JCM proposed methodology and its attached sheet are preliminary drafts and have neither been officially approved under the JCM, nor are guaranteed to be officially approved under the JCM.

Joint Crediting Mechanism Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

Host Country	The Kingdom of Cambodia
Name of the methodology proponents submitting this form	Conservation International Japan
Sectoral scope(s) to which the Proposed Methodology applies	REDD+
Title of the proposed methodology, and version number	Title: REDD in Cambodia Version number: 0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☐Additional information
Date of completion	23 Feb, 2015

History of the proposed methodology

Version	Date	Contents revised

A. Title of the methodology

REDD in Cambodia

This methodology was developed based on Verified Carbon Standard (VCS) methodology "Methodology for Avoided Unplanned Deforestation" VM0015 version 1.1 as a MRV methodology under JCM scheme. In addition to the change of the format from the one for VCS to the one for JCM, changes have been made to adapt the methodology to circumstance in Cambodia.

B. Terms and definitions

Terms	Definitions
Deforestation	The direct, human-induced and long-term conversion of forest land to non-forest land.
Reference scenario	Future scenario without the proposed project activities
Reference emission level	In this methodology, projected greenhouse gas emission level which attributes to deforestation in reference scenario is called reference emission level.
Significant	A threshold to be considered as significance/insignificance is defined in the JCM methodological guideline.

C. Summary of the methodology

Items	Summary
Calculation of reference emissions	The main steps to estimate the reference emission are: • Analysis of historical land-use and land-cover change, • Analysis of deforestation drivers, • Projection of future deforestation area in the reference region, • Projection of future deforestation area in the project area, • Estimation of emission factors and • Calculation of reference emission.
Calculation of project emissions	In this methodology, for *ex-ante* estimate estimation, carbon stock changes due to planned activities is required to be estimated, but that due to unplanned deforestation is not.

	Unplanned deforestation which is not avoided with the project activity will be monitored, verified and reported *ex- post*.
Monitoring parameters	• Area of deforestation within the project area • Area of deforestation within the leakage belt

D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	Activities under reference scenario may include unplanned logging for timber, fuel-wood collection, charcoal production, agricultural and grazing activities as long as the category is deforestation without plans by the host country government.
Criterion 2	At project commencement, the project area shall include only land qualifying as “forest” for a minimum of 10 years prior to the project start date.
Criterion 3	The project area can include forested wetlands (such as bottomland forests, floodplain forests, mangrove forests) as long as they do not grow on peat. Peat shall be defined as organic soils with at least 65% organic matter and a minimum thickness of 50 cm. If the project area includes a forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable.
Criterion 4	Forest fire is not common in the project area.
Criterion 5	The planned project activity does not increase biomass burning or intensify livestock comparing to the reference scenario.

E. Emission Sources and GHG types

Sources	Gas	Included/ TBD/excluded	Justification/Explanation of choice
Land use change	CO2	Included	
Biomass burning	CO2, CH4, N2O	Excluded	According to the eligibility criteria, forest fire is not common in the region, and the project activity does not increase biomass burning from the reference scenario.

Livestock emissions	CO2, CH4, N2O	Excluded	According to the eligibility criteria, the project does not intensify livestock,

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Section numbers which are referred in this part F are those described in the part F.

1. Main steps to estimate the reference emission

The main steps to estimate the reference emission are:

- Analysis of historical land-use and land-cover change,
- Analysis of deforestation drivers,
- Projection of future deforestation area in the reference region,
- Projection of future deforestation area in the project area,
- Estimation of emission factors and
- Calculation of reference emission.

2. Project Boundaries[1]

Spatial boundaries, temporal boundaries, carbon pools; and sources of emissions of greenhouse gases (other than carbon stock changes) are determined in this chapter.

2.1 Spatial boundaries

Define the boundaries of the following spatial features:

- Reference region;
- Project area; and
- Leakage belt.

2.1.1 Reference region

The boundary of the reference region is the spatial delimitation of the analytic domain from which information about rates, agents, drivers, and patterns of land-use and land-cover change (LU/LC-change) will be obtained, projected into the future and monitored.

[1] Cited from "Methodology for Avoided Unplanned Deforestation" VM0015 version 1.1

The reference region should contain strata with agents, drivers and patterns of deforestation that in the 10-15 year period prior to the start date of the proposed project activity are similar to those expected to exist within the project area.

The boundary of the reference region shall be defined as follows:

- The national and, where applicable, sub-national government shall be consulted to determine whether the country or sub-national region has been divided in spatial units for which deforestation reference emission level will be developed. If such divisions exist and are endorsed by the national or sub-national government, they must be used to determine the boundary of the reference region.
- If such divisions do not exist, a reference emission level must be developed for a reference region encompassing the project area, the leakage belt and any other geographic area that is relevant to determine the reference emission level of the project area.
- A geographic area is relevant for determining the reference emission level of the project area when agents, drivers and overall deforestation patterns observed in it during the 10-15 year period preceding the start date of the proposed project activity represent a credible proxy for possible future deforestation patterns in the project area.

The reference region may include one or several discrete areas. Agents and drivers of deforestation, landscape configuration and ecological conditions and socio-economic and cultural conditions are relevant to demonstrate that the conditions determining the likelihood of deforestation within the project area are similar or expected to become similar to those found within the reference region.

Where the current situation within the project area is expected to change (e.g. because of population growth, infrastructure development or any other plausible reason), the reference region might be divided in *i* strata, each representing proxies for the chrono-sequence of current and future conditions within the project area. The boundary of such strata may be static (fixed during a fixed reference period) or dynamic (changing every year), depending on the modeling approaches used.

2.1.2 Project area

The project area is the area or areas of land under the control of the project proponent on which the project proponent will undertake the project activities. At the project start date, the project area must include only forest land.

Any area affected by planned deforestation due to the construction of planned infrastructure (except if such planned infrastructure is a project activity) must be excluded from the project area.

2.1.3 Leakage belt

The leakage belt is the land area or land areas surrounding or adjacent to the project area in which activities under the reference scenario could be displaced due to the project activities implemented in the project area. In this methodology, the leakage belt is defined as forest area in the reference region but outside legally protected area from deforestation and outside the project area. The project developer must confirm that the leakage belt is larger than the projected deforestation area in the reference region in the reference scenario.

2.2 Temporal boundaries

2.2.1 Starting date and end date of the historical reference period

The starting date should not be more than around 10-15 years in the past and the end date as close as possible to the project start date. The project start date is the date at which the additional project activities which lead effective avoiding deforestation have or are to be started.

2.2.2 Starting date and end date of the first fixed reference period

The fixed reference period shall be 10 years. The starting and end dates must be defined.

2.2.3 Monitoring period

The minimum duration of a monitoring period is one year and the maximum duration is one fixed reference period.

2.3 Carbon pools

The six carbon pools listed in Table 1are considered in this methodology.

Table 1 Carbon pools included or excluded within the boundary of the proposed project activity

Carbon pools	Included / TBD / Excluded	Justification / Explanation of choice
Above-ground	Tree: Included	Carbon stock change in this pool is always significant
	Non-tree: TBD	Must be included in categories with final land cover of perennial crop
Below-ground	TBD	Optional and recommended but not

		mandatory
Dead wood	TBD	Recommended only when significant
Harvested wood products	TBD	To be included when significant
Litter	TBD	Recommended only when significant.
Soil organic carbon	TBD	Recommended only when significant.

To determine significance, the most recent version of the "Tool for testing significance of GHG emissions in A/R CDM project activities" and the JCM methodological guideline shall be used[2].

3. Reference Scenario[3]

Only Calculation method 2 and 3 need this step.

3.1 Analysis of historical land-use and land-cover change

The goal of this step is to collect and analyze spatial data in order to identify current land-use and land-cover conditions and to analyze LU/LC change during the historical reference period within the reference region. The tasks to be accomplished are the following:

- Collection of appropriate data sources;
- Definition of classes of land-use and land-cover;
- Definition of categories of land-use and land-cover change;
- Analysis of historical land-use and land-cover change; and
- Map accuracy assessment.

3.1.1 Collection of appropriate data sources

Collect the data that will be used to analyze land-use and land-cover change during the historical reference period within the reference region and project area. It is good practice to do this for at least three time points, about 3-5 years apart, but the project proponent must follow the JCM methodological guideline. For areas covered by intact forests, it is sufficient to collect data for one single date, which must be as closest as possible to the project start date (< 2 years).

As a minimum requirement:

- Collect medium resolution spatial data (from 10 m x 10 m up to a maximum of 100 m x

2 Available at: http://cdm.unfccc.int/EB/031/eb31_repan16.pdf
3 Cited from "Methodology for Avoided Unplanned Deforestation" VM0015 version 1.1

100 m resolution) from optical and non-optical sensor systems, such as (but not limited to) Landsat, SPOT, ALOS, AVNIR2, ASTER, IRS sensor data) covering the past 10-15 years.

- Collect high resolution data from remote sensors (< 5 x 5 m pixels) and/or from direct field observations for ground-truth validation of the posterior analysis. Describe the type of data, coordinates and the sampling design used to collect them.
- In tabular format (Table 2), provide the following information about the data collected:

Table 2 Data used for historical LU/LC change analysis

Vector (Satellite or airplane)	**Sensor**	**Resolution**		**Coverage**	**Acquisition date**	**Scene or point identifier**	
		Spatial	Spectral	(km^2)	(DD/MM/YY)	Path / Latitude	Row / Longitude

Where already interpreted data of adequate spatial and temporal resolution are available, with some caution these can also be considered for posterior analysis.

3.1.2 Definition of classes of land-use and land-cover

Identify and describe the land-use and land-cover (LU/LC) classes present in the reference region at the project start date. A LU/LC class is a unique combination of land-use and land-cover for which:

- The boundary can be defined by utilizing remotely sensed data and/or other sources of information, such as maps of vegetation, soil, elevation, management category, etc., as defined by the project proponent to unambiguously define a LU/LC class; and.
- Carbon stocks per hectare (tCO2-e ha-1) within each class are about homogeneous across the landscape. Carbon stocks must be at least estimated for classes inside the project area and leakage belt, which will be done in section 4.2.

The following criteria shall be used to define the LU/LC classes:

- The minimum classes shall be “Forest Land” and “Non-Forest Land”.
- “Forest-land” will in most cases include strata with different carbon stocks. Forest-land must therefore be further stratified in forest classes having different average carbon densities within each class.
- “Non-Forest Land” may be further stratified in strata representing different non-forest

classes. IPCC classes used for national GHG inventories may be used to define such classes (Crop Land, Grass Land, Wetlands, Settlements, and Other Land). See IPCC 2006 GL AFOLU Chapter 3, Section 3.2, p. 3.5 for a description of these classes. However, where appropriate to increase the accuracy of carbon stock estimates, additional or different sub-classes may be defined.

- The description of a LU/LC class must include criteria and thresholds that are relevant for the discrimination of that class from all other classes. Select criteria and thresholds allowing a transparent definition of the boundaries of the LU/LC polygons of each class. Such criteria may include spectral definitions as well as other criteria used in post-processing of image data, such as elevation above sea level, aspect, soil type, distance to roads and existing vegetation maps.
- For all forest classes present in the project area, specify whether degradation due to logging for timber, fuel wood collection or charcoal production are happening in the reference scenario..
- In most cases one single Land-Use and Land-Cover Map representing the spatial distribution of forest classes at the project start date will be sufficient. However, where certain areas of land are expected to undergo significant changes in carbon stock due to degradation in the reference scenario, a sequence of Land-Use and Land-Cover Maps representing the mosaic of forest-classes of each future year may be generated.
- This methodology ignores increase of carbon stock in the forest in the project area as a conservative choice.

3.1.3 Definition of categories of land-use and land-cover change

Identify all LU/LC-change categories that could occur within the project area and leakage belt during the project crediting period in both, the reference and project case. The result should be presented in a land-use change matrix that might combines all LU/LC-classes previously defined.

3.1.4 Analysis of historical land-use and land-cover change

Using the data collected in section 3.1.1, divide the reference region in polygons representing the LU/LC-classes and LU/LC-change categories defined in 3.1.2 and 3.1.3. In the project area, LU/LC-change analysis is required to exclude any area with forests that are less than 10 years old at the project start date.

Use existing LU/LC or LU/LC-change maps if the mapping process of the the classes and categories are well documented and fulfill the requirement in sections 3.1.2, 3.1.3 and 3.1.4.

Where processed data of good quality are not available, unprocessed remotely sensed data must be analyzed to produce LU/LC maps and LU/LC-change maps. Given the heterogeneity of methods, data sources and image processing software, LU/LC-change detection should be performed by trained interpreters.

Typically, the analysis of LU/LC-change involves performing the following three tasks:

- Pre-processing;
- Interpretation and classification; and
- Post-processing.

3.1.4.1 Pre-processing

Pre-processing typically includes:

- 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 should be < 1 pixel.
- Cloud and shadow removal using additional sources of data (e.g. radar, aerial photographs, field-surveys).
- Radiometric corrections may be necessary (depending on the change-detection technique used) to ensure that similar objects have the same spectral response in multi-temporal datasets.
- Reduction of haze, as needed.

See the most recent version of the GOFC-GOLD sourcebook for REDD or consult experts and literature for further guidance on pre-processing techniques. Duly record all pre-processing steps for later reporting.

3.1.4.2 Interpretation and classification

The methodology does not prescribe any specific method. As a general guidance:

- Automated classification methods should be preferred because the interpretation is more efficient and repeatable than a visual interpretation.
- Independent interpretation of multi-temporal images should be avoided (but is not forbidden).
- Interpretation is usually more accurate when it focuses on change detection with interdependent assessment of two multi-temporal images together. A technique that may be effective is image segmentation followed by supervised object classification.
- Minimum mapping unit size shall not be more than two hectare irrespective of forest

definition.

- See the most recent version of the GOFC-GOLD sourcebook on REDD or consult experts and literature for further guidance on methods to analyze LU/LC-change using remotely sensed data.

Duly record all interpretation and classification steps in the PDD..

3.1.4.3 Post-processing

Post-processing includes the use of non-spectral data to further stratify LU/LC-classes with heterogeneous carbon density in LU/LC classes with homogenous carbon density. Post-classification stratification can be performed efficiently using a Geographical Information System (GIS). Some forest types (e.g. broadleaved forest, coniferous forests, mangroves) can be discriminated with high accuracy using remotely-sensed data only. Combination of remote sensed products (i.e from lidar, radar) with filed survey data can be used under this methodology.

LU/LC-classes that cannot be stratified further using remote sensing techniques but that are likely to contain a broad range of carbon density classes should be stratified using:

- Biophysical criteria (e.g. climate or ecological zone, soil and vegetation type, elevation, rainfall, aspect, etc.);
- Disturbance indicators (e.g. vicinity to roads; forestry concession areas; etc.); age (in cases of plantations and secondary forests);
- Land management categories (e.g. protected forest, indigenous reserve, etc.); and/or
- Other criteria relevant to distinguish carbon density classes.
- See the most recent version of the GOFC-GOLD sourcebook for REDD and IPCC 2006 GL AFOLU for further guidance on stratification. The criteria finally used should be reported transparently.

Duly record all post-processing steps in the PDD.

The following products should be prepared for the reference region

(a) <u>A Forest Cover Benchmark Map</u> for at least the most recent date (±2 years from the project start date) and 10 (± 2) years prior to the project start date, showing only “forest” and “non-forest”.

(b) <u>A Land-Use and Land-Cover Map</u> for at least the most recent date (±2 years from the project start date) depicting the LU/LC-classes defined in section 3.1.2. If such a map cannot be generated at the levels of accuracy required by this methodology, areas of the different LU/LC-classes may be estimated by sampling techniques (e.g. by overlaying a grid of dots on the satellite image and then counting the points falling in each LU/LC-class, or by sampling the landscape with higher resolution images and then classifying the sampled images), or by using other sources of data, such as official statistical data on land-use (e.g. agricultural census data):

(c) A Deforestation Map for each sub-period analyzed, depicting at least the category "deforestation". Many projects will have some level of no-data areas because of cloud-cover. In this case change rates should be calculated for each time step based only on areas that were not cloud-obscured in either date in question. Then, a maximum possible forest cover map should be made for the most recent year (±2 years from the project start date). The historical rate in % should be multiplied by the maximum forest cover area at the start of the period for estimating the total area of deforestation during the period.

(d) A Land-Use and Land-Cover Change Map for at least the most recent period analyzed (3-5 years) depicting the LU/LC-change categories defined in 3.1.3. In most cases, this map will be prepared by combining the Deforestation Map of the most recent period (3-5 years) with the most recent Land-Use and Land-Cover Map. If the area of the LU/LC-classes was estimated using sampling techniques or other sources of information, a LU/LC-Change Map is not required.

(e) A Land-Use and Land-Cover Change Matrix for at least the most recent period analyzed, derived from the LU/LC-change map or the Deforestation Map and the post-deforestation land-use data mentioned above, showing activity data for each LU/LC-change category.

3.1.4.4 Map accuracy assessment

A verifiable accuracy assessment of the maps produced in section 3.1.4.3 is necessary to produce a credible reference scenario.

The accuracy must be estimated on a class-by-class (LU/LC map) and, where applicable, category-by-category (LU/LC-change map) basis, respectively. A number of sample points on the map and their corresponding correct classification (as determined by ground-surveys or interpretation of higher resolution data as collected in section 3.1.1) can be used to create an error matrix with the diagonal showing the proportion of correct classification and the off-diagonal cells showing the relative proportion of misclassification of each class or category into the other class or, respectively, categories. Based on the error matrix (also called confusion matrix), a number of accuracy indices can be derived (see e.g. Congalton, 1991 and Pontius, 2000).

The minimum overall accuracy of the Forest Cover Benchmark Map should be 90%.

The minimum classification accuracy of each class or category in the Land-Use and Land-Cover Map and Land-Use and Land-Cover Change Map, respectively, should be 80%. If the classification of a class or category is lower than 80%:

- Consider merging the class/category with other classes/categories; or
- Exclude from the Forest Cover Benchmark Map the forest-classes that are causing the greatest confusion with non-forest classes according to the error matrix (e.g. initial secondary succession and heavily degraded forest may be difficult to distinguish from certain types of grassland or cropland, such as agro-forestry and silvo-pastoral systems not meeting the definition of "forest"). This implies conservatively reducing the area of the Forest Cover Benchmark Map.
- Both commission errors (false detection of a class/category, such as "deforestation") and omission errors (non-detection of actual class/category, such as "deforestation") should be estimated and reported.
- If ground-truthing data are not available for time periods in the past, the accuracy can be assessed only at the most recent date, for which ground-truthing data can be collected.

Where the assessment of map accuracy requires merging or eliminating classes or categories to achieve the required map accuracy, the definitions in the previous sub-steps must be adjusted accordingly. The final maps and the class/category definitions must be consistent.

3.2 Analysis of agents, drivers and underlying causes of deforestation and their likely future development

Understanding "who" is deforesting the forest (the "agent") and what drives land-use decisions ("drivers" and "underlying causes") is necessary for two mains reasons: (i) Estimating the quantity and location of future deforestation; and (ii) Designing effective measures to address deforestation, including leakage prevention measures.

This analysis is performed through the following five tasks:

- Identification of agents of deforestation;
- Identification of deforestation drivers;
- Identification of underlying causes;
- Analysis of chain of events leading to deforestation; and
- Conclusion

3.2.1 Identification of agents of deforestation

Identify the main agent groups of deforestation (farmers, ranchers, loggers, etc.) and their relative importance (i.e. the amount of historical LU/LC-change that can be attributed to each of them). To do this identification, use existing studies, the maps prepared in section 3.1, expert-consultations, field-surveys and other verifiable sources of information, as needed.

Sometimes, the relative importance of each agent can be determined from the LU/LC-change matrix developed in section 3.1.4.3, since each agent usually converts forests for a specific purpose (cattle ranching, cash-crop production, subsistence farming, etc.).

If the relative importance of different agents is spatially correlated (e.g. small farmers are concentrated in the hills, while ranchers on the planes) it may be useful to stratify the reference region, the project area and the leakage belt accordingly, and to continue the reference scenario assessment for each stratum i separately in order to increase the accuracy of the projections.
For each identified agent group, provide the following information:

(a) Name of the main agent group or agent;
(b) Brief description of the main social, economic, cultural and other relevant features of each main agent group. Limit the description to aspects that are relevant to understand why the agent group is deforesting;
(c) Brief assessment of the most likely development of the population size of the identified main agent groups in the reference region, project area and leakage belt;
(d) Statistics on historical deforestation attributable to each main agent group in the reference region, project area and leakage belt.

3.2.2 Identification of deforestation drivers

For each identified agent group, analyze factors that drive their land-use decisions. The goal is to identify the immediate causes of deforestation.

Two sets of driver variables have to be distinguished:

(a) Driver variables explaining the quantity (hectares) of deforestation (to be used in section 4.1.1 as appropriate), such as:
- Prices of agricultural products;
- Costs of agricultural inputs;
- Population density;
- Rural wages;
- Etc.

(b) Driver variables explaining the location of deforestation, also called "predisposing factors" (de Jong, 2007) (to be used in section 4.1.2), such as:
- Access to forests (such as vicinity to existing roads, railroads, navigable rivers and coastal lines);
- Slope;
- Proximity to markets;
- Proximity to existing or industrial facilities (e.g. sawmills, pulp and paper mills, agricultural products processing facilities, etc.);
- Proximity to forest edges;
- Proximity to existing settlements;
- Spatial variables indicating availability within the forest of land with good ecological conditions to expand agricultural activities, such as soil fertility and rainfall;
- Management category of the land (e.g. national park, indigenous reserve, etc.);
- Etc.

For each of these two sets of variables:

1) List the key driver variables and provide any relevant source of information that provides evidence that the identified variables have been a driver for deforestation during the historical reference period.
2) Briefly describe for each main agent group identified in 3.2.2 how the key driver variables have and will most likely impact on each agent group's decision to deforest.
3) For each identified key driver variable provide information about its likely future development, by providing any relevant source of information.

3.2.3 Identification of underlying causes of deforestation

The agents' characteristics and decisions are themselves determined by broader forces, the underlying causes of deforestation, such as:

- Land-use policies and their enforcement;
- Population pressure;
- Poverty and wealth;
- War and other types of conflicts;
- Property regime;
- Etc.

1) List the key underlying causes and cite any relevant source of information that provides evidence that the identified variables have been an underlying cause for deforestation

during the historical reference period.

2) Briefly describe how each key underlying cause has determined and will most likely determine the key drivers identified in section 3.2.2 and the decisions of the main agent groups identified in section 3.2.1

3) For each identified key underlying cause provide information about its likely future development, by citing any relevant source of information.

3.2.4 Analysis of chain of events leading to deforestation

Based on the historical evidence collected, analyze the relations between main agent groups, key drivers and underlying causes and explain the sequence of events that typically has lead and most likely will lead to deforestation. Consult local experts, literature and other sources of information, as necessary. An established tool such as the Open Standards for the Practice of Conservation[4] may be used for the analysis. Summarize the results of this analysis in the project document.

3.2.5 Conclusion

The analysis of section 3.2 must conclude with a statement about whether the available evidence about the most likely future deforestation trend within the reference region and project area is:

- Inconclusive or
- Conclusive.

"Conclusive" evidence in this methodology means that the hypothesized relationships between agent groups, driver variables, underlying causes and historical levels of deforestation can be verified at hand of statistical tests, literature studies, or other verifiable sources of information, such as documented information provided by local experts, communities, deforestation agents and other groups with good knowledge about the project area and the reference region.

To arrive at an overall "conclusive" conclusion when multiple agents and drivers are present, the evidence obtained for each of them must lead to a "conclusive" decision for all.

When the evidence is conclusive, state whether the weight of the available evidence suggests that the overall trend in future deforestation rates will be:

- Decreasing;
- About constant;
- Increasing.

Then proceed to section 4.

[4] http://cmp-openstandards.org/

The analysis must obtain conclusive evidence. When the evidence is inconclusive, additional analysis must be carried out under section 3, such as more literature reviews, expert consultations, and, as the case may be, additional field surveys, until conclusive evidence on the most likely future deforestation trend is found, otherwise it will not be possible to continue with the next steps of the methodology.

4. Reference Emissions and Calculation[5]

4.1 Projection of future deforestation

The analysis in this section is the core of the MRV methodology. Its objective is to quantify the future deforestation expected to occur within the reference region and then the project area.

If a jurisdiction (national or sub-national government) has established reference deforestation rate that is applicable to the reference region, the adopted rate must be used and no further analysis is required under this section and continue with section 4.2.2.

4.1.1 Projection of the quantity of future deforestation

The quantity of reference scenario deforestation (in hectares) for each future year within the reference region is determined.

Where appropriate, the reference region can be stratified according to the findings of section 3 and different deforestation rates be estimated for each stratum. If the reference region is stratified, the rationale for the stratification must be explained and a map of the strata provided.

Where the above condition does not exist, a projected deforestation rate must be determined by the project proponent taking into account possible future changes at the level of agents, drivers and underlying causes of deforestation, as well as the remaining forest area that is potentially available for conversion to non-forest uses. This task is performed through the following two analytical steps:

- Selection of the approach for projection of future deforestation;
- Quantitative projection of future deforestation.

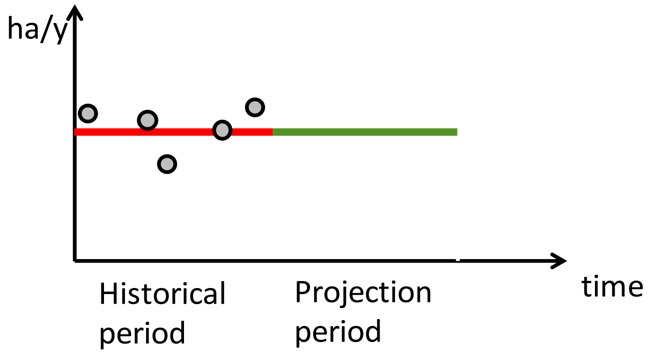
4.1.1.1 Selection of the approach for projection of future deforestation

To project future deforestation three approaches are available:

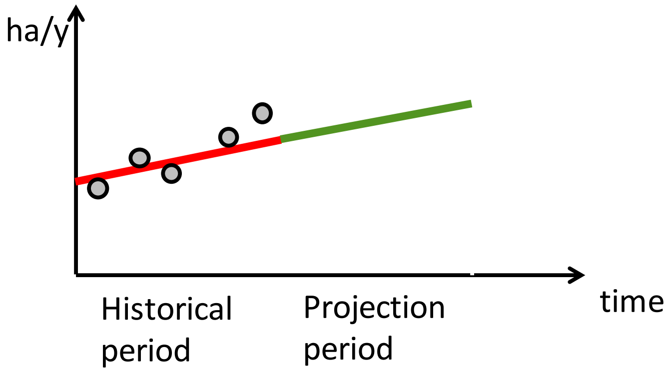
(a) Historical average approach: Under this approach, the rate of deforestation is assumed to be a continuation of the average annual rate measured during the

[5] Cited from "Methodology for Avoided Unplanned Deforestation" VM0015 version 1.1

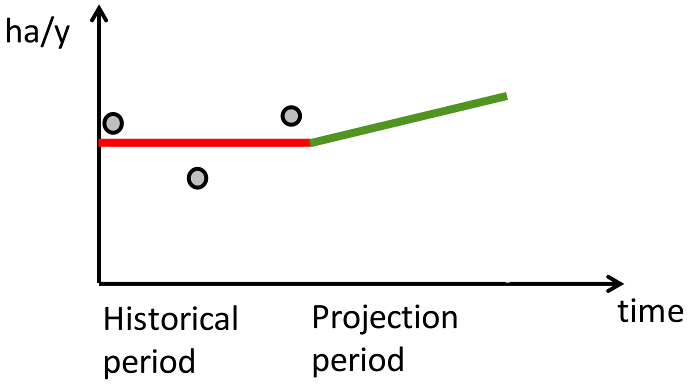
historical reference period within the reference region or, where appropriate, within different strata of the reference region.



(b) Time function approach: With this approach, the rate of deforestation is estimated by extrapolating the historical trend observed within the reference region (or its strata) as a function of time using either linear regression, logistic regression or any other statistically sound regression technique. This approach requires multiple deforestation measurements during the past 10-15 years.



(c) Modeling approach: With this approach, the rate of deforestation will be estimated using a model that expresses deforestation as a function of driver variables selected by the project proponents. Such driver variables may be spatial and consistency with the analysis of section 3.2must exist.



Based on the conclusive evidence found in section 3, select and justify the most appropriate approach following the decision criteria described below. Different approaches can be used in different strata of the reference region, where appropriate.

1 The deforestation rates measured in different historical sub-periods in the reference region (or a stratum of it) do not reveal any trend (decreasing, constant or increasing deforestation) and:

1.1 Use approach "c" if there is at least one variable that can be used to project the deforestation rate, otherwise use approach "a".

2 The deforestation rates measured in different historical sub-periods in the reference region (or a stratum of it) reveal a clear trend and this trend is:

2.1 A <u>decrease</u> of the deforestation rate and:

- The conclusive shows that it is likely that this trend will continue in the future: use approach "b".
- The conclusive evidence also suggests that the decreasing trend will change in the future due to predictable changes at the level of agents and drivers: use approach "c".

2.2 A <u>constant</u> deforestation rate and:

- The conclusive evidence suggests it is likely that this trend will continue in the future: use approach "a".
- The conclusive evidence suggests that the historical trend will change in the future due to predictable changes at the level of agents and drivers: use approach "c".

2.3 An <u>increase</u> of the deforestation rate and:

- The conclusive evidence suggests that it is likely that this trend will continue in the future: use approach "b". If the future deforestation trend is likely to be higher than predicted with approach "b", use approach "c".

- The conclusive evidence suggests that the future trend will change: use approach “a” or develop a model (approach “c”).

In all cases, the project proponent can select a more conservative approach.

4.1.1.2 Quantitative projection of future deforestation

The method to be used depends on the approach selected.

Approach “a”: Historical average

The annual reference level deforestation area that applies at year *t* to stratum *i* within the reference region is calculated as follows:

$$AREFRR_{i,t} = ARR_{i,t-1} * RREFRR_{i,t} \qquad (1)$$

Where:

$AREFRR_{i,t}$	Annual area of deforestation in reference scenario in stratum *i* within the reference region at year *t*; ha yr^{-1}
$ARR_{i,t-1}$	Area with forest cover in stratum *i* within the reference region at year *t-1*: ha
$RREFRR_{i,t}$	Deforestation rate[6] applicable to stratum *i* within the reference region at year *t*; %
t	1, 2, 3 ... *T*, a year of the proposed project crediting period; dimensionless
i	1, 2, 3 ... I_{RR}, a stratum within the reference region; dimensionless

Approach “b”: Time function

The annual area of reference level deforestation that applies at a year t to stratum i within the reference region is calculated using one of the following equations:

Linear regression: $$ARELRR_{i,t} = a + b*t \qquad (2.a)$$

Logistic regression: $$ARELRR_{i,t} = ARR_i / (1+e^{-k*t}) \qquad (2.b)$$

Other types of regression: $$ARELRR_{i,t} = f(t) \qquad (2.c)$$

Where:

$ARELRR_{i,t}$	Annual area of deforestation in reference scenario in stratum *i* within the reference region at a year *t*; ha yr^{-1}

[6] See Puyravaud, J.-P., 2003. Standardizing the calculation of the annual rate of deforestation. Forest Ecology and Management, 177: 593-596

a	Estimated intercept of the regression line; ha yr^{-1}
b	Estimated coefficient of the time variable (or slope of the linear regression); ha yr^{-1}
e	Euler number (2,71828); dimensionless
k	Estimated parameter of the logistic regression; dimensionless
ARR_i	Total forest area in stratum i within the reference region at the project start date; ha
$f(t)$	A function of time
t	1, 2, 3 … T, a year of the proposed project crediting period; dimensionless
i	1, 2, 3 ... I_{RR}, a stratum within the reference region; dimensionless

The model and its parameters are derived from data obtained from the historical reference period and are used to project future deforestation trends

Approach "c": Modeling

The annual area of reference level deforestation that applies at year t in stratum i within the reference region is estimated using a statistical model, such as simple regression, multiple regressions, logistic regression, or any other possible model to be proposed and justified by the project proponent. The proposed model must demonstrably comply with statistical good practice.

The following equations are given for illustration purposes only:

$$AREFRR_{i,t} = a + b1_i * V1_{i,t} \tag{3.a}$$

$$AREFRR_{i,t} = a + b1_i * V1_{i,t} + b2_i * V2_{i,t} \tag{3.b}$$

$$AREFRR_{i,t} = ARR_i/(1+e^{-k*V1i,t}) \tag{3.c}$$

Where:

$AREFRR_{i,t}$	Annual area of reference level deforestation in stratum i within the reference region at a year t; ha yr^{-1}
$a; b1_i; b2_i; ... ; bn_i; k$	Estimated coefficients of the model
e	Euler number (2,71828); dimensionless
$V1_{i,t}; V2_{i,t}; ...;Vn_{i,t}$	Variables included in the model

ARR_i Total forest area in stratum i within the reference region at the project start date; ha

t 1, 2, 3 … T, a year of the proposed project crediting period; dimensionless

i 1, 2, 3 ... I_{RR}, a stratum within the reference region; dimensionless

The model may also be constructed with the annual area deforested ($AREFLRR_{i,t}$), or the deforestation rate ($RREFRR_{i,t}$ = percentage of remaining forest area at year t-1 in stratum i to be deforested at year t) as the dependent variable, and independent variable(s) (e.g. population density in stratum i at time t, average opportunity costs in stratum i at time t, etc.) from which the annual areas of deforestation ($AREFRR_{i,t}$) or the deforestation rates ($RREFRR_{i,t}$) are inferred from changes in the independent variables.

For each of the selected independent variables, there must be a description of the historical data (including source), an explanation of the rationale for using the variable(s), and a credible future projection based on documented and verifiable sources. To determine the future values of the variables included in the model, official projections, expert opinion, other models, and any other relevant and verifiable source of information must be used. Justify with logical and credible explanations any assumption about future trends of the driver variables and use values that yield conservative estimates of the projected deforestation ($AREFRR_{i,t}$ or $RREFRR_{i,t}$).

The model and its rationale must be explained by the project proponent using logical arguments and verifiable sources of information and must be consistent with the analysis of section 3.2.The model must demonstrably comply with statistical good practice.

4.1.2 Projection of the location of future deforestation

Section 4.1.1 was to estimate the annual areas of future deforestation in the reference region. Section 4.1.2 is to analyze where future deforestation is most likely to happen in the reference scenario in order to match the location of the projected deforestation with carbon stocks and determine the annual areas of reference level deforestation in the project area and leakage belt.

Section 4.1.2 is based on the assumption that deforestation is not a random event but a phenomenon that occurs at locations that have a combination of bio-geophysical and economic attributes that is particularly attractive to the agents of deforestation. For example, a forest located on fertile soil, flat land, and near to roads and markets for agricultural commodities is likely to be at greater risk of deforestation than a forest located on poor soil, steep slope, and far from roads and markets. Locations at higher risk are assumed to be deforested first. This hypothesis can be tested empirically by analyzing the spatial correlation between historical deforestation and geo-referenced bio-geophysical and economic variables. In the previous example, soil fertility, slope, distance to roads and distance to markets are the hypothesized spatial driver variables (SDVi) or “predisposing factors” (De Jong, 2007). These variables can be represented in a map (or “Factor Map”) and overlaid to a map showing historical deforestation using a Geographical Information System (GIS). From the combined spatial dataset information is extracted and analyzed statistically in order to produce a map that shows the level of deforestation risk at each spatial location (“pixel” or “grid cell”). The deforestation risk (or probability of deforestation) at a given spatial location changes at the time when one or more of the spatial driver variables change their values due to projected changes, e.g. when population density increases within a certain area, when a road is build nearby, or when areas recently deforested are coming closer, etc.

The basic tasks to perform the analysis described above are:

- Preparation of factor maps;
- Preparation of risk maps for deforestation;
- Selection of the most accurate deforestation risk map; and
- Mapping of the locations of future deforestation.

Several model/software are available and can be used to perform these tasks in slightly different ways, such as Geomod, Idrisi Taiga, Dinamica Ego, Clue, and Land-Use Change Modeler. The model/software used must be peer-reviewed and must be consistent with the methodology (to be proven at validation).

4.1.2.1 Preparation of factor maps

Based on the analysis of sections 3 and 3.2.1, identify the spatial variables that most likely explain the patterns of future deforestation in the reference region. Obtain spatial data for each variable and create digital maps representing the Spatial Features of each variable (i.e. the shape files representing the point, lines or polygon features or the raster files representing surface features). Some models will require producing Distance Maps from the mapped features (e.g. distance to roads or distance to already deforested lands) or maps representing continuous variables (e.g. slope classes) and categorical variables (e.g. soil quality classes). If the model/software allows working with dynamic Distance Maps (i.e. the software can calculate a new Distance Maps at each time step), these should be used. For simplicity, these maps are called “Factor Maps”. Other models do not require Factor Maps for each variable, and instead analyze all the variables and deforestation patterns together to produce a risk map.

Where some of the spatial variables are expected to change, collect information on the expected changes from credible and verifiable sources of information. Then prepare Factor Maps that represent the changes that will occur in different future periods. Sometimes, projected changes can be represented by a dynamic spatial model that may change in response to deforestation.

In case of planned infrastructure (e.g. roads, industrial facilities, settlements) provide documented evidence that the planned infrastructure will actually be constructed and the time table of the construction. In case of planned new roads, road improvements, or railroads provide credible and verifiable information on the planned construction of different segments (e.g. how many kilometers will be constructed, where and when). Evidence includes: approved plans and budgets for the construction, signed construction contracts or at least an open bidding process with approved budgets and finance. If such evidence is not available exclude the planned infrastructure from the factors considered in the analysis.

In case of unplanned infrastructure (e.g. secondary roads), provide evidence that the unplanned infrastructure will actually develop, e.g. from historical developments such as those from a wall-to-wall assessment (or at least five randomly sampled observations in the reference region) or from literature sources appropriate to the reference region, estimate the average annual length of new unplanned infrastructure per square kilometer that was constructed during the historical reference period. Alternatively, determine the historical rate of change as related to variables for which there are good projections (e.g. km of new unplanned infrastructure as related to population). To avoid projecting unplanned infrastructure in areas where geographic and socio-economic conditions are unfavorable for infrastructure developments (e.g. areas with steep slopes, swampy soils, low opportunity costs, etc.), develop a map representing a proxy of the suitability for future infrastructure development. For each “suitability” class or gradient (using a minimum of two classes, e.g. suitable, not suitable), determine the most plausible rate of unplanned infrastructure development. To do this, apply the following steps:

(a) Using historical data, expert opinion, participative rural appraisal (PRA), literature and/or other verifiable sources of information list all relevant criteria that facilitate (at least one criterion) and constrain (at least one criterion) the development of new unplanned infrastructure.
(b) For each criterion, generate a map using a GIS.
(c) Using multi-criteria analysis or similar approach, determine the most likely rate of unplanned infrastructure development (e.g. km km^{-2} yr^{-1} or a similar indicator) per different sectors (suitability classes or gradients) within the reference region.
(d) Projections of unplanned infrastructure development shall be conservative, in particular projections in forested areas shall meet this requirement

To create the Factor Maps use one of the following two approaches:

- Empirical approach: Categorize each Distance Map in a number of predefined distance classes (e.g. class 1 = distance between 0 and 50 m; class 2 = distance between 50 and 100 m, etc.). In a table describe the rule used to build classes and the deforestation likelihood assigned to each distance class. The deforestation likelihood is estimated as the percentage of pixels that were deforested during the period of analysis (i.e. the historical reference period).
- Heuristic approach: Define "value functions" representing the likelihood of deforestation as a function of distance from point features (e.g., saw mills) or linear features (e.g., roads), or as a function of polygon features representing classes (e.g. of soil type, population density) based on expert opinion or other sources of information. Specify and briefly explain each value function in the project document.

4.1.2.2 Preparation of deforestation risk maps

A Risk Map shows at each pixel location the risk (or "probability") of deforestation in a numerical scale (e.g., 0 = minimum risk; 255 = maximum risk).

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

Several Risk Maps should be produced using different combinations of Factor Maps and modeling assumptions in order to allow comparison and select the most accurate map. A list of Factor Maps, including the maps used to produce them and the corresponding sources shall be presented in the project document together with a flow-chart diagram illustrating how the Risk Map is generated.

4.1.2.3 Selection of the most accurate deforestation risk map

Confirming the quality of the model output (commonly referred to as model validation) is needed to determine which of the deforestation risk maps is the most accurate. A good practice to confirm a model output (such as a risk map) is "calibration and validation", referred to here as "calibration and confirmation".

Two options are available to perform this task: (a) calibration and confirmation using two historical sub-periods; and (b) calibration and confirmation using tiles. Option (b) should be preferred where recent deforestation trends have been different from those in the more distant past.

(a) Where two or more historical sub-periods have shown a similar deforestation trend, data from the most recent period can be used as the “confirmation” data set, and those from the previous period as the “calibration” data set.

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

(b) Where only one historical sub-period is representative of what is likely to happen in the future, divide the reference region in tiles and randomly select half of the tiles for the calibration data set and the other half for the confirmation set. Do the analysis explained above (see Castillo-Santiago et al., 2007).

The Prediction Map with the best fit is the map that best reproduced actual deforestation in the confirmation period. The best fit must be assessed using appropriate statistical techniques. Most peer-reviewed modeling tools, such as Geomod, Idrisi Taiga, Land Use Change Modeler, and Dinamica Ego, include in the software package appropriate assessment techniques, which can be used under this methodology.

One of the assessment techniques that can be used is the “Figure of Merit” (FOM) that confirms the model prediction in statistical manner (Pontius et al. 2008; Pontius et al. 2007)[7].

The FOM is a ratio of the intersection of the observed change (change between the reference maps in time 1 and time 2) and the predicted change (change between the reference map in time 1 and simulated map in time 2) to the union of the observed change and the predicted change (equation 4). The FOM ranges from 0.0, where there is no overlap between observed and predicted change, to 1.0 where there is a perfect overlap between observed and predicted change. The highest percent FOM must be used as the criterion for selecting the most accurate Deforestation Risk Map to be used for predicting future deforestation.

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

$$FOM = B / (A+B+C) \quad (4)$$

Where:

FOM	"Figure of Merit"; dimensionless
A	Area of error due to observed change predicted as persistence; ha
B	Area correct due to observed change predicted as change; ha
C	Area of error due to observed persistence predicted as change; ha

The minimum threshold for the best fit as measured by the Figure of Merit (FOM) shall be defined by the net observed change in the reference region for the calibration period of the model. Net observed change shall be calculated as the total area of change being modeled in reference region during the calibration period as percentage of the total area of the reference region. The FOM value shall be at least equivalent to this value. If the FOM value is below this threshold, the project proponent must demonstrate that the model is accurate.

4.1.2.4 Mapping of the location of future deforestation

Future deforestation is assumed to happen first at the pixel locations with the highest deforestation risk value. To determine the locations of future deforestation do the following:

- In the most accurate deforestation risk map select the pixels with the highest value of deforestation probability. Add the area of these pixels until their total area is equal to the area expected to be deforested in the reference region in project year one.
- Repeat the above pixel selection procedure for each successive project year t to produce a series of maps deforestation for each future project year. Do this at least for the fixed projection period and, optionally, for the entire project crediting period.
- Add all yearly (reference level deforestation maps in one single map showing the expected deforestation for the fixed projection period and, optionally, for the entire project crediting period.

The described pixel selection procedure and production of annual maps of reference level deforestation can be programmed in most state of the art modeling tools/software.

To obtain the annual areas of reference level deforestation within the project area, combine the annual maps of reference level deforestation for the reference region with a map depicting only the polygon corresponding to the project area. The same must be done for the leakage belt area.

4.1.3 Definition of the land-use and land-cover change component in reference scenario

The goal of this step is to calculate activity data of the initial forest classes (*icl*) that will be deforested and activity data of the post-deforestation classes (*fcl*) that will replace them in the reference scenario.

After section 4.1.2.4, the area and location of future deforestation are both known and pre-deforestation carbon stocks can be determined by matching the predicted location of deforestation with the location of forest classes with known carbon stocks.

Pre-deforestation carbon stocks shall be those existing or projected to exist at the year of the projected deforestation. This implies that forest classes in areas undergoing degradation in the reference scenario may not be the ones existing at the project start date, but the ones projected to exist at the year of deforestation.

Post-deforestation carbon stocks is determined as the historical area-weighted average carbon stock.
Apply the following tasks:

- Calculation of deforestation area per forest class (section 4.1.3.1); and
- Calculation of deforestation area per post-deforestation class (section 4.1.3.2).

4.1.3.1 Calculation of deforestation area per forest class

Combine the maps of annual deforestation of each future year produced in the previous step with the Land-Use and Land-Cover Map produced for the current situation in 4.1 to produce a set of maps showing for each forest class the polygons that that would be deforested each year in absence of the project activities. Extract from these maps the number of hectares of each forest class that would be deforested and present the results in Table 3 for the project area and Table 4 for the leakage belt area. Do this at least for the fixed projection period and, optionally, for the project crediting period.

In most cases one single Land-Use and Land-Cover Map representing the spatial distribution of forest classes at the project start date will have been produced in 4.1. However, where certain areas of land are expected to undergo significant changes in carbon stocks due to growth or degradation in the reference scenario, a sequence of Land-Use and Land-Cover Maps representing the mosaic of forest-classes of each future year may have been generated in3.1.2, in which case it must be used this step.

Table 3 Annual areas deforested per forest class *icl* within the project area

Area deforested per forest class *icl* within the project area			Total reference level deforestation in the project area	
ID_{icl}>	1	2		
Name >			$AREFPA_t$ annual	*AREFPA* cumulative
Project year *t*	ha	ha	ha	ha
1				
2				
3				
4				
5				
6				
7				
8				
..				
10				

Table 4 Annual areas deforested per forest class icl within the leakage belt

Area deforested per forest class *icl* within the leakage belt area			Total reference level deforestation in the leakage belt area	
ID_{icl}>	1	2		
Name >			$AREFLK_t$ annual	*AREFLK* cumulative
Project year *t*	ha	ha	ha	ha
1				
2				
3				
4				
5				
6				
7				
8				
..				
10				

4.1.3.2 Calculation of deforestation area per post-deforestation class

Historical LU/LC-changes are assumed to be representative for future trends. Hence, post-deforestation land-uses are allocated to the projected areas of annual deforestation in same proportions as those observed on lands deforested during the historical reference period.

The proportions can be estimated by producing the historical LU/LC-change matrix based on existing studies or documents. If no data exists, local survey needs to be conducted. If the analysis of agents and drivers of deforestation reveals clear tendency of type of post-deforestation LU/LC type in deforested area by a certain driver, such information can be also used. Calculate the area of each post-deforestation LU/LC and report the result in Table 5 for the project area and Table 6 for the leakage belt. Do this at least for the fixed reference period and, optionally, for the entire project crediting period.

Table 5 Annual areas deforested per post-deforestation class fcl within the project area

Area established after deforestation per post-deforestation class *fcl* within the project area			Total reference level deforestation in the project area	
IDfcl	1	2		
Name >			$AREFPA_t$ annual	*AREFPA* cumulative
Project year	ha	ha	ha	ha
1				
2				
3				
4				
5				
6				
7				
8				
..				
10				

Table 6 Annual areas deforested per post-deforestation class fcl within the leakage belt

Area established after deforestation per post-deforestation class *fcl* within the leakage belt			Total reference level deforestation in the leakage belt area	
IDfcl	1	2		
Name >			$AREFLK_t$	*AREFLK*

			annual	cumulativ e
Project year	ha	ha	ha	ha
1				
2				
3				
4				
5				
6				
7				
8				
..				
10				

4.2 Estimation of reference level carbon stock changes

Before calculating the reference carbon stock changes it is necessary to estimate the average carbon stock (tCO_2-e ha^{-1}) of each LU/LC class.

4.2.1 Estimation of the average carbon stocks of each LU/LC class

Average carbon stocks must be estimated for:

- the forest classes existing within the project area;
- the forest classes existing within the leakage belt;
- the post-deforestation classes projected to exist in the project area in the reference scenario; and
- the post-deforestation classes projected to exist in the leakage belt in the project scenario.

Collect existing carbon-stock data for these classes from local published studies and existing forest and carbon inventories. Do additional field measurements for the classes for which there is insufficient information. Follow the guidance below:

(a) Assess the existing data collected and, where appropriate, use them. It is likely that some existing data could be used to quantify the carbon stocks of one or more classes. These data could be derived from a forest inventory or perhaps from scientific studies. Analyze these data and use them if the following criteria are fulfilled:

- The data are less than 10 years old;
- The data are derived from multiple measurement plots;

- All species above a minimum diameter are included in the inventories;
- The minimum diameter for trees included is 30 cm or less at breast height (DBH);
- Data are sampled from good coverage of the classes over which they will be extrapolated.

Existing data that meet the above criteria shall only be applied across the classes from which they were representatively sampled and not beyond that. See the latest version of the GOFC-GOLD sourcebook on REDD and Gillespie, et al. (1992) for methods to analyze these data.

(b) Collect missing data. For the classes for which no existing data are available it will be necessary to either obtain the data from field measurement or to use conservative estimates from the literature.

Field measurements:

- Locate the sampling sites. If the locations of future deforestation are known at the time of field measurements, the sample sites should be located at the locations expected to be deforested to achieve maximum accuracy of the carbon stock estimates.
- Design the sampling framework and conduct the field measurements (see chapter 4.3 of GPG LULUCF and in the sourcebook for LULUCF by Pearson et al., 2005). Summarize the sampling design in the project document and provide a map and the coordinates of all sampled locations.

Literature estimates:

- The use of carbon stock estimates in similar ecosystems derived from local studies, literature and IPCC defaults is permitted, provided the accuracy and conservativeness of the estimates are demonstrated.
- When defaults are used, the lowest value of the range given in the literature source (or the value reduced by 30%) must be used for the forest classes, and the highest value (or the value augmented by 30%) for non-forest classes.

(c) Calculate the carbon stocks existing in each forest class in the project area prior to the year of reference level deforestation. For all years preceding the year in which the projected reference level deforestation will occur ($t <= t^*$) carbon stocks and boundaries of the forest-classes are assumed to remain the same, except in the following cases:

- If in the reference scenario the forest within certain polygons of the project area is degrading and loosing carbon stocks, a map sequence showing the spatial and temporal sequence of forest classes with successively lower carbon stocks must be prepared to account for the degradation occurring prior to deforestation. If the boundary of the forest classes undergoing degradation is fixed (i.e. does not change over time) it is sufficient to show the estimated changes in carbon stocks in Table 7. To do the projection, use credible and verifiable sources of data from existing studies, or measure field plots in degraded forests of different known age.

- If in the reference scenario the forest within certain polygons of the project area has increasing carbon stocks, changes in carbon stocks can conservatively be omitted. If a projection is done, use credible and verifiable sources of data from existing studies, or measure field plots in secondary forests of different known age.
- If carbon stocks in the project area are decreasing more in the project case than in the reference scenario (e.g. when the project activity involves logging for timber, fuel-wood collection or charcoal production in areas not subject to such activities in the reference scenario), this will have to be accounted in the project case.
- If logging activities are present in the reference scenario, the harvested wood product carbon pool must be estimated and, if significantly higher in the reference level compared to the project scenario, it will have to be accounted.
- Report the results of the estimations in Table 7 and another table in the same format (values used in calculations after considering discounts for uncertainties according to “f” below).
- Carbon stocks in the harvested wood products carbon pool must be estimated as the sum of planned and unplanned harvesting activities in the reference scenario and the additional volume harvested prior to the deforestation event in year t* (if applicable).

(d) Calculate the carbon stocks existing in each forest class in the leakage belt prior to the year of reference level deforestation (t = t*): For all years preceding the year in which the projected reference level deforestation will occur (t > t*) carbon stocks and boundaries of the forest-classes are assumed to remain the same, except in the following cases:

- If in the reference scenario the forest within certain polygons of the leakage belt is growing and carbon stocks are increasing, a map sequence showing the spatial and temporal sequence of forest classes with successively higher carbon stocks must be prepared to account for the carbon stock enhancement. To do the projection, use credible and verifiable sources of data from existing studies, or measure field plots in secondary forests of different known age.

- If in the reference scenario the forest within certain polygons of the leakage belt is degrading and loosing carbon stocks, changes in carbon stocks can conservatively be omitted and preparing a map sequence is optional for these polygons.
- Report the results of the estimations in Table 7. The same table format is used for values used in calculations after considering discounts for uncertainties according to "f" below.

Table 7 Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt

project year t	**Initial forest class *icl***									
	Name: **ID*icl***									
	Average Carbon stock per hectare ± 90% CI									
	Cab*icl*		**Cbb*icl***		**Cdw*icl***		**Csoc*icl***		**Ctot*icl***	
	Cstock	**± 90% CI**	**Cstock**	**± 90% CI**	**Cstock**	**± 90% CI**	**Cstock**	**± 90% CI**	**Cstock**	**± 90% CI**
	t CO_2e ha^{-1}	**t CO_2e ha^{-1}**	**t CO_2e ha^{-1}**	**t CO_2e ha^{-1}**	**t CO_2e ha^{-1}**	**t CO_2e ha^{-1}**	**t CO_2e ha^{-1}**	**t CO_2e ha^{-1}**	**t CO_2e ha^{-1}**	**t CO_2e ha^{-1}**
1										
2										
3										
4										
5										
6										
7										
8										
..										
10										

For space reasons Cwp_{icl} is shown in the table above.

Where:

Cab_{icl} Average carbon stock per hectare in the above-ground biomass carbon pool of class *icl*; tCO_2-e ha^{-1}

Cbb_{icl} Average carbon stock per hectare in the below-ground biomass carbon pool of class *icl*; tCO_2-e ha^{-1}

Cdw_{icl} Average carbon stock per hectare in the dead wood biomass carbon pool of class *icl*; tCO_2-e ha^{-1}

$Csoc_{icl}$ Average carbon stock per hectare in the soil organic carbon pool of LU/LC class *icl*; tCO_2-e ha^{-1}

Cwp_{icl} Average carbon stock per hectare accumulated in the harvested wood products carbon pool between project start and the year of deforestation of class icl; tCO_2-e ha^{-1}

Note: In the reference scenario, Cwp_{cl} must be subtracted from the sum of the other pools in the calculation of $Ctot_{cl}$

$Ctot_{icl}$ Average carbon stock per hectare in all accounted carbon pools of LU/LC *icl*; tCO_2-e ha^{-1}

(e) Calculate the long-term (20-years) average carbon stocks of post-deforestation classes: These classes often do not have a stable carbon stock because different land uses may be implemented in a time sequence or because the land use after deforestation implies carbon stocks changes over time (e.g. in case of tree plantations). The carbon stock of post-deforestation classes must be estimated as the long-term (20 years) average carbon stock and can be determined from measurements in plots of known age, long-term studies and other verifiable sources.

For each post-deforestation LU/LC class, report the calculation of the long-term (20-year) average carbon stock using Table 8. If area-weighted average is calculated, use the same table.

Table 8 Long-term (20-years) average carbon stocks per hectare of post-deforestation LU/LC classes

Project year t	**Post deforestation class *fcl***									
	Name:									
	IDf*cl*									
	Average Carbon stock per hectare ± 90% CI									
	Cab*icl*		**Cbb*icl***		**Cdw*icl***		**Csoc*icl***		**Ctot*icl***	
	Cstock	±	Cstock	±	Cstock	±	Cstock	±	Cstock	±

	t CO_2e ha^{-1}	90% CI t CO_2e ha^{-1}	t CO_2e ha^{-1}	90% CI t CO_2e ha^{-1}	t CO_2e ha^{-1}	90% CI t CO_2e ha^{-1}	t CO_2e ha^{-1}	90% CI t CO_2e ha^{-1}	t CO_2e ha^{-1}	90% CI t CO_2e ha^{-1}
t										
t+1										
t+2										
t+3										
t+4										
t+5										
t+6										
t+7										
t+8										
t+9										
t+10										
t+11										
t+12										
t+13										
t+14										
t+15										
t+16										
t+17										
t+18										
t+19										
t+20										
average										
average to be used in calculations										

For space reasons Cwp_{fcl} is shown in the table above.

(f) Do an uncertainty assessment of all carbon stock estimates. If the uncertainty of the total average carbon stock ($Ctot_{cl}$) of a class *cl* is less than 10% of the average value, the average carbon stock value can be used. If the uncertainty is higher than 10%, the lower boundary of the 90% confidence interval must be considered in the calculations if the class is an initial forest class in the project area or a final non-forest class in the leakage belt, and the higher boundary of the 90% confidence interval if the class is an initial forest class in the leakage belt or a final non-forest class in the project area.

4.2.2 Calculation of carbon stock change factors

In this methodology, the decay of carbon stock in initial forest classes (*icl*) and increase in carbon stock in post-deforestation classes, which are estimated in Table **7** and Table **8**, respectively, are considered to happen in the year in which deforestation occurs in all carbon pools but soil organic carbon.

<u>Soil organic carbon:</u>

- It is assumed that in a 20-years period the carbon stock changes from the level estimated for the initial forest classes (*icl*) (in Table 7) to the level estimated for the post-deforestation class *fcl* (or their area weighted average). The change occurs linearly and can be either a decrease or an increase, depending on the carbon stock estimated for the initial forest class and for the final post-deforestation class *fcl*.
- If carbon stocks in the soil organic carbon pool are included in the reference level, it will be necessary to calculate activity data per category. This is because the linear decay (or increase) function is category-dependent. It will be necessary to define categories (from initial forest classes *icl* to post-deforestation classes *fcl*). Calculate annual deforestation area for each category (*ctz*: combination of *icl* and *fcl*) and report the results in Table 9 for the project area and Table 10 for the leakage belt. Do this at least for the fixed reference period and the project area and leakage belt and, optionally, for the entire project crediting period and for the reference region.

Table 9 Annual areas deforested in each category ctz within the project area in the reference scenario

Activity data per LU/LC category ctz within the project area					Total reference level deforestation in the project area	
IDctz	1	2	…	ctz		
Name >					$AREFPA_t$ annual	*AREFPA* cumulative
Project year v	ha	ha	ha	ha	ha	ha
1						

2						
3						
4						
5						
….						
10						

Table 10 Annual areas deforested in each category ctz within the leakage belt area in the reference scenario

Activity data per LU/LC category *ctz* within the leakage belt					Total reference level deforestation In the leakage belt area	
IDctz	1	2	…	ctz		
Name >					$AREFLK_t$ annual	*AREFLK* cumulative
Project year v	ha	ha	ha	ha	ha	ha
1						
2						
3						
4						
5						
….						
10						

F.2. Calculation of reference emissions

1. Calculation of reference level stock changes

The total reference carbon stock change in the project area at year t is calculated as follows:

$$\Delta CREFPA_t = \sum_{icl=1}^{lcl} AREFPA_{icl,t} \times Cp_{icl,t} - \sum_{fcl=1}^{fcl} AREFPA_{fcl,t} \times Cp_{fcl,t}$$

Where:

$\Delta CREFPA_t$ Total reference level carbon stock change within the project area at year *t*; tCO_2-e

$AREFPA_{icl,t}$ Area of initial forest class *icl* deforested at time *t* within the project area in the

	reference scenario; ha
$Cp_{icl,t=t^*}$	Average carbon stock for carbon pool *p* in the initial forest class *icl* applicable at time *t* (as per Table 11); tCO_2-e ha^{-1}
$Cp_{icl,t=t^*+1}$	Average carbon stock for carbon pool *p* in the initial forest class *icl* applicable at time *t*=*t**+1 (= 2nd year after deforestation, as per Table 11); tCO_2-e ha^{-1}
…	
$Cp_{icl,t=t^*+19}$	Average carbon stock for carbon pool *p* in the initial forest class *icl* applicable at time *t*=*t**+19 (20th year after deforestation, (as per Table 11); tCO_2-e ha^{-1}
$AREFPA_{fcl,t}$	Area of the post-deforestation class *fcl* "deforested" at time *t* within the project area in the reference scenario; ha
$Cp_{fcl,t=t^*}$	Average carbon stock for carbon pool *p* in post-deforestation class *fcl* applicable at time *t* = *t** (as per Table 12); tCO_2-e ha^{-1}
icl	1, 2, 3 … *Icl* initial (pre-deforestation) forest classes; dimensionless
fcl	1, 2, 3 … *fcl* final (post-deforestation) classes; dimensionless
p	1, 2, 3 ... *P* carbon pools included in the reference scenario; dimensionless
t	1, 2, 3 … *T*, a year of the proposed project crediting period; dimensionless

Table 11 Carbon stock change factors for initial forest classes *icl*

Year after deforestation		**ΔC*ab* *icl,t*** $tCO_2ha^{-1}year^{-1}$	**ΔC*bb* *icl,t*** $tCO_2ha^{-1}year^{-1}$	**ΔCdw *icl,t*** $tCO_2ha^{-1}year^{-1}$	**ΔCsoc *icl,t*** $tCO_2ha^{-1}year^{-1}$	**ΔCtot icl,t** $tCO_2ha^{-1}year^{-1}$
1	t					
2	t+1					
3	t+2					
4	t+3					
5	t+4					
6	t+5					
7	t+6					
8	t+7					
9	t+8					
10	t+9					
11	t+10					
12	t+11					

13	t+12					
14	t+13					
15	t+14					
16	t+15					
17	t+16					
18	t+17					
19	t+18					
20	t+19					

Table 12 Carbon stock change factors for post-deforestation classes *fcl*

Year after deforestation		**ΔC*ab fcl,t*** $tCO_2ha^{-1}year^{-1}$	**ΔC*bb fcl,t*** $tCO_2ha^{-1}year^{-1}$	**ΔCdw *fcl,t*** $tCO_2ha^{-1}year^{-1}$	**ΔCsoc *fcl,t*** $tCO_2ha^{-1}year^{-1}$	**ΔCtot icl,t** $tCO_2ha^{-1}year^{-1}$
1	t					
2	t+1					
3	t+2					
4	t+3					
5	t+4					
6	t+5					
7	t+6					
8	t+7					
9	t+8					
10	t+9					
11	t+10					
12	t+11					
13	t+12					
14	t+13					
15	t+14					
16	t+15					
17	t+16					
18	t+17					
19	t+18					
20	t+19					

Report the result of the calculations for each carbon pool per initial forest class (Table 13) and final post-deforestation class (Table 14). Although only the tables for above-ground biomass are shown, the same tables are produced for other pools.

Table 13 Reference level carbon stock change in the above-ground biomass in the project area per initial forest class icl

Carbon stock changes in the above-ground biomass per initial forest class *icl*			**Total carbon stock change in the above-ground biomass of the initial forest classes in the project area**	
ID *icl*			**Δ *CabREFPA* $_{icl,t}$**	**Δ *Cab REFPA* $_{icl}$**
Name:			**annual**	**cumulative**
Project year t	**tCO_2-e**	**tCO_2-e**	**tCO_2-e**	**tCO_2-e**
1				
2				
3				
4				
5				
6				
7				
8				
..				
10				

Table 14 Reference level carbon stock change in the above-ground biomass in the project area per post-deforestation class fcl

Carbon stock changes in the above-ground biomass per post-deforestation class *fcl*			**Total carbon stock change in the above-ground biomass of the post-deforestation zones in the project area**	
ID *fcl*			**Δ *Cab REFPA* $_{fcl,t}$**	**Δ *Cab REFPA* $_{fcl}$**
Name:			**annual**	**cumulative**
Project year t	**tCO_2-e**	**tCO_2-e**	**tCO_2-e**	**tCO_2-e**
1				
2				
3				
4				
5				
6				
7				

8				
..				
10				

G. Ex-ante Calculation of project emissions and leakage

1. Project Emissions[8]

In this methodology, for *ex-ante* estimate estimation, carbon stock changes due to planned activities is required to be estimated, but that due to unplanned deforestation is not. Unplanned deforestation which is not avoided with the project activity will be monitored, verified and reported *ex- post*. The methodology provides maximum potential emission reduction without discounting emission from deforestation under project scenario.

It is possible that certain discrete areas of forest within the project area will be subject to project activities that will change the carbon stocks of these areas compared to the reference level. Such activities are:

(a) Planned deforestation (e.g. to build project infrastructure);
(b) Planned degradation (e.g. timber logging, fuel-wood collection or charcoal production);

If the project activity generates a significant decrease in carbon stocks during the fixed projection period, the carbon stock change must be measured ex post. If the decrease is not significant, it must not be accounted, and ex post monitoring will not be required.

Changes in carbon stocks that are not attributable to the project activity cannot be accounted.

Where the avoided unplanned deforestation project activity includes planned deforestation, harvesting of timber, fuel-wood collection or charcoal production above the reference scenario do the following:

(a) Identify the forest areas (polygons) within the project area that will be subject to planned deforestation and planned degradation activities (logging, fuel-wood collection or charcoal production) during the project crediting period.
(b) Prepare maps showing the annual locations of the planned activities.

8 Cited from "Methodology for Avoided Unplanned Deforestation" VM0015 version 1.1

(c) Identify the forest classes that are located within these polygons.

(d) Define activity data (annual areas) for each forest class, according to the planned interventions and types of intervention.

(e) Estimate the impact of the planned activities on carbon stocks as follows:

- Planned deforestation: Conservatively assume that 100% of the carbon stocks will be lost at the year of the planned deforestation.
- Areas subject to planned logging, fuel-wood collection or charcoal production above the reference scenario: Conservatively assume that the carbon stock of these areas will be the lowest of the production cycle according to the planned levels of extraction.

(f) Total carbon stock decrease due to planned logging activities within the project area is calculated with the below equation. Summarize the result of the previous assessments and calculations in Table 15 and Table 16.

Where:

$\Delta CPLDPA_{,t}$ Total carbon stock decrease due to planned logging activities within the project area at year t; tCO_2-e

$\Delta Ctot_{icl,t}$ Average carbon stock change in the initial forest class *icl*; tCO_2-e ha^{-1}

$APLPA_{icl,t}$ Area of planned logging activities in initial forest class *icl* at time *t* within the project area; ha

Table 15 Ex ante estimated actual carbon stock decrease due to planned logging activities in the project area

Project year	Areas of planned logging activities x Carbon stock change (decrease)								Total carbon stock decrease due to planned logging activities	
	ID_{cl} = 1		ID_{cl} = 2		ID_{cl} = . . .		ID_{cl} = Icl		annual	cumulative
	$APLPA_{icl,t}$	$\Delta Ctot_{icl,t}$	$APLPA_{icl,t}$	$Ctot_{icl,t}$	$APLPA_{icl,t}$	$Ctot_{icl,t}$	$APLPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CPLdPA_t$	$\Delta CPLDPA$
	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	tCO_2-e	tCO_2-e
1										
2										

3										
4										
5										
6										
7										
8										
..										
10										

Table 16 Total ex ante carbon stock decrease due to planned activities in the project area

Project year	Total carbon stock decrease due to planned deforestation		Total carbon stock decrease due to planned logging activities		Total carbon stock decrease due to planned fuelwood & charcoal activities		Total carbon stock decrease due to planned activities	
	annual	cumulative	annual	cumulative	annual	cumulative	annual	cumulative
	$\Delta CPDdPA_t$	$\Delta CPDdPA$	$\Delta CPLdPA_t$	$\Delta CPLdPA$	$\Delta CPFdPA_t$	$\Delta CPFdPA$	$\Delta CPAdPA_t$	$\Delta CPAdPA$
	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e
1								
2								
3								
4								
5								
6								
7								
8								
..								
10								

Total carbon stock change in the project case in year t, $\Delta CPSPA,t$, is equal to total carbon stock decrease due to planned logging activities, $\Delta CPLDPA_{,t}$.

2. Leakage emissions and Calculation[9]

Since decrease in carbon stocks and increase in GHG emissions associated with activity displacement leakage will be subject to monitoring, reporting, verification and accounting, it is not predicted as *ex-ante* estimation. The methodology provides maximum potential emission reduction without discounting decrease in carbon stocks and increase in GHG emissions associated with activity displacement leakage.

H. Calculation of *ex-ante* potential; emissions reductions

The maximum potential emission reduction from the proposed project activity is defined as follows:

$$ER_t = \Delta CREFPA_t \quad - \Delta CPSPA_t - \Delta CLK_t$$

Where:

ERy Maximum potential emission reduction in year t, tCO2/y

ΔCREFPAt Reference emissions in year t, tCO2/y

ΔCPSPAt Project emissions in year t, tCO2/y, which is equal to decrease due to planned logging activities, $\Delta CPLDPA_{,t}$.

ΔCLKt Leakage emissions in year t, tCO2/y, which is set as zero in *ex-ante* estimation

I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* will be described in the blow table..

Parameter	Description of data	Source

J. Monitoring of carbon stock changes and GHG emissions

[9] Cited from "Methodology for Avoided Unplanned Deforestation" VM0015 version 1.1

There are three main monitoring tasks:

1. Monitoring of actual carbon stock changes and GHG emissions within the project area;
2. Monitoring of leakage; and
3. *Ex post* calculation of net anthropogenic GHG emission reduction.

Prepare a Monitoring Plan describing how these tasks will be implemented. For each task the monitoring plan must include the following sections:

Technical description of the monitoring tasks.

a) Data to be collected.
b) Overview of data collection procedures.
c) Quality control and quality assurance procedures.
d) Data archiving.
e) Organization and responsibilities of the parties involved in all the above.

To allow a transparent comparison between ex ante and ex post estimates, use the same formats and tables presented in Part F, of the methodology to report the results of monitoring.

1 Monitoring of actual carbon stock changes and GHG emissions within the project area

This task involves:

1.1 Monitoring of project implementation;
1.2 Monitoring of land-use and land-cover change;
1.3 Monitoring of carbon stocks and non-CO2 emissions; and
1.4 Monitoring of impacts of natural disturbances and other catastrophic events.

1.1 Monitoring of project implementation

Project activities implemented within the project area should be consistent with the management plans of the project area and the PDD. All maps and records generated during project implementation should be conserved and made available to verifiers at verification for inspection to demonstrate that the project activity has actually been implemented.

1.2 Monitoring of land-use and land-cover change within the project area

The categories of changes that may be subject to MRV are listed below

- Category I: Area of forest land converted to non-forest land.
- Category II: Area of forest land undergoing carbon stock decrease.
    - Mandatory only for the project activities having planned logging, fuel-wood collection and charcoal production activities above the baseline.
    - Change in carbon stock must be significant according to *ex ante* assessment, otherwise monitoring is not required

If the project area is located within a region subject to MRV by a jurisdictional program, the MRV data generated by this program must be used.
Similarly, if the project area is located within a region that is subject to a monitoring program that is approved or sanctioned by the national or sub-national government, the data generated by such program must be used, unless they are not applicable according to the criteria listed below:

a) Monitoring occurs in the entire project area and, if the project must monitor a leakage belt, in the leakage belt.
b) If data from the existing monitoring program are used to periodically revisit the baseline, monitoring must occur in the entire reference region at least at the beginning, middle and end of the fixed baseline period.
c) At least category I above is subject to monitoring (conversion of forest land to non-forest land).
d) If the project must do a monitoring of the Category II and this is not included in the existing program, the existing program can only be used for monitoring category I, and the project proponent must implement a separate monitoring program for the Category II.
e) Monitoring will occur during the entire fixed reference period.
f) Monitoring methods are transparently documented and are similar to those used to determine the reference scenario of the project activity.
g) Monitoring protocols and data must be accessible for inspection by accredited verifier, if any.

If no existing monitoring program exist or can be used, monitoring must be done by the project proponent or outsourced to a third party having sufficient capacities to perform the monitoring tasks. Methods used to monitor LU/LC change categories and to assess accuracy must be similar to those explained in part F, section 3.1.4.4.

1.3 Monitoring of carbon stock changes and non-CO2 emissions from forest fires

Monitoring of carbon stock changes
In most cases, the *ex ante* estimated average carbon stocks per LU/LC class (or carbon stock change factors per LU/LC change category) will not change during a fixed reference period and monitoring of carbon stocks will not be necessary.
Monitoring of carbon stocks is not mandatory and does not need to be conducted unless the project proponent wishes. Some project proponents may wish to do additional carbon stock measurements during project implementation to gain accuracy and credits. If new and more

accurate carbon stock data become available, these can be used to estimate the net anthropogenic GHG emission reduction of the subsequent fixed reference period. For the current fixed reference period, new data on carbon stocks can only be used if they are validated by an verifier, if verification is required under the JCM methodological guideline. If new data are used in the current fixed reference period, the reference emissions must be recalculated using the new data.

The results of monitoring activity data and carbon stocks must be reported using the same formats and tables used for the *ex ante* assessment:

Monitoring of non-CO2 emissions from forest fires

Although the methodology is only eligible where forest fires are uncommon, forest fires are subject to monitoring and accounting, when significant. In this case, under the project scenario it will be necessary to monitor the variables within the project area and to report the results.

1.4 Monitoring of impacts of natural disturbances and other catastrophic events

Decreases in carbon stocks in GHG emissions (e.g. in case of forest fires) due to natural disturbances (such as hurricanes, earthquakes, volcanic eruptions, tsunamis, flooding, drought, fires, tornados or winter storms) or man-made events, including those over which the project proponent has no control (such as acts of terrorism or war), are subject to monitoring and must be accounted under the project scenario, when significant.

If the area (or a sub-set of it) affected by natural disturbances or man-made events generated carbon emission reductionss in past verifications, follow the JCM methodological guideline how to deal with the situation.

1.5 Total *ex post* estimated actual net carbon stock changes and GHG emissions in the project area

Summarize the results of all *ex post* estimations in the project area using the same table format used for the *ex ante* assessment.

2 Monitoring of leakage

Monitoring of leakage may not be required if the project area is located within a jurisdiction that is monitoring, reporting, verifying and accounting GHG emissions from deforestation under an UNFCCC registered program. In such cases, the most recent relevant guidelines on this subject matter shall be applied.

In all other circumstances, the sources of leakage identified as significant in the *ex ante* assessment are subject to monitoring. Two sources of leakage are potentially subject to monitoring:

2.1 Decrease in carbon stocks and increase in GHG emissions associated with leakage prevention activities;

2.2 Decrease in carbon stocks and increase in GHG emissions in due to activity displacement leakage.

2.1 Monitoring of carbon stock changes and GHG emissions associated to leakage prevention activities

Monitoring of the sources of emissions associated with leakage prevention activities must follow the methods and tools described in part G of the methodology.

Results must be reported using the same formats and tables used in the *ex ante* assessment.

2.2 Monitoring of carbon stock decrease and increases in GHG emissions due to activity displacement leakage

Monitoring of carbon stock changes

Deforestation above the reference scenario in the leakage belt area will be considered activity displacement leakage.

Activity data for the leakage belt area must be determined using the same methods applied to monitoring deforestation activity data (category I) in the project area. Monitoring of the categories II outside the project area is not required because no credits are claimed for avoided degradation under this methodology.

The result of the *ex post* estimations of carbon stock changes must be reported using the same table formats used in the *ex ante*. Leakage will be calculated as the difference between the *ex ante* and the *ex post* assessment.

Where strong evidence can be collected that deforestation in the leakage belt is attributable to deforestation agents that are not linked to the project area, the detected deforestation may not be attributed to the project activity and considered leakage. The operational entity verifying the monitoring data shall determine whether the documentation provided by the project proponent represents sufficient evidence to consider the detected deforestation as not attributable to the project activity and therefore not leakage.

2.3 Total *ex post* estimated leakage

Summarize the results of all *ex post* estimations of leakage using the same table format used for the *ex ante* assessment.

3 ***Ex post* net anthropogenic GHG emission reductions**

The calculation of *ex post* net anthropogenic GHG emission reductions is similar to the e*x ante* calculation with the only difference that *ex post* estimated carbon stock changes and GHG emissions must be used in the case of the project scenario and leakage.

Report the *ex post* estimated net anthropogenic GHG emissions and calculation of carbon emission reductions using the same table format used for the *ex ante* assessment**.**

Note: A map showing Cumulative Areas Credited within the project area shall be updated and presented to verifiers at each verification event. The cumulative area cannot generate additional carbon emission reductions in future periods.

K. Revisiting the baseline projections for future fixed baseline period

Reference scenario and emissions, independently from the approach chosen to establish them, must be revisited over time because agents, drivers and underlying causes of deforestation change dynamically. Frequent and unpredicted updating of the reference scenario and emissions can create serious market uncertainties. The JCM methodological guideline must be referred to determine the frequency of the revision. Where an applicable sub-national or national jurisdictional reference emission becomes available, the project reference emissions may be reassessed. Tasks involved in revisiting the baseline are:

1 Update information on agents, drivers and underlying causes of deforestation.

2 Adjust the land-use and land-cover change component of the baseline.

3 Adjust, as needed, the carbon component of the baseline.

1 **Update information on agents, drivers and underlying causes of deforestation**

Information on agents, drivers and underlying causes of deforestation in the reference region must be collected periodically, as these are essential for improving future deforestation projections and the design of the project activity.

- Collect information that is relevant to understand deforestation agents, drivers and underlying causes.
- Redo the part F section 3.2 at the beginning of each fixed baseline period.
- Where a spatial model was used to locate future deforestation, new data on the spatial driver variables used to model the deforestation risk must be collected as they become

available. These must be used to create updated spatial datasets and new “Factor Maps” for the subsequent fixed reference period.

2 Adjustment of the land-use and land-cover change component of the baseline

If an applicable sub-national or national reference level becomes available during the fixed reference period, it must be used for the subsequent period.

If an applicable sub-national or national reference level is not available, the reference level projections must be revisited and adjusted as necessary.

The two components of the baseline projections that must be reassessed are:

2.1 The annual areas of baseline deforestation; and

2.2 The location of baseline deforestation.

2.1 Adjustment of the annual areas of deforestation under the reference scenario

At the end of each fixed reference period, the projected annual areas of deforestation under the reference scenario for the reference region need to be revisited and eventually adjusted for the subsequent fixed reference period.

Adjustments must be made using the methods described in the part F of the methodology and using the data obtained from monitoring LU/LC changes in the reference region during the past fixed reference period, updated information on deforestation agents, drivers and underlying cases of deforestation and, where applicable, any updated information on the variables included in the estimation of the projected areas of deforestation under the reference scenario.

2.2 Adjustment of the location of the projected deforestation under the reference scenario

Using the adjusted projections for annual areas of deforestation and any improved spatial data for the creation of the factor maps included in the spatial model, the location of the projected deforestation must be reassessed using the methods explained in part F of the methodology.

All areas credited for avoided deforestation in past fixed reference periods must be excluded from the revisited reference projections as these areas cannot be credited again. To perform this exclusion use the map of “cumulative areas credited” that was updated in all previous verification events.

Note: If the boundary of the leakage belt area was assessed, the boundary of the leakage belt will have to be reassessed at the end of each fixed reference period using the same methodological approaches used in the first period. This will be required until monitoring of leakage will become unnecessary.

3 Adjustment of the carbon component of the reference level

Adjusting the carbon component of the reference level will not be necessary in most cases. However, improved carbon stock data are likely to become available over time and if this is the case, they must be used when revisiting the reference projections.