/matrices by dividing the land transition rates by the duration in between the two states represented by the maps. The annual rates of land transition changes for the project area on which no ANR activities are planned is $\Delta area_{projectAreaWithoutANR,projectScenario}(t, i)$ in Equation [EQ1].
- Because forest degradation is conservatively omitted on land on which ANR activities are planned, and increases in forest biomass are quantified using CDM-AR-ACM0001 version 03 (see section II.2.4), set all forest degradation and forest regeneration values to zero on the ANR areas. In other words, only retain values for deforestation and increased forest cover transitions. These are the values for $\Delta area_{projectAreaWithANR,projectScenario}(t, i)$ in Equation [EQ1].
- For the ANR areas, calculate values of $\Delta C(t, i)$ using Equation [EQ71]. Measure the current aboveground tree biomass density, $B_{AG}(t, i)$, for every stratum i, and calculate the belowground tree biomass density $B_{BG}(t, i)$ using the procedures in section II.1.4.5. Project proponents may choose to increase the number of sampling plots during the crediting period of previous plots on forest land become deforested or lost through some other cause. An update of the sampling design may be necessary based on updated standard deviations of biomass stock densities.

- Actual emissions from sources under the project scenario within the project area, $E_{sources,projectArea}(t)$ must be calculated using monitored data.
- Actual emissions from sources under the project scenario due to site preparation for ANR activities, $E_{sources,ANR}(t)$ must be calculated using monitored data.
- $C_{LWP,project,t}$ net carbon stock change in long-lived wood products during time t must be calculated using monitored data as explained in section II.4.1.

In the case that credits from avoided degradation were excluded from the generated NERS due to the fact that forest strata cannot be detected with sufficient accuracy, credits from the introduction of fuel-efficient woodstoves may still be issued, as explained in section II.2.1 under "Decrease the consumption of fuel-wood". Credits must be calculated according to the approved gold standard methodology "Indicative Programme, Baseline, and Monitoring Methodology for Improved Cook-Stoves and Kitchen Regimes" (Currently V.02), discounted using equation [EQ60], and added to the total NERs according to [EQ1]. The factor "0.75" is to discount the credits from fuel-efficient woodstoves to remain conservative.

III.2.3 Calculation of CH4 Emissions from Fires other than from Controlled Burning

As was explained in section II.3.2.4, losses of carbon in biomass due to fires other than from controlled burning are accounted for through the stock change approach within the methodology. Emissions of CH_4 from fires other than from controlled burning, $E_{fires,projectArea}(t)$, must still be accounted for and added to $E_{sources,projectArea}(t)$, so they are subtracted from the NERs following Equation 1. Small-scale fires usually remain undetected on the remote-sensing based LULC classification maps produced using the procedures in this methodology. However, large-scale (>10 ha) catastrophic fires in which a significant part of the tree biomass is removed usually, can be easily detected through the LULC classification maps. Therefore, the procedures to account for CH4 emissions from fires were separated between small-scale fires and large-scale fires.

III.2.3.1 Small-scale Fires, not detectable through optical remote sensing

At validation, in the project document, it was determined whether historical emissions of fires were significant (see section II.3.2.4). If emissions from fire were found to be significant at validation, the emissions from fire must be calculated using the following equation:

$$E_{small-scale\ fires,projectArea}(t) = \frac{16}{12} \cdot GWP_{CH4} \cdot ER_{CH4} \cdot \sum_{i=1}^{nrTransitions} \Delta C_{fire}(i) \cdot \Delta area_{projectArea,projectScenario}(t,i) \cdot fireExtent(t,i)$$

[98]

where:

$E_{fires,projectArea}(t)$ = Emissions of CH_4 due to fires other than from controlled burning

i = Fire-induced transition between a "from" forest class and a "to" forest class. [-]

t	=	Time since project start [yr]
GWP_{CH4}	=	Global Warming Potential for CH_4 (IPCC default value = 21 for the first commitment period). [-]
ER_{CH4}	=	Emission ratio for CH_4 (IPCC default value = 0.012). See Table 3A.1.15 in IPCC GPG-LULUCF (2003). [-]
$nrTransitions$	=	Number of change categories between two land classes or forest strata.
$\Delta C_{fire}(i)$	=	Calculate as the difference in carbon stock densities between the "from" and "to" class or stratum for transition i, or 10% of the carbon stock density of the "from" class of the transition, whichever is greatest. [tCO_2-eq ha^{-1}].
$\Delta area_{projectArea,projectScenario}(t,i)$	=	Hectares undergoing transition i within the project area, under the project scenario for year t. [ha yr^{-1}].
$fireExtent(t,i)$	=	Proportion of area that was affected by fire. By default, assume 100% or substantiate a smaller percentage using remote sensing data products, on the condition that the quantification is conservative. [-]

III.2.3.2 Large-scale Fires, not detectable through optical remote sensing

Methane emissions from large-scale (>10 ha) catastrophic fires must always be included as secondary emissions, even if they occur in areas for which no fires were observed during the historical reference period.

$$E_{large-scale\ fires,projectArea}(t) = \frac{16}{12} \cdot GWP_{CH4} \cdot ER_{CH4} \cdot \sum_{i=1}^{nrTransitions} \Delta C_{fire}(i) \cdot \Delta area_{projectArea,projectScenario}(t,i) \quad [99]$$

where:

$E_{fires,projectArea}(t)$	=	Emissions of CH_4 due to fires other than from controlled burning
i	=	Fire-induced transition between a "from" forest class and a "to" forest class. [-]
t	=	Time since project start [yr]
GWP_{CH4}	=	Global Warming Potential for CH_4 (IPCC default value = 21 for the first commitment period). [-]
ER_{CH4}	=	Emission ratio for CH_4 (IPCC default value = 0.012). See Table 3A.1.15 in IPCC GPG-LULUCF (2003). [-]
$nrTransitions$	=	Number of change categories between two land

classes or forest strata.

$\Delta C_{fire}(i)$ = Calculate as the difference in carbon stock densities between the "from" and "to" class or stratum for transition i, or 10% of the carbon stock density of the "from" class of the transition, whichever is greatest. [tCO_2-eq ha^{-1}].

$\Delta area_{large\ scale\ fires}\ (t,i)$ = Hectares on which a large scale (>10 ha) fire was detected using medium-resolution satellite imagery leading to transition i for year t. [ha yr^{-1}].

The same procedure as above must be used in case of large-scale fires, with the empirically detected size of the large-scale fire (this corresponds to monitoring parameter [MN 77], and $\Delta C_{fire}(i)$ the decrease in carbon between the empirically determined "from" and "to" class.

III.2.4 Calculation of *Ex-post* GHG Emissions and Changes in Sinks under the Project Scenario outside the Project Area (Leakage)

This section relates to the following parameters from Equation [EQ1]: $\Delta area_{leakageArea,projectScenario}(t,i)$, $GHG_{otherLeakageSources}(t)$, $GHG_{sources,leakagePrevention}(t)$

Similar to section II.3.1, a distinction is made between the calculation of leakage from geographically constrained drivers and leakage from geographically unconstrained drivers. See section II.3.1 for a distinction between these two categories.

III.2.4.1 Calculation of *Ex-post* Leakage from Geographically Constrained Drivers

The land-use and land cover changes[48] under the project scenario in the leakage area must be calculated using the same remote sensing change analysis as for the project area under the project scenario:

- Acquire (a) remote sensing image(s) between validation or the last verification and the current date, and use a similar procedure as used for the baseline to produce (a) land use, land cover, and forest cover map(s).
- Compare the changes in between consecutive map(s) since the last time the project was verified and until the current map of land use, land cover, and forest cover. For every leakage belt, produce (a) land transition matrix/matrices between the consecutive map(s) since the last verification.
- Annualize the land transition matrix/matrices by dividing the land transition rates by the duration in between the two states represented by the maps. The annual rates of land transition changes for the leakage area is $\Delta area_{leakageArea,projectScenario}(t,i)$ in Equation [EQ1].
- Add CH_4 emissions from fires in the leakage area using a similar procedure as the one described in section III.2.3, except for the following changes: (1) the PRAs or

[48] These land-use and land cover (LULC) changes do not only include deforestation and forest degradation, but also LULC changes on non-forest land such as the conversion of woodlands to grasslands due to fuel-wood collection.

remote-sensing based procedure to determine whether forest fires occur must be conducted in the leakage area, (2) $\Delta area_{leakageArea,projectScenario}(t,i)$ must be used instead of $\Delta area_{projectArea,projectScenario}(t,i)$, and (3) $fireExtent(t,i)$ must be calculated explicitly for the leakage area.

III.2.4.2 Calculation of *Ex-post* Leakage from Geographically Unconstrained Drivers

Activity-shifting leakage from geographically unconstrained drivers is quantified *ex-post* using a factor approach in which default leakage cancellation factors, set by the VCS (VCS 2007.1, 2008) are used. Use Equation [EQ1] to calculate $GHG_{otherLeakageSources}(t)$.

III.2.4.3 Calculation of Ex-post Emission Sources from Leakage Prevention Activities

Actual emissions from sources from leakage prevention activities, $GHG_{sources,leakagePrevention}(t)$, must be calculated using the equations in section II.3.4II.3.4, but with monitored data.

III.3 Adjustments to the Project Activities and Sampling Design

III.3.1 Addition of New Project Area before First Verification

Following VCS 2007.1, 2008 p16-17, new discrete project area parcels that were not yet under control or covered with clouds at the time of validation and that have, meanwhile, become under control or for which cloud-free imagery was obtained, respectively, may be integrated into an existing project as long as the additionality is not impacted. Adding new discrete project area parcels can occur only at the first verification and must be proposed in the monitoring report of the first verification. After the first verification, the geographical boundaries of the project area are fixed for the rest of the crediting period. In addition to the requirements from the VCS, the following conditions must be met before new project area can be added:

- The new project area is not larger than 20% of the total project area (including the newly added area).
- Barriers to forest conservation must exist for the extended area at the time of verification, and thus the inclusion of new project areas does not impact the additionality of the project. The following two conditions must be present: (1) additionality must have been proven by barriers during validation and (2) it must be demonstrated that the same barriers exist at the time of verification for the new project area. Use the additionality tool related to this methodology to demonstrate these conditions
- The new project area is located within the reference region and follows all requirements and applicability conditions as defined in this methodology.
- A valid leakage belt can be demarcated around the new project area and this leakage belt is still completely located within the reference region.
- The monitoring plan is flexible enough to accommodate the new discrete project area parcels by adding a number of sampling plots proportional to the increase in area.
- A valid baseline for the new areas is added to the monitoring report.

These conditions must be demonstrated in the monitoring report of the fist verification event. In addition, the monitoring report must contain the spatial boundaries of the new discrete project area parcels. The addition of new discrete project area parcels can only occur upon a positive evaluation of the relevant section in the monitoring report by a VCS-accredited verifier.

III.3.2 Adjustments to the ANR Management Plans before First Verification

Adjustment of the assisted natural regeneration management plans is allowed until to the first verification on the condition that any adjustments do not impact the additionality as demonstrated using the included additionality tool. Project proponents must demonstrate that additionality is not impacted in the monitoring report of the first verification event. The adjustments must be formally approved by the validator during the first verification. After the first verification, the management plan, including the size and location of ANR activities is fixed.

III.3.3 Update of the Sampling Design of Biomass Inventory Plots

It is likely that during the crediting period, permanent forest sampling plots will have to be abandoned due to unforeseen deforestation or natural disasters. When this is the case, new permanent sampling plots must be established. Additionally, the number of permanent sampling plots may be increased simply to decrease $u_{inventory}$ and generate a higher volume of NERs.

III.4 Updates to Baseline Net GHG Removals by Sinks

Once the baseline (calculated *ex-ante*) is verified, it is locked during the baseline validation period. After this period, a new baseline needs to be calculated and verified. No *ex-post* adjustment of the baseline is allowed. The baseline must be re-assessed and updated every ten years (VCS 2007.1, 2008), unless one or more of the following conditions is present.

- New national, local and/or sectoral policies are implemented that affect allowable forest use.
- A natural disturbance, such as a major crown fire, pests, tsunami, earthquake, volcanic eruption, landslide, flooding, etc., affecting more than 20% of the land has occurred.
- Significant changes of political, social or economic nature have occurred, making previous baseline estimates inaccurate.
- A change in opportunity costs has occurred such that alternative land uses on the land become much more attractive than the REDD project due to market effects such as a significant price rising of timber and non-woody products, or the increase of prices of agricultural commodities would increase the deforestation pressure on the current forest land.
- New roads or were or will be constructed.
- Any other potential significant change relevant for the project region beyond the events already covered above and identified at validation.

Every monitoring report must explicitly test the presence or absence of each of these conditions. If one or more of these conditions is present, a baseline update must be conducted within the monitoring report.

The updated baseline must be included in the monitoring report when it is submitted to the VCS-accredited verifier. The baseline update must also contain the frequency and years of verification, fixed for the duration the baseline is valid.

Baseline updates must follow section II.1, using updated values for all the variables that indicated as such in the monitoring table. The following exceptions to the procedures of section II.1 must be followed:

- The baseline must be re-calculated for every year of the whole crediting period, meaning from the start of the crediting period onwards and until the end of the crediting period. However, only the ex-ante NERs and baseline calculations until the next baseline update will be validated. Note that the re-calculation of previous years is necessary to understand the baseline state in the project area at the time of the baseline update.
- The new historical reference period used for the baseline update extends from the original start date of the historical reference period to the time at which the baseline update event is scheduled. In other words, all intermediate values for deforestation and forest degradation rates from the beginning of the historical reference period until the current time must be included. During the crediting period, the graphs of deforestation and forest degradation rates versus time will contain an increasing number of points.
- In addition, after project start, the reference period must exclude project areas and leakage belts. If after project start, new areas within the reference region become protected, these must be excluded from the updated reference region. Protected areas include:
    - National parks that are effectively protected
    - Areas under conservation that are effectively protected
    - Areas under a logging or economic land concession where access is effectively being restricted
    - Large plantations that are effectively protected
- Allometric equations used for biomass stock density calculations may be revised during a baseline update.
- Project proponents must use the same remote sensing data sources and analysis procedures as were used for project design or in the previous baseline update. However, if improved (i.e., spectral resolution of minimally 20% higher) data sources and remote sensing data analysis procedures become available to the project participants during the crediting period, or if the sensors used for the previous ex-ante baseline calculations become unavailable, it is allowed to change the procedures used previously on the following conditions:
    - Any change in data sources and analysis procedures shall be duly explained and recorded. The Standard Operations Procedure for remote sensing analyses must be updated when a new sensor is used and the baseline is updated.
    - Similar spectral bands (e.g., Red, Green, Blue, NIR, SWIR, MIR, etc.) used for classification from the original sensor must be present in the alternative sensor. A formal comparison of the sensors shall be added to the baseline update section within the monitoring report.
    - If a new sensor is used and the baseline is not updated, the spectral resolution must be down-sampled to the spectral resolution of the original sensor, so that the same remote sensing procedure as used during the baseline calculation can be used. Demonstrate that the

classification results of the images from the previous sensor and the new sensor are comparable.
    - The full resolution may only be used forward-looking after a baseline update and sufficient historical images of the higher resolution are available to calculate the baseline, according to the procedures in Table 5. As a consequence, the inclusion of forest degradation based on higher-resolution data may only occur during a baseline update.
- The discounting factors $u_{stratification}$ and $u_{classification}$ must be updated during the baseline update period based on the classification and stratification accuracies for the period until the baseline update.
- The relative forest cover increase and regeneration rates described in Step 5B (section II.1.5.2) may only be updated using data that is less than 10 years old.
- Summarize all updated baseline land transitions Update the *ex-ante* NERs using the updated baseline estimates, and present an updated version of the overview table in the monitoring report.
- Conduct the significance test whether CH4 emissions from fire are to be monitored again for every project parcel and forest stratum, following the procedures in section II.3.2.4.

III.5 Guidance on Social Assessments

Social assessments must be conducted to collect social information regarding project conditions. For most data items that are to be collected within the methodology, personal interviews with individual households are preferred; these are referred to as "household surveys". However, for data items that are more challenging to quantify such as forest fires and forest encroachment, semi-structured focus group discussions with representative community members are more appropriate; these are referred to as "participatory rural appraisals". The sample size for household surveys can be based on a comparatively small proportion of the target population (UN 2008). The required number of household surveys must be selected so that a minimal confidence level of 95% is attained. The exact number of surveys can be determined using the formula in Krejcie and Morgan (1970). In case of semi-structured interviews in participatory rural appraisals; at least 10 focus group discussions must be conducted. Further guidelines for carrying out these appraisals can be found in Cochran (1977), Freudenberger (1994), Kish (1995), Top et al. (2004) and UN (2008). The following steps are to be followed for designing and conducting surveys.

(1) **Assemble all information** that must be collected and determine the goals of the questionnaire. Identify all information that is required by the methodology.
(2) Determine the **target group** of the questionnaire, and sub-divide the group into different strata. Strata should be defined according to geography, household size, age, gender, etc. Take proper care to avoid the selection of a biased target group.
(3) Determine the **total sample size** and the number of samples required in each stratum. Identify the population in each of the strata categories defined in the previous step. Set quotas, a minimal number of surveys from each of the sample strata. Surveys must be collected until the quotas have been reached.

(4) **Create your questionnaire.** Transform the required data into neutral, simple and systematic questions. If possible and relevant, generate a set of expected answers. Include partially redundant questions to ensure consistency of data. Include space for some sketch mapping, if relevant. Expected answers could be complemented with graphs, figures, maps and pictures. Allow a "not applicable" or "uncertain" category. Group questions logically according to their contents and leave difficult or sensitive questions until near the end of a survey.

(5) Choose **interviewing methodology** and develop a standard operations procedure for interviewing. Include QA/QC procedures such as re-sampling a randomly selected sub-group by different experts, and the requirement to take geo-tagged pictures. All surveys must contain date, time, location, and name of the expert who conducted the survey. In addition, include a section on how to introduce the purpose of the questionnaires to the interviewees.

(6) **Pre-test the questionnaire** and methodology, and adjust the questionnaire and its methodology, if necessary. More specifically, if questions are multiple choice (discrete), ensure that all potential answers are included.

(7) **Train experts for conducting interviews**. Through instruction, role playing exercises, and test sessions followed by immediate feedback, train experts to conduct interviews. Experts should be properly trained in explaining the broader scope of the social assessments.

(8) **Conduct interviews** and enter data. Make sure a copy is made of all surveys in put in a secure archive. Furthermore, all surveys should be scanned and stored electronically to avoid loss of data. Surveys should be immediately evaluated and if systematic problems arise, the survey must be adjusted or experts conducting the interviews should be re-trained. Make sure that experts are accompanied by an experienced supervisor for at least 10% of the interviews throughout the surveying campaign, and not only in the beginning of the campaign.

(9) **Analyze the data** - Produce reports.

III.6 Conservative Approach and Uncertainties

NERs are calculated by multiplying activity data, area of land that is converted, and emission factors, the decrease in carbon content upon conversion of the land. Both the activity data and the emission factors must be discounted based on the empirically quantified uncertainty of classification into LULC classes, stratification into more narrow forest strata, and biomass inventory using sampling plots, respectively.

- The **activity data** from avoided deforestation must be discounted using $u_{classification}$, the **activity data** from avoided degradation must be discounted using $u_{stratification}$. The $u_{classification}$ and $u_{stratification}$ factors are selected based on the empirically observed accuracy of discerning forest/non-forest classes, and forest biomass classes, respectively. Use Table 7 to select $u_{classification}$ and $u_{stratification}$ based on the accuracies. Note that a minimal accuracy of 70% for the LULC classification and forest biomass density stratification must be attained. If stratification does not meet this accuracy threshold, credits from avoided deforestation may still be generated, on the condition that the relevant accuracy threshold is met. However, if the LULC classification does not meet the accuracy threshold, the project is not eligible.

- The **emission factor** must be discounted with $u_{inventory}$, which is based on the half-width of the 95% confidence interval around the mean difference between the two carbon stock densities. This is explained in II.1.4.6.

III.7 Quality Assurance and Quality Control Procedures

To ensure the precise, verifiable and transparent calculation of net NERs, a quality assurance and quality control (QA/QC) procedure shall be implemented.

QA/QC for **field measurements**

- Persons involving in the field measurement work should be fully trained in the field data collection and data analyses.
- List all names of the field teams and the project leader and the dates of the training sessions.
- Record which teams have measured each sampling plot. Record who was responsible for each task.
- Develop Standard Operating Procedures (SOPs) for each step of the field measurements and adhere to these at all times, both ex-ante and ex-post.
- Put a mechanism in place to correct potential errors or inadequacies in the SOPs by a qualified person.
- Verify that plots have been installed and measured correctly, by having approximately 10% of all plots re-measured by an independent team. If the deviation between measurement and re-measurement is larger than 5%, investigate the source of the error, record and correct.

QA/QC for **data entry, documentation and analyses**

- Review the entry of data into the data analyses spreadsheets by an independent source.
- Archived all original data sheets safely. Electronic data shall be backed up adequately on durable media.
- Ensure that all files are named appropriately. Ensure that all database fields, spreadsheet headings or cells are adequately documented in such a way that it can be verified independently.
- Verify calculations for trivial errors such as unit conversion errors.
- If parameters are common between analyses (e.g., emission factors), ensure that consistent values are used.
- Check for consistency among time series data. Identify outliers as soon after the actual measurement as possible. Investigate the cause of the outlying observation, and correct if needed.
- Compare estimates from field measurements or social appraisals with literature values.
- An SOP for non-biomass monitoring must be developed and adhered to at all times.

QA/QC for **remote sensing analyses**

- Develop Standard Operating Procedures (SOPs) for each step of the remote sensing analyses and adhere to these at all times, both ex-ante and ex-post.
- Use ground-truthing data to validate the LULC classification and forest stratification. Use confusion matrices and accuracy indices to analyze and quantify the accuracy of the classification.
- Use visual interpretation of high-resolution satellite imagery to complement the medium resolution imagery.
- Check for consistency among time series data. If outliers are present (e.g., in deforestation quantities), analyze the cause and correct if errors were made.
- Compare estimates of deforestation and forest degradation rates with relevant estimates from the literature.

QA/QC for **land use change modeling**

- Split the available data in 2/3 for calibration purposes, and 1/3 for validation purposes. Never use the same data for calibration and validation.
- Report a measure for the accuracy of the land use change model.

Monitoring plan description requirements in PD

Include the following elements in the monitoring plan:
• Variables to be tracked continuously
    o Authority responsible for tracking.
    o List of variables that will be tracked continuously.
    o Which potential natural disturbances are foreseen?
    o Who will record information on natural disturbances?
    o How will adoption rates and super-acceptance leakage be monitored?
• Variables to be monitored periodically
    o Decision on monitoring frequency and rationale.
    o Decision on the duration of the subsequent monitoring period.
    o Who will monitor the boundaries of the project regions?
    o Field inventory
        ▪ Sample size rationale
        ▪ Sampling plot size and layout rationale
        ▪ Sampling plot location
        ▪ Standard Operations Procedure for field sampling.
    o Information on agents and drivers
        ▪ List of variables to be collected.
        ▪ If a social appraisal needs to be conducted, a list of the variables to be queried.
• Decision and rationale on the period of baseline validation.
• All relevant information on natural disturbances & catastrophes.

Section IV: Lists of Acronyms and References

IV.1 List of Acronyms Used in this Methodology

AFOLU	Agriculture, Forestry, and Other Land Use
ANR	Assisted Natural Regeneration
ARR	Afforestation, Reforestation, and Revegetation
CDM	Clean Development Mechanism
CP	Conference of the Parties
CV	Coefficient of Variation
DBH	Diameter at Breast Height (1.3 m)
DF	Deforestation
DG	Forest Degradation
DM	Dry Matter
DNA	Designated National Authority
EF	Emission Factor
GHG	Greenhouse Gas
GIS	Geographic Information System
GPG-LULUCF	Good Practice Guide for Land Use, Land Use Change and Forestry
GPS	Global Positioning System
GWP	Global Warming Potential
ha	Hectare
IPCC	Intergovernmental Panel on Climate Change
LCL	Lower Confidence Limit
LULC	Land Use and Land Cover
Mg	Mega gram = 1 metric tonne
MMU	Minimum Mapping Unit
tCO_2-eq	Metric Tonne of Carbon Dioxide Equivalents
NER	Net Greenhouse Gas Emission Reduction
PD	Project Document
QA/QC	Quality Assurance / Quality Control
RED	Reduced Emissions from Deforestation
REDD	Reduced Emissions from Deforestation and forest Degradation
SOC	Soil Organic Carbon
VCS	Voluntary Carbon Standard
VCU	Voluntary Carbon Unit

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