ESTIMATION OF EMISSIONS FROM ACTIVITY SHIFTING FOR AVOIDING UNPLANNED DEFORESTATION (LK-UD-AS)

Document Prepared by Climate Focus

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1 SOURCES

This module is based on the following modules/tools/methodologies:

Other relevant sources employed by this Module are those listed in the relevant VCS Methodology:

- *Module J-ADB-UD* - Determination of Jurisdictional Activity Data Baseline for Unplanned Deforestation
- *Module BL-UD* - Estimation of Baseline greenhouse gas emissions within the Project Area and Leakage Belt from unplanned deforestation
- *Module Mon-AUD* - Methods for monitoring greenhouse gas emissions within the Project Boundary and Leakage Belt from unplanned deforestation
- CDM tool *Estimation of direct N_2O emissions from nitrogen application (E-NA)*
- VMD0005 CP-W *Estimation of carbon stocks in the long-term wood products pool*

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 ($\Delta C_{LK\text{-}AS}$).

The estimation of leakage is assessed in two components:

- Potential activity shifting leakage directly surrounding the AUD Project Area, through the use of a Leakage Belt.
- Potential activity shifting leakage to a location within the National Boundaries, but outside of the Leakage Belt. This is assumed to be caused by geographically unconstrained agents and by the regional demand for wood products.

3 DEFINITIONS

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

Activity Data (AD)
The area of deforested or degraded forest registered in a specific area over a given period

Protected Forest
Forests managed with activities to prevent unauthorized immigration and land clearings by migrants.

4 APPLICABILITY CONDITIONS

This module is applicable for estimating carbon stock changes and greenhouse gas emissions related to the displacement of activities that cause a change in land use outside the Project Boundary due to avoiding unplanned deforestation within the Project Boundary.

The module is applicable for estimating carbon stock changes and greenhouse gas emissions related to the displacement of activities. Activities subject to potential displacement are conversion of land to grazing lands, crop lands, and other land uses.

The module is mandatory where required by the relevant methodology.

5 PROCEDURES

5.1 General

Activities that land cover transition agents would implement inside the AUD Project Area in the absence of the project activity could be displaced outside the AUD Project Area as a consequence of the implementation of the AUD project activity.

Where this displacement of activities increases the GHG emissions outside the AUD Project Area above the baseline, the related carbon stock changes and non-CO_2 emissions must be conservatively estimated and counted as activity shifting leakage.

Two different groups of land cover transition agents may be displaced:

1. **Local Deforestation and Degradation Agents**
   Geographically constrained agents obtaining their livelihood inside or near the AUD Project Area since the start of the avoided unplanned deforestation project activity. The rate of land cover change and resulting emissions in the area surrounding the project area, defined as the Leakage Belt, must be monitored compared to the baseline rate and counted as leakage.

It is advisable that the project proponent implement leakage mitigation measures to maintain or increase these agents' livelihoods, however, emissions from such leakage mitigation measures must be monitored.

2. **Non-geographically constrained Deforestation Agents**
   Agents who, under the baseline scenario would be expected to migrate to near the project area and cause deforestation within the project area.

   Influencing the land-use decisions of this land cover transition 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.

5.2 Definition of Boundaries

The analytical domain from which information on the levels of Deforestation within the Leakage Belt (LB) and outside the leakage belt (OLB) and resulting GHG Emissions must be delineated by spatial and temporal boundaries.

5.2.1 Spatial Boundaries

As land cover transitions may be displaced from both geographically constrained and non-geographically constrained agents, two different types of leakage areas are delineated:

Geographically Constrained Agents - AUD Leakage Belt

To estimate the displacement of land cover transitions to the area directly outside the project area by geographically constrained agents, a 'Leakage Belt' shall be delineated.

The spatial extent of the AUD Leakage Belt shall be based on delineating the forest area within a maximum of a 10 km buffer around the AUD Project Area, excluding the area of other active AFOLU Project Areas and areas outside of the Jurisdiction. "Active" AFOLU Project Areas are those that have undergone verification or validation within five years prior to the monitoring event covering this AUD Leakage Belt. If the forest area within the 10 km buffer exceeds 100% of the AUD Project Area, it is allowable to decrease the buffer size such that the area of forest in the AUD Leakage Belt is at least 100% of the forest area within the AUD Project Area at the start of the AUD Project Activity. However, the minimum LB buffer distance from the AUD Project Area shall be 2 km.

For activity displacement from Project Areas with tidal wetland forest or peatland forest, the Leakage Belt requirements can be adjusted to be limited to adjacent tidal wetlands or peatlands if it can be demonstrated that activity displacement is unlikely to go to non-wetlands. This is for example the case with aquaculture.

Where the Project Area includes non-contiguous forest patches, each patch is considered a separate "PA segment" for the purpose of LB generation. PA segments whose boundaries are located within 4 km of the boundaries of any other PA segment may be grouped into a single PA segment prior to LB development. Many small segments may thus be aggregated into one or a small number of PA segments and the calculation of forest area required to assess LB buffer radius is derived from combined forest area within the segment. All activity shifting to areas outside the Leakage Belt shall be assumed to be accounted for in the procedures for non-geographically constrained agents.

As leakage belts for an AUD Project Area shall not intersect the Leakage Belts or Project Areas of other AUD projects. Therefore, Project Proponents initially delineate the AUD Leakage Belt, but such boundaries will need to be modified where overlaps between AUD projects LBs occur.

Relevant project proponents shall be responsible for evaluating and correcting any spatial overlaps in the Leakage Belts between AUD projects.

1. Wherever the LB from an AUD project intersects with the PA of a different AUD project, this intersecting area shall be excluded from the LB.
2. Wherever two or more leakage belts from different projects intersect, the area of overlap shall be subdivided and allocated among leakage belts such that:
    a. each subdivision is only assigned to a single leakage belt
    b. each subdivision contains an equal area of forest, assessed against the FCBM
    c. the distance between each subdivision and the associated PAs are minimized.

The current map of all PAs and LBs for a jurisdiction should be continuously updated and made available publicly available through the Verra Registry.

Project proponents must demonstrate that the revised versions of the Leakage Belt boundaries are utilized within all methodology procedures that pertain to the AUD Leakage Belt.

For each spatial feature, the criteria used to define the geographic boundaries must be described and justified. Vector or raster files, maps, GPS coordinates or any other geographic information that allows the unambiguous identification of boundaries must be available.

Non-geographically Constrained Agents – National Country Boundary

To estimate the displacement of land cover transitions to the area outside the AUD Project Area and Leakage Belt by non-geographically constrained agents, the analysis shall take place across the national administrative boundary, excluding:

- Total AFOLU Project Area.

- AUD Leakage Belt.

5.2.2 Leakage Belt Temporal boundaries

The following temporal boundaries must be defined:

Monitoring Period Start and End Date

The Monitoring Period Start Date and End Date shall be stated in the Monitoring Report.

5.3 Emissions from Activity Shifting due to displacement of unplanned Deforestation to the Leakage Belt

5.3.1 Net difference in carbon stocks within the Leakage Belt during the Monitoring Period vs the Baseline Scenario

The carbon stock changes within the Leakage Belt in the baseline scenario and with project activities are estimated f following the provisions in the applied methodology. The difference in carbon stocks changes between the Baseline Scenario and the Monitoring period within the Leakage Belt since the Project Start Date to year *t** is calculated as $\Delta C_{LK\text{-}ASU\text{-}LB}$.

Note that $\Delta C_{LK\text{-}ASU\text{-}LB}$ may be less than zero at this step, where carbon forest carbon stocks in the Monitoring period are greater than projected under the Baseline. Negative values are accounted for at a later step such that positive leakage is never attributed to the project.

$$\Delta C_{LK-net-LB} = \Delta C_{BSL,\mathrm{LB}-UD} - \Delta C_{MP,\mathrm{LB}-UD} \quad (1)$$

Where:

$\Delta C_{LK\text{-}net\text{-}LB}$	Difference in net greenhouse gas emissions between the Baseline and Monitoring Period within the AUD Leakage Belt due to unplanned deforestation, up to year *t** (t CO_2e)
$\Delta C_{BSL\_LB\text{-}UD}$	Net greenhouse gas emissions in the Baseline within the AUD Leakage Belt, up to year *t**; t CO_2e
$\Delta C_{MP\_LB\text{-}UD}$	Net greenhouse gas emissions within the AUD Leakage Belt up to year *t**; t CO_2e

5.3.2 Other Deforestation and Degradation Emissions within the Leakage Belt during the Monitoring Period

Where significant, fossil-fuel related and non-CO_2 gas greenhouse emissions occurring within the AUD Leakage Belt must be evaluated. For example, where deforestation occurs within the AUD Leakage Belt and fire is used as a means of forest clearance, the non-CO_2 emissions may be significant.

It is assumed that the fossil-fuel related and non-CO_2 gas greenhouse emissions resulting from land cover transition per unit area in the AUD Leakage Belt equates to that estimated during the baseline period within the AUD Project Area. This is calculated by summing the total emissions over the baseline period for each stratum across the AUD Project Area and then dividing this by the sum of Activity Data per stratum and land cover transition (Equation 2) over the baseline period. These average emissions per unit area are then applied to the difference in activity data between the baseline and monitoring within the AUD Leakage Belt (Equation 3).

$$GHG_{LB,E,LCT,i,Area,t} = \frac{1}{\sum_{t=1}^{tBSL} AD_{BSL,PA-UD,LCT,i,t}} \times \sum_{t=1}^{tBSL} \left(E_{FC,i,t} + E_{BiomassBurn,BSL,i,t} + N_2O_{direct-N,BSLi,t}\right) \quad (2)$$

Where:

$GHG_{LB,E,LCT,i,Area,t}$	Annual per-hectare other greenhouse gas emissions as a result of deforestation activities per hectare, in stratum *i,* in year *t*; t CO_2-e ha^{-1}
$AD_{BSL,PA\text{-}AUD\ ,LCT,i}$	UD Activity data in the AUD Project Area allocated to land cover transition *LCT* in forest stratum *i,* in year *t*; ha y^{-1}
$E_{FC,i,t}$	Emission from fossil fuel combustion in stratum *i* within the AUD Leakage Belt in year *t* of the Baseline; t CO_2-e
$E_{BiomassBurn,BSL,i,t}$	Non-CO_2 emissions due to biomass burning during the Baseline in stratum *i* in year *t* of the Baseline; t CO_2-e
$N_2O_{direct\text{-}N,BSL,i,t}$	Direct N_2O emission as a result of nitrogen application on the alternative land use in stratum *i* within the AUD Leakage Belt in year *t* of the Baseline; t CO_2-e
i	1, 2, 3, …*M* strata
t	1, 2, 3, …t^{BSL} years of the Baseline Validity Period

$$GHG_{MP,LK-UDD,E} = \sum_{t=1}^{t^*} \sum_{LCT}^{LCT*} \sum_{i=1}^{M} \left(\left(A_{BSL,LB-UD,LCT,i,t} - A_{MP,LB-UD,LCT,i,t} \right) * GHG_{LB,E,LCT,i,Area,t} \right) \quad (3)$$

Where:

$GHG_{MP,LK-UD,E}$	Other greenhouse gas emissions as a result of deforestation within the AUD Leakage Belt during the Monitoring Period up to year *t**; t CO_2e
$AD_{BSL,LB-UD,LCT,i,t}$	Unplanned Deforestation baseline Activity Data in the AUD Leakage Belt, in stratum *i*, in year *t* of the Baseline*;* ha
$AD_{MP,LB-UD,LCT,i,t}$	Unplanned Deforestation Activity Data in the AUD Leakage Belt, in stratum *i*, in year *t* during the Monitoring Period; ha
i	1, 2, 3, …*M* strata
t	1, 2, 3, …t^{BSL} years of the Baseline Validity Period

5.3.3 Net difference in GHG Emissions within the Leakage Belt during the Monitoring Period vs the Baseline Scenario

The net greenhouse gas emissions are summed for the entire Leakage Belt as:

$$\Delta C_{MP,LB} = \Delta C_{LK-net-LB} + GHG_{MP,LK-UD,E} \quad (4)$$

Where:

$\Delta C_{MP,LB}$	Net greenhouse gas leakage emissions within the AUD Leakage Belt during the Monitoring Period up to year *t**; t CO_2e
$\Delta C_{LK-net-LB}$	Difference in emissions from carbon stock change between the Baseline and Monitoring Period within the AUD Leakage Belt due to unplanned deforestation, up to year *t** (t CO_2e)
$GHG_{MP,LK-UD,E}$	Other greenhouse gas emissions as a result of deforestation activities within the AUD Leakage Belt during the Monitoring Period up to year *t**; t CO_2e

5.4 Emissions from Activity Shifting due to displacement of unplanned deforestation by geographically unconstrained agents (migrants) during the Monitoring Period

5.4.1 Introduction

Geographically unconstrained agents (migrants) of Deforestation in the baseline are susceptible to shift land cover change activities to areas outside of the Leakage Belt as a result of project activities.

The total increase in the area of deforestation outside the Leakage Belt as a result of project activities is proportional to the difference in Baseline and Monitoring Period deforestation in hectares, the proportion of deforestation under the baseline caused by migrant agents, and the proportion of national migration from rural areas that results in rural to urban migration.

Emissions from deforestation outside the leakage belt are estimated using a single emission factor encompassing all lands available for conversion to agricultural land use[1]. This emission factor is approximated using area-weighted carbon stocks of all lands, forested and non-forested, outside the Leakage Belt that are assessed to be physically accessible to migrant agents, suitable for agriculture, and unprotected. Migrants are conservatively presumed to be typically driven by demand for agricultural land, and consequently soil emissions must be assessed.

Note the limitation of lands available for conversion in case of displacement from Project Areas with tidal wetland forest or peatland forest, in section 5.2.1.

The general steps to estimating migrant leakage emissions, detailed in this section, area as follows:

1. Assess the fraction of deforestation in the baseline within the Project Area and Leakage Belt that is driven by migrant vs local agents
2. Assess the fraction of national internal migration that results in immigration to urban areas versus rural areas
3. Determine if Activity Shifting analysis is required. If it is required, undertake remaining steps:
    a. Spatially delineate all lands nationally that are physically accessible to migrant agents, suitable for agriculture, and protected along several levels from unprotected to fully protected.
    b. Calculate an area-weighted carbon stock for a single land cover stratum encompassing all lands mapped as Available in Step 3a.
    c. Develop emission factors from activity shifting to outside the Leakage Belt.
    d. Estimate the total area of activity shifting to outside the Leakage Belt due to project activities, based on A) the net reductions in deforestation from the Baseline to Monitoring Period within the combined area of the Project Area

[1] Including conversion to aquaculture and grazing land.

and Leakage Belt, B) proportion of migrant agents of deforestation in the Baseline, and C) the proportion of internal migration resulting in settlement in urban areas.

e. Estimate total emissions due to activity shifting of deforestation to outside the leakage belt using the estimate of deforestation area calculated in Step 3d, and the emission factor calculated in Step 3c.

5.4.2 Estimation of the Proportion Immigrant and Resident Land Cover Transition Agents in the Baseline ($PROP_{IMM}$)

Randomly sample households living within the Leakage Belt and within the Project Area to determine the proportion of the baseline agents within the population residing within the Leakage Belt and Project Area for ≥ 5 years ($PROP_{RES}$) and the proportion of the baseline agents within the population that has migrated into the area in the last 5 years ($PROP_{IMM}$). The minimum sample size of respondents shall be at least 1100 households[2,3]. If the total number of households is less than 1100, then the sample size must be at least 80% of the households.

This assessment must be repeated within two years prior to each new Baseline Validity Period and the estimated proportions will be assumed to be representative for the Baseline Validity Period.

5.4.3 Estimate the relative rate of migration to urban versus rural areas ($PROP_{urban}$)

The parameter $PROP_{urban}$ may be developed to represent the proportion of internal migration occurring within a country during the monitoring period, originating in rural areas, that results in settlement in urban areas versus rural areas.

A project may conservatively use a default value of 0 for $PROP_{urban}$, which assumes 100% of Land Cover Transition in the baseline attributable to migrant agents results in activity shifting to areas outside Project Area and Leakage Belt.

Projects may assess a different value for $PROP_{urban}$ where sufficient data or existing studies are available to support an alternative value. Data available to develop $PROP_{urban}$ will vary widely across countries, but generally, $PROP_{urban}$ should be calculated using empirical observations such as national census, estimates provided by international sources like the UN, or published demographic studies conducted within ten years prior to the end of the Project Activity.

[2] Valliant, R., Dever, J. and Kreuter, F. (2018) Practical Tools for Survey Sampling and Weighting. Berlin: Springer. Second edition

[3] Israel, G. D. (2012). *Determining Sample Size* (pp. 1–5). University of Florida, IFAS Extension, Publication #PEOD6.

5.4.4 Determine if Activity Shifting to outside the leakage belt must be evaluated

If ($PROP_{IMM}$ * (1- $PROP_{urban}$)) is less than or equal to 0.1, no activity shifting to outside the leakage belt is assessed, and no additional elements of section 5.4 are required. In this case, $\Delta C_{MP,OLB,t}$ shall equal 0.

Where:

$\Delta C_{MP,OLB,t}$ Sum of emissions from carbon stock change in due to activity shifting in available areas outside the Leakage Belt in all carbon pools (excluding wetland soils), in year *t*;* t CO_2

If ($PROP_{IMM}$ * (1- $PROP_{urban}$)) is greater than 0.1, $\Delta C_{MP,OLB,t}$ is assessed following the remaining guidance of Section 5.4.

5.4.5 Delineation of area of land available for activity shifting leakage outside of PA and LB

The area within national boundaries that is available for Migrant leakage on both Forest and Non-Forest land is determined by spatial distribution of the following factors:

1) Suitability of land for agriculture.
2) Physically accessibility.
3) Relative protection status.

Each of these three factors must be developed as a map that covers the entire country containing the jurisdiction.

Note: The following datasets, described in proceeding text, need only to be generated once per J-ADB-UD Validity Period. If the following datasets have already been developed and verified for the country in which the Jurisdiction is located, by any project developer within a time period equal to or less than the J-ADB-UD validity period length, it is allowable to adopt those existing maps rather than generate new versions:

- Digital Map of Potentially Arable Land.
- Digital Map of Physically Accessible Land.
- Digital Map of Protection Status.
- Digital Map of Available Land for Activity Shifting.
- National Carbon Stratification Map.
- Digital Map of Tidal Wetlands and Peatlands.

A project may adopt these datasets verbatim, or choose to alter them following the guidelines below, if it can be justified that national circumstances have changed since they were originally developed.

5.4.5.1 Potentially Arable Land

Lands that are capable of supporting agriculture[4], but that are not yet currently under agricultural use, are considered to be 'potentially arable.' These lands may currently be forested or non-forested.

Using peer-reviewed and accuracy-assessed map-based sources, calculate potentially arable land.

All temperate and tropical natural forests are considered potentially arable. Forests that have conditions rendering them unsupportive of the typical forms of agriculture practice by migrants in the Jurisdiction, may be excluded from the estimation of potentially arable forest land where it can be demonstrated why those conditions make smallholder agriculture unlikely in the country.

Natural vegetation such as grassland, shrubland, savanna, bushland, and wetlands should also be considered potentially arable. Areas of natural vegetation that are unsupportive of agriculture due to reasons such as insufficient annual precipitation should be excluded from the estimation of potentially arable non-forest land. It is required that at a minimum, a lower limit of mean annual precipitation be established for rainfed agriculture in the country, and that a map of mean annual precipitation be used to conduct the analysis.

Projects located in countries with peatlands or tidal wetlands must include such areas in the assessment of the area of land available, excluding those for which it can be demonstrated that they are not suitable for baseline deforestation activities, or A) that baseline deforestation agents do not drain peatlands or degrade tidal wetlands to carry out their activities (i.e., 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 tidal wetlands, or that such activities cannot by their nature be developed on drained peatland or tidal wetlands), or B) that baseline deforestation agents in tidal wetland habitats do not migrate to non-tidal wetlands to carry out their activities (i.e., that the historical data used to construct the deforestation baseline can demonstrate that the identified tidal wetlands deforestation agents have never carried out their activities on non-tidal wetlands, or that such activities cannot by their nature be developed on non-tidal wetlands).

In areas where agricultural potential is marginal or ambiguous, the data developer should conservatively err towards including Forest as potentially arable, while at the same time conservatively excluding Non-forest from potentially arable.

[4] Also including aquaculture

The output of this analysis is a **Digital Map of Potentially Arable Land** with all lands indicated to be either "potentially arable" or "not potentially arable".

5.4.5.2 Physical Accessibility

Potentially arable land must be physically accessible to transportation networks to be eligible for migrant leakage.

A rasterized national map shall be developed that indicates the cumulative time, in minutes, it takes to travel on foot[5] from the transportation network to every location in the country, up to a maximum of two hours. Transportation networks should include permanent roads. A least-cost-path directional map should be generated, where each pixel's cost value is the fraction of an hour that it should take to traverse it on foot.

The equation for generating the per-pixel travel costs in a GIS are derived using a Tobler's Hiking Function (Tobler, 1993):

$$cost = \frac{1}{6e^{-3.5|S+0.05|}} \times \frac{res}{1000} \quad (5)$$

Where:

cost	time required to traverse a distance equal to the map's pixel resolution, hr pixel^{-1}
res	pixel resolution of travel cost map; m
S	topographic slope; fraction

All areas mapped as requiring more than two hours to access on foot from travel networks shall be considered inaccessible, while all areas within this limit shall be considered accessible. For predominantly flat landscapes, this two-hour time limit will result in roughly a 10km buffer around transportation networks.

The output of this analysis is a **Digital Map of Physically Accessible Land** with all lands indicated to be either "accessible" or "inaccessible" by the 2-hour travel time standard.

5.4.5.3 Protection Status

The protection status of land limits its availability for migration. This module recognizes that the effective level of protection is often in reality less than the intended management objective due to lack of enforcement, allowance of certain economic activities, or land tenure conflict. "Protection" in this context does not pertain only to state protected conservation lands, but also areas such as timber concessions and large privately-held forests and non-forested land that would typically undertake activities to exclude migrant settlement.

[5] In countries where water travel is common, navigable waterways and shorelines should be included. Travel times must be assessed accordingly.

Using a map of landscape management units, the Jurisdiction shall be segmented into parcels and each assigned one of five protection categories (Table 1). A relative protection factor F_p is assigned to each protection category *p* and used in the calculation of area-weighted available carbon stocks.

Existing AUD Project Areas and Leakage Belts associated with projects that have been validated or verified in the past 5 years should be assigned to category 5.

Table 1. Levels of effective protection

Protection Status	Protection Category *p*	Protection Factor *Fp*	Description
Completely Effective	5	1.0	Well-managed, sustainably funded protected areas that engage in substantial and sufficient measures to deter non-permitted land clearing, such as patrols, co management with local communities, and with no history of recent settlement by migrants.
Highly Effective	4	0.75	Effective protection that deters most deforestation, but that may be contending with high levels of demand for land that results in occasional incursions. Also includes areas that may allow limited small-scale agricultural uses by local residents, but otherwise effectively excludes significant in migration or large clearings.
Partially Effective	3	0.50	Protection that deters a significant amount of deforestation compared to adjacent unprotected areas, but that are experiencing continual incursions and settlement.
Minimally Effective	2	0.25	Protected areas that exist largely in name only, where there is widespread recent or continuing land clearing by migrants.
Unprotected	1	0.00	Lands with no specific protection status beyond what is required for all lands nationally.

Lands otherwise mapped as “not potentially arable” or “inaccessible” do not require that a protection level assessed, as they are by default already considered unavailable to migrants.

The output of this analysis is a **Digital Map of Protection Status** with all lands assigned to one of the five protection categories.

5.4.5.4 AUD Map of available land

The Digital Maps of Potentially Arable Land, Physically Accessible Land, and Protection Status shall be combined into a single map.

Lands indicated as either "not potentially arable," "inaccessible," or as having a protection category of "5" are considered "Unavailable." All remaining lands identified as "Available" should be classified with their associated protection level 1-4.

For peatlands and tidal wetlands, note the potential limitation of available land as outlined is section 5.4.1.

The output of this analysis is a **Digital Map of Available Land for Activity Shifting.**

The parameter assigned to the calculated area "Available" by each protection level *p*, in hectares, is termed $\boldsymbol{A_{available,p.}}$

5.4.6 Emission Factors for activity shifting to areas outside the Leakage Belt

Emissions factors for land conversion are developed for lands subject to activity shifting. It is conservatively assumed that activity shifting results in long term agricultural land use.

Changes in aboveground (AB); belowground (BB); deadwood (DW); and litter (LI) pools are estimated as the difference in biomass stocks in pre and-post land use transition.

5.4.6.1 Non-soil emissions from carbon stock changes in land available for activity shifting

Area-weighted carbon stocks for all non-soil and wood product pools are developed within the Digital Map of Available Land for Activity Shifting, using *F* to weight biomass from areas proportional to their partial protection level. Procedures for soil pools are provided in section 5.4.7.

A **National Carbon Stratification Map** shall be sourced to conduct a spatial overlay to identify the area of each national carbon stratum that falls within each protection category *P*. At a minimum, the National Carbon Stratification Map must include a forest and a non-forest class. There is no limit to the number of strata.

Where peatlands or tidal wetlands are present, these must be delineated as separate strata.

Where available, carbon stocks in associated strata in the National Carbon Stratification Map should be derived from a peer-reviewed source or a recognized national source such as the National Forest Inventory, National Forest Monitoring System, or Forest Reference Emissions Level.

The calculation of area, in hectares, of each carbon stratum *i* from the National Carbon Stratification Map, located within Available land for each protection level is termed $A_{available,p,i.}$ Where

Pre-agricultural conversion carbon stocks are calculated by the area-weighted carbon estimates for Available areas outside the Leakage Belt:

$$C_{AB-tree,OLB} = \frac{\sum_{i=1}^{M}\sum_{p=1}^{p<5}(1-F_p) \times A_{Available,p,i} \times C_{AB-tree,OLB,i}}{\sum_{i=1}^{M}\sum_{p=1}^{p\leq 4}(1-F_p) \times A_{Available,p,i}} \quad (6)$$

$$C_{BB-DW-LI,OLB} = \frac{\sum_{i=1}^{M}\sum_{p=1}^{p<5}(1-F_p) \times A_{Available,p,i} \times C_{BB-DW-LI,OLB,i}}{\sum_{i=1}^{M}\sum_{p=1}^{p\leq 4}(1-F_p) \times A_{Available,p,i}} \quad (7)$$

Where:

$C_{AB\text{-}tree,OLB}$	Area-weighted aboveground tree biomass in areas Available for activity shifting outside the leakage belt; t CO_2 ha^{-1}
$C_{BB\text{-}DW\text{-}LI,OLB}$	Area-weighted belowground, deadwood, leaf litter biomass in areas Available for activity shifting outside the leakage belt; t CO_2 ha^{-1}
$C_{AB\text{-}tree,OLB,i}$	Aboveground tree biomass in areas Available for activity shifting outside the leakage belt, stratum *i*; t CO_2 ha^{-1}
$C_{BB\text{-}DW\text{-}LI,OLB,i}$	Belowground, deadwood, leaf litter biomass in areas Available for activity shifting outside the leakage belt, stratum *i*; t CO_2 ha^{-1}
$A_{Available,p,i}$	Area of Jurisdiction mapped as Available for activity shifting outside the leakage belt, with protection level *p*, in carbon stratum *i*, *ha*
F_p	Forest protection factor, unitless
i	1,2,3…M biomass strata in the available areas outside of the PA and Leakage Belt
p	*1,2,3…P Protection status*

In the case that a national carbon stratification map meeting the standards described above is not available, a peer-reviewed and accuracy assessed continuously variable biomass maps may be utilized. In this case, each pixel is treated as a separate stratum *i*, and $A_{Available,i,p}$ would equal the raster's pixel resolution in hectares.

The following verified datasets must be made available on request to Verra and to other AUD projects operating in the Jurisdiction:

- Digital Map of Potentially Arable Land.
- Digital Map of Physically Accessible Land.
- Digital Map of Protection Status.
- Digital Map of Available Land for Activity Shifting.
- National Carbon Stratification Map.
- Digital Map of Tidal Wetlands and Peatlands.

Agricultural land use carbon stocks resulting from activity shifting to outside the leakage belt should represent the most likely agricultural land use which migrant agents of deforestation would engage in, and should be provided by peer-reviewed sources. Where values can be sourced from such nationally-approved documents as FREL, National Communication, or National Forest Inventory, those values should be adopted. Agricultural carbon stocks can represent a proportional weighting of multiple published values for agricultural land use where a mix of agricultural practices is expected to be undertaken by migrants.

If $\Delta C_{AB\text{-}BB\text{-}DW\text{-}LI,OLB}$ is less than zero, $\Delta C_{AB\text{-}BB\text{-}DW\text{-}LI,OLB}$ shall be assigned a value of zero.

$$\Delta C_{AB-BB-DW-LI,OLB} = C_{AB-tree,OLB} + C_{BB-DW-LI,OLB} - C_{AB-tree,OLB,agric} - C_{BB-DW-LI,OLB,agric} \quad (8)$$

Where:

$\Delta C_{AB\text{-}BB\text{-}DW\text{-}LI,OLB}$	Emission from carbon stock change due to land cover conversion in areas available for activity shifting outside the Leakage Belt, over a one-year period in aboveground; belowground; deadwood; and litter pools; t CO_2e ha^{-1}
$C_{AB\text{-}tree,OLB}$	Area-weighted aboveground tree biomass in areas Available for activity shifting outside the leakage belt; t CO_2 ha^{-1}
$C_{BB\text{-}DW\text{-}LI,OLB}$	Area-weighted belowground, deadwood, leaf litter biomass in areas Available for activity shifting outside the leakage belt; t CO_2 ha^{-1}
$C_{AB\text{-}tree,OLB,agric}$	Aboveground tree biomass in areas converted to agricultural land use through activity shifting to outside the leakage belt; t CO_2 ha^{-1}
$C_{BB\text{-}DW\text{-}LI,OLB,agric}$	Belowground, deadwood, leaf litter biomass in converted to agricultural land use through activity shifting to outside the leakage belt; t CO_2 ha^{-1}

The following factors related to harvesting of wood products should be developed in line with the relevant methodology requirements.

$C_{WP,OLB,t}$	Carbon stock entering the wood products pool at the time of land cover conversion in areas available outside the Leakage Belt, in year *t*; t CO_2 ha^{-1}
$C_{WP100,OLB,t}$	Carbon stock entering the wood products pool at the time of land cover conversion in areas available outside the Leakage Belt, and that is expected to be emitted over 100, in year *t*; t CO_2 ha^{-1}

5.4.6.2 Emissions from changes in non-wetland soil carbon stocks and wood products

Area-weighted non-wetland soil carbon stocks and wood products for Available areas outside the Leakage Belt are calculated as:

$$C_{NonW-SOC\_WP100,OLB} = \frac{\sum_{i=1}^{M}\sum_{p=1}^{p<5}(1-F_p) \times A_{Available,p,i} \times C_{Non-W-SOC\_WP100,i}}{\sum_{i=1}^{M}\sum_{p=1}^{p\leq 4}(1-F_p) \times A_{Available,p,i}} \quad (9)$$

Where:

$C_{NonW\text{-}SOC\_WP100,OLB}$	Area-weighted emissions from carbon stock change to occur over a 20-year period in the non-wetland soil organic carbon and wood products in available areas outside the AUD-PA and AUD-LB; t CO_2 ha^{-1}
$\Delta C_{NonW\text{-}SOC\_WP100,i}$	Emissions from carbon stock change to occur over a 20-year period in in available areas outside the AUD-PA and AUD-LB in the non-wetland soil organic carbon and wood products in stratum *i*; t CO_2e ha^{-1}
$A_{Available,p,i}$	Area of Jurisdiction mapped as Available for activity shifting outside the leakage belt, with protection level *p*, in carbon stratum *i*, *ha*
F_p	Forest protection factor, unitless
i	1,2,3…M strata in the available areas outside of the PA and Leakage Belt
p	*1,2,3…P Protection status*

Where peatlands or tidal wetlands are present, these must be delineated as separate strata. All strata containing wetland soils, the non-wetland soil carbon pool shall be set to zero and instead the calculations for peatland and tidal-wetland must be employed.

5.4.6.3 Emissions from peatland and tidal-wetland soil carbon stocks

For the land cover conversion on peatlands and tidal wetlands, the area-weighted loss of soil organic carbon at peat depletion time (PDT) and soil organic carbon depletion time (SDT) must be assessed[6]. The use of PDT and SDT generates a conservative outcome because the total peat loss at PDT or the total soil organic carbon loss at SDT is an instant loss.

Soil organic carbon stocks at project start, at PDT and at SDT must be obtained from relevant methodologies or modules. These parameters are subject to stratification depending on differences in for example peat depth and soil organic matter content.

Area-weighted emissions from peatlands and tidal wetland must be estimated for activity shifting to wetland areas, based on the difference between soil organic carbon stocks at project start, at PDT and at SDT, and using the best available official or peer-reviewed data from the area of available land. These parameters are subject to stratification and area weighting is based on the relative area of each stratum identified.

$$\Delta C_{PEAT,OLB} = \frac{\sum_{i=1}^{M}\sum_{p=1}^{p<5}(1-F_p) \times A_{Available,p,i} \times LK_{PEAT-EF-OLB,i}}{\sum_{i=1}^{M}\sum_{p=1}^{p\leq 4}(1-F_p) \times A_{Available,p,i}} \quad (10)$$

$$\Delta C_{TW,OLB} = \frac{\sum_{i=1}^{M}\sum_{p=1}^{p<5}(1-F_p) \times A_{Available,p,i} \times LK_{TW-EF-OLB,i}}{\sum_{i=1}^{M}\sum_{p=1}^{p\leq 4}(1-F_p) \times A_{Available,p,i}} \quad (11)$$

$\Delta C_{PEAT,OLB}$	Area-weighted emission factor from peat loss at peat depletion time (PDT) in the area outside the Leakage Belt and Project Boundary (t CO_2e ha^{-1})
$\Delta C_{TW,OLB}$	Area-weighted emission factor from soil organic carbon loss at soil organic carbon depletion time (SDT) in the area outside the Leakage Belt and Project Boundary (t CO_2e ha^{-1})
$LK_{PEAT-EF-OLB}$	Emissions from peat loss at peat depletion time (PDT) in the area outside the Leakage Belt and Project Boundary (t CO_2e ha^{-1})

[6] PDT and SDT are the times at which all soil organic carbon has disappeared, or at which they reach a level where no further oxidation or other losses occur.

$LK_{TW\text{-}EF\text{-}OLB}$	Emissions from soil organic carbon loss at soil organic carbon depletion time (SDT) in the area outside the Leakage Belt and Project Boundary (t CO_2e ha^{-1})
F_p	Forest protection factor, unitless
i	1,2,3…M strata in the available areas outside of the PA and Leakage Belt
p	*1,2,3…P Protection status*

For strata without wetland, the value for $LK_{PEAT\text{-}EF\text{-}OLB}$ and $LK_{TW\text{-}EF\text{-}OLB}$ must be set to zero.

5.4.7 Total area of activity shifting areas outside the Leakage Belt

It is conservatively assumed that recently settled migrant agents of LCT in the Project Area and Leakage Belt are primarily driven by a need to secure agricultural land. The amount of leakage to outside the Leakage Belt is taken as the summed area of avoided Land Cover Transition in the Project Area and Leakage Belt, scaled by the proportion of recent immigrants ($PROP_{IMM}$) and by the proportion of rural migration in the country that results in immigration to urban versus rural areas ($PROP_{urban}$).

$$AD_{AS-OLB,t} = PROP_{IMM} \times (1 - PROP_{urban}) \times \sum_{i=1}^{M} \begin{pmatrix} AD_{BSL,PA-UDD,LCT,i,t} + AD_{BSL,LB-UDD,LCT,i,t} \\ -AD_{MP,PA-UDD,LCT,i,t} - AD_{MP,LB-UDD,LCT,i,t} \end{pmatrix} \quad (12)$$

Where:

$AD_{AS\text{-}OLB,t}$	Area outside the Leakage Belt experiencing land cover conversion by activity shifting, in year *t* of the Project Activity, ha
$PROP_{IMM}$	Proportion of area deforested by immigrant agents in the leakage belt and project area, proportion
$PROP_{urban}$	Proportion of internal migration within National Boundaries that results in settlement to urban areas versus rural areas, proportion
$AD_{BSL,PA\text{-}UD,LCT,i,t}$	Unplanned Deforestation Activity Data in the AUD Project Area in land cover transition *LCT*, in stratum *i*, in year *t*; ha
$AD_{BSL,LB\text{-}UD,LCT,i,t}$	Unplanned Deforestation Activity Data in the AUD Leakage Belt in land cover transition *LCT*, in stratum *i*, in year *t*; ha
$AD_{MP,PA\text{-}UD,LCT,i,t}$	Unplanned Deforestation Activity Data in the AUD Project Area in land cover transition *LCT*, in stratum *i*, in year *t* of the Project Activity; ha

$AD_{MP,LB\text{-}UD,LCT,i,t}$	Unplanned Deforestation and Forest Degradation Activity Data in the AUD Leakage Belt in land cover transition *LCT*, in stratum *i*, in year *t* of the Project Activity; ha
i	1,2,3…M biomass strata in the PA and Leakage Belt

5.4.8 Emissions from activity shifting to areas outside the Leakage Belt

This displaced area of deforestation from the Project Area and Leakage Belt ($AD_{AS\text{-}OLB,t}$) is assumed to result in land cover conversion of an equal area outside of the Leakage Belt.

Emissions from this land cover transition are estimated based on the emission factors developed specific to the mapped Available area outside of the Leakage Belt. Continuing emission from soil and harvested wood products associated with past years' activity shifting due to project activities must be accounted for all lands subject to activity shifting within the 20 years preceding (and inclusive of) latest year of monitoring.

$$\Delta C_{MP,OLB,t} = AD_{AS-OLB,t} \times \left(\Delta C_{AB-BB-DW-LI,OLB} - C_{WP,OLB} + \Delta C_{PEAT,OLB} + \Delta C_{TW,OLB}\right) + \sum_{t*-20}^{t*} AD_{AS-OLB,t} \times \frac{C_{NonW-SOC\_WP100,OLB,t}}{20} \quad (13)$$

Where:

$\Delta C_{MP,OLB,t}$	Sum of emissions from carbon stock change due to activity shifting in available areas outside the Leakage Belt in all carbon pools, in year *t*;* t CO_2
$AD_{AS\text{-}OLB,t}$	Area outside the Leakage Belt experiencing land cover transition by activity shifting, in year *t* of the Project Activity, ha
$\Delta C_{AB\text{-}BB\text{-}DW\text{-}LI,OLB}$	Emission from carbon stock change due to land cover transition in areas available for activity shifting outside the Leakage Belt, over a one-year period in aboveground; belowground; deadwood; and litter pools, pools; *t* CO_2e ha^{-1}
$C_{WP,OLB}$	Carbon stock entering the wood products pool at the time of land cover transition in areas available outside the Leakage Belt, in year *t*; t CO_2 ha^{-1}
$\Delta C_{PEAT,OLB}$	Area-weighted emission factor from peat loss at peat depletion time (PDT) within the in areas Available for activity shifting outside the leakage belt (t CO_2e ha^{-1})

$\Delta C_{TW,OLB}$	Area-weighted emission factor from soil organic loss within tidal wetlands at peat depletion time (SDT) within the in areas Available for activity shifting outside the leakage belt (t CO_2e ha^{-1})
$C_{WP100,OLB,t}$	Carbon stock entering the wood products pool at the time of land cover transition in areas available outside the Leakage Belt, and that is expected to be emitted over 100, in year *t*; t CO_2 ha^{-1}
$\Delta C_{NonW\text{-}SOC,OLB,t}$	Emissions from carbon stock change to occur over a 20-year period following land cover transition in the non-wetland soil organic carbon and wood products pools in available areas outside the Leakage Belt, in year *t*; t CO_2e ha^{-1}
t	1, 2, 3, … *t** years elapsed since the start of the project activity

5.5 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]

$$GHG_{LK,E} = \sum_{t=1}^{t^*} \sum_{i=1}^{M} \left(E_{FC,i,t} + E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t} \right) \quad (14)$$

Where:

$GHG_{LK,E}$	Other greenhouse gas emissions as a result of leakage prevention activities up to year *t** (t CO_2-e)
$E_{FC,i,t}$ t CO_2e	Net CO_2e emission from fossil fuel combustion in stratum *i* in year *t*;
$E_{BiomassBurn,i,t}$	Non-CO_2 emissions due to biomass burning as part of unplanned deforestation activities in stratum *i* in year *t*; t CO_2e
$N_2O_{direct\text{-}N,i,t}$	Direct N_2O emission as a result of nitrogen application on the alternative land use in stratum *i* in year *t*; t CO_2e
i	1, 2, 3, … *M* strata
t	1, 2, 3, …t^* years elapsed since the start of project activity

[7] E.g., soil type, elevation, precipitation regime, temperature, slope and aspect

5.6 Estimation of Total Leakage Due to the Displacement of Unplanned Deforestation and Forest Degradation

Total leakage emissions are the sum of leakage from within the Leakage Belt, from outside the Leakage Belt, and GHG emissions from leakage prevention activities. If total leakage is calculated to be less than zero, $\Delta C_{MP,LK\text{-}DD\text{-}AS}$ shall be assigned a value of zero.

$$\Delta C_{MP,LK\text{-}DD\text{-}AS,t} = \Delta C_{MP,LB,t} + \Delta C_{MP,OLB,t} + GHG_{LK,E} \quad (15)$$

Where:

$\Delta C_{MP,LK\text{-}DD\text{-}AS,t}$	Net greenhouse gas leakage emissions due to the displacement of UDD activities during the Monitoring Period up to year *t**; t CO_2e
$\Delta C_{AS\text{-}LB,t}$	Net greenhouse gas leakage emissions within the AUD Leakage Belt during the Monitoring Period up to year *t**; t CO_2e
$\Delta C_{AS\text{-}OLB,t}$	Net change in carbon stocks outside the leakage belt in all carbon pools due to activity shifting (excluding wetland soils), up to year *t*;* t CO_2e
$GHG_{LK,E}$	Other greenhouse gas emissions as a result of leakage prevention activities up to year *t**; see Equation 18 (t CO_2-e)

6 DATA AND PARAMETERES

6.1 Data and Parameters Available at Validation

N/A

6.2 Data and Parameters Monitored

Data / Parameter:	$\Delta C_{BSL\text{-}LB\text{-}UD,t}$
Data unit:	t CO_2e
Description:	Sum emissions from the baseline carbon stock change within AUD Leakage Belt in all carbon pools (excluding wetland soils) up to year *t**
Equations	1
Source of data:	VCS BL-UD module
Description of measurement methods	see source methodology

and procedures to be applied:	
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$\Delta C_{MP\text{-}LB\text{-}UD,t}$
Data unit:	t CO_2e
Description:	Sum of emissions from the carbon stock change within AUD Leakage Belt in all carbon pools (excluding wetland soils) in year *t*
Equations	1
Source of data:	VCS MON-AUD module
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$A_{BSL,LB\text{-}UD,LCT,i,t}$
Data unit:	ha
Description:	Unplanned Deforestation and Forest Degradation Activity Data in the AUD Leakage Belt in land cover transition *LCT*, in stratum *i*, in year *t* of the Baseline
Equations	2
Source of data:	VCS BL-UD module
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period

QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$E_{FC,i,t}$
Data unit:	t CO_2e
Description:	Emission from fossil fuel combustion in stratum i within the AUD Leakage Belt in year *t* of the Baseline
Equations	2
Source of data:	VCS BL-UD module
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$E_{BiomassBurn,BSL,i,t}$
Data unit:	t CO_2e
Description:	Non-CO2 emissions due to biomass burning during the Baseline in stratum *i* in year *t* of the Baseline
Equations	2
Source of data:	VCS BL-UD module
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	

Comments:	

Data / Parameter:	$N_2O_{direct\text{-}N,BSL,i,t}$
Data unit:	t CO_2e
Description:	Direct N2O emission as a result of nitrogen application on the alternative land use in stratum i within the AUD Leakage Belt in year *t* of the Baseline
Equations	2
Source of data:	VCS BL-UD module
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$AD_{BSL,LB\text{-}UD,LCT,i,t}$
Data unit:	ha
Description:	Unplanned Deforestation Activity Data in the AUD Leakage Belt in land cover transition *LCT*, in stratum *i*, in year *t*
Equations	3,11,13
Source of data:	VCS BL-UD module
Description of measurement methods and procedures to be applied:	see data source
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$AD_{MP,LB\text{-}UD,LCT,i,t}$
Data unit:	ha

Description:	Unplanned Deforestation Activity Data in the AUD Leakage Belt in land cover transition *LCT*, in stratum *i*, in year t during the Monitoring Period
Equations	3, 9
Source of data:	MON-AUD
Description of measurement methods and procedures to be applied:	see data source
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	Digital Map of Potentially Arable Land
Data unit:	n/a
Description:	Map of all lands nationally indicated to be either “potentially arable” or “not potentially arable”
Equations	n/a
Source of data:	This module
Description of measurement methods and procedures to be applied:	as described in this module
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	Digitial Map of Physically Accessible Land
Data unit:	n/a
Description:	Map of all lands indicated to be either “accessible” or “inaccessible”
Equations	n/a
Source of data:	This module
Description of measurement methods	as described in this module

and procedures to be applied:	
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	Digital Map of Protection Status
Data unit:	n/a
Description:	Map of Protection Status with all lands assigned to one of the five protection categories.
Equations	n/a
Source of data:	This module
Description of measurement methods and procedures to be applied:	as described in this module
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	Digital Map of Available Land for Activity Shifting.
Data unit:	n/a
Description:	Map of all lands nationally that are potentially arable, physically accessible, spatially delineated by protections status.
Equations	n/a
Source of data:	This module
Description of measurement methods and procedures to be applied:	as described in this module
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	

Comments:	

Data / Parameter:	Digital Map of Wetlands
Data unit:	n/a
Description:	Map of all lands nationally that contain wetlands
Equations	n/a
Source of data:	This module
Description of measurement methods and procedures to be applied:	as described in this module
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	

Comments:	S
Data unit:	Fraction
Description:	Topographic slope
Equations	5
Source of data:	This module
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	Res
Data unit:	M
Description:	pixel resolution of travel cost map
Equations	
Source of data:	This module
Description of measurement methods and procedures to be applied:	Equation 6

Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	Fp
Data unit:	unitless
Description:	Relative protection factor F*p* assigned to each protection category *p*.
Equations	
Source of data:	This module
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$A_{Available,p,i}$
Data unit:	ha
Description:	Area of Jurisdiction mapped as Available for activity shifting outside the leakage belt, with protection level *p*, in carbon stratum *i*
Equations	
Source of data:	This module
Description of measurement methods and procedures to be applied:	Digital Map of Available Land for Activity Shifting
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$C_{AB\text{-}tree,OLB,i}$

Data unit:	t CO_2e ha^{-1}
Description:	Aboveground tree biomass in areas Available for activity shifting outside the leakage belt, stratum *i*
Equations	Equation 6
Source of data:	This module
Description of measurement methods and procedures to be applied:	Strata shall include both pre-land use transition carbon strata and post-land cover transition strata.
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$C_{BB\text{-}DW\text{-}LI,OLB,i}$
Data unit:	t CO_2e ha^{-1}
Description:	Belowground, deadwood, leaf litter biomass in areas Available for activity shifting outside the leakage belt, stratum *i*
Equations	Equation 7
Source of data:	This module
Description of measurement methods and procedures to be applied:	Strata shall include both pre-land use transition carbon strata and post-land cover transition strata.
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$C_{AB\text{-}tree,OLB,agric}$
Data unit:	t CO_2e ha^{-1}
Description:	Aboveground tree biomass in areas converted to agricultural land use through activity shifting to outside the leakage belt
Equations	Equation 8
Source of data:	This module
Description of measurement methods	

and procedures to be applied:	
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	Post-agricultural conversion carbon stocks for activity shifting to outside the leakage belt should represent the most likely agricultural land use that migrant agents of deforestation would engage in, and should be provided by peer-reviewed sources. Where values can be sourced from such nationally-approved documents as FREL, National Communication, or National Forest Inventory, it those values should be adopted. The value can represent a proportional weighting of multiple published values for agricultural land use where a mix of agricultural practices is expected to be undertaken by migrants.

Data / Parameter:	$C_{BB\text{-}DW\text{-}LI,OLB,agric}$
Data unit:	t CO_2e ha^{-1}
Description:	Belowground, deadwood, leaf litter biomass in converted to agricultural land use through activity shifting to outside the leakage belt
Equations	Equation 8
Source of data:	This module
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	Post-agricultural conversion carbon stocks for activity shifting to outside the leakage belt should represent the most likely agricultural land use that migrant agents of deforestation would engage in, and should be provided by peer-reviewed sources. Where values can be sourced from such nationally-approved documents as FREL, National Communication, or National Forest Inventory, it those values should be adopted. The value can represent a proportional weighting of multiple published values for agricultural land use where a mix of agricultural practices is expected to be undertaken by migrants.

Data / Parameter:	$\Delta C_{NonW\text{-}SOC\_WP100,OLB}$
Data unit:	t CO_2e ha^{-1}

Description:	Emissions from carbon stock change to occur over a 20-year period in the non-wetland soil organic carbon and wood products pools in available areas outside the PA and LB
Equations	Equation 9
Source of data:	Relevant VCS Methodology
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$LK_{PEAT\text{-}EF\text{-}OLB}$
Data unit:	t CO_2e
Description:	Area weighted emission factor from peat loss at peat depletion time within the in areas Available for activity shifting outside the leakage belt
Equations	Equation 10
Source of data:	Relevant VCS Methodology
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$LK_{TW\text{-}EF\text{-}OLB}$
Data unit:	t CO_2e
Description:	Area weighted emission factor from soil organic loss within tidal wetlands at peat depletion time within the in areas Available for activity shifting outside the leakage belt
Equations	Equation 10
Source of data:	Relevant VCS Methodology
Description of measurement methods and	see source methodology

procedures to be applied:	
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Comments:	$PROP_{IMM}$
Data unit:	Proportion
Description:	Proportion of area deforested by immigrant agents in the leakage belt and project area, proportion
Equations	
Source of data:	This module
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$PROP_{urban}$
Data unit:	proportion
Description:	Proportion of internal migration within National Boundaries that results in settlement to urban areas versus frontier areas, proportion
Equations	
Source of data:	This module
Description of measurement methods and procedures to be applied:	A default value of 0.0 may be used. If another value is used, project proponent should provide justification for the value selected, citing published peer-reviewed studies or official statistics. If a project develops its own factor, it must provide a description of the data sources utilized ans the methods applied.
Frequency of monitoring/recording:	Once before first monitoring event of each baseline validity period

QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$AD_{BSL,PA\text{-}UD,LCT,i,t}$
Data unit:	ha
Description:	Unplanned Deforestation Activity Data in the AUD Project Area in land cover transition LCT, in stratum *i*, in year *t*
Equations	Equation 11
Source of data:	VCS BL-UD module
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$AD_{MP,PA\text{-}UD,LCT,i,t}$
Data unit:	Ha
Description:	Unplanned Deforestation Activity Data in the AUD Project Area in land cover transition LCT, in stratum *i*, in year *t* of the Project Activity
Equations	Equation 11
Source of data:	VCS MON-AUD module
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$E_{FC,i,t}$
Data unit:	t CO_2e
Description:	Net CO_2e emission from fossil fuel combustion in stratum *i* in year *t*
Equations	Equation 21
Source of data:	This module
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$E_{biomassburn,i,t}$
Data unit:	t CO_2e
Description:	Non-CO_2 emissions due to biomass burning in stratum *i* in year *t*
Equations	Equation 11
Source of data:	Relevant VCS Methodology
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

Data / Parameter:	$N_2O_{direct\text{-}N,i,t}$
Data unit:	t CO_2e
Description:	Direct N_2O emission as a result of nitrogen application on the alternative land use in stratum *i* in year *t*
Equations	Equation 11

Source of data:	Relevant VCS Methodology
Description of measurement methods and procedures to be applied:	see source methodology
Frequency of monitoring/recording:	Once per monitoring period
QA/QC procedures to be applied:	
Purpose of data:	
Calculation method:	
Comments:	

7 REFERENCES

Tobler, W. (1993). Three Presentations on Geographical Analysis and Modeling: Non- Isotropic Geographic Modeling; Speculations on the Geometry of Geography; and Global Spatial Analysis (93-1). https://escholarship.org/uc/item/05r820mz