

REDD Methodology Module

“Estimation of emissions from activity shifting for avoided unplanned deforestation” – LK-ASU

Version – April 2010

I. SCOPE, APPLICABILITY, DATA REQUIREMENT AND OUTPUT PARAMETERS

Scope

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

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 avoided 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 forest landscape configuration can be either mosaic or frontier.

The following required and exclusionary conditions are full applicability conditions:

Required conditions

- **BL-UP** must have been used to define the baseline and the applicability criteria for **BL-UP** must have been complied with in full.
- The module shall be applied by all project activities where the baseline agents of deforestation clear the land for crop production (agriculturalist) or ranching, have no legal or sanctioned rights to deforest the land for these purposes, and are either resident in or immigrants to the reference region. If these criteria for application of the module are not met the module cannot be used.
- A baseline of carbon stock changes and greenhouse gas emissions must have been defined for the Leakage Belt area.

Exclusionary conditions

- If deforestation is planned the Module is not applicable and therefore the methodology cannot be used.
- Any leakage prevention activity implemented shall not increase emissions more than the de minimus¹ threshold. If any leakage prevention activity

¹ According to the VCS standards the de minimus is 5% or less of the total emission reduction

implemented increases emissions more than the *de minimis* threshold the Module is not applicable and therefore the methodology cannot be used.

Output parameters

This Module provides methods to determine the following parameter:

Parameter	SI Unit	Description
$\Delta C_{LK-AS,unplanned}$	t CO ₂ -e	Sum of carbon stock changes and greenhouse gas emissions due to activity shifting from avoided unplanned deforestation

II. PROCEDURE

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:

- a) **Local deforestation 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 fuel-wood, improved crop or animal production systems, and employment².

- b) **Immigrant deforestation agents** expected to encroach into the Project Area in future periods. This will be the main agent group in most cases of frontier

² Note applicability condition above precluding leakage prevention activities that cause greater than *de minimis* increases in emissions

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 to happen.

Definition of the boundary of the Leakage Belt

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

STEPS

The basic steps to estimate displacement of unplanned deforestation are:

- STEP 1. Estimation of baseline carbon stock changes and greenhouse gas 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. Estimation of total leakage due to the displacement of unplanned deforestation

STEP 1. Estimation of baseline carbon stock changes and greenhouse gas 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**.

STEP 2. Estimation of the proportions of area deforested by immigrant and local deforestation agents in the baseline

Randomly sample communities living in the Leakage Belt and Project Area (defined in **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 the Leakage Belt and Project Area for ≥ 5 years ($PROP_{RES}$) and the proportion of area deforested by population that has migrated into the Leakage Belt and Project 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.

STEP 3. Estimation of unplanned deforestation displaced from the Project Area to the Leakage Belt

a. *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 Belt³.

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.

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-EXP**.

Leakage in the Leakage Belt is estimated as follows:

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

Where:

$\Delta C_{LK-ASU-LB}$ Sum of carbon stock changes and greenhouse gas emissions due to unplanned deforestation displaced from the Project Area to the Leakage Belt up to year t^* ; t CO₂-e

³ 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.

$\Delta C_{BSL,LK,unplanned}$	Sum of baseline carbon stock changes from unplanned deforestation in the Leakage Belt up to year t^* (Module BL-UP); t CO ₂ -e
$\Delta C_{P,LB}$	Net CO ₂ equivalent emissions within the leakage belt in the project case up to year t^* ; (Module M-EXP); t CO ₂ -e

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 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.

- Define the total available national forest area (*TOTFOR*). This can be assessed with a coarse-scale imagery (e.g. 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 forests⁴ (*PROTFOR*) and the area of managed forests⁵ (*MANFOR*) may be omitted.

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

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

- 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*).

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

⁴ Protected forests should be defined as forests with active protection in place including forest guards and policies to evict squatters. The effectiveness of protection must be demonstrable for areas to be excluded from total available forest area

⁵ Active management should be defined as under a specific ownership which has management plans and actively defends lands against invasion by squatters. 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

- c. 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. Module **X-STR** shall be used to determine the threshold for separation of strata in terms of variability/homogeneity of stocks.⁶ 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**). 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 CO₂-e ha⁻¹
- C_{LB} Area weighted average aboveground tree carbon stock for forests available for unplanned deforestation inside the Leakage Belt; t CO₂-e ha⁻¹

- d. 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.

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

Where:

⁶ At validation the source national datasets/maps shall be presented alongside the stratification of $AVFOR$ and any divergence shall be explained

- 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 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

- e. *Ex ante*, leakage due 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 baseline scenario minus the change in stocks in the project scenario multiplied by the proportional leakage factor for areas with immigrating populations:

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

Where:

- $\Delta C_{LK-ASU,INM-OLB}$ Sum of carbon stock changes and greenhouse gas emissions due to unplanned deforestation displaced outside the Leakage Belt up to year t^* ; t CO₂-e
- $\Delta C_{BSL,LK,unplanned}$ Sum of baseline carbon stock changes from unplanned deforestation in the Leakage Belt up to year t^* (Module **BL-UP**); t CO₂-e
- $\Delta C_{P,LB}$ Net CO₂ equivalent emissions within the leakage belt in the project case up to year t^* ; t CO₂-e
- LK_{PROP} Proportional leakage for areas with immigrating populations; proportion

- f. 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-EXP**.
- g. *Ex post*, as deforestation in the Project Area and Leakage Belt will be measured, $\Delta C_{LK-ASU,INM-OLB}$ will be estimated as follows:
- *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.

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

Where:

$A_{LK-IMM,t}$	Total area deforested by immigrant agents in the baseline and project scenario at year t ; ha
$PROP_{IMM}$	Proportion of area deforested by immigrant agents in the Leakage Belt and Project; proportion
$A_{BSL,PA,unplanned,t}$	Annual area of unplanned baseline deforestation in the Project Area at year t ; ha

- Calculate the area deforested by immigrants in the Project Area and Leakage Belt under the project scenario as follow:

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

Where:

$A_{LK-ACT-IMM,t}$	Area deforested by immigrants in the Project Area and Leakage Belt under the project scenario at year t ; ha
$PROP_{IMM}$	Proportion of area deforested by immigrant agents in the Leakage Belt and Project Area; proportion <u>Note:</u> This proportion is estimated at least every 5 years.
$A_{DefPA,i,t}$	Area deforested in the Project Area under the project scenario in stratum i at year t as measured (Module M-EXP); ha
$A_{DefLB,i,t}$	Area deforested in the Leakage Belt under the project scenario in stratum i at year t as measured (Module M-EXP); ha
i	1, 2, 3 ... M strata in the project scenario

- 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 at year t ; ha
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$A_{LK-IMM,t}$	Total area deforested by immigrant agents in the baseline and project scenario at year t ; ha
$A_{LK-ACT-IMM,t}$	Area deforested by immigrants in the Project Area and Leakage Belt under the project scenario at year t ; ha

- 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.

- 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 up to year t^* ; t CO ₂ -e
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- If leakage outside the Leakage Belt has occurred:

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

Where:

$\Delta C_{LK-ASU-OLB}$	Sum of carbon stock changes due to unplanned deforestation displaced outside the Leakage Belt up to year t^* ; t CO ₂ -e
$PROP_{CS}$	The proportional difference in stocks between areas of forest available for unplanned deforestation both inside and outside the Leakage Belt; proportion
$A_{LK-OLB,t}$	Area deforested by immigrants outside the Leakage Belt and Project Area under the project scenario at year t ; ha

STEP 5. Estimation of total leakage due to the displacement of unplanned deforestation

$$\Delta C_{LK-AS,unplanned} = \Delta C_{LK-ASU-LB} + \Delta C_{LK-ASU-OLB} \quad (12)$$

Where:

- $\Delta C_{LK-AS,unplanned}$ Sum of carbon stock changes and greenhouse gas emissions due to activity shifting from avoided unplanned deforestation up to year t^* ; t CO₂-e
- $\Delta C_{LK-ASU-OLB}$ Sum of carbon stock changes and greenhouse gas emissions due to unplanned deforestation displaced outside the Leakage Belt up to year t^* ; t CO₂-e
- $\Delta C_{LK-ASU-LB}$ Sum of carbon stock changes and greenhouse gas emissions due to unplanned deforestation displaced from the Project Area to the Leakage Belt up to year t^* ; t CO₂-e

III. DATA AND PARAMETERS NOT MONITORED (DEFAULT OR MEASURED ONE TIME)

Data / parameter:	C_{LB}
Data unit:	t CO ₂ -e ha ⁻¹
Used in equations:	4
Description:	Area weighted average aboveground tree carbon stock for forests available for unplanned deforestation inside the Leakage Belt
Source of data:	Literature, field surveys
Measurement procedures (if any):	Calculate from field measurements using Module CP-AB
Any comment:	As forests in the leakage belt are deforested, the area weighted average must be recalculated at each monitoring period.

Data / parameter:	C_{OLB}
Data unit:	t CO ₂ -e ha ⁻¹
Used in equations:	4
Description:	Area weighted average aboveground tree carbon stock for forests available for unplanned deforestation outside the Leakage Belt
Source of data:	
Measurement procedures (if any):	<p><i>Either:</i></p> <ol style="list-style-type: none"> 1. Calculate directly from field measurements using Module CP-AB

	2. <i>Use numbers derived from peer-reviewed literature that are nationally or at least regionally appropriate</i>
Any comment:	<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 MANFOR and PROTFOR will change over time. The area weighted average must be recalculated at least every 5 years.</p>

IV. DATA AND PARAMETERS MONITORED

Data / parameter:	MANFOR
Data unit:	Ha
Used in equations:	2
Description:	Total area of forests under active management nationally
Source of data:	Official data, peer reviewed publications and other verifiable sources
Measurement procedures (if any):	
Monitoring frequency:	Must be reexamined at least every 5 years
QA/QC procedures:	
Any comment:	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

Data / parameter:	PROP _{IMM}
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Data unit:	Proportion
Used in equations:	5, 7, 8
Description:	Estimated proportion of baseline deforestation caused by immigrating population
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
Measurement procedures (if any):	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
Monitoring frequency:	Must be reexamined at least every 5 years
QA/QC procedures:	
Any comment:	

Data / parameter:	$PROP_{RES}$
Data unit:	Proportion
Used in equations:	
Description:	Proportion of population in the reference región that has been resident for ≥ 5 years
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
Measurement procedures (if any):	Estimated as proportion of the area deforested in the past 5 years by population resident in the Leakage Belt and Project Area since more than 5 years
Monitoring	Must be reexamined at least every 5 years

frequency:	
QA/QC procedures:	
Any comment:	

Data / parameter:	<i>PROTFOR</i>
Data unit:	Ha
Used in equations:	2
Description:	Total area of fully protected forests nationally
Source of data:	Official data, peer reviewed publications and other verifiable sources
Measurement procedures (if any):	
Monitoring frequency:	Must be reexamined at least every 5 years
QA/QC procedures:	
Any comment:	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

Data / parameter:	<i>TOTFOR</i>
Data unit:	Ha
Used in equations:	2
Description:	Total available national forest area
Source of data:	Official data, peer reviewed publications, remotely sensed imagery (coarse scale imagery is appropriate) or cadastral maps and other verifiable sources
Measurement procedures (if any):	
Monitoring	Must be reexamined at least every 5 years

frequency:	
QA/QC procedures:	
Any comment:	Limited to forest areas within 5km of roads and rivers suitable for conversion to agriculture / livestock

V. TERMS ORIGINATING IN OTHER MODULES

Data / parameter:	$A_{BSL,PA-unplanned,t}$
Data unit:	Ha
Used in equations:	7
Description:	Annual area of unplanned baseline deforestation in the Project Area at year t
Module parameter originates in:	BL-UP
Any comment:	

Data / parameter:	$A_{DefLB,i,t}$
Data unit:	Ha
Used in equations:	8
Description:	Area deforested in the Leakage Belt under the project scenario in stratum i at year t as measured
Module parameter originates in:	M-EXP
Any comment:	

Data / parameter:	$A_{DefPA,i,t}$
Data unit:	Ha
Used in equations:	8
Description:	Area deforested in the Project Area under the project scenario in stratum i at year t as measured
Module parameter originates in:	M-EXP
Any comment:	

Data / parameter:	$\Delta C_{BSL,LK,unplanned}$
Data unit:	t CO ₂ -e
Used in equations:	1, 6
Description:	Sum of baseline carbon stock changes from unplanned deforestation in the Leakage Belt up to year t^*
Module parameter originates in:	BL-UP
Any comment:	

Data / parameter:	$\Delta C_{P,LB}$
Data unit:	t CO ₂ -e
Used in equations:	1, 6
Description:	Net CO ₂ equivalent emissions within the leakage belt in the project case up to year t^*
Module parameter originates in:	M-EXP
Any comment:	

Data / parameter:	<i>Leakage Belt Forest Cover Benchmark Map</i>
Data unit:	
Used in equations:	3
Description:	Map showing the location of forest land within the leakage belt area at the beginning of each monitoring period. Only applicable where leakage is to be monitored in a leakage belt
Module parameter originates in:	M-EXP
Any comment:	