

VCS Module

VMD0010

Estimation of emissions from activity shifting for avoiding unplanned deforestation (LK-ASU)

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Sectoral Scope 14

Module developed by:



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1 SOURCES

This module is one of numerous modules that constitute VCS methodology *VM0007 REDD+ Methodology Framework (REDD-MF)*.

This module uses the latest versions of the following tools and modules:

- CDM tool *Estimation of direct N₂O emissions from nitrogen application (E-NA)*
- *VMD0001 Estimation of carbon stocks in the above- and belowground biomass in live tree and non-tree pools (CP-AB)*
- *VMD0007 Estimation of baseline carbon stock changes and greenhouse gas emissions from unplanned deforestation (BL-UP)*
- *VMD0013 Estimation of greenhouse gas emissions from biomass and peat burning (E-BPB)*
- *VMD0016 Methods for stratification of the project area (X-STR)*
- *VMD0015 Methods for monitoring of greenhouse gas emissions and removals in REDD project activities (M-REDD)*

2 SUMMARY DESCRIPTION OF THE MODULE

This module provides methods for estimating emissions from displacement of unplanned deforestation (leakage due to activity shifting).

This module provides methods to determine the net greenhouse gas emissions due to activity shifting leakage for projects preventing unplanned deforestation ($\Delta C_{LK-AS,unplanned}$).

3 DEFINITIONS

In addition to the definitions set out in VCS document *Program Definitions* and methodology REDD-MF, the following definitions apply to this methodology:

Active Management

Under a specific ownership which has management plans and actively defends lands against invasion by squatters

Protected Forest

Forests with active protection in place including forest guards and policies to evict squatters

Road

A maintained open public way for the passage of vehicles, people and animals

River

A waterway flowing along a definite course, usually into the sea, fed by tributary streams and navigable by vessels able to transport people and animals

4 APPLICABILITY CONDITIONS

This module is applicable for estimating carbon stock changes and greenhouse gas emissions related to the displacement of activities that cause deforestation of lands outside the project area due to the avoiding unplanned deforestation in the project area.

Activities subject to potential displacement are conversion of forest land to grazing lands, crop lands, and other land uses.

The module is mandatory if module *BL-UP* has been used to define the baseline and the applicability conditions in module *BL-UP* must be complied with in full.

5 PROCEDURES

Activities that deforestation agents would implement inside the project area in the absence of the REDD project activity could be displaced outside the project boundary as a consequence of the implementation of the REDD project activity.

Where this displacement of activities increases the rate of deforestation, the related carbon stock changes and non-CO₂ emissions must be estimated and counted as leakage.

Two different groups of deforestation agents may be displaced:

- 1. Local Deforestation Agents.** Agents obtaining their livelihood inside or near the project area since the start of the REDD project activity. This will be the main agent group in most cases of mosaic deforestation. This group will also be present in some cases of frontier deforestation.

The risk of displacing activities of local agent groups must be addressed in the design of the REDD project activity using one or both of the following two approaches:

- Exclusion from the project area of the forest locations that are likely to be deforested by these groups during the implementation of the REDD project activity. Changes in the rate of deforestation in these areas, compared to the baseline case, must be counted as leakage; and
- Implementation of leakage prevention measures to maintain or increase the agents' livelihoods, such as, but not limited to, the creation of alternative sources of fuelwood, improved crop or animal production systems, and employment¹.

¹ Note the applicability condition above that precludes leakage prevention activities that cause greater than *de minimis* increases in emissions.

- 2. Immigrant Deforestation Agents.** Agents expected to encroach into the project area in future periods. This will be the main agent group in most cases of frontier deforestation. This group will also be present in some cases of mosaic deforestation.

Influencing the land-use decisions of this deforestation agent groups will not be possible in most cases, particularly if the agents are coming from distant locations and are driven by economic reasons. Leakage prevention measures may not be sufficient to avoid some level of activity displacement from happening.

Definition of the Boundary of the Leakage Belt

A leakage belt is a critical component of the analysis of leakage for unplanned deforestation. Module *BL-UP* must be used to establish the boundary of the leakage belt.

The basic steps to estimate displacement of unplanned deforestation are:

- Step 1. Estimation of baseline carbon stock changes and GHG emissions in the leakage belt
- Step 2. Estimation of the proportions of area deforested by immigrant and local deforestation agents in the baseline
- Step 3. Estimation of unplanned deforestation displaced from the project area to the leakage belt
- Step 4. Estimation of unplanned deforestation displaced from the project area to outside the leakage belt
- Step 5. Emissions from activity shifting resulting in peatland drainage
- Step 6. Emissions from leakage prevention activities
- Step 7. Estimation of total leakage due to the displacement of unplanned deforestation

5.1 Step 1: Estimation of Baseline Carbon Stock Changes and GHG Emissions in the Leakage Belt

A baseline for the leakage belt must be estimated in order to assess leakage due to displacement of unplanned deforestation.

For methods to define the baseline of the leakage belt refer to module *BL-UP*.

5.2 Step 2: Estimation of the Proportions of Area Deforested by Immigrant and Local Deforestation Agents in the Baseline

Randomly sample communities living within 2km of the boundaries of the leakage belt and project area (defined in module *BL-UP* – Part 1). At least 10% of communities shall be sampled. If 10%

of communities is less than 10 communities then the sample size shall be set as 10 (or 100% of the communities). If 10% is more than 30 communities then the sample size shall be set as 30.

Using a participatory rural appraisal (PRA) approach, existing studies and other verifiable sources of information, determine the proportion of area deforested by the population that has been resident in and around the leakage belt and project area for ≥ 5 years ($PROP_{RES}$) and the proportion of area deforested by population that has migrated into the area in the last 5 years ($PROP_{IMM}$).

This assessment shall be repeated at least every 5 years and the estimated proportions will be assumed to be representative for up to five future years.

5.3 Step 3: Estimation of Unplanned Deforestation Displaced from the Project Area to the Leakage Belt

5.3.1 Ex ante Assessment

Based on the expected effectiveness of the proposed REDD project activities, conservatively estimate the carbon stock changes and greenhouse gas emissions in the leakage belt that are expected to occur due to the implementation of the REDD project activity and that would not occur in the baseline case. This shall be done by multiplying the estimated baseline carbon stock changes and greenhouse gas emissions for the project area by a factor < 1.0 representing the % of deforestation expected to be displaced into the leakage belt².

The result is added to the estimated baseline for the leakage belt (Step 1) to estimate carbon stock changes and greenhouse gas emissions in the leakage belt under the project scenario. The difference between project and baseline carbon stock changes and greenhouse gas emissions in the leakage belt is the *ex ante* estimated leakage due to displacement of unplanned deforestation from the project area to the leakage belt.

5.3.2 Ex post Assessment

Measure the area deforested in the project area ($A_{PA,unplanned,t}$) and leakage belt ($A_{LK,unplanned,t}$). Follow instructions and guidance in module *M-REDD*.

Leakage in the leakage belt is estimated as follows:

$$\Delta C_{LK-ASU-LB} = \Delta C_{P,LB} - \Delta C_{BSL,LK,unplanned} \quad (1)$$

Where:

$\Delta C_{LK-ASU-LB}$ Net CO₂ emissions due to unplanned deforestation displaced from the project area to the leakage belt (t CO₂e)

² If no leakage prevention activities are planned the factor shall be equal to 1. Where leakage prevention activities are implemented the factor shall be equal to the proportion of the baseline agents estimated to be given the opportunity to participate in leakage prevention activities. Leakage prevention activities must be planned to fully replace income, product generation and livelihood.

$\Delta C_{BSL,LK,unplanned}$ Net CO₂ emissions in the baseline from unplanned deforestation in the leakage belt (t CO₂e)

$\Delta C_{P,LB}$ Net greenhouse gas emissions within the leakage belt in the project case (t CO₂e)

If $\Delta C_{LK-ASU-LB}$ as calculated is <0 then $\Delta C_{LK-ASU-LB}$ shall be set equal to 0 (to prevent positive leakage).

5.4 Step 4: Estimation of Unplanned Deforestation Displaced from the Project Area to Outside the Leakage Belt

Immigrants prevented from migrating into and deforesting the project area are conservatively assumed to migrate to an alternative forest area and to cause deforestation, and where applicable, peatland drainage, in the alternative area. The alternative forest area could be within the leakage belt or it could be elsewhere in the country.

The proportion migrating to the leakage belt is calculated as the area of the leakage belt as a proportion of the total available forest area nationally.

- 5.4.1** Define the total available national forest area (ie, the total forest area in the country (*TOTFOR*)). This can be assessed with a coarse-scale imagery (eg, using MODIS imagery or similar), or with official government statistics on forest area. The total national forest area should be reduced to just the area of forest within 5km of a road or river that is suitable for conversion to agriculture or raising livestock. If boundaries are available then area of protected forests³ (*PROTFOR*) and the area of managed forests⁴ (*MANFOR*) may be excluded from the total forest area calculated in this step.

$$AVFOR = TOTFOR - PROTFOR - MANFOR \quad (2)$$

Where:

AVFOR Total available national forest area for unplanned deforestation (ha)

TOTFOR Total available national forest area (ha)

PROTFOR Total area of fully protected forests nationally (ha)

MANFOR Total area of forests under active management nationally (ha)

- 5.4.2** Calculate the area of forest in the leakage belt as a proportion of the total available national forest area. Note that if areas of protected forests and/or areas of managed forests are excluded from the total available national forest area they must also be excluded from the leakage belt forest area (*LBFOR*).

$$PROP_{LB} = LBFOR / AVFOR \quad (3)$$

³ The effectiveness of protection must be demonstrable for areas to be excluded from total available forest area.

⁴ The effectiveness of active management for preventing deforestation must be demonstrable for areas to be excluded from total available forest area

Where:

- $PROP_{LB}$ Area of forest available in the leakage belt for unplanned deforestation as a proportion of the total national forest area available for unplanned deforestation (proportion)
- $LBFOR$ Total available forest area for unplanned deforestation in the leakage belt (ha) (calculated from the *Leakage Belt Forest Cover Benchmark Map*)
- $AVFOR$ Total available national forest area for unplanned deforestation (ha)

- 5.4.3** Stratify $AVFOR$ by carbon stock. The stratification shall use peer-reviewed assessments of forest carbon stocks across the country in combination with coarse forest type maps. An initial stratification should be derived from biophysical parameters (eg, soil type, elevation, precipitation regime, temperature, slope and aspect, tree species composition, age class/disturbance history). Carbon stocks data shall be associated with each of the strata either through limited field measurements or through values derived from the peer-reviewed literature. Carbon stock shall include only live above-ground tree biomass (C_{AB_tree} – see module *CP-AB*). $AVFOR$ shall be separated into different strata where contiguous areas of at least 100 ha differ in stocks by $\geq 20\%$.⁵ Take the area-weighted average carbon stock across the leakage belt (C_{LB}) and the area-weighted average carbon stock for all available forest area outside the leakage belt (C_{OLB}). The proportional difference in stocks is calculated by dividing the stock outside the leakage belt by the stock inside the leakage belt.

$$PROP_{CS} = C_{OLB} / C_{LB} \quad (4)$$

Where:

- $PROP_{CS}$ The proportional difference in carbon stocks between areas of forest available for unplanned deforestation both inside and outside the leakage belt (proportion)
- C_{OLB} Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation outside the leakage belt (t CO₂e ha⁻¹)
- C_{LB} Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation inside the leakage belt (t CO₂e ha⁻¹)

- 5.4.4** The proportional leakage for areas with immigrating populations would then be equal to the immigrating proportion multiplied by the proportion of available national forest area outside the leakage belt multiplied by the proportional difference in stocks between forests inside and outside the leakage belt.

$$LK_{PROP} = PROP_{IMM} \times (1 - PROP_{LB}) \times PROP_{CS} \quad (5)$$

⁵ At validation the source national datasets/maps shall be presented alongside the stratification of $AVFOR$ and any divergence shall be explained

Where:

- LK_{PROP} Proportional leakage for areas with immigrating populations (proportion)
- $PROP_{IMM}$ Estimated proportion of baseline deforestation caused by immigrating population (proportion)
- $PROP_{LB}$ Area of forest available for unplanned deforestation in the leakage belt as a proportion of the total national forest area available for unplanned deforestation (proportion)
- $PROP_{CS}$ The proportional difference in stocks between areas of forest available for unplanned deforestation both inside and outside the leakage belt (proportion)

- 5.4.5** *Ex ante*, leakage due to the proportion of the baseline deforestation actors who are displaced to areas outside the leakage belt would therefore be equal to the change in stocks in the leakage belt the baseline scenario minus the change in stocks in the leakage belt in the project scenario multiplied by the proportional leakage factor for areas with immigrating populations:

$$\Delta C_{LK-ASU,OLB} = (\Delta C_{BSL,LK,unplanned} - \Delta C_{P,LB}) \times LK_{PROP} \quad (6)$$

Where:

- $\Delta C_{LK-ASU,OLB}$ Net CO₂ emissions due to unplanned deforestation displaced outside the leakage belt (t CO₂e)
- $\Delta C_{BSL,LK,unplanned}$ Net CO₂ equivalent emissions in the baseline from unplanned deforestation in the leakage belt (t CO₂e)
- $\Delta C_{P,LB}$ Net CO₂ equivalent emissions within the leakage belt in the project case (t CO₂e)
- LK_{PROP} Proportional leakage for areas with immigrating populations (proportion)

In each monitoring period, measure the area deforested in the project area ($A_{DefPA,i,t}$) and leakage belt ($A_{DefLB,i,t}$). Use module *M-REDD*.

- 5.4.6** *Ex post*, as deforestation in the project area and leakage belt will be measured, $\Delta C_{LK-ASU,OLB}$ is estimated as follows:

1. *Ex post*, the proportion of the total area deforested by immigrant agents in the project scenario shall be determined from the same proportion calculated in the baseline data. The proportional area deforested by immigrant agents in the baseline and project scenarios is assumed to remain the same.

$$A_{LK-IMM,t} = PROP_{IMM} \times A_{BSL,PA,unplanned,t} \quad (7)$$

Where:

- $A_{LK-IMM,t}$ Total area deforested by immigrant agents in the baseline and project scenario in year t (ha)
- $PROP_{IMM}$ Proportion of area deforested by immigrant agents in the leakage belt and project area (proportion)

$A_{BSL,PA,unplanned,t}$ Projected area of unplanned baseline deforestation in the project area in year t (ha)
 t 1, 2, 3 ... t^* time elapsed since the start of the project activity (year)

2. Calculate the area deforested by immigrants in the project area and leakage belt under the project scenario as follows:

$$A_{LK-ACT-IMM,t} = PROP_{IMM} \times \left(\sum_{i=1}^M A_{DefPA,i,t} + A_{DefLB,i,t} \right) \quad (8)$$

Where:

$A_{LK-ACT-IMM,t}$ Area deforested by immigrants in the project area and leakage belt under the project scenario in year t (ha)
 $PROP_{IMM}$ Proportion of area deforested by immigrant agents in the leakage belt and project area⁶ (proportion)
 $A_{DefPA,i,t}$ Area of recorded deforestation in the project area in the project case in stratum i in year t (ha)
 $A_{DefLB,i,t}$ Area of recorded deforestation in the leakage belt in the project case in stratum i in year t (ha)
 i 1, 2, 3 ... M strata
 t 1, 2, 3 ... t^* time elapsed since the start of the project activity (year)

3. Calculate the area deforested by immigrants outside the leakage belt and project area:

$$A_{LK-OLB,t} = A_{LK-IMM,t} - A_{LK-ACT-IMM,t} \quad (9)$$

Where:

$A_{LK-OLB,t}$ Area deforested by immigrants outside the Leakage Belt and project area under the project scenario in year t (ha)
 $A_{LK-IMM,t}$ Total area deforested by immigrant agents in the baseline and project scenario in year t (ha)
 $A_{LK-ACT-IMM,t}$ Area deforested by immigrants in the project area and Leakage Belt under the project scenario in year t (ha)
 t 1, 2, 3 ... t^* time elapsed since the start of the project activity (year)

4. Determine whether leakage outside the Leakage Belt has occurred:

If: $A_{LK-OLB,t} \leq 0 \rightarrow$ Leakage outside the Leakage Belt has not occurred.

If: $A_{LK-OLB,t} > 0 \rightarrow$ leakage outside the Leakage Belt has occurred.

⁶ Note: this proportion is estimated at least every 5 years.

5. If leakage outside the Leakage Belt has not occurred:

$$\Delta C_{LK-ASU,OLB} = 0 \quad (10)$$

Where:

$\Delta C_{LK-ASU,OLB}$ Sum of carbon stock changes and greenhouse gas emissions due to unplanned deforestation displaced outside the Leakage Belt (t CO₂e)

6. If leakage outside the Leakage Belt has occurred:

$$\Delta C_{LK-ASU,OLB} = C_{OLB} \times \left(\sum_{t=1}^{t^*} A_{LK-OLB,t} \right) \quad (11)$$

Where:

$\Delta C_{LK-ASU,OLB}$ Net CO₂ emissions due to unplanned deforestation displaced outside the Leakage Belt (t CO₂-e)

C_{OLB} Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation outside the Leakage Belt (t CO₂-e ha⁻¹)

$A_{LK-OLB,t}$ Area deforested by immigrants outside the Leakage Belt and project area under the project scenario in year t (ha)

t 1, 2, 3 ... t^* time elapsed since the start of the project activity (year)

5.5 Step 5: Emissions from Activity Shifting Resulting in Peatland Drainage

The total available national forest area for unplanned deforestation (AVFOR) identified in Step 2 may contain undrained peatland, to be determined using official data, where available, or recent (ie, less than 5-year old) remote sensing products. In such cases, the project proponent shall account for possible emissions from peatland drainage linked to activity shifting activities to the Leakage Belt and outside the Leakage Belt and project area.

Activity shifting to peatland areas may happen regardless of whether the project area contains peatland or not. Therefore, all projects located in countries with peatland shall carry out the estimations presented in this step. However this is not required if it can be demonstrated that peatland areas in the country are not suitable for the baseline deforestation activities (ie, that AVFOR does not contain peatland areas) or that baseline deforestation agents do not usually drain peatlands in the country in order to carry out their activities (ie, that the historical data used to construct the deforestation baseline can demonstrate that the identified deforestation agents have never carried out their activities on drained peatland, or that such activities cannot by their nature be developed on drained peatland).

Total emissions from peatland drainage due to activity shifting leakage are estimated as:

$$\Delta C_{LK-ASU-PEAT} = (PROP_{PEAT-LB} \times LK_{PEAT-EF-LB} \times A_{LK,unplanned,t}) + (PROP_{PEAT-OLB} \times LK_{PEAT-EF-OLB} \times A_{LK-OLB,t}) \quad (12)$$

Where:

- $\Delta C_{LK-ASU-PEAT}$ Net CO₂ emissions due to peatland drainage from unplanned deforestation displaced from the project area (t CO₂e)
- $PROP_{PEAT-LB}$ Proportion of undrained peatland areas in the Leakage Belt with respect to the total area of the Leakage Belt (ha)
- $LK_{PEAT-EF-LB}$ Emission factor from peat loss at peat depletion time in the Leakage Belt (t CO₂e ha⁻¹)
- $A_{LK,unplanned,t}$ Area of recorded deforestation in the leakage belt in the project case in year t (ha)
- $PROP_{PEAT-OLB}$ Proportion of undrained peatland areas in the area outside the Leakage Belt and project area with respect to the total area outside the Leakage Belt and project area (ha)
- $LK_{PEAT-EF-OLB}$ Emission factor from peat loss at peat depletion time in the area outside the Leakage Belt and project area (t CO₂e ha⁻¹)
- $A_{LK-OLB,t}$ Area deforested by immigrants outside the Leakage Belt and project area under the project scenario in year t (ha)

The proportion undrained peatland areas of the total area of the Leakage Belt represents the probability of leakage affecting such areas and is estimated as follows:

$$PROP_{PEAT-LB} = A_{PEAT-LB}/A_{LB} \quad (13)$$

Where:

- $PROP_{PEAT-LB}$ Proportion of undrained peatland areas in the Leakage Belt with respect to the total area of the Leakage Belt (ha)
- $A_{PEAT-LB}$ Total undrained peatland area found within the Leakage Belt (ha)
- A_{LB} Total area of the Leakage Belt (ha)

The emission factor from peat drainage in the Leakage Belt is determined as the total amount of carbon that would be lost at peat depletion time (PDT) in the Leakage Belt divided by the total undrained peatland area found within the Leakage Belt:

$$LK_{PEAT-EF-LB} = C_{PDT-LB}/A_{PEAT-LB} \quad (14)$$

Where:

- $LK_{PEAT-EF-LB}$ Emission factor from peat loss at peat depletion time in the Leakage Belt (t CO₂-e ha⁻¹)
- C_{PDT-LB} Total carbon loss from peatland drainage at $tPDT$ (t CO₂-e)
- $A_{PEAT-LB}$ Total undrained peatland area found within the Leakage Belt (ha)

C_{PDT-LB} may be estimated either by applying the guidance provided in module X-STR (noting that similarity in peat depth and land use with stratum i referred to must be demonstrated. $tPDT$ may be assumed to exceed the project crediting period) or by using default values derived from the peer-reviewed literature, including default factors, where available.

$A_{LK,unplanned}$, is the area of recorded deforestation in the leakage belt in the project case in year t ; ha, *ex ante*, it is equal to the area used to estimate *ex-ante* project-case emissions in Step 3a above (ie, by multiplying the estimated baseline area of deforestation the project area by a factor < 1.0 representing the % of deforestation expected to be displaced into the Leakage Belt), *ex post* it is obtained by applying module *M-REDD*.

$PROP_{PEAT-OL}$, $LK_{PEAT-EF-OLB}$ and $A_{LK-OLB,t}$ are estimated following Equations 13 and 14 above but using the best available official or peer-reviewed data from the area outside the Leakage Belt and project area instead of data from the Leakage Belt. *Ex ante*, the value of $A_{LK-OLB,t}$ is based on the area value used to estimate $\Delta C_{P,LB}$ in Step 4e above; *ex post*, use the value of $A_{LK-OLB,t}$ estimated in Equation 9.

5.6 Step 6: Emissions from Leakage Prevention Activities

Where leakage prevention activities are implemented, the emissions from biomass burning and fertilizer usage must be counted and conservatively included in their entirety as emissions caused by project implementation. Stratification of leakage prevention activities must be on the basis of biophysical parameters.⁷

$$GHG_{LK,E} = \sum_{t=1}^{t^*} \sum_{i=1}^M (E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t}) \quad (15)$$

Where:

| | |
|-----------------------|---|
| $GHG_{LK,E}$ | Greenhouse gas emissions as a result of leakage of avoiding deforestation activities (t CO ₂ -e) |
| $E_{BiomassBurn,i,t}$ | Non-CO ₂ emissions due to biomass burning in stratum i in year t (t CO ₂ e) |
| $N_2O_{direct-N,i,t}$ | Direct N ₂ O emission as a result of nitrogen application on the alternative land use in stratum i in year t (t CO ₂ e) |
| i | 1, 2, 3 ... M strata |
| t | 1, 2, 3 ... t^* time elapsed since the start of the project activity (years) |

⁷ Eg, soil type, elevation, precipitation regime, temperature, slope and aspect

5.7 Step 7: Estimation of Total Leakage Due to the Displacement of Unplanned Deforestation

$$\Delta C_{LK-AS,unplanned} = \Delta C_{LK-A\ SU-LB} + \Delta C_{LK-ASU-OLB} + \Delta C_{LK-ASU-PEAT} + GHG_{LK,E} \quad (16)$$

Where:

$\Delta C_{LK-AS,unplanned}$ Net greenhouse gas emissions due to activity shifting leakage for projects preventing unplanned deforestation Net CO₂ emissions (t CO₂e)

$\Delta C_{LK-ASU-OLB}$ Net CO₂ emissions due to unplanned deforestation displaced outside the Leakage Belt (t CO₂e)

$\Delta C_{LK-ASU-LB}$ Net CO₂ emissions due to unplanned deforestation displaced from the project area to the Leakage Belt (t CO₂e)

$\Delta C_{LK-ASU-PEAT}$ Net CO₂ emissions due to peatland drainage from unplanned deforestation displaced from the project area (t CO₂e)

$GHG_{LK,E}$ Greenhouse gas emissions as a result of leakage of avoiding deforestation activities (t CO₂-e)

6 PARAMETERS

6.1 Data and Parameters Available at Validation

| | |
|--|--|
| Data / Parameter | $\Delta C_{BSL,LK,unplanned}$ |
| Data unit | t CO ₂ e |
| Description | Net CO ₂ emissions in the baseline from unplanned deforestation in the leakage belt |
| Equations | 1, 6 |
| Source of data | Module <i>BL-UP</i> |
| Value applied | N/A |
| Justification of choice of data or description of measurement methods and procedures applied | See module <i>BL-UP</i> |
| Purpose of Data | Calculation of leakage emissions |
| Comments | N/A |

| | |
|------------------|----------|
| Data / Parameter | C_{LB} |
|------------------|----------|

| | |
|--|---|
| Data unit | t CO ₂ e ha ⁻¹ |
| Description | Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation inside the Leakage Belt |
| Equations | 4 |
| Source of data | Literature, field surveys |
| Value applied | N/A |
| Justification of choice of data or description of measurement methods and procedures applied | Calculate from field measurements using module <i>CP-AB</i> . As forests in the leakage belt are deforested, the area weighted average must be recalculated at each monitoring period. |
| Purpose of Data | Calculation of leakage emissions |
| Comments | N/A |

| | |
|--|---|
| Data / Parameter | C _{OLB} |
| Data unit | t CO ₂ e ha ⁻¹ |
| Description | Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation outside the Leakage Belt |
| Equations | 4 |
| Source of data | Literature, field surveys |
| Value applied | N/A |
| Justification of choice of data or description of measurement methods and procedures applied | <p>Either:</p> <ol style="list-style-type: none"> 1. Calculate directly from field measurements using module <i>CP-AB</i> 2. Use numbers derived from peer-reviewed literature that are nationally or at least regionally appropriate <p>Areas included in the calculation of C_{OLB} shall be limited to areas demonstrated to be suitable for agriculture or livestock ranching. Demonstration shall be through existing areas of agriculture or livestock ranching on adjacent lands with the same soil type and climate. Areas unsuitable for agriculture or livestock such as areas that are excessively dry, flooded or nutrient poor shall be excluded.</p> <p>The available national forest area and <i>MANFOR</i> and <i>PROTFOR</i> will change over time. The area-weighted average must be recalculated at least every 5 years.</p> |

| | |
|-----------------|----------------------------------|
| Purpose of Data | Calculation of leakage emissions |
| Comments | N/A |

| | |
|--|--|
| Data / Parameter | $A_{BSL,PA-unplanned,t}$ |
| Data unit | ha |
| Description | Projected area of unplanned baseline deforestation in the project area in year t |
| Equations | 7 |
| Source of data | Module <i>BL-UP</i> |
| Value applied | N/A |
| Justification of choice of data or description of measurement methods and procedures applied | See module <i>BL-UP</i> |
| Purpose of Data | Calculation of leakage emissions |
| Comments | N/A |

| | |
|--|---|
| Data / Parameter | $A_{PEAT-LB}$ |
| Data unit | ha |
| Description | Total undrained peatland area found within the Leakage Belt |
| Equations | 13, 14 |
| Source of data | Literature, field surveys |
| Value applied | N/A |
| Justification of choice of data or description of measurement methods and procedures applied | Analysis of Remote Sensing data and/or legal records and/or survey information. As peatlands in the leakage belt are drained, the area must be recalculated at each monitoring period. |
| Purpose of Data | Calculation of leakage emissions |
| Comments | N/A |

6.2 6.2 Data and Parameters Monitored

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|-------------------|--|
| Data / Parameter: | <i>MANFOR</i> |
| Data unit: | ha |
| Description: | Total area of forests under active management nationally |

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| Equations | 2 |
| Source of data: | Official data, peer reviewed publications and other verifiable sources |
| Description of measurement methods and procedures to be applied: | A demonstration is required that areas will be protected against deforestation. Such a demonstration shall include the existence of forest guards in sufficient numbers to prevent illegal colonization and an active management plan detailing harvest plans and return intervals, and/or evidence that the concession owner has previously evicted illegal colonists/squatters from the forest areas. <i>Ex-ante</i> it can be assumed that <i>MANFOR</i> shall remain constant. |
| Frequency of monitoring/recording: | Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event |
| QA/QC procedures to be applied: | See Section 9.3 of REDD-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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|--|---|
| Data / Parameter: | <i>PROTFOR</i> |
| Data unit: | ha |
| Description: | Total area of fully protected forests nationally |
| Equations | 2 |
| Source of data: | Official data, peer reviewed publications and other verifiable sources |
| Description of measurement methods and procedures to be applied: | A demonstration is required that areas will be protected against deforestation. Such a demonstration shall include either: <ol style="list-style-type: none"> 1. Designation as a UNESCO World Heritage Site, or 2. Management by an international NGO, or 3. Evidence that the government has immediately acted to evict any and all illegal squatters <i>Ex ante</i> it can be assumed that <i>PROTFOR</i> shall remain constant. |
| Frequency of monitoring/recording: | Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must |

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| | occur prior to any verification event |
| QA/QC procedures to be applied: | See Section 9.3 of REDD-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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|--|--|
| Data / Parameter: | <i>TOTFOR</i> |
| Data unit: | ha |
| Description: | Total available national forest area |
| Equations | 2 |
| Source of data: | Official data, peer reviewed publications, remotely sensed imagery (coarse scale imagery is appropriate) or cadastral maps and other verifiable sources |
| Description of measurement methods and procedures to be applied: | Limited to forest areas within 5 km of roads and rivers suitable for conversion to agriculture / livestock <i>Ex ante</i> it can be conservatively be assumed that <i>TOTFOR</i> shall remain constant for the baseline period. |
| Frequency of monitoring/recording: | Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event |
| QA/QC procedures to be applied: | See Section 9.3 of REDD-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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|------------------------------------|--|
| Data / Parameter: | $\Delta C_{P, LB}$ |
| Data unit: | t CO ₂ e |
| Description: | Net greenhouse gas emissions within the leakage belt in the project case |
| Equations | 1, 6 |
| Source of data: | Module <i>M-REDD</i> |
| Description of measurement methods | See module <i>M-REDD</i> |

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| and procedures to be applied: | |
| Frequency of monitoring/recording: | See module <i>M-REDD</i> |
| QA/QC procedures to be applied: | See Chapter 9.3 of REDD-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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|--|---|
| Data / Parameter: | $PROP_{IMM}$ |
| Data unit: | Proportion |
| Description: | Estimated proportion of baseline deforestation caused by immigrating population |
| Equations | 5, 7, 8 |
| Source of data: | The source of data shall be chosen with priority from higher to lower preference as follows: <ol style="list-style-type: none"> 1. Official (government) data 2. Peer-reviewed published sources 3. Other verifiable sources 4. PRA |
| Description of measurement methods and procedures to be applied: | Estimated as proportion of the area deforested in the past 5 years by population that migrated into the Leakage Belt and project area in the past 5 years (all areas within 2 km of the boundaries of the project area and the leakage belt shall be considered here) |
| Frequency of monitoring/recording: | Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event. <i>Ex ante</i> it can be assumed that $PROP_{IMM}$ will remain constant during the baseline period. |
| QA/QC procedures to be applied: | See Section 9.3 of REDD-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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|--|---|
| Data / Parameter: | $PROP_{RES}$ |
| Data unit: | Proportion |
| Description: | Estimated proportion of baseline deforestation caused by population that has been resident for ≥ 5 years |
| Equations | N/A |
| Source of data: | The source of data shall be chosen with priority from higher to lower preference as follows: <ol style="list-style-type: none"> 1. Official (government) data 2. Peer-reviewed published sources 3. Other verifiable sources 4. PRA |
| Description of measurement methods and procedures to be applied: | Estimated as proportion of the area deforested in the past 5 years by population resident in the Leakage Belt and project area for ≥ 5 years (all areas within 2km of the boundaries of the project area and the leakage belt shall be considered here). <i>Ex ante</i> it can be assumed that $PROP_{RES}$ will remain constant during the baseline period |
| Frequency of monitoring/recording: | Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event |
| QA/QC procedures to be applied: | See Section 9.3 of REDD-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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|---|---|
| Data / Parameter: | $A_{DefLB,i,t}$ |
| Data unit: | ha |
| Description: | Area of recorded deforestation in the leakage belt in the project case in stratum i in year t |
| Equations | 8 |
| Source of data: | Module <i>M-REDD</i> |
| Description of measurement methods and procedures to be | See module <i>M-REDD</i> |

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| applied: | |
| Frequency of monitoring/recording: | See Module <i>M-REDD</i> |
| QA/QC procedures to be applied: | See Section 9.3 of REDD-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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|--|---|
| Data / Parameter: | $A_{DefPA,i,t}$ |
| Data unit: | ha |
| Description: | Area of recorded deforestation in the project area in the project case in stratum <i>i</i> in year <i>t</i> |
| Equations | 8 |
| Source of data: | Module <i>M-REDD</i> |
| Description of measurement methods and procedures to be applied: | See module <i>M-REDD</i> |
| Frequency of monitoring/recording: | See module <i>M-REDD</i> |
| QA/QC procedures to be applied: | See Section 9.3 of REDD-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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|---|---|
| Data / Parameter: | $E_{biomassburn,i,t}$ |
| Data unit: | t CO ₂ e |
| Description: | Non-CO ₂ emissions due to biomass burning in stratum <i>i</i> in year <i>t</i> |
| Equations | 12 |
| Source of data: | Module <i>E-BPB</i> |
| Description of measurement methods and procedures to be | See module <i>E-BPB</i> |

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| applied: | |
| Frequency of monitoring/recording: | See module <i>E-BPB</i> |
| QA/QC procedures to be applied: | See Section 9.3 of REDD-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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| Data / Parameter: | $N_2O_{direct-N,i,t}$ |
| Data unit: | t CO ₂ e |
| Description: | Direct N ₂ O emission as a result of nitrogen application in stratum <i>i</i> in year <i>t</i> |
| Equations | 12 |
| Source of data: | Module <i>E-NA</i> |
| Description of measurement methods and procedures to be applied: | See module <i>E-NA</i> |
| Frequency of monitoring/recording: | See module <i>E-NA</i> |
| QA/QC procedures to be applied: | See Section 9.3 of REDD+-MF or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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|--|--|
| Data / Parameter: | C_{PDT-LB} |
| Data unit: | t CO ₂ e |
| Description: | Total carbon loss from peatland drainage at <i>tPDT</i> |
| Equations | 14 |
| Source of data: | Default factor; module <i>X-STR</i> |
| Description of measurement methods and procedures to be applied: | May be estimated either by applying the guidance provided in Module <i>X-STR</i> (noting that similarity in peat depth and land use with stratum <i>i</i> referred to must be demonstrated. <i>tPDT</i> may be assumed to exceed the Project Crediting Period) or by using |

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| | default values derived from the peer-reviewed literature, including default factors, where available. |
| Frequency of monitoring/recording: | See module M-REDD |
| QA/QC procedures to be applied: | See Section 9.3 of <i>REDD-MF</i> or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

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| Data / Parameter: | <i>Leakage Belt Forest Cover Benchmark Map</i> |
| Data unit: | |
| Description: | Map showing the location of forest land within the leakage belt area at the beginning of each monitoring period. Only applicable where leakage is to be monitored in a leakage belt |
| Equations | 3 |
| Source of data: | Module M-REDD |
| Description of measurement methods and procedures to be applied: | See module M-REDD |
| Frequency of monitoring/recording: | See module M-REDD |
| QA/QC procedures to be applied: | See Section 9.3 of <i>REDD-MF</i> or other VCS methodology that uses this module. |
| Purpose of data: | Calculation of leakage emissions |
| Calculation method: | N/A |
| Comments: | N/A |

7 REFERENCES

None.

DOCUMENT HISTORY

| Version | Date | Comment |
|---------|--------------|--|
| v1.0 | 3 Dec 2010 | Initial version |
| v1.1 | 9 March 2015 | The module was updated to include activities on peatlands. |