



## T-VER-P-METH-13-03

Reducing Emissions from Deforestation and Forest Degradation  
and Enhancing Carbon Sink in Forest Area Project Level:

P-REDD+ (Except Wetlands)

Version 01

Sectoral Scope: 14 –Afforestation and reforestation

Entry into force on 1 March 2023

1. Methodology Title	Reducing Emissions from Deforestation and Forest Degradation and Enhancing Carbon Sink in Forest Area Project Level: P-REDD+ (Except Wetlands)
2. Project Type	Reduction, absorption and removal of greenhouse gases from the forestry and agriculture sectors
3. Sectoral Scope	14 – Afforestation and reforestation
4. Project Outline	Greenhouse gas sequestration activities by increasing carbon stocks in the above-the-ground and below-ground biomass including dead woods, plants, and organic soil in forest area (except wetlands)
5. Applicability	<ol style="list-style-type: none"> <li>1. The project area has land-use rights certificate as specified by law</li> <li>2. Project must implement activities possessing at least one of the characteristics mentioned below:               <ol style="list-style-type: none"> <li>2.1 Measures preventing the conversion of forest areas for other uses are in place; and/or</li> <li>2.2 Measures reducing forest degradation/GHG emissions from deforestation are in place; and/or</li> <li>2.3 Activities increasing carbon in forest areas are in place</li> </ol> </li> </ol>
6. Project Conditions	<ol style="list-style-type: none"> <li>1. Project area covers activities reducing GHG emission from deforestation and forest degradation (REDD). Activities under collaboration between REDD and Afforestation, Reforestation and Revegetation (AR) activities</li> <li>2. For REDD activities, the project area must possess characters of a forest. The area must possess not less than 1 rai; canopy density is not less than 30%; fully-grown trees must be taller than 3 meters, and they must be there for at least for 10 years.</li> <li>3. For REDD activities, the project area must be likely to change from forest area to non-forest area.</li> <li>4. For AR activities, the project area must be an area of degraded forest or a non-forest area before the project start date, and must not change the original ecosystem.</li> <li>5. Production of fuel woods is allowed in the area of AR activities.</li> <li>6. In case of additional planting, the project must select plant species suitable with original ecosystem of the area</li> </ol>

	<p>7. It must be an activity that is in addition to what is already required by law. However, it must not be contrary to or inconsistent with the laws related to the activities, except activities of government agencies, state enterprises and agencies under the supervision of the state.</p> <p>8. The project area can combine many areas together.</p>
7. Project starting date	<ul style="list-style-type: none"><li>• The date that the project proponent began to forest preservation activities according to measures to prevent the conversion of forest areas for other uses; and/or</li><li>• The date that the project proponent began to forest restoration activities according to measures to reduce forest degradation / measures to reduce greenhouse gas emissions from deforestation; and/or</li><li>• The date that the project proponent began to planting in the project area.</li></ul>
8. Remark	-

Definitions

Baseline	The occurrence of normal greenhouse gas emissions where a greenhouse gas emission reduction project has not yet been implemented.
Deforestation	Direct conversion of forest land to non-forest land by humans. Deforestation refers to long-term or permanent loss of forest areas. For this Methodology The change of land use from forest to non-forest area must not be less than 3 years.
Leakage	Leakage resulting from the application of conservation practices in Project This leads to undesirable movement of Drivers of Forest Change (DoFC) factors outside the project area, leading to greenhouse gas emissions due to deforestation and forest degradation in those areas. In case of changes in activity, DoFC rates increase, relevant land use changes. change in carbon content and non-CO <sub>2</sub> greenhouse gas emissions must be assessed and treated as leakage.
Reducing Emissions from Deforestation and forest Degradation	Reducing greenhouse gas emissions by halting deforestation/forest degradation from degraded to intact forests. that has expanded in the past or may expand in the future as a result of easier forest access
Leakage Management Zone (LMZ)	An area designated as an area with a purpose to reduce leakage from project activities.
Degradation	Ongoing declines in canopy cover and/or forest carbon stocks due to human activities such as animal husbandry, firewood, illegal harvesting or other activities but does not result in the conversion of forest areas to non-forest areas. and falls within the requirements of the IPCC (2003) Good Practice Guidance land category of forest remaining forest for this methodology. Continued loss of carbon from forest areas for at least three years is considered forest degradation.
Small scale project	The greenhouse gas reduction project that capable of reducing or removing greenhouse gas emissions up to 16,000 tonnes of carbon dioxide equivalent per year.
Large scale project	The greenhouse gas reduction project that capable of reducing or removing greenhouse gas emissions more than 16,000 tonnes of carbon dioxide equivalent per year.

Baseline validation period	The baseline period is set to 10 years, and it needs to be reassessed every 10 years throughout the project credit period.
Historical reference period	The interval at which the selected reference area changes from a forested area to a non-forested area. or in the case of deterioration, the period during which deterioration occurred.
Drivers of Forest Change (DoFC)	Activities that contribute to the depletion of forest carbon
Degraded forest	Forest area in whole or part of the National Forest Reserve where only a small fraction of the intact precious wood remains. The forest is difficult to recover naturally. This forest has trees that are more than 2 meters tall, scattered throughout the area, not more than 20 trees per rai. Or there are trees that are measured around the trunk at a height of 130 centimeters, ranging from 50 - 100 centimeters, scattered throughout the area, not more than 2 meters high. 8 trees per rai. Or there are trees with a height of more than 100 centimeters scattered throughout the area, not more than 2 trees per rai, or forest areas with trees that meet all 3 of these criteria, Where combined, must not exceed 2 trees per rai. 16 trees.
Leakage area	Areas outside the project area where the drivers of deforestation and forest degradation have been removed due to REDD activities.
Reference Region (RR)	An area that simulates the historical trend of changes in forest areas. Based on these trends, it is possible to predict the expected changes within the project area in the baseline
Below Ground Biomass (BLG)	The dry weight of the part of the tree that is underground.
Above Ground Biomass (AGB)	The dry weight of all parts of the tree above the ground, i.e., trunk, branches, leaves, flowers and fruit.
Dead wood	Fallen or dead tree
Litter)	The parts of a tree that fall to the ground are branches, stems, leaves, flowers, and fruit.
Allometry equation	The relationship equation between the height at breast height or 1.30 meters (diameter at breast height: DBH) and the total

	height (Height) of the tree, which is used to calculate the dry weight of the tree, has units in kilograms.
Additionality	A project activity is additional if the project participants can demonstrate that GHG emission are reduced below those that would have occurred in the absence of the project activity or business as usual (BAU). Demonstration of additionality shall be done following the guideline set by TGO.
Diameter at Breast Height (DBH)	The height of the trees was measured at a height of 1.30 m.
Strat date	The date when project developers begin planting or sowing seeds in the project area, or carrying out natural restoration activities, excluding site preparation such as weed control.
Minimum Mapping Unit (MMU)	The minimum unit used for classification and remote sensing analysis is set to 1 ha.
Legal Land Use Rights Certificate	Documents demonstrating ownership of land, rights to use the land according to the law, such as a land title deed (Nor. Sor 4), a certificate of utilization (Nor Sor. 3), a document on land use rights in land reform area (Sor Por.), a request for public use, letter of permission to use in the self-establishing industrial estate (NorKhor.3) or land utilization certificate from the relevant government agency

In addition to the definitions contained in this document, Use definitions consistent with definitions in the T-VER, CDM and IPCC Guidelines.

**Abbreviations**

- AR                Afforestation, Reforestation and Revegetation
- REDD            Reducing Emissions from Deforestation and forest Degradation
- REDD+          AR + REDD
- PRA              Participatory Rural Appraisal
- FGD              Focus Group Discussion

## T-VER Methodology For Reducing Emissions from Deforestation and Forest Degradation and Enhancing Carbon Sink in Forest Area Project Level: P-REDD+ (Except Wetlands)

### 1. Scope of Project

#### 1.1 Operation Characteristics

Greenhouse gas emission reduction from deforestation and forest degradation, as well as increase of carbon sink in forest area includes the following activities:

- Reducing Emission from Deforestation and Forest Degradation (REDD) implemented from collaboration between REDD and AR (Afforestation, Reforestation and Revegetation activities)

- For REDD activities, the project area must meet the definition of forest area at least 10 years prior to the project start date

- For AR activities, the project area must be degraded area or non-forest area before the project start date, and must not change the original ecosystem. The project developer must carry out activities and follow conditions as specified in *TVER-METH-13-01 Afforestation/Reforestation of lands except wetlands*

- Production of fuel woods is allowed in the area of AR activities.

This methodology cannot be used under the following conditions:

- Activities aim to reduce greenhouse gas emissions from deforestation and forest degradation that are permitted by law such as tree planting in permitted areas, mining concessions at the end of contracts, and others
- Only AR activities are implemented
- AR activities replace agricultural land which contains more than 50% of the project area
- Project activities take place on wetlands or swamp forests.

#### 1.2 Scope of Work

##### 1.2.1 Geographical Boundaries

The spatial boundaries of the project must be clearly defined. To facilitate the measurement, tracking, accounting and validation of project GHG reduction and emissions. Project activities may have more than one area and must complete the following information

- 1) location and position of the area
- 2) Map (preferably in digital format)
- 3) The geographic coordinates of each turning point, together with a document showing its authenticity from a geographically referenced digital map.
- 4) Total area
- 5) Details of land owner and user rights

1.2.2 Reference Region: RR

The project must identify and analyze the reference area to accurately analyze the trend of deforestation and forest degradation in the baseline. Reference area requirements include:

- The reference area must not be less than the project area.
- The reference area does not have to have boundaries overlapping the project area.
- The reference area does not have to be the same area adjacent to each other.

Guidelines for assessing forest destruction in the past recommends analyzing the reference area compared to the project area, in which two approaches are defined as follows.

Approach 1

The selection of the reference area must be based on all comparisons between the reference area and the total project area (Table 1).

**Table 1** Comparison between reference region and project area

Factor	Comparison
Forest type and landscape factors	<ul style="list-style-type: none"> <li>● Forest types and landscape factors within the reference area must be similar to the project area.</li> <li>● Must list all forest types within the project area and reference area. The forest type in the reference area must be comparable to the project area in the proportion of <math>\pm 20</math> percent.</li> <li>● Any forest type found at least 5% of the project area must be present in the reference area and any forest type found in the reference area more than 5% but not found in the project area must be excluded from the land use analysis.</li> </ul>

Factor	Comparison
	<ul style="list-style-type: none"> <li>Topography must compare relevant factors between the project area and the reference area such as elevation, slope, etc., and climatic conditions such as temperature and precipitation, etc. Each factor must be shown to have similar proportions.</li> </ul>
Drivers of Forest Change: DoFC	<p><u>The types of forest cover change drivers in the reference area and the project area must be the same.</u> (Forest change drivers are shown in Table 2.) To consider, two list of possible forest change drivers must be prepared for the reference area and the project area. All factors that are in the reference area but not found in the project area must be specified. And the areas affected by such factors must also be identified. For more details, analysis of factors driving forest area change This is discussed in section 5.7.</p>
Land tenure and management	<p>It must be demonstrated that the land tenure and management system practiced in the reference area is similar to that of the project area. Based on relevant documents, reports or expert opinions.</p>
Policies and regulations	<p>Policies and regulations affecting land use change patterns within the reference area and project area must be of the same type or equivalent, taking into account the current level of enforcement.</p>
Population factors and transportation infrastructure	<p>The proportion of the population and its infrastructure and transport potential such as roads at the beginning of the historical reference period must be close to the project area.</p>

**Table 2** Drivers of Forest Change: DoFC

Factors driving forest area change and activities considered under the methodology	Deforestation or forest degradation
Unsustainable/unplanned fuel harvesting	Forest degradation
Unsustainable non-timber forest Produce (NTFP)	Forest degradation
Unplanned fuel harvesting	Forest degradation
Animal husbandry and uncontrolled foraging	Forest degradation
Man-made forest fires	Deforestation
Unplanned land digging and mining	Deforestation
Expansion of subsistence agriculture through the conversion of forest areas	Deforestation

Factors driving forest area change and activities considered under the methodology	Deforestation or forest degradation
Forest invasion	Deforestation

**Approach 2**

The project area must meet all of the following conditions.

- 1) The project area is equal to or less than 6,250 rai (1,000 hectares), and
- 2) Some part of the project area is within 120 meters of the deforestation area; it must be able to demonstrate that such deforestation occurred within 10 years prior to the project start date; and
- 3) The project boundary area is at least 25% away from the deforested area analyzed in item 2) within 120 meters.

Data must be presented following the conditions using social and geographic surveying tools and techniques, such as land survey reports/records. Participatory Community Analysis, Participatory Rural Appraisal (PRA), Focus Group Discussion (FGD), Land Use Land Cover (LULC), and records from the Revenue Department. There may be references to academic documents that have been verified and published. Within 10 years prior to the project start date and must show a map that clearly demarcates the project area and reference area.

**1.2.3 Leakage Management Zone: LMZ**

The Leakage Management Zone is an area established to manage potential leaks from the implementation of a project to support the same amount of goods and services from the forest as the project scenario Where compared to the baseline. The leakage management zone is located at the maximum distance that stakeholders are willing to travel to take advantage of the specific goods and services available in the baseline. The maximum distance that stakeholders are willing to travel can be verified using tools such as PRA, interviews with key informants, FGD, surveys and expert opinions.

In the event that there is no development of a leakage management zone The project developer must map the source of the goods and services to be procured during the project period. from the start date of project activities. These sources must be regarded as potential points of leakage. and also displayed as a spatial map. This source of goods and services to be provided must be updated each time the project is renewed along with a new baseline assessment.

In cases where forest products and services are found to be reduced due to project activities, for example, project activities have developed equipment and encouraged local

residents to use biofuels (cow manure, pig manure, and waste from other crops) to replace firewood and charcoal. In this case, there is no need to show the leakage management zone.

1.2.4 Monitoring and evaluation period

The minimum period of follow-up and evaluation of the project is 1 year, and a new baseline assessment is required for the renewal of the project.

**2. Selection of carbon sources and greenhouse gases used in the calculations**

**2.1 Carbon sources used in the calculations**

Assessable and non-assessed carbon deposits of REDD and AR activities are shown in Table 3 and 4.

**Table 3** Source of carbon sink that must be assessed and not assessed in REDD activities.

Carbon pools	Selected	Explanation
Aboveground biomass (ABG)	Yes	This is a major carbon pool subjected to project activities and is calculated from tree biomass and saplings collected above ground, such as stems, branches, and leaves.
Belowground biomass (BLG)	Yes	Below-ground biomass stock is expected to increase from project activities and is calculated from tree biomass and sapling collected belowground such as root
Dead wood (DW)	Optional*	This is a carbon pool may increase from project activities, calculated from the dry weight of dead woods in the project area
Litter (LI)	Optional*	This is a carbon pool may increase occurred from project activities calculated from litters in the project area
Soil organic carbon	Optional*	This is a carbon pool may increase occurred from project activities calculated from soil organic carbon in the project area

Remark\* Assess Where project activities may cause a significant increase or decrease in greenhouse gas emissions, comparing to the baseline.

**Table 4** Source of carbon sink that must be assessed and not assessed in AR activities

Carbon pools	Selected	Explanation
Aboveground biomass (ABG)	Yes	This is the major carbon pool subjected to project activity and calculated from tree biomass (tree) and sapling collected aboveground such as stem, branches, and leaves, which may be increased or decreased for each baseline assessment and may increase from project activities
Belowground biomass (BLG)	Yes	This is a carbon pool that is expected to increase from project activities, carbon stock calculated from wood biomass (tree) and sapling collected belowground such as root
Dead wood (DW)	Optional*	This is a carbon pool that may increase from project activities, especially in non-forest areas or degraded forest areas and calculated from the dry weight of dead wood in the project area.
Litter (LI)	Optional*	This is a carbon pool that may increase from project activities and calculated from the litter in the project area.
Soil Organic Carbon (SOC)	Optional*	This is a carbon pool that may increase due to project activities. This increase can be estimated from changes in carbon stocks and calculated from soil organic carbon in the project area

Remark\* Assess Where project activities may cause a significant increase or decrease in greenhouse gas emissions, comparing to the baseline.

## 2.2 Emission sources and types of greenhouse gases used in the calculation

Projects shall take into account significant increases in carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>) emissions relative to the baseline in relation to project activities (Tables 5 and 6).

A test of the significance of greenhouse gas emissions for project activities may be used according to the calculation tool T-VER-P-TOOL-01-09 tool for testing significance of GHG

emissions in project activities to determine whether GHG emission sources are significant or not. If attribution is included in the GHG emissions estimate in the baseline, the emission source must also be included in the project and leakage calculations.

**Table 5** Emission sources and types of assessable and non-assessed greenhouse gases of REDD activities

Sources		Greenhouse Gas	Selected	Explanation	
Baseline	Burning of woody biomass)	CO <sub>2</sub>	Yes	CO <sub>2</sub> emissions from burned biomass are estimated from changes in carbon stock	
		CH <sub>4</sub>	Yes	Non-CO <sub>2</sub> emissions from burned biomass must also be taken into account for GHG emissions. Not assessing on the basis of conservation	
		N <sub>2</sub> O	Yes		
	Combustion of fossil fuels	CO <sub>2</sub>	No	Not assessing on the basis of conservation	
		CH <sub>4</sub>	No	Less greenhouse gas emissions	
		N <sub>2</sub> O	No	Less greenhouse gas emissions	
	Use of fertilizers	CO <sub>2</sub>	No	Less greenhouse gas emissions	
		CH <sub>4</sub>	No	Less greenhouse gas emissions	
		N <sub>2</sub> O	No	Not assessing on the basis of conservation	
	Project	Burning of woody biomass	CO <sub>2</sub>	No	Emissions are not included as part of changes in carbon stocks
			CH <sub>4</sub>	Yes	Non-CO <sub>2</sub> emissions from burned biomass must also be taken into account for GHG emissions. must be included in the event of a fire
			N <sub>2</sub> O	Yes	
Combustion of fossil fuels		CO <sub>2</sub>	No	Less greenhouse gas emissions	
		CH <sub>4</sub>	No	Less greenhouse gas emissions	
		N <sub>2</sub> O	No	Less greenhouse gas emissions	
Use of fertilizers)		CO <sub>2</sub>	No	Less greenhouse gas emissions	

Sources		Greenhouse Gas	Selected	Explanation
		CH <sub>4</sub>	No	Less greenhouse gas emissions
		N <sub>2</sub> O	No	Less greenhouse gas emissions

**Table 6** Emission sources and types of assessable and non-assessed greenhouse gases of AR activities

Emission sources		GHG	Conditions	Details
Baseline	Burning of woody biomass	CO <sub>2</sub>	No	CO <sub>2</sub> emissions from burned biomass are estimated from changes in carbon stock
		CH <sub>4</sub>	No	Less greenhouse gas emissions
		N <sub>2</sub> O	No	
Project	Burning of woody biomass	CO <sub>2</sub>	No	Emissions are not included as part of changes in carbon stocks
		CH <sub>4</sub>	Yes	Incineration from site preparation and other activities in the management of planted forests and the occurrence of forest fires must also be taken into account in the calculation of greenhouse gas emissions
		N <sub>2</sub> O	Yes	
	Use of fossil fuel	CO <sub>2</sub>	Yes	The use of fuel for machinery in plantation and forest management activities such as land preparation must be taken into account for GHG emissions calculations for large-scale projects.

### 3. Identification of baseline scenario and demonstration of additionality

Project developers can calculate the amount of carbon sink in the base year by evaluating from the pattern/nature of land use before project start in order to determine the baseline that is suitable for the project. The baseline for this methodology is the analysis of past and/or ongoing land use patterns and associated carbon stock changes in all selected carbon deposits within the project scope. The procedure is shown in Figure 1. The start and

end points of the specified baseline must be predetermined for each year during the review period.

Demonstration of additionality of a small project shows a simple increment by analyzing the obstacles. Large-scale projects require additionality analysis in every step.

The baseline scenario and demonstration of additionality uses *T-VER-P-TOOL-01-01 Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality in Forest Project Activities*

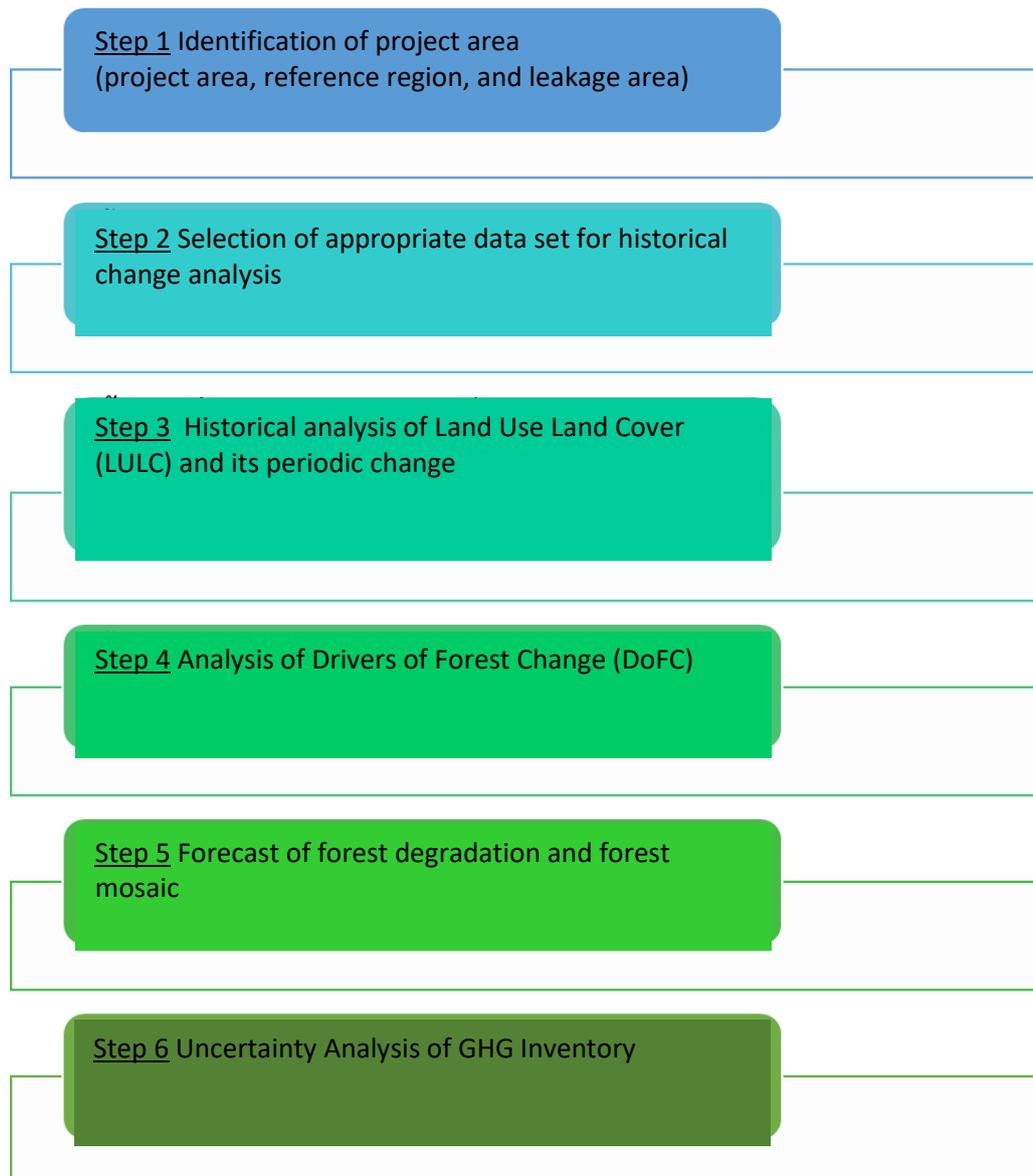


Figure 1 Procedure for consideration of baseline and greenhouse gas emissions

#### 4. Stratification

If the project area is heterogeneous, stratification is required to make biomass assessment more accurate as follows:

- Net GHG removal of the baseline can be stratified according to major vegetation types and their crown cover and/or type of land use.
- Net GHG removal of project activities, the stratification for projections is based on plant societies, vegetation types and their crown cover, management planning for renovation, restoration, etc.

- Estimates of the net GHG removal of the project (post implementation), which depends on the actual operation according to the planting and management plan. In the event that there is an impact on the project from natural or human disasters such as forest fires or other factors such as soil type which change the trend of the biomass of the project. A new stratification is needed accordingly.

Stratification can be calculated using *T-VER-P-TOOL-01-08 Calculation of Appropriate Number of Sample Plots for Carbon Measurements in Forest Project Activities*

## 5. Calculation of baseline net GHG removals by sinks

### 5.1 Baseline Emissions (BE)

Greenhouse gas emissions in the baseline includes all emissions that occur in the project area in the event that the project is not implemented. For both for REDD and AR activities, the quantification of greenhouse gas emissions in the baseline was carried out by the following steps:

#### 5.1.1 Identification of project area

The project developer must clearly define the project area. The project area may match natural boundaries and geographical boundaries or administrative boundaries such as forest management areas and the boundary of the community forest area, which will be easy to manage the project area and avoid duplicate boundaries which allows to divide the project area as appropriate.

#### 5.1.2 Identification of reference area

The reference area must meet the conditions specified in item 1.2.2. Land use changes within the reference boundary will be analyzed to determine the baseline of the project area. It must be demonstrated that the drivers of forest cover change within the reference area are also active within the project area and the same reference scope must be used for the REDD activity to validate the baseline of the AR activity in the same project.

#### 5.1.3 Selection of data set for historical change analysis

The project developer must select the appropriate data set for analyzing historical changes in the reference region. The selected dataset must be a series of the same season or different expected datasets to maintain consistency. The reference set must meet the following requirements.

- Analysis of changes must not be less than 10 years but not more than 30 years before the project start date. Going back no later than 2000, which has adjusted the methodology to assess forest areas.
- Change analysis must have at least 3 points to analyze past land use changes.
- Time points must be at least 4 years apart.
- At least one data set must be within 2 years of the project start date.

The time period for analyzing changes must be selected after considering all local, provincial and national policy, legislative, and trend information. that may affect carbon Sink of forest areas.

During the verification, the Validation and Verification Body (VVB) must use special care to assess that the time period is not over-extended to account for larger changes in carbon stocks. This can be done through a detailed policy change analysis and an impact assessment that the project developer must undertake and present to the VVB.

#### 5.1.4 Land use classification

The project developer must identify and describe the type of land use that exists in the reference area as of the project start date. Methodology for sampling and classification shall be in accordance with regional/national methodology or procedures consistent with the Intergovernmental Panel on Climate Change (IPCC) and international guidelines. The stratum classification must consider land use classification according to the national classification model and should be considered according to the 6 categories specified by IPCC namely forests, farmland, grasslands, wetlands. Settlement and other land. Wetlands are not included in this methodology.

Forest areas will need to be further classified according to forest type and forest density. These stratum may be subdivided according to alternative, or stratum classification techniques as deemed appropriate by the project developer.

Non-forest land may be further subdivided into different stratum. Plantations may be classified into sub-tiers due to the possibility of cropping/arable land systems. and guidelines that are directly or indirectly related acting as a driver of deforestation and forest degradation This would lead to a depletion of forest carbon in each of these substrata during the forest cover transition. However, such a classification is not mandatory.

A description of the land use type must have reference criteria. Such criteria may include different types of information such as elevation, slope direction, soil type, distance to roads and villages and the category of forest management.

#### 5.1.5 Spatial analysis and techniques

The final spatial classification map must contain at least six IPCC-defined land-use classifications. to measure the amount of deforestation In the case of different forest types in the reference area The map must also show the major forest types present in the landscape. The project developer may use forest/non-forest areas in the existing administration of the relevant divisions. or studying land use dynamics within or around a landscape to improve the accuracy of land use classifications. This does not require further classification by the project developer.

#### (1) Vegetation Index Model

Vegetation index models must be based on satellite imagery translation. By creating a map showing the type of land use or the density of the canopy divided by forest type. Project developers may use strata based on forest type or density, or a combination of both. To assess forest degradation A change model must be developed. Between changes in the area according to land use type/density in each forest type.

The basis of the applicability of mapping is the use of satellite data in conjunction with field surveys. Nationally accepted sampling methodologies in forestry may be used in this process. For determining the number of sample plots can be performed according to *T-VER-P-TOOL-01-08 Calculation of Appropriate Number of Sample Plots for Carbon Measurements in Forest Project Activities*.

#### (2) Analysis of land use change

Remote sensing will provide a tool for analyzing past land use changes in reference areas to assess baselines and determine rates of deforestation and forest degradation. Analysis of remote sensing data provides historical changes and the current state of land use change within the reference range.

#### (3) Assessing the accuracy of land use change maps

Accuracy in reporting and monitoring results is a key component of any monitoring system. Accuracy may be measured in accordance with the recommendations in Section 5 of the IPCC Good Practice Guidance 2003, Chapter 3A.2.4 of the IPCC 2006 Guidelines for AFOLU, and the most recent edition of the GOF-C-GOLD Sourcebook on tracking and reporting of man-made greenhouse gas emissions.

Satellite maps without cloud cover are required (if available). However, multiple images may be used in the same year to reduce the cumulative cloud cover effect for all time points to  $\leq 10\%$  of the reference area e.g. in  $t_1$ ,  $t_2$  and  $t_3$ . The cloud cover percentages are  $x$ ,  $y$ , and  $z$ , where  $x+y+z \leq 10$ , which requires subtracting cloud cover and cloud shadow from the baseline calculation.

From the above information, the accuracy of the Tier 1 classification must be estimated according to land use class or forest type. At least 25 checkpoints must be selected for each

floor. The minimum accuracy must be 85 percent. Accuracy of classification of Tier 2 or Tier 1 subcategories derived from Tier 1 classification in land use and cover change maps. shall be equal to 80% in case the classification accuracy is less than 80%. Project developers should consider the integration of land use hierarchies, for example, level 1 community forest hierarchy based on forest type using satellite images. There must be at least 25 field inspection points to verify the accuracy of the resulting forest type. and must have an accuracy of at least 85%. Later, in Level 2, sub-classification of each forest type was classified according to the degree of canopy cover density. which must be validated and an accuracy of at least 80 percent.

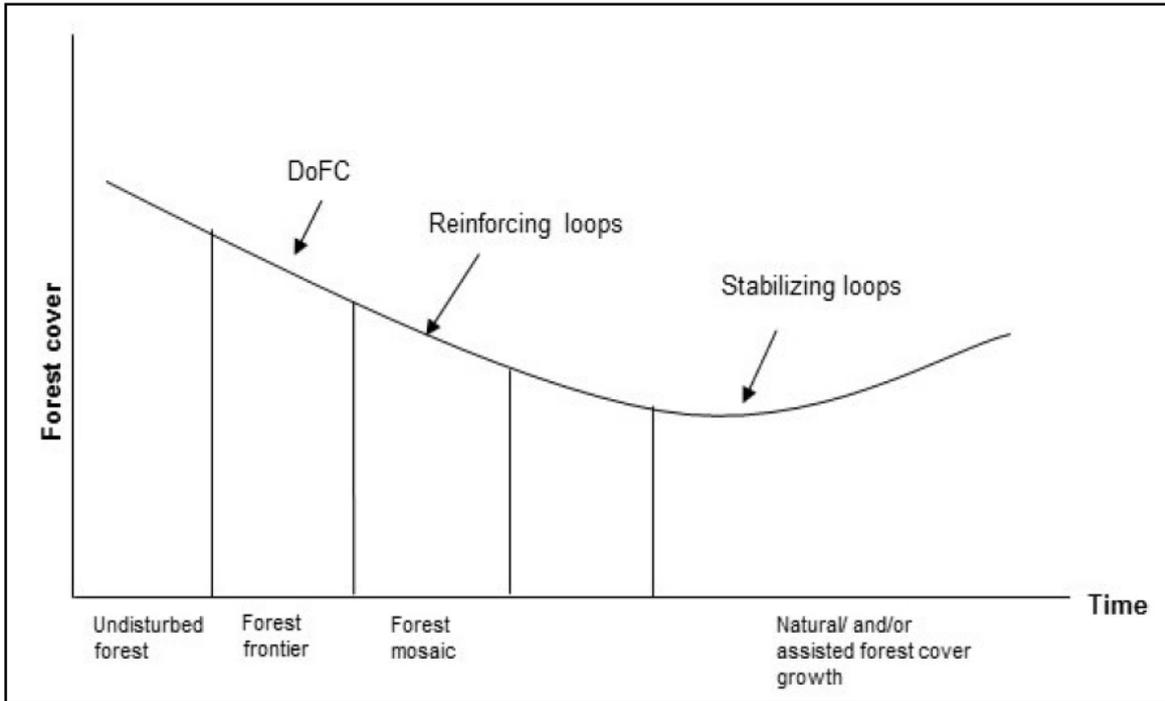
To assess the accuracy of forest degradation mapping Model results must be verified in conjunction with field surveys. Model correlations and field surveys must be subjected to linear regression analysis or other statistically appropriate techniques. with reasonable reasons and the lowest correlation coefficient of 0.7.

For verifying the accuracy of past data High resolution maps are required. In the absence of high-resolution maps. Accuracy may be assessed by other forms of surveys, such as focus group discussions. expert interview personal interview and research published in the past

#### 5.1.6 Annual Rate Conversion (ARC) Analysis

The transitional phases of forest areas are shown in Figure 2 as follows.

- 1) Undisturbed forest, inaccessible forest Due to the poor infrastructure and difficult access to the market.
- 2) Forest frontier: The driving factor for forest area change has begun to occur and high level of initial deforestation. This may be due to expanding infrastructure and easier access to land. Economic, social and political pressures are often found to lead to reductions in the ongoing rate of deforestation.
- 3) Forest degradation, or forest mosaic.
- 4) Stabilization leading to natural and/or assisted forest cover growth Lack of ecosystem services economic development and changes in policies/regulations. This is an impetus for better forest conservation and management. **The reference may belong at some point in the forest's transition period.**



**Figure 2** The transition period of the forest area. The reference may be at some point in the forest's transition period

The project shall estimate the average annual forest cover change from one stratum to another for a historical reference period. The historical reference period may be divided into two or more periods as appropriate. To calculate annual forest area change, there are the following requirements:

- Analysis of changes must not be less than 10 years but not more than 30 years before the project start date. Going back no later than 2000, which has adjusted the methodology to assess forest areas.
- Change analysis must have at least 3 points to analyze past land use changes.
- Time points must be at least 4 years apart.
- At least one data set must be within 2 years of the project start date.

The change of forest from one stratum to another is assessed through mapping of both forested and non-forested areas in the project area. The annual rate of change is calculated as the equation:

$$AC (1 \rightarrow 2)_{t_2-t_1} = \frac{(A1_{t_1} \rightarrow A2_{t_2})}{t_2 - t_1}$$

Where

- $AC (1 \rightarrow 2)_{t_2-t_1}$  = Mean Annual Change of Forest Area from stratum 1 to stratum 2 at the time interval t1 to t2 (rai).
- $A1_{t_1} \rightarrow A2_{t_2}$  = Forest area in stratum 1 at time t1 transformed into forest in stratum 2 at time t2 (rai)
- $t_1$  = Reference year at time point 1
- $t_2$  = Reference year at time point 2

From the mean annual change of forest area from stratum 1 to stratum 2, this can be calculated as the annual change rate of forest area as per the equation below.

$$ARC = \left( \frac{AC (1 \rightarrow 2)_{t_2-t_1}}{A1_{t_1}} \right) \times 100$$

Where

- $ARC$  = Annual change rate of forest area from stratum 1 to stratum 2 at the interval t1 to t2 (%)
- $AC (1 \rightarrow 2)_{t_2-t_1}$  = Mean Annual Change of Forest Area from stratum 1 to stratum 2 at the time interval t1 to t2 (rai).
- $A1_{t_1}$  = Forest area in stratum 1 at time t1 (rai)

In case more than four historical time points are considered, the rate of change from one forest stratum to another may be developed using regression equations. in the case of three time points. The average rate of change may be taken into account to estimate the overall rate of change of the forest from one stratum to another over a historical reference period. for baseline GHG emission estimation. The rate of change of one stratum to another must be estimated for all historical reference periods.

The annual change rate of the forest area from this reference area will also be used in the project area if it is found that during the project implementation period the forest area does not change. proceed as follows.

- 1) GHG emissions are not counted in the baseline in the stratums where changes are found to mature forest areas.
- 2) Using the discount factor to distribute GHG emissions in the estimated baseline evenly throughout the project credit period as per the equation below.

$$N_{LT} = \frac{tAC (i), trans}{crediting period}$$

Where

$N_{LT}$	=	Area change discount factor
$tAC(i), trans$	=	Period of transition of stratum i to another stratum (years)
<i>crediting period</i>	=	Project credit period (year)

### 5.1.7 Drivers of Forest Change (DoFC)

Project developers must analyze the driving factors of forest area change by addressing the following issues:

1) Driving factors of forest area change at national level (if any)

2) If no driving factor of forest area change is found at the national level Project developers must analyze with reference to internationally accepted norms, such as the concepts of David Kaimowitz and Arild Angelsen (1998), which use 5 simple factors as follows:

- (1) **Size and location of deforestation:** estimated by remote sensing analysis and field survey.
- (2) **Stakeholders contributing to forest degradation:** analysis of individuals/communities/companies. involved in the region causing forest transformation.
- (3) **Factors/Variables Factors that drive forest change:** identify the factors and variables that influence forest change activities undertaken by different stakeholder groups, such as demand for monocultures. community-based forestry, for example, which may include the factors mentioned below or others.
  - Land allocation
  - Labor allocation and migration
  - Capital allocation
  - Consumption
  - Other technological and management decisions
- (4) **Contributing factors to forest cover change:** These factors directly influence stakeholder decisions on forest degradation, such as wages, other costs, access to land. Technology and related information Risks Asset governance system government restrictions environmental (physical) factors.
- (5) **Macro and policy variables:** These variables will not directly affect stakeholders who cause forest degradation, but they affects the overall forest

area changes such as population growth, forest dependency ratio, government policies, customs duties, tax rates, and international exchange rates.

Areas affected by these drivers are often estimated using remote sensing technology in conjunction with field surveys. By referring to survey data from national forest statistics (tier 2) and project-level survey data (tier 3), in the implementation of the project, REDD does not only consider carbon-related factors. Social, environmental and economic dimensions must also be taken into account. The evaluation method is as shown in Table 7, where each type of tool has different efficiency in obtaining data (Table 8).

**Table 7** Economic and Social Impact Assessment Guidelines for REDD Projects

Methodology		Stakeholder discussion	Forecasts based on stakeholder perspectives	Use of available information	Project data collection
Data collection	Participatory Rural Appraisal (PRA)	√	√	X	√
	Household survey	√	√	√	√
	Key informant Interviews	√	X	X	√
	Focus group discussion	√	X	X	√
Use of secondary data	Population census Academic publications	X	X	√	X

**Table 8** The effectiveness of socio-economic impact assessment tools to analyze the drivers of forest cover change

Socio-economic tool	Drivers							
	Unsustainable extraction of Fuel-wood	Unsustainable extraction of NTFP	Uncontrolled grazing and fodder collection	Expansion of subsistence agriculture by conversion of forestland	Unplanned timber harvesting	Anthropogenic Forest fire	Encroachment	Unplanned mining and quarrying
Participatory Rural Appraisal (semi-structured focus group discussions)	Yes	Yes	Yes	Yes	NA	Yes	Yes	Yes
Household Survey	Yes	Yes	Yes	Yes	Yes	NA	Yes	NA
Key informant interviews	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Focus group discussions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Government census and records.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This methodology allows for a number of methods to be assessed depending on the suitability of the data, such as 1) questionnaires 2) checklists 3) interview recordings and discussions 4) audiovisual interviews and discussions. 5) Observational records 6) Records of previous surveys and studies or others

Assessment frequency requires at least one evaluation before every update of baseline data.

Any sampling must refer to a statistical method or accepted standard and a good representation of the populations to be studied.

The data on the drivers of forest cover change above affect carbon stocks in forest areas. This has to be calculated in order to estimate changes in carbon Sink spatially.

## 5.2 Baseline net GHG removals by sinks

The net GHG removals by sinks of the baseline considers the change in carbon Sink or carbon loss from forest degradation and change in net GHG stocks of AR activities in the baseline as follows:

### 5.8.1 REDD

Deforestation is the conversion of forest areas to other land uses. Changes in carbon stocks in forest areas were derived from the application of geographic information systems. Field inspections will assess the carbon content of each stratum through data collection in sampling plots. to assess the carbon footprint of the entire area.

$$C_{REDD,BSL,i} = (C_{TREE\_BSL,i} + C_{SAP\_BSL,i} + C_{DW\_BSL,i} + C_{LI\_BSL,i} + C_{SOC\_BSL,i}) \times \frac{1}{A_{REDD,i}}$$

Where

- $C_{REDD,BSL,i}$  = Carbon stock in baseline of REDD activity in stratum i (tonnes of carbon dioxide per rai)
- $C_{TREE\_BSL,i}$  = Carbon stock in baseline tree biomass in stratum i (tonnes of carbon per sample plot area) using calculation tool *T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities*
- $C_{SAP\_BSL,i}$  = Carbon stocks in baseline sapling biomass in year t in the baseline in stratum i (Optional) (tonnes carbon per sample plot area) using calculation tool *T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities*
- $C_{DW\_BSL,i}$  = Carbon stocks in baseline dead wood biomass in stratum i (alternative) (tonnes carbon per sample plot) using calculation tool *T-VER-P-TOOL-01-03 Calculation for carbon stocks and change in carbon stocks of dead wood and litter in forest project activities*
- $C_{LI\_BSL,i}$  = Carbon stocks in baseline litters biomass in stratum i (alternative) (tonnes carbon per sample plot area) using calculating tool *T-VER-P-TOOL-01-03 Calculation for carbon stocks and change in carbon stocks of dead wood and litter in forest project activities*
- $C_{SOC\_BSL,i}$  = Carbon stocks in baseline soil in stratum i (optional) (tonnes of carbon per sample plot area) using calculating tool *T-VER-P-TOOL-01-04 Calculation for change in soil organic carbon stocks in forest project activities*
- $A_{REDD,i}$  = Area of the sample plot in stratum i (Rai)

Changes in carbon stocks due to forest degradation will depend on land shrinkage using survey and analysis technologies such as satellite (such as SAR) or Light Detection and Ranging System (LIDAR). If there is no such technology Each type of forest must be classified according to its canopy cover. at least 4 tiers must be defined according to the country's assessment guidelines in the absence of any national guidelines or other guidelines

that are more appropriate for the analysis. The density of the canopy must be separated by at least 10% and the change in carbon content must be estimated.

To calculate this, details of carbon changes in forest areas due to forest degradation must be provided. Therefore, a deforestation-related greenhouse gas emissions factor matrix is developed that will turn forest areas into non-forest areas as the equation below.

$$\Delta C_{(1 \rightarrow 2)_{t_2-t_1}} = C1_{t_1} - C2_{t_2}$$

Where

- $\Delta C_{(1 \rightarrow 2)_{t_2-t_1}}$  = Change in the carbon stocks in forest from stratum 1 to stratum 2 (tonnes of carbon dioxide per rai) in the t2-t1 period
- $C1_{t_1}$  = Carbon stocks in stratum 1 (tonnes carbon per rai) at time t1
- $C2_{t_2}$  = Carbon stocks in stratum 2 (tonnes carbon per rai) at time t2

Changes in carbon stock or carbon loss from forest degradation in the project The baseline area for each stratum is calculated as per the equation below:

$$\Delta C_{REDD,BSL,i,t} = \Delta C_{(1 \rightarrow 2)_{t_2-t_1}} \times ARC \times A_{REDD,i}$$

Where

- $\Delta C_{REDD,BSL,i}$  = Change in carbon stock in baseline of REDD activity in stratum i (tonnes of carbon)
- $\Delta C_{(1 \rightarrow 2)_{t_2-t_1}}$  = Change in carbon stock in forest in stratum 1 to level 2 (tonnes of carbon dioxide per rai)
- $ARC$  = Annual change rate of forest cover in the t1-t2 period (%)
- $A_{REDD,i}$  = Area of stratum i in the REDD project (Rai)

Changes in carbon stock or GHG emissions in all baseline are calculated using the equation below:

$$\Delta C_{REDD,BSL,t} = \sum \Delta C_{REDD,BSL,i,t} \times \frac{44}{12}$$

Where

$\Delta C_{REDD,BSL,t}$  = Change in carbon stock in baseline of REDD activity in stratum i (Tonne of CO<sub>2</sub> equivalent)

$\Delta C_{REDD,BSL,i,t}$  = Change in carbon stock in baseline of REDD activity in stratum i in all strata (tonnes of carbon)

### 5.8.2 AR

Net GHG removal calculation of AR activity baseline based on TVER-METH-13-01. Voluntary Greenhouse Gas Reduction Methodology for forest planting activities (Afforestation /Reforestation of Lands Except Wetlands) can be calculated as follows:

$$\Delta C_{AR,BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SAP\_BSL,t} + \Delta C_{DW\_BSL,t} + \Delta C_{LI\_BSL,t}$$

Where

$\Delta C_{AR,BSL,t}$  = Change in GHG removal by sink of the baseline in any year (Tonne of CO<sub>2</sub> equivalent)

$\Delta C_{TREE\_BSL,t}$  = Change in the carbon stocks in tree biomass in baseline in year t (alternative) (Tonne of CO<sub>2</sub> equivalent) using calculation tool *T-VER-P-TOOL-01-02 Calculation for carbon stocks and changes in carbon stocks of trees in forest project activities*

$\Delta C_{SAP\_BSL,t}$  = Change in the carbon stocks in sapling in baseline in year t (alternative) (Tonne of CO<sub>2</sub> equivalent) using calculation tool *T-VER-P-TOOL-01-02 Calculation for carbon stocks and changes in carbon stocks of trees in forest project activities*

$\Delta C_{DW\_BSL,t}$  = Change in the carbon stocks in dead wood in baseline in year t (alternative) (Tonne of CO<sub>2</sub> equivalent) using calculation tool *T-VER-P-TOOL-01-03 Calculation for carbon stocks and changes in carbon stocks of dead wood and litter in forest project activities*

$\Delta C_{LI\_BSL,t}$  = Change in carbon stock in litter in baseline in year t (alternative) (Tonne of CO<sub>2</sub> equivalent) using calculating tool *T-VER-P-TOOL-01-03 Calculation for carbon stocks and changes in carbon stocks of dead wood and litter in forest project activities*

The baseline carbon stock and/or baseline net GHG change for any year may be set to zero. If the conditions set forth in the GHG Sink change quantification tool of the relevant carbon deposit are met.

## 6. Actual net GHG emission and removals by sinks

Calculation of net GHG emissions and removals by sinks from project activities. Change in GHG emission and removals by sinks of project activities occur from the selected carbon pools and increasing greenhouse gas emissions from project activities. Net GHG emission and removals by sinks from project activities can be calculated as follows:

### 6.1 Calculating the change in carbon removals by sinks in project activities

Quantification of the change in carbon stock of AR activity from selected carbon pools in any follow-up year ที่ดำเนินการติดตามผล is based on TVER-METH-13-01 Methodology for Afforestation /Reforestation of Lands Except Wetlands can be calculated as follows:

$$\Delta C_{AR,PROJ,t} = \Delta C_{TREE,P,t} + \Delta C_{SAP,P,t} + \Delta C_{DW,P,t} + \Delta C_{LI,P,t} + \Delta SOC_{P,t}$$

Where

$\Delta C_{AR,PROJ,t}$  = Change in carbon stock of AR activity in year t (Tonne of CO<sub>2</sub> equivalent)

$\Delta C_{TREE,P,t}$  = Change in the carbon stocks in tree biomass in project in year t (Tonne of CO<sub>2</sub> equivalent) using calculation tool *T-VER-P-TOOL-01-02 Calculation for carbon stocks and changes in carbon stocks of trees in forest project activities*

$\Delta C_{SAP,P,t}$  = Change in the carbon stocks in sapling in project in year t (alternative) (Tonne of CO<sub>2</sub> equivalent) using calculation tool *T-VER-P-TOOL-01-02 Calculation for carbon stocks and changes in carbon stocks of trees in forest project activities*

$\Delta C_{DW,P,t}$  = Change in the carbon stocks in dead wood in project in year t (alternative), (Tonne of CO<sub>2</sub> equivalent) using calculation tool *T-VER-P-TOOL-01-03 Calculation for carbon stocks and changes in carbon stocks of dead wood and litter in forest project activities*

$\Delta C_{LI,P,t}$  = Change in carbon stock in litter in project in year t (alternative) in year t, (Tonne of CO<sub>2</sub> equivalent) using calculation tool *T-VER-P-TOOL-01-03 Calculation for carbon stocks and changes in carbon stocks of dead wood and litter in forest project activities*

$\Delta SOC_{P,t}$  = Change in carbon stock in SOC in project, in year t (alternative) (Tonne of CO<sub>2</sub> equivalent) using calculation *T-VER-P-TOOL-01-04 Calculation for change in soil organic carbon stocks in forest project activities*

## 6.2 Additional GHG emission calculation from project activities

To calculate the additional greenhouse gas emissions from project activities. For REDD and AR areas, calculate the emissions of non-CO<sub>2</sub> gases from burning biomass, i.e. land preparation or land management by burning and forest fire. AR activity areas calculate greenhouse gas emissions from burning fossil fuels from the use of machinery in various activities. in planting and managing planted forests such as preparing or managing land from through machinery application.

For smaller projects, GHG emissions from fossil fuel consumption from project activities do not have to be calculated.

The project does not have to assess the amount of greenhouse gas emissions that increase from the following activities.

- 1) cuttings of herbaceous plants and shrubs
- 2) fertilizing
- 3) decomposition of plant residues and roots
- 4) construction of roads in the project area and transportation from project activities

Greenhouse gas emissions from such activities considered to have no significant effect on the amount of GHG removal by sink from project activities and set the amount of greenhouse gas emissions from such activities to be zero. GHG emissions from project activities can be calculated from the equation.

$$GHG_{PROJ,t} = GHG_{Burning,t} + GHG_{Fuel,t}$$

Where

- $GHG_{PROJ,t}$  = Additional GHG emission from project activities in year t (Tonne of CO<sub>2</sub> equivalent)
- $GHG_{Burning,t}$  = GHG emission from project activities' biomass burning in year t (Tonne of CO<sub>2</sub> equivalent) were calculated according to the calculation tool *T-VER-P-TOOL-01-05 Calculation for non-CO<sub>2</sub> greenhouse gas emissions from burning of biomass in forest project activities*
- $GHG_{Fuel}$  = GHG emission from project activities' fossil fuel use (Tonne of CO<sub>2</sub> equivalent), which is calculated as the equation

$$GHG_{Fuel} = \sum (FC_i \times (NCV_i \times 10^{-6}) \times EF_{CO_2i}) \times 10^{-3}$$

Where

- $GHG_{Fuel}$  = GHG emission from project activities' fossil fuel use of machinery (Tonne of CO<sub>2</sub> equivalent)

- $FC_i$  = Quantity of fossil fuel use type  $i$  for the operating project (Unit)
- $NCV_i$  = Net Calorific Value of fossil fuel use type  $i$  (megajoules per unit)
- $EF_{CO_2_i}$  = GHG emission from fossil fuel burning type  $i$  (kilogram carbon dioxide/terajoules)

## 7. Leakage Emission

### 7.1 Leakage Management Zones (LMZ)

Leakage management areas are mentioned in section 1.2.3, which must be assessed as follows:

- 1) Assessment of leakage due to replacement of unplanned forest cover change drivers
- 2) The project developer must define a leak management area using socio-economic surveys and local wisdom
- 3) An assessment must select a good agent and a thorough investigation must be undertaken to account for the leak
- 4) All communities which are included in the project The area shall be inspected periodically or at least once while verified by social and economic surveys to inform what current requirements are fulfilled with the help of project activities and what the remaining requirements are so that communities have to rely on other forest areas.

### 7.2 Activity Shifting Leakage

Application of conservation guidelines in the project could lead to the shift of drivers of unwanted and unintended forest cover change outside the project area, leading to greenhouse gas emissions due to deforestation and forest degradation in the area. Those changes in activity increases the rate of the relevant driving factor. Changes in carbon content/density and non-carbon dioxide emissions must be assessed and treated as leakage.

The magnitude of the leakage for each activity in different conservation projects will vary, for example if nearby forest areas are easily accessible and the drivers of forest cover change are mobile. Leaks may occur from large-scale event changes. In cases where the forest area is not easily accessible or the driving factor cannot be moved. The risk of leakage is relatively low, for example, determined using the tools in Table 9.

**Table 9** Source of leakage

Source of leakage	Explanation
Movement of agricultural activities	Leakage due to the movement of agricultural activities as a result of project activities must be taken into account using <i>T-VER-P-TOOL-01-06 Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in forest project activities</i>
Illegal harvesting	Leakage due to illegal harvesting must be taken into account. However, if the socio-economic survey finds that there is no illegal harvesting out of the project area, then the leakage of illegal harvesting outside the project area will be considered. Project area can be assessed.  Reference tool: Socio-economic survey and expert review Relevant academic documents

### 7.3 Market Leakage

Market leakage must be measured quantitatively. Due to conservation within the project area affecting the supply chain of forest products and must be updated every time the project is renewed. along with a new baseline assessment. As a result, forest products are shifted elsewhere to meet demand in the chain. The calculation is shown as the equation.

$$LK_{MARKET,t} = LF \times \Delta C_{BSL,t}$$

Where

$LK_{MARKET,t}$  = GHG emissions due to market leakage from project activities in year t.

(Tonne of CO<sub>2</sub> equivalent)

$LF$  = Leakage Factor for market impact calculations (No Unit)

$\Delta C_{BSL,t}$  = Baseline net GHG removals by sinks, in year t (Tonne of CO<sub>2</sub> equivalent)

The leakage reduction factor was estimated by comparing the ratio of salvable figure biomass to total biomass in the project area at the base year and the ratio of salvable figure biomass to total biomass within the area where harvesting is likely to occur. The following discount factors may be used for market leakage.

1) There are supporting measures to minimize the driving factors of forest area change or not occur. In this case, the discount factor is 0.

2) There are supporting measures to reduce harvesting such as a moratorium on debt settlement, which will cause a decrease in harvesting in the long run. In this case, the discount factor is 0.1.

3) In case of supporting measures that permanently reduce the level of harvesting Depending on the availability of biomass, a three-level discount factor may be applied, i.e. timber in the Leakage Management Area has the same quality and availability as the timber sold in the project area. The three-level discount factor is:

3.1) If the ratio of figure biomass sold to total biomass in the leakage area is higher than the project area by more than 15%, the discount factor is 0.2.

3.2) If the ratio of salable figure biomass to total biomass in the leakage area is close to the ratio of the project area  $\pm$  15%, the discount factor is 0.4.

3.3) If the ratio of figure biomass sold to total biomass in the leakage area is less than 15% lower than the project area, the discount factor is 0.7.

The leakage factor was determined by considering project activities that could result in an increase in the country's harvesting. This was a result of a decrease in the supply of timber caused by the project. A market leakage can be ignored if it shows that no market-impacting leak occurs within a country. Due to market leakage and the amount of timber cut each year has increased only slightly. is emissions of less than 5% of the total greenhouse gas emissions of the project And no illegal harvesting was found in the country of the project owner.

Outbound leakage needs not be taken into account.

#### 7.4 Leakage caused by changes in farmland from AR activities

Calculation of GHG emissions outside the project boundary if the project's AR activities cause encroachment on new areas such as farming, settlement, etc. The carbon emissions from the leakage must be calculated as follows:

$$LK_t = LK_{AGR,t}$$

$LK_t$  = GHG emissions due to leakage outside project boundaries in year t  
(Tonne of CO<sub>2</sub> equivalent)

$LK_{AGR,t}$  = Leakage due to the conversion of agricultural land from the AR activities of the project in year t (Tonne of CO<sub>2</sub> equivalent)  
using *T-VER-P-TOOL-01-06 Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in forest project activities*

#### 7.5 GHG emissions outside the project boundaries

All greenhouse gas emissions occurring outside the project boundary can be calculated as follows:

$$LK_t = LK_{MARKET,t} + LK_{REDD\_AGR,t} + LK_{AR\_AGR,t}$$

Where

- $LK_t$  = GHG emissions due to leakage outside the project scope in year t (Tonne of CO<sub>2</sub> equivalent)
- $LK_{MARKET,t}$  = GHG emissions due to market leakage from project activities in year t (tonne of CO<sub>2</sub> equivalent)
- $LK_{REDD\_AGR,t}$  = GHG emissions due to market leakage from changes in agricultural land from REDD activities in year t (Tonne of CO<sub>2</sub> equivalent) using *T-VER-P-TOOL-01-06 Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in forest project activities*
- $LK_{AR\_AGR,t}$  = GHG emissions due to the change of agricultural land from the project's AR activities in year t (Tonne of CO<sub>2</sub> equivalent) using *T-VER-P-TOOL-01-06 Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in forest project activities*

## 8. Calculation of net GHG removal by sink from project implementation

Net GHG removal by sink from project implementation can be calculated from the equation.

$$\Delta C_{REDD+,t} = \Delta C_{REDD,t} + \Delta C_{AR,t} - GHG_{PROJ,t} - LK_t$$

Where

- $\Delta C_{REDD+,t}$  = Net GHG removals by sinks from project implementation (Tonne of CO<sub>2</sub> equivalent)
- $\Delta C_{REDD,t}$  = Net GHG removals by sinks from REDD activities in any year (Tonne of CO<sub>2</sub> equivalent)
- $\Delta C_{AR,t}$  = Net GHG removals by sinks from AR project activities in any year (Tonne of CO<sub>2</sub> equivalent)
- $GHG_{PROJ,t}$  = Additional GHG emission from project activities in year t (Tonne of CO<sub>2</sub> equivalent)

$LK_t$  = GHG emissions due to leakage outside the project scope in year t  
 $t$  = Year of monitoring and evaluation (year)

Net GHG removal by sink from AR activities is calculated from the equation.

$$\Delta C_{AR,t} = \Delta C_{AR,PROJ,t} - \Delta C_{AR,BSL,t}$$

Where

$\Delta C_{AR,t}$  = Net GHG removal by sink from AR activities in any year  
(Tonne of CO<sub>2</sub> equivalent)

$\Delta C_{AR,PROJ,t}$  = Net GHG removal by sink from AR activities in any year  
(Tonne of CO<sub>2</sub> equivalent)

$\Delta C_{AR,BSL,t}$  = Change in net GHG removal by sink of the baseline from AR  
activities in any t (Tonne of CO<sub>2</sub> equivalent)

$t$  = Year of monitoring and evaluation (year)

## 9. Uncertainty Analysis

The project developer must demonstrate the cumulative uncertainty calculation for the project from the uncertainty arising from the calculation of GHG emissions and carbon change in the deposit, both from the baseline and from the calculations. carry out the project in order to comply with conservation rules. This methodology specifies an uncertainty of 10%, a confidence interval of 90%. The project developer can assess the uncertainty according to the calculation tools used or according to academic principles. If the project has cumulative uncertainty for the project greater than 10%, the resulting value must be deducted from the amount of change in carbon deposits both from the baseline and from project operations. According to the ratio in Annex 1.

## 10. Monitoring Procedure

### 10.1 Monitoring Plan

The Project Performance Monitoring Plan provides for the collection of data needed to quantify changes in carbon sink from selected carbon deposits, and greenhouse gas emissions from project activities and greenhouse gas emissions outside the project boundaries.

### 10.2 Monitoring of project implementation

Information for project follow-up will be provided in the Project Design Document (PDD). Parameters to be monitored include measurement methods, and frequency of measurements. It meets the requirements of the TGO.

## 11. Parameter

### 11.1 Parameter not required monitoring

Parameter	$NCV_i$
Unit	MJ/Unit
Definition	Net Calorific Value of fossil fuel type i
Source of information	Option 1 Net Calorific Value of fossil fuel specified in invoice from fuel supplier Option 2 from monitoring Option 3 Thailand energy statistics report, Department of Alternative Energy Development and Efficiency, Ministry of Energy
Remark	

Parameter	$EF_{CO_2,i}$
Unit	kg CO <sub>2</sub> /TJ
Definition	GHG emission value from fossil fuel type i
Source of information	Table 1.4 2006 IPCC Guidelines for National GHG Inventories
Remark	-

For other parameters, not required monitoring appears in the corresponding calculation tools.

### 11.2 Parameter required monitoring

Parameter	Project location
Unit	UTM or Latitude, Longitude
Definition	Location coordinates of project boundary
Source of information	Monitoring report
Monitoring Methods	Geographic coordinate from geolocation measuring tool or

	A value from a government map of at least four points indicating the location of the different directions: north-most, southern-most, eastern-most, and westernmost
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	Project boundary
Unit	Rai
Definition	Total project area
Source of information	Monitoring report
Monitoring Methods	- Exploration in the boundary - Use satellite/aerial imagery
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{TREE\_BSL,t}$
Unit	t CO <sub>2</sub> -e
Definition	Change in carbon stock in tree biomass in baseline in year t
Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities</i>
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{SAP\_BSL,t}$
Unit	Tonne of CO <sub>2</sub> equivalent
Definition	Change in carbon stock in sapling in baseline in year t
Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities</i>

Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{DW\_BSL,t}$
Unit	t CO <sub>2</sub> -e
Definition	Change in carbon stock in dead wood in baseline in year t
Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-03 Calculation of carbon stocks and change in carbon stocks in dead wood and litter in forest project activities</i>
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{LI\_BSL,t}$
Unit	t CO <sub>2</sub> -e
Definition	Change in carbon stock in litters in baseline in year t
Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-03 Calculation of carbon stocks and change in carbon stocks in dead wood and litter in forest project activities</i>
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{SOC\_BSL,t}$
Unit	t CO <sub>2</sub> -e
Definition	Change in carbon stock in soil in baseline in year t
Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-04 Calculation for change in soil organic carbon stocks in forest project activities</i>
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{TREE,P,t}$
Unit	t CO <sub>2</sub> -e
Definition	Change in carbon stock in tree biomass in project in year t
Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities</i>
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{SAP,P,t}$
Unit	t CO <sub>2</sub> -e
Definition	Change in carbon stock of sapling under the project activities year t
Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-02 Calculation for carbon stocks and change in carbon stocks of trees in forest project activities</i>
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{DW,P,t}$
Unit	t CO <sub>2</sub> -e
Definition	Change in carbon stock of dead wood under the project activities year t
Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-03 Calculation of carbon stocks and change in carbon stocks in dead wood and litter in forest project activities</i>
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{LI,P,t}$
Unit	t CO <sub>2</sub> -e
Definition	Change in carbon sink of plant decomposition under the project activities year t

Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-03 Calculation of carbon stocks and change in carbon stocks in dead wood and litter in forest project activities</i>
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$\Delta C_{SOC,P,t}$
Unit	t CO <sub>2</sub> -e
Definition	Change in carbon sink in soil under the project activities year t
Source of information	Monitoring report
Monitoring Methods	<i>T-VER-P-TOOL-01-04 Calculation for change in soil organic carbon stocks in forest project activities</i>
Frequency	According to the monitoring cycle for certification A monitoring every 3-5 years is recommended
Remark	-

Parameter	$FC_i$
Unit	Fuel unit
Definition	Consumption of fossil fuel type i for project implementation
Source of information	Fuel consumption report
Monitoring Methods	Fuel consumption report
Frequency	Continuously and record data at least on a monthly basis
Remark	-

Parameter	$GWP_{CH_4}$
Unit	tCO <sub>2</sub> e/tCH <sub>4</sub>
Definition	Global warming potential of methane
Source of information	Using data from the climate change assessment report prepared by Intergovernmental Panel on Climate Change or IPCC announced by TGO

Monitoring Methods	<p><b><u>For project document preparation</u></b></p> <ul style="list-style-type: none"> <li>- Use the latest GWP<sub>CH4</sub> value announced by the TGO</li> </ul> <p><b><u>For GHG emission monitoring</u></b></p> <ul style="list-style-type: none"> <li>- Use the value of GWP<sub>N2O</sub> as announced by the TGO for assessing the amount of greenhouse gases according to the crediting period for which the GHG emissions certification is requested.</li> </ul>
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Parameter	GWP <sub>N2O</sub>
Unit	tCO <sub>2</sub> e/tN <sub>2</sub> O
Definition	Global Warming Potential of Nitrous Oxide
Source of information	Using data from the climate change assessment report prepared by Intergovernmental Panel on Climate Change or IPCC announced by TGO
Monitoring Methods	<p><b><u>For project document preparation</u></b></p> <ul style="list-style-type: none"> <li>- Use latest GWP<sub>N2O</sub> value announced by TGO</li> </ul> <p><b><u>For GHG emission monitoring</u></b></p> <ul style="list-style-type: none"> <li>- Use GWP<sub>N2O</sub> value as announced by the TGO for assessing the amount of greenhouse gases according to the credit period requesting to certify the amount of greenhouse gases</li> </ul>

For other parameters, not required monitoring appears in the corresponding calculation tools.

## 12. References

- 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Agriculture, Forestry and Other Land Use
- ACR REDD Methodology Modules
- VM0007 REDD+ Methodology Framework (REDD+ MF) Version 1.6
- VM0037 Methodology for Implementation of REDD+ Activities in Landscapes Affected by Mosaic Deforestation and Degradation
- T-VER-METH-FOR-02 Reducing Emission from Deforestation and Forest Degradation and Enhancing Carbon Sink in Forest Area Project Level P-REDD+ (version 04)
- TVER-METH-13-01 Afforestation/Reforestation of lands except wetlands

## Annex

### Annex 1 Application of uncertainty discount

Calculation results with high uncertainty can be used further Where such estimates are conservative. This appendix outlines procedures for applying uncertainty discounts to make Parameter's estimates conservative (e.g., quantity. carbon in trees)

Where the uncertainty in the mean of Parameter's evaluation is more than 10%, the mean will be adjusted up or down from the percentage of uncertainty as follows:

Uncertainty discount factors

Uncertainty (U)	Discount (% of uncertainty)	Application
$U \leq 10\%$	0%	<p><b>Example</b></p> <p>Mean biomass = <math>60 \pm 9</math> tonnes dry weight/rai</p> <p>Uncertainty = <math>9/60 \times 100</math></p> <p>= 15%</p> <p>Discount = <math>25\% \times 9</math></p> <p>= 2.25 tonnes dry weight/rai</p> <p>The discount calculation is based on conservation principles as follows:</p> <p>Baseline = <math>60+2.25</math></p> <p>= 62.25 tonnes dry weight/rai</p> <p>Project execution = <math>60-2.25</math></p> <p>= 57.75 tonnes dry weight/rai</p>
$10 < U \leq 15$	25%	
$15 < U \leq 20$	50%	
$20 < U \leq 30$	75%	
$U > 30$	100%	



Document information

Version	Amendment	Entry into force	Description
01	--	1 March 2023	-