ESTIMATION OF EMISSION REDUCTIONS FROM AVOIDING UNPLANNED DEFORESTATION

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1 SOURCES

This module is based on the following modules, tools and methodologies:

- *JNR Scenarios 1, 2* and *3 Requirements*

- *VM0007 REDD+ Methodology Framework (REDD+ MF), v1.6*

- *VM0015 Methodology for Avoided Unplanned Deforestation, v1.1*

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

- *VT0007 Unplanned Deforestation Activity Data Allocation Procedure (UDef-AP)*

- *VT0008 Unplanned Deforestation Risk Modeling and Mapping Procedure (UDef-RP)*

- CDM Methodological Tool: Estimation of Direct N_2O Emissions from Nitrogen Fertilization *(E-NA)*

- CDM Tool for Testing Significance of GHG Emissions in A/R CDM Project Activities (T-SIG)

This methodology uses the estimation procedures described in the following modules for estimating carbon stocks in relevant pools, leakage, direct emissions, and monitoring:[1]

- *VMD0001 Estimation of Carbon Stocks in Above- and Belowground Biomass in Live Tree and Non-tree Pools (CP-AB)*

- *VMD0002 Estimation of Carbon Stocks in the Dead Wood Pool (CP-D)*

- *VMD0003 Estimation of Carbon Stocks in the Litter Pool (CP-L)*

- *VMD0004 Estimation of Carbon Stocks in the Soil Organic Carbon Pool (CP-S)*

- *VMD0005 Estimation of Carbon Stocks in the Long-term Wood Products Pool (CP-W)*

- *VMD0011 Estimation of Emissions from Market-effects (LK-ME)*

- *VMD0013 Estimation of Greenhouse Gas Emissions from Biomass and Peat Burning (E–BPB)*

- *VMD0014 Estimation of Emissions from Fossil Fuel Combustion (E-FFC)*

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[1] These modules are currently associated with *VM0007 REDD+ Methodology Framework (REDD+MF)*. The modules used by this methodology (and others) will soon be updated to remove references to VM0007; until then, those references should be ignored by users of this methodology.

- *VMD0015 Methods for monitoring of GHG emissions and removals in REDD and CIW projects (M-REDD)*

- *VMD0016 Methods for Stratification of the Project Area (X-STR)*

2 SUMMARY DESCRIPTION OF THE MODULE

This module describes the procedures and methods for accounting for the greenhouse gas (GHG) emissions reductions from projects that aim to avoid unplanned deforestation. The module includes the following:

- Procedures for activity data (AD) collection, construction of forest cover benchmark maps and application of the *Unplanned Deforestation Risk Modeling and Mapping Procedure* (UDef-RP) and *Unplanned Deforestation Activity Data Allocation Procedure* (UDef-AP).

Note – the above activities are carried out by Verra through third-party data service providers (DSPs). Where a project is to be nested in a registered Jurisdictional and Nested REDD+ (JNR) Scenario 1 or 2 program, the jurisdictional proponent is responsible for generating and allocating the project this information.

- Procedures for estimating GHG baseline emissions from carbon stock changes resulting from unplanned deforestation (UDef) in the project area (PA). To establish carbon stock changes in the baseline, project proponents estimate emission factors and combine them with unplanned deforestation AD generated by Verra for the UDef PA and leakage belt (LB).

- Procedures for estimating the net GHG emissions from displacement of unplanned deforestation (leakage due to activity shifting) triggered by projects preventing unplanned deforestation. Leakage inside and beyond the area directly around the project (the leakage belt) caused by geographically unconstrained agents and by regional demand for wood products is assessed.

- Methods for ex post monitoring of GHG emissions due to deforestation in the UDef PA and UDef LB.

3 DEFINITIONS

3.1 Definitions

In addition to the definitions set out in the *VCS Program Definitions* and *VM0184 Methodology for Reducing Emissions from Deforestation and Forest Degradation*, the following definitions are used in this module.

Avoiding unplanned deforestation project area (UDef PA)

The discrete parcel(s) which, at the start of the project, are under threat of unplanned deforestation and on which the project proponent will undertake the project activities (i.e., on which unplanned deforestation will be avoided)

Avoiding unplanned deforestation project leakage belt (UDef LB)

The discrete parcel(s) surrounding the UDef PA to which unplanned deforestation in the UDef PA may be potentially displaced as a consequence of implementing the project activities aimed at avoiding unplanned deforestation

Data service provider (DSP)

Entities contracted by Verra to develop activity data and/or risk maps

Forest reference emission level (FREL)

The amount of emissions from deforestation and forest degradation from a geographical area

Geographically constrained deforestation and degradation agents

Agents that have generated their livelihood inside or near the UDef PA since the start of the avoiding unplanned deforestation project.

Geographically mobile deforestation agents

Deforestation agents that, in the baseline scenario, are expected to migrate into or near the PA and cause deforestation therein

Industrial agriculture

Large-scale (>1,000 ha) production of crops that relies on extensive use of synthetic chemical inputs and mechanization of processes to maximize production.

Project activities region

The region in which the historical agents and drivers of deforestation are analyzed: the UDef PA, the UDef LB and the surrounding deforested areas extending 10 km from the UDef PA.

Ranching

Raising large herds of animals on large areas (>1,000 ha) of land.

Large-scale aquaculture

Industrial-scale –as opposed to subsistence or artisanal– farming of aquatic organisms, including fish, mollusks, crustaceans, and aquatic plants.

Tidal wetlands

Subset of wetlands under the influence of the wetting and drying cycles of the tides (e.g., marshes, seagrass meadows, tidal forested wetlands, and mangroves).

3.2   Acronyms

AD	Activity data
BVP	Baseline validity period
CHC	Change categories
DLF	Displacement leakage factor
DSP	Data service provider
FCBM	Forest cover benchmark map
FREL	Forest reference emission level
FSC	Forest Stewardship Council
FSM	Forest stratification map
HRP	Historical reference period
LB	Leakage belt
LMA	Leakage management areas
PA	Project area
PAI	Project activity instances
RFP	Request for proposal
SF	Stable forest
SNF	Stable non-forest
SOC	Soil organic carbon
SOP	Standard operating procedures
UDef	Unplanned deforestation

4 APPLICABILITY CONDITIONS

This module may only be used under the following conditions:

1) Where the land use transition in the baseline scenario is forest land to non-forest land, meeting the definition of unplanned deforestation;

2) Where the project involves activities aimed at avoiding UDef;

3) Where agents of deforestation in the baseline scenario clear the land for tree harvesting, settlements, roads, unsanctioned expansion of roads or other infrastructure, agricultural crop production, ranching, and aquaculture; and

4) Where timber harvest is included in the project case, the associated emissions are calculated using the *M-REDD* section related to "Monitoring degradation due to selective logging of forest management areas possessing an FSC [Forest Stewardship Council] certificate", whether or not the areas possess an FSC certificate.

This module is not applicable under any of the following conditions:

1) Where land is legally authorized to be converted to non-forest;

2) Where agents of deforestation in the baseline scenario clear land for industrial agriculture, ranching, or large-scale aquaculture;

3) Where more than 2 percent of the vegetation in the PA is peatland or tidal wetland vegetation;

4) Where wetlands are being drained in the baseline scenario or where wetland drainage occurs in the project scenario;

5) Where more than 10 percent of the vegetation in a 10 kilometer wide buffer around the PA is peatland or tidal wetland vegetation;

6) Where leakage prevention activities include:

a) Flooding agricultural lands to increase production (e.g., for rice paddies), or

b) Intensifying livestock production through the use of feed-lots[2] and/or manure lagoons;[3]

or

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[2] Feedlots are defined as areas in which naturally grazing animals are confined to an area which produces no feed and are fed on stored feeds.

[3] Anaerobic lagoons that function as receptacles for animal waste flushed from animal pens. Anaerobic organisms present in the manure and the environment decompose the waste in the lagoon.

7) Where in the baseline scenario post-deforestation land use constitutes reforestation.

Conditions 3-7 above may be covered by another VCS Program methodology or module.

5 PROCEDURES

5.1 Project Boundary

5.1.1 Jurisdiction Boundary

The jurisdiction of relevance to the project will be defined by Verra following the criteria described in Section of Appendix 1, and will be provided to the project proponent.

5.1.2 Avoiding Unplanned Deforestation Project Area (UDef PA)

The entire UDef PA must be forest at the project start date and must only include land qualifying as forest for a minimum of 10 years prior to the project start date. The boundaries of the UDef PA remain fixed for the duration of the project crediting period, regardless of any land cover change after the start of the avoiding UDef project.

The PA may include different project activity instances (UDef PAI), all of which must meet the above requirements.

Where a project activity instance (or equivalent) leaves the project (e.g., a landowner decides to leave a project) before the end of the crediting period:

- The project must conservatively assume a loss of all previously verified emission reductions and removals associated with the excluded area.

- The project proponent must submit vectorized digital files (e.g., KML) to Verra that clearly differentiate the remaining UDef PA from the excluded instance.

- The baseline emissions must be recalculated by the project proponent to adjust to the revised UDef PA.

A project deviation detailing these changes must be introduced in the subsequent monitoring report and assessed by the VVB.

5.1.3 Avoiding Unplanned Deforestation Leakage Belt (UDef LB)

The LB (UDef LB) is the forest area where unplanned deforestation by geographically constrained agents may be displaced and is monitored.

The spatial extent of the UDef LB will be defined by Verra following the criteria described in Section A1.2.2 of Appendix 1, and will be provided to the project proponent. Baseline AD will be allocated by Verra to each project's UDef LB following Section 1.4.3 of Appendix 1.

The project proponent must spatially exclude from the baseline AD any other VCS AFOLU PAs that are allocated to its UDef LB and monitored ex post. The exclusion enters into force and related leakage emissions may be omitted once the other VCS AFOLU projects have submitted an initial verification report to the Verra Registry but no sooner than the other projects' start date. The onus is on the project proponent to demonstrate this and on the VVB to confirm it.

Leakage emissions associated with other overlapping VCS REDD[4] project LB(s) may be omitted by the project where:

- An LB agreement is signed between the project proponents that clearly defines the location of the boundaries of the different LB areas overlapping with UDef LB, as well as the related monitoring responsibilities; and

- The other VCS REDD project has submitted a verification report in the last five years. Where the other VCS REDD project ends or fails to present a verification report for more than five consecutive years, the excluded areas and discounted AD are reintroduced to UDef LB.

The omission only applies to the UDef LB portions that will be monitored by the other project, as per the LB agreement. When leakage emissions are omitted, the project must discount the corresponding allocated Baseline AD. The project description must clearly describe the excluded areas and the related discounting calculations. Post-validation changes must be described and assessed by the VVB as project description deviations.

5.1.4 Land Available for Activity Shifting Leakage

Geographically mobile agents may displace their activities outside the UDef PA and beyond the UDef LB. The area available for this kind of activity shifting corresponds to all potentially arable, physically accessible and unprotected land in the country.

The spatial extent of land available for geographically mobile activity shifting will be defined by Verra following the criteria and procedures described in Section A2.1 of Appendix 2. This will be provided by Verra to the project proponent.

5.1.5 Leakage Management Areas (UDef-LMA)

Leakage management areas are part of the overall project design. These are non-forest areas under the control of the project, and where the project proponent intends to implement activities to minimize the risk of activity-shifting leakage, such as afforestation, reforestation, enhanced cropping or grazing land management. UDef-LMA may overlap with another VCS AFOLU project. Emissions associated with the implementation of the leakage prevention measures (see Section 5.3.3.7) may be omitted for portions of UDef-LMA that falls within another VCS AFOLU project when these emissions are accounted for by the other project. For

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[4] Limited to projects that use this module.

example, agroforestry activities implemented to reduce deforestation may be registered as a separate project (or as an ARR component of the same project) and related emissions omitted because accounted for in the framework of this other project (or other component of a multiple activity project).

5.1.6 Project Activities Region

The project zone corresponds to the UDef PA, the UDef LB and the surrounding deforested areas extending 10 km from the UDef PA. This is the region in which the historical agents and drivers of deforestation are analyzed.

5.2 Baseline Scenario

Under this module, the baseline scenario is assumed to be a continuation of ongoing unplanned deforestation. This scenario must be described through a detailed analysis of the agents, proximate causes, drivers and underlying causes of deforestation in the project activities region. All of the analysis described in this section must be summarized in the project description.

Understanding "who" is deforesting and what drives their decision is necessary to understand the risk of activity-shifting leakage and design effective measures to address deforestation.

The analysis must use existing studies, maps (including the jurisdictional forest cover benchmark map (FCBM) and risk map), expert consultations, field surveys (such as participatory rural appraisal) and other verifiable sources of information.

Describe the measures that the project will implement to address the drivers and underlying causes of deforestation.

5.2.1 Identification and Characterization of Deforestation Agents

Identify the main groups of deforestation agents (farmers, ranchers, loggers etc.) and describe how they contribute to deforestation and their relative importance to historical land use and land cover change.

For each identified group, provide the following information:

1) Name of the group of deforestation agents

2) Brief description of the related deforestation activity (e.g., slash and burn agriculture, unsustainable logging) and the main social, economic and cultural features that are relevant to understand why the agent group is deforesting (e.g., subsistence versus commercial activities)

3) Brief assessment of the most likely change in the agent population size in the future. For groups of agents that are expected to increase in number, specify whether the increase will be due to migration from outside the UDef PA and UDef LB.

4) For each identified group, describe the alternative and/or mitigation activities that will be facilitated by the project, where applicable.

An avoiding UDef project, by protecting the UDef PA, may cause some portion of deforestation agents to relocate their activities to another location (i.e., be "displaced" from the UDef PA). Two types of deforestation agents may be displaced, as described below and summarized in Table 1. As part of the analysis of the deforestation agents, assess whether each group of agents should be considered geographically constrained or whether they may shift their activity outside the UDef LB.

The characterization must be based on the proportion of these agents that have migrated into the project activities region in the last five years and must be confirmed through local survey as described in Section 5.3.3.4.

Table 1: Summary of activities of geographically constrained and geographically mobile agents of deforestation in the baseline and project scenarios

Unplanned Deforestation Agent Type	Residing Location at Start of the Baseline Validity Period	Impact in the project zone under the baseline scenario	Evolution of practices due to project implementation (project scenario)
Geographically constrained	Residing within or near the UDef PA	Causes deforestation in the UDef PA and in the UDef LB	Agents* may: • Continue causing deforestation in the UDef PA (activities inefficiency) • Adopt new practices and stop deforesting (no leakage) • Displace their activities in the nearest accessible forest represented as UDef LB (leakage)
Geographically mobile	Residing anywhere in the country outside the UDef PA and UDef LB	Migrates into or near the UDef PA or UDef LB, and causes deforestation in the UDef PA or UDef LB	Agents* may: • Migrate to the UDef PA or UDef LB and cause deforestation (activities inefficiency) • Migrate to an area other than the UDef PA or UDef

Unplanned Deforestation Agent Type	Residing Location at Start of the Baseline Validity Period	Impact in the project zone under the baseline scenario	Evolution of practices due to project implementation (project scenario)
			LB without causing deforestation (no leakage) • Migrate to an area other than the UDef PA or UDef LB and cause deforestation (leakage)

*In most cases, the project scenario will result in a combination of the possibilities listed, i.e., a portion of the group of agents will stop deforesting or displace their activities inside or outside of the UDef LB.

Note that the term displacement in this context does not mean that deforestation agents living in or near the UDef PA or UDef LB are relocated to other areas through project implementation. It refers to the displacement of forecasted baseline activities (activities that have not occurred) into other locations. For geographically mobile deforestation agents, "displacement" means relocating from their point of origin outside the UDef PA and UDef LB to another location that is also outside the PA and LB, in lieu of migrating into the PA as originally projected in the baseline.

5.2.2   Identification of Drivers of Deforestation

Analyze the factors that drive the land-use decisions of each group of deforestation agents in order to identify the proximate causes of deforestation. First describe and, where possible, quantify the deforestation drivers (e.g., prices of agricultural, mineral, timber or other commodities, costs of agricultural inputs, population density and growth and rural wages). Second, describe drivers that explain the location of deforestation (access to forests, slope, proximity to markets, proximity to existing or industrial facilities, proximity to existing settlements, land management type).

For each of these two sets of deforestation drivers:

1. Provide evidence for one to five key variables of having a driver of deforestation in the project activities region (as defined in Section 5.1.6) during the historical reference period (HRP); and

2. Briefly describe, for each main agent group identified in Section Identification and Characterization of Deforestation5.2.1, how the key drivers have and will most likely impact the agents' decision to deforest; and

3. Provide information about likely future development of each deforestation driver (e.g., how a growing geographically constrained population might exert greater pressure on the forest through firewood collection or an increasing price for a mineral is likely to drive an increase in illegal mining).

5.2.3 Analysis of Chain of Events Leading to Deforestation

The agents' characteristics and decisions are themselves determined by the underlying causes of deforestation, such as land-use policies and their enforcement, population pressure, socioeconomic dynamics, war and other types of conflicts, property regime and climate change. List one to five key underlying causes and cite any relevant source of information that provides evidence that the identified variables have been an underlying cause of deforestation during the HRP. Briefly describe how each underlying cause is impacting the decisions of the main agent groups to deforest. For each underlying cause, provide information about its likely future development.

Based on the historical evidence collected, analyze the relations between main agent groups, key drivers and underlying causes and explain the sequence of events that typically has led and most likely will lead to deforestation. Consult local experts, literature, and other sources of information, as necessary.

In addition, the analysis of agents and drivers of deforestation must be used to assess the following ex ante:

1) Expected project effectiveness at reducing deforestation (Section 5.3.2.1);

2) Non-permanence internal risks; and

3) Risk of leakage by geographically constrained and geographically mobile agents (Section 5.2.1).

5.3 Quantification of GHG Emission Reductions

5.3.1 Baseline Emissions

The key steps to be undertaken by the project proponent to estimate the project baseline are described in Figure 1.

Figure 1: Steps for estimation of the project baseline

Stratify forests in the project area and leakage belt

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Apply allocated baseline UDef to the forest strata

↓

Estimate uncertainty-discounted emission factors for each stratum

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Estimate annual net baseline emissions for the baseline validity period
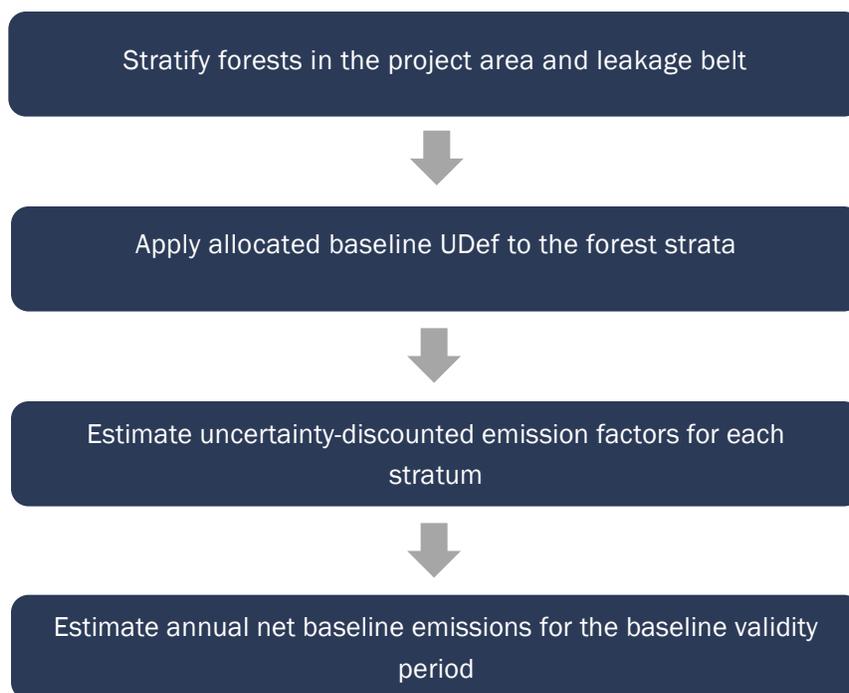
5.3.1.1 Creation of Forest Stratification Map

Project proponents must define the forest strata relevant to calculating emissions pertaining to the UDef PA and UDef LB. *X-STR* must be used to define strata. Separate strata delineation is required for areas that exceed 2 hectares and meet any of the following criteria:

1) Forested wetland soils;[5]

2) Tree cover that is not considered under the relevant national forest definition (e.g., tree cover in agricultural landscapes);

3) Areas of forest that was planted or reestablished within the past 30 years or, where such forests cannot be reliably differentiated, distinct areas/forest types where forest carbon stocks differ significantly from surrounding forest.

A forest stratification map (FSM) depicting strata and forest classes must be developed or adopted. The FSM must:

a) Be identical to, or directly derived from, the spatial stratification used to estimate project carbon stocks from forest inventories (e.g., a map with a higher number of

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[5] For guidance on identifying wetland soils, see Chapter 1.2 in Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. & Troxler, T.G. (eds) (2014).

classes used for forest inventory may be simplified by combining classes after the inventory analysis is complete); and

b) Encompass the UDef PA and UDef LB and use the same set of forest strata definitions in both areas.

No accuracy standard is applied to the project FSM. The spatial accuracy of the FSM will be reflected in the uncertainty of the estimates of carbon stocks for each forest stratum.

Where, during monitoring, a large-scale natural disturbance[6] is identified to have taken place within the UDef PA and/or UDef LB during the BVP, the disturbed area must be delineated and treated as a separate forest stratum. Where the event qualifies as a loss as per the *VCS Program Definitions*, applicable VCS rules and requirements will apply. Baseline emissions must be updated through a project description deviation after a loss.

5.3.1.2 Estimation of Baseline Annual Unplanned Deforestation within the Project Boundary

Through the *AD Baseline Allocation Report*, which will be posted on a project's page in the Verra Registry, Verra[7] will provide project proponents with the projected baseline area of unplanned deforestation for each risk class in the UDef PA and UDef LB ($AD_{PA-UDef,r}$ and $AD_{LB-UDef,r}$, respectively).

Where:

$AD_{PA-UDef,r}$ = Activity data allocated to the unplanned deforestation project area in risk class r (ha y^{-1})

$AD_{LB-UDef,r}$ = Activity data allocated to the unplanned deforestation leakage belt in risk class r (ha y^{-1})

r = 1, 2, 3, ..., R risk class

To determine baseline emissions from unplanned deforestation, project proponents must use the following information from the *AD Baseline Allocation Report*:

1) Parameters $AD_{PA-UDef,r}$ and $AD_{LB-UDef,r}$;

2) The FSM; and

3) The jurisdictional deforestation risk map.

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[6] Such as tectonic activity (earthquake, landslide, volcano), extreme weather (hurricane), pest, drought or fire that result in a significant degradation of forest carbon stock.

[7] Throughout this module, Verra is referred to as the entity generating and issuing the *AD Baseline Allocation Report*. Where a project is to be nested in a registered Jurisdictional and Nested REDD+ Scenario 1 or 2 program, the jurisdictional proponent is responsible for generating and allocating the project this information.

The baseline annual area of unplanned deforestation allocated to each UDef PA and UDef LB risk class ($AD_{PA-UDef,r}$, $AD_{LB-UDef,r}$) must be allocated among forest strata within these areas based on the relative area of each forest stratum within each risk class.

Where other VCS AFOLU PAs or LBs are excluded from UDef LB, the FSM must be adjusted to exclude the corresponding strata and the baseline annual area of unplanned deforestation ($AD_{LB-UDef}$) must be reduced accordingly. These adjustments must be made before allocating the baseline AD to the UDef LB.

The areas of forest stratum i in risk class r in the UDef PA and UDef LB are termed $A_{PA-UDef,r,i}$ and $A_{LB-UDef,r,i}$, respectively. These parameters must be calculated by spatial overlay of the following layers:

1) Digital maps of UDef PA boundaries;

2) Digital maps of UDef LB boundaries;

3) FSM; and

4) Jurisdictional deforestation risk map.

The allocation of AD to forest strata in the project area is described in Equation (1):

$$AD_{BSL,PA-UDef,i,t} = \sum_{r=1}^{R} \left(AD_{PA-UDef,r} \times \frac{A_{PA-UDef,r,i}}{\sum_{i=1}^{M} A_{PA-UDef,r,i}} \right) \tag{1}$$

Where:

$AD_{BSL,PA-UDef,i,t}$ = Unplanned deforestation activity data in the baseline scenario allocated to forest stratum i in the unplanned deforestation project area in the baseline validity period associated with year t (ha y^{-1})

$AD_{PA-UDef,r}$ = Activity data allocated to the unplanned deforestation project area in risk class r (ha y^{-1})

$A_{PA-UDef,r,i}$ = Area of forest stratum i in the unplanned deforestation project area at the start of BVP in risk class r (ha)

i = 1, 2, 3, …, M forest stratum

r = 1, 2, 3, …, R risk class

t = 1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

The allocation of AD to forest strata in the leakage belt is described in Equation (2):

$$AD_{BSL,LB-UDef,i,t} = \sum_{r=1}^{R} \left(AD_{LB-UDef,r} \times \frac{A_{LB-UDef,r,i}}{\sum_{i=1}^{M} A_{LB-UDef,r,i}} \right) \tag{2}$$

Where:

$AD_{BSL,LB\text{-}UDef,i,t}$ = Unplanned deforestation activity data in the baseline scenario allocated to forest stratum i in the unplanned deforestation leakage belt in the baseline validity period associated with year t (ha y^{-1})

$AD_{LB\text{-}UDef,r}$ = Activity data allocated to the unplanned deforestation leakage belt in risk class r (ha y^{-1})

$A_{LB\text{-}UDef,r,i}$ = Area of forest stratum i in the unplanned deforestation leakage belt at the start of BVP in risk class r (ha)

i = 1, 2, 3, …, M forest stratum

r = 1, 2, 3, …, R risk class

t = 1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

New Identified Exclusions

Where, through project monitoring, a new occurrence of an identified excluded area is detected, such areas may be spatially delineated. The risk class for identified exclusions is changed to "excluded risk class" ($r = exclude$). For such areas, $AD_{PA\text{-}UDef,r=exclude}$ and $AD_{LB\text{-}UDef,r=exclude}$ are both set to zero for all years of the monitoring period. Further detail is provided in Section 5.3.2.2 Step 1 below. Such areas must be recorded with description and supporting imagery as evidence of reason for exclusion.

5.3.1.3 Estimation of Emissions from Carbon Stock Changes

The carbon stocks before and after deforestation for the forest strata within the UDef PA and UDef LB must be estimated to allow estimation of the change in carbon stocks resulting from deforestation within each forest stratum.

Step 1: Estimation of Carbon Stocks per Forest Stratum

Estimation of Forest Carbon Stocks

Carbon stocks in each of the pools selected for the project are estimated using modules *CP-AB*, *CP-D*, *CP-L*, *CP-S,* and *CP-W*. The modules and derived parameters are listed in Table 2.

Table 2: Carbon pools used in this module, with originating modules and resulting parameters

Pool	Module	Parameters	Parameter Description
Aboveground tree biomass	CP-AB	$C_{AB\_tree,i}$	Mean carbon stock in the aboveground tree biomass pool in forest stratum i (t CO_2e ha^{-1})
		$C_{AB\_tree,post,i}$	Mean carbon stock in the post-deforestation aboveground tree biomass pool in forest stratum i (t CO_2e ha^{-1})
Belowground tree biomass	CP-AB	$C_{BB\_tree,i}$	Mean carbon stock in the belowground tree biomass pool in forest stratum i (t CO_2e ha^{-1})
		$C_{BB\_tree,post,i}$	Mean carbon stock in the post-deforestation belowground tree biomass pool in forest stratum i (t CO_2e ha^{-1})
Aboveground non-tree biomass	CP-AB	$C_{AB\_nontree,i}$	Mean carbon stock in the aboveground non-tree biomass pool in forest stratum i (t CO_2e ha^{-1})
		$C_{AB\_nontree,post,i}$	Mean carbon stock in the post-deforestation aboveground non-tree biomass pool in forest stratum i (t CO_2e ha^{-1})
Belowground non-tree biomass	CP-AB	$C_{BB\_nontree,i}$	Mean carbon stock in the belowground non-tree biomass pool in forest stratum i (t CO_2e ha^{-1})
		$C_{BB\_nontree,post,i}$	Mean carbon stock in the post-deforestation belowground non-tree biomass pool in forest stratum i (t CO_2e ha^{-1})
Dead wood	CP-D	$C_{DW,i}$	Carbon stock in the dead wood pool in forest stratum i (t CO_2e ha^{-1})
		$C_{DW,post,i}$	Carbon stock in the post-deforestation dead wood pool in forest stratum i (t CO_2e ha^{-1})
Litter	CP-L	$C_{LI,I}$	Carbon stock in the litter pool in forest stratum i (t CO_2e ha^{-1})
		$C_{LI,post,i}$	Carbon stock in the post-deforestation litter pool in forest stratum i (t CO_2e ha^{-1})
Soil organic carbon	CP-S	$C_{SOC,i}$	Mean carbon stock in the soil organic carbon pool in forest stratum i (t CO_2e ha^{-1})
		$C_{SOC,post,i}$	Mean carbon stock in the post-deforestation soil organic carbon pool in forest stratum i (t CO_2e ha^{-1}) (parameter is $C_{SOC,PD-BSL,i}$ in CP-S

Pool	Module	Parameters	Parameter Description
Harvested wood products	CP-W	$C_{WP,i}$	Mean carbon stocks entering the wood products pool at the time of deforestation from forest stratum i (t CO_2e ha^{-1})
		$C_{WP100,i}$	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100 years from stratum i (t CO_2e ha^{-1})

In instances where the UDef LB contains forest strata not found within the UDef PA (and not expected to be found in UDef PA under either the baseline or project scenarios), carbon pool estimates from a national dataset (e.g., forest reference emission level (FREL) or national forest inventory) or peer-reviewed published source may be used.

Estimation of Non-Forest Carbon Stocks

The carbon stocks following deforestation are assumed to be the area-weighted average stocks of all post-deforestation land use classes present in the area surrounding the project (within a 10 km wide area surrounding the UDef PA), referencing the most current land use/land cover classification covering the jurisdiction. This area-weighted average stock of the post-deforestation land use may be calculated for each forest stratum separately. Or, a single area-weighted average stock of the post-deforestation land use class may be calculated and applied to all forest strata.

Step 2: Estimation of Emissions from Carbon Stock Changes

Stock changes (ΔC_p) in each carbon pool are calculated by subtracting the post-deforestation carbon stocks from forest carbon stocks. For simplicity here $\Delta C_{p,i}$ to encompass all pools, in application $C_{p,i}$ and $C_{p,post,i}$ should reflect the parameters included in Table 2. The stock changes are calculated for each pool of each forest stratum, as follows:

$$\Delta C_{p,i} = C_{p,i} - C_{p,post,i} \tag{3}$$

Where:

$\Delta C_{p,i}$ =   Estimated emissions from carbon stock change in pool p in forest stratum i (t CO_2e ha^{-1})

$C_{p,i}$ =   Estimated carbon stock in pool p of forest stratum i (t CO_2e ha^{-1})

$C_{p,post,i}$ =   Estimated carbon stock in post-deforestation pool p in forest stratum i (t CO_2e ha^{-1})

p =   Pools: aboveground tree biomass (*AB_Tree*), aboveground non-tree biomass (*AB_nontree*), belowground tree biomass (*BB_tree*), belowground non-tree biomass (*BB_nontree*), dead wood (*DW*), litter (*LI*) and soil organic carbon (*SOC*)

i =   1, 2, 3, …, M forest stratum

Step 3: Evaluation of Uncertainty of Carbon Stock Estimates

Estimates of the carbon stocks in each carbon pool must be accompanied by an estimate of their uncertainty. The percentage uncertainty of each carbon stock estimate is defined as the half width of the two-sided 90 percent confidence interval divided by the estimate. The following requirements apply:

1) Where carbon stock estimates are derived from sampling (e.g., measuring aboveground biomass or other carbon pools in sample plots), uncertainty must be at minimum derived from the sampling uncertainty.

2) Where literature sources (including IPCC guidance) are used for carbon stock estimates, these sources must also include an estimate of the uncertainty and/or data ranges (data ranges may be used as proxies of confidence intervals).

3) The project documentation must include a table of carbon stock estimates in each pool and forest stratum (mean and 90 percent confidence interval) and an indication of which sources of uncertainty were included.

4) The uncertainty of calculation parameters (e.g., carbon fraction, wood density, soil-organic carbon stock change factors and root-to-shoot ratio) must be included and propagated.

Estimating the uncertainty associated with allometric equations and measurement error (e.g., tree height or diameter measurements) is not required.

To evaluate uncertainty, the standard deviation of each estimate[8] must be calculated. The standard deviation of estimate A is denoted as $S(A)$. The uncertainty of this estimate is evaluated in terms of the half-width of its two-sided 90 percent confidence interval and is denoted as $U(A) = t_{alpha=10\%} \times S(A)$, where $t_{alpha=10\%}$ is the t-value for a two-sided 90 percent confidence interval. The percentage uncertainty is the uncertainty expressed as a percentage of the estimate and is denoted as $U\%(A) = 100 \times t_{alpha=10\%} \times S(A)/A$. Error propagation is necessary to track uncertainty through the various calculation steps involved in estimating carbon stocks. The equations in Table 3 summarize simplified rules of error propagation that must be used when carrying out summations, subtractions, multiplications and divisions of two variables A and B. Multiplication with an exactly known coefficient c is also shown.

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[8]   It is important to distinguish between the standard deviation of a population parameter and the standard deviation of the estimator of that population parameter. For example, where a population mean is estimated from sample measurements, the estimator will be the sample mean. The standard deviation of the mean estimate (often referred to as standard error) will consider the number of sample units, n, and is calculated by dividing the standard deviation by the square root of $(n − 1)$.

Table 3: Equations for error propagation

Function	Standard Deviation of Estimate	Percentage Uncertainty of Estimate
$A + B$	$S(A+B) = \sqrt{S(A)^2 + S(B)^2}$	$U\%(A+B) = 100\% \times t_{alpha=10\%} \times \sqrt{S(A)^2 + S(B)^2}/(A+B)$
$A \times B$	$S(A \times B) = \lvert A \times B \rvert \times \sqrt{\left(\frac{S(A)}{A}\right)^2 + \left(\frac{S(B)}{B}\right)^2}$	$U\%(A \times B) = 100\% \times t_{alpha=10\%} \times \lvert A \times B \rvert \times \sqrt{\left(\frac{S(A)}{A}\right)^2 + \left(\frac{S(B)}{B}\right)^2}\bigg/ (A \times B)$
$A - B$	$S(A-B) = \sqrt{S(A)^2 + S(B)^2}$	$U\%(A-B) = 100\% \times t_{alpha=10\%} \times \sqrt{S(A)^2 + S(B)^2}/(A-B)$
A/B	$S\left(\frac{A}{B}\right) = \lvert A/B \rvert \times \sqrt{\left(\frac{S(A)}{A}\right)^2 + \left(\frac{S(B)}{B}\right)^2}$	$U\%\left(\frac{A}{B}\right) = 100\% \times t_{alpha=10\%} \times \lvert A/B \rvert \times \sqrt{\left(\frac{S(A)}{A}\right)^2 + \left(\frac{S(B)}{B}\right)^2}\bigg/ \left(\frac{A}{B}\right)$
$c \times A$	$S(c \times A) = c \times S(A)$	$U\%(c \times A) = 100\% \times t_{alpha=10\%} \times S(A)/A$

Estimation of Uncertainty for Each Pool and Stratum

The uncertainty of each carbon pool and stratum must first be propagated using the equation for subtraction from Table 3 as follows:

$$U(\Delta C_{p,i}) = U(C_{p,i} - C_{p,post,i}) = \sqrt{U(C_{p,i})^2 + U(C_{p,post,i})^2}$$

(4)

Where:

$U()$ = Uncertainty as half-width of the two-sided 90 percent confidence interval (t CO_2e ha^{-1})

$\Delta C_{p,i}$ = Estimated emissions from carbon stock change in pool p of forest stratum I (t CO_2e ha^{-1})

$C_{p,i}$ = Estimated carbon stock in pool p of forest stratum i (t CO_2e ha^{-1})

$C_{p,post,i}$ = Estimated carbon stock in post-deforestation pool p in forest stratum i (t CO_2e ha^{-1})

p = Pools: aboveground tree biomass (*AB_Tree*), aboveground non-tree biomass (*AB_nontree*), belowground tree biomass (*BB_tree*), belowground non-tree biomass (*BB_nontree*), dead wood (*DW*), litter (*LI*), and soil organic carbon (*SOC*)

i = 1, 2, 3, …, *M* forest stratum

Step 4: Estimation of an Uncertainty Discount Factor

Conservative estimation of changes in carbon stocks is achieved by applying an uncertainty discount factor.

Averaging Carbon Stock Changes Over Forest Strata and Carbon Pools

To establish the uncertainty discount factor, first stock changes are averaged over forest strata and carbon pools. The stock changes are averaged over the area of UDef AD within each forest stratum over the baseline period for each pool separately, using an area-weighted average. The area data to be used for averaging are those obtained in Section 5.3.1.2. This calculation is carried out as follows:

$$W\Delta C_p = \frac{\sum_{i=1}^{M} AD_{BSL,PA-UDef,i,t} \times \Delta C_{p,i}}{\sum_{i=1}^{M} AD_{BSL,PA-UDef,i,t}}$$

(5)

Where:

$W\Delta C_p$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in pool *p* (t CO_2e ha^{-1})

$AD_{BSL,PA-uDef,i,t}$ = Unplanned deforestation activity data in the baseline scenario allocated to forest stratum *i* in the unplanned deforestation project area in the baseline validity period associated with year *t* (ha y^{-1})

$\Delta C_{p,i}$ = Estimated emissions from carbon stock change in pool *p* in forest stratum *i* (t CO_2e ha^{-1})

p = Pools: aboveground tree biomass (*AB_Tree*), aboveground non-tree biomass (*AB_nontree*), belowground tree biomass (*BB_tree*), belowground non-tree biomass (*BB_nontree*), dead wood (*DW*), litter (*LI*) and soil organic carbon (*SOC*)

i = 1, 2, 3, …, *M* forest stratum

t = 1, 2, 3, …, *t** years elapsed since the start of the unplanned deforestation project

The UDef AD baseline weighted stock changes are then summed across all the relevant carbon pools. To establish the discount factor, this must be undertaken for all pools together, although soil organic carbon and carbon stocks entering the wood products pools are kept separate

when emission factors are applied to AD. The soil organic pools is derived from module *CP-S* with $\Delta C_{SOC,I} = C_{SOC,i} - C_{SOC,post.i}$.

$$
W\Delta C = W\Delta C_{AB\_tree} + W\Delta C_{BB\_tree} + W\Delta C_{AB\_nontree} + W\Delta C_{BB\_tree} \\
+ W\Delta C_{DW} + W\Delta C_{LI} + W\Delta C_{SOC} - WC_{WP} + WC_{WP100}
$$

(6)

Where:

$W\Delta C$ = Overall unplanned deforestation activity data baseline weighted average emissions from carbon stock changes (t CO_2e ha^{-1})

$W\Delta C_{AB\_tree}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the aboveground tree biomass pool (t CO_2e ha^{-1})

$W\Delta C_{BB\_tree}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the belowground tree biomass pool (t CO_2e ha^{-1})

$W\Delta C_{AB\_nontree}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the aboveground non-tree biomass pool (t CO_2e ha^{-1})

$W\Delta C_{BB\_nontree}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the belowground non-tree biomass pool (t CO_2e ha^{-1})

$W\Delta C_{DW}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the dead wood pool (t CO_2e ha^{-1})

$W\Delta C_{LI}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the litter pool (t CO_2e ha^{-1})

$W\Delta C_{SOC}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the soil organic carbon pool (t CO_2e ha^{-1})

WC_{WP} = Unplanned deforestation activity data baseline weighted average carbon stock entering the wood products pool at the time of deforestation (t CO_2e ha^{-1})

WC_{WP100} = Unplanned deforestation activity data baseline weighted average carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100 years (t CO_2e ha^{-1})

Uncertainty must be propagated accordingly. In doing this, the AD area values are considered, for simplicity, as simple multiplication factors with no uncertainty.

$$U(W\Delta C_p) = U\left(\frac{\sum_{i=1}^{M} AD_{BSL,PA-UDef,i,t} \times \Delta C_{p,i}}{\sum_{i=1}^{M} AD_{BSL,PA-UDef,i}}\right)$$

$$= \frac{\sqrt{\sum_{i=1}^{M}\left(AD_{BSL,PA-UDef,i,t} \times U(\Delta C_{p,i})\right)^2}}{\sum_{i=1}^{M} AD_{BSL,PA-UDef,i,t}}$$

(7)

Where:

$U()$ = Uncertainty as half-width of the two-sided 90 percent confidence interval (t CO$_2$e ha^{-1})

$W\Delta C_p$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in pool p (t CO$_2$e ha^{-1})

$AD_{BSL,PA-UDef,i,t}$ = Unplanned deforestation activity data in the baseline scenario allocated to forest stratum i in the unplanned deforestation project area in the baseline validity period associated with year t (ha y^{-1})

$\Delta C_{p,i}$ = Estimated emissions from carbon stock change in pool p in forest stratum i (t CO$_2$e ha^{-1})

p = Pools: aboveground tree biomass (*AB_Tree*), aboveground non-tree biomass (*AB_nontree*), belowground tree biomass (*BB_tree*), belowground non-tree biomass (*BB_nontree*), dead wood (*DW*), litter (*LI*) and soil organic carbon (*SOC*)

i = 1, 2, 3, …, M forest stratum

t = 1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

Further, uncertainty must be propagated using the equations for addition and subtraction from Table 3 per Equations (8) and (.

$$U(W\Delta C) = \sqrt{\begin{array}{l} U\left(W\Delta C_{AB\_tree}\right)^2 + U\left(W\Delta C_{BB\_tree}\right)^2 + U\left(W\Delta C_{AB\_nontree}\right)^2 \\ + U\left(W\Delta C_{BB\_nontree}\right)^2 + U(W\Delta C_{DW})^2 + U(W\Delta C_{LI})^2 \\ + U(W\Delta C_{SOC})^2 + U(WC_{WP})^2 + U(WC_{WP100})^2 \end{array}}$$

(8)

$$U\%(W\Delta C) = 100 \times \frac{U(W\Delta C)}{W\Delta C}$$

(9)

Where:

$U()$ = Uncertainty as half-width of the two-sided 90 percent confidence interval (t CO_2e ha^{-1})

$U\%()$ = Percentage uncertainty (i.e., uncertainty expressed as a percentage of the estimate) (%)

$W\Delta C$ = Overall unplanned deforestation activity data baseline weighted average emissions from carbon stock changes (t CO_2e ha^{-1})

$W\Delta C_{AB\_tree}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the aboveground tree biomass pool (t CO_2e ha^{-1})

$W\Delta C_{BB\_tree}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the belowground tree biomass pool (t CO_2e ha^{-1})

$W\Delta C_{AB\_nontree}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the aboveground non-tree biomass pool (t CO_2e ha^{-1})

$W\Delta C_{BB\_nontree}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the belowground non-tree biomass pool (t CO_2e ha^{-1})

$W\Delta C_{DW}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the dead wood pool (t CO_2e ha^{-1})

$W\Delta C_{LI}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the litter pool (t CO_2e ha^{-1})

$W\Delta C_{SOC}$ = Unplanned deforestation activity data baseline weighted average emissions from carbon stock change in the soil organic carbon pool (t CO_2e ha^{-1})

WC_{WP} = Unplanned deforestation activity data baseline weighted average carbon stock entering the wood products pool at the time of deforestation (t CO_2e ha^{-1})

WC_{WP100} = Unplanned deforestation activity data baseline weighted average carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100 years (t CO_2e ha^{-1})

Estimation of an Uncertainty Discount Factor

The discount factor for emissions from carbon stock change, $DF_{W\Delta C,}$ is calculated based on the resulting uncertainty of the baseline UDef AD weighted average carbon stock change, $U\%(W\Delta C)$. Where the percentage uncertainty is less than or equal to 10 percent, the discount factor is 0 (calculated using Equation (10). Where the percentage uncertainty is greater than 10 percent, the discount factor is calculated using Equation (11). In accord with VCS requirements uncertainty must remain below 100 percent, if uncertainty is greater than 100 percent additional sampling must be undertaken.

If $U\%(W\Delta C) < 10\%$ then: $DF_{W\Delta C} = 0$

$$(10)$$

If $U\%(W\Delta C) > 10\%$ then: $DF_{W\Delta C} = \dfrac{U\%(W\Delta C) \times t_{alpha=66.67\%}}{100 \times t_{alpha=10\%}}$

$$(11)$$

Where:

$DF_{W\Delta C}$	=	Uncertainty discount factor for stock changes
$U\%(W\Delta C)$	=	Percentage uncertainty in emissions from carbon stock change (%)
$t_{alpha=10\%}$	=	Value of the t distribution for a two-sided 90 percent confidence interval
$t_{alpha=66.6\%}$	=	Value of the t distribution for a one-sided 66.66 percent confidence interval

Step 5: Conservative Estimation of Emissions from Carbon Stock Change

Conservative estimates of the emissions from carbon stock change in the UDef PA are calculated by summing over the carbon stock pools and applying the discount factor. This adjustment must be undertaken separately for each carbon pool: aboveground biomass, belowground biomass, litter and dead wood, soil organic carbon and carbon stocks entering the wood products pool.

$$\Delta Cc_{AB-LI,i} = \left(\left(\Delta C_{AB\_tree,i} - C_{WP,i} \right) + \Delta C_{AB\_nontree,i} + \Delta C_{LI,i} \right) \times \left(1 - DF_{W\Delta C} \right)$$

$$(12)$$

Where:

$\Delta Cc_{AB-LI,i}$	=	Conservatively estimated emissions from annual carbon stock change in the unplanned deforestation project area in aboveground biomass and litter pools in forest stratum i (t CO_2e ha^{-1})
$\Delta C_{AB\_tree,i}$	=	Emissions from carbon stock change in the aboveground tree biomass pool in forest stratum i (t CO_2e ha^{-1})
$\Delta C_{AB\_nontree,i}$	=	Emissions from carbon stock change in the aboveground non-tree biomass pool in stratum i (t CO_2e ha^{-1})
$\Delta C_{LI,i}$	=	Emissions from carbon stock change in the litter pool in forest stratum i (t CO_2e ha^{-1})
$C_{WP,i}$	=	Carbon stock entering the wood products pool in forest stratum i (t CO_2e ha^{-1})
$DF_{W\Delta C}$	=	Uncertainty discount factor for stock changes
i	=	1, 2, 3, …, M forest stratum

$$\Delta Cc_{BB-DW,i} = \left(\Delta C_{BB\_tree,i} + \Delta C_{BB\_nontree,i} + \Delta C_{DW,i}\right) \times \left(1 - DF_{W\Delta C}\right)$$

(13)

Where:

$\Delta Cc_{BB-DW,i}$ = Conservatively estimated emissions from annual carbon stock change in the unplanned deforestation project area in belowground biomass and dead wood pools in forest stratum i (t CO_2e ha^{-1})

$\Delta C_{BB\_tree,i}$ = Emissions from carbon stock change in the belowground tree biomass pool in forest stratum i (t CO_2e ha^{-1})

$\Delta C_{BB\_nontree,i}$ = Emissions from carbon stock change in the belowground non-tree biomass pool in forest stratum i (t CO_2e ha^{-1})

$\Delta C_{DW,i}$ = Emissions from carbon stock change in the dead wood pool in forest stratum i (t CO_2e ha^{-1})

$DF_{W\Delta C}$ = Uncertainty discount factor for stock changes

i = 1, 2, 3, …, M forest stratum

$$\Delta Cc_{SOC\_WP,i} = \left(\Delta C_{SOC,i} + C_{WP100,i}\right) \times \left(1 - DF_{W\Delta C}\right)$$

(14)

Where:

$\Delta Cc_{SOC\_WP,i}$ = Conservatively estimated emissions from carbon stock change over a 20-year period in the unplanned deforestation project area in soil organic carbon and wood products pools in forest stratum i (t CO_2e ha^{-1})

$\Delta C_{SOC,i}$ = Emissions from carbon stock change in the soil organic carbon pool in forest stratum i (t CO_2e ha^{-1})

$C_{WP100,i}$ = Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100 years in forest stratum i (t CO_2e ha^{-1})

$DF_{W\Delta C}$ = Uncertainty discount factor for stock changes

i = 1, 2, 3, …, M forest stratum

Emissions from carbon stock change in the UDef LB are calculated similarly, but uncertainty is not quantified:

$$\Delta C_{LB,AB-LI,i} = \left(\Delta C_{AB\_tree,i} - C_{WP,i}\right) + \Delta C_{AB\_nontree,i} + \Delta C_{LI,i}$$

(15)

Where:

$\Delta C_{LB,AB-LI,i}$ = Estimated emissions from annual carbon stock change in the unplanned deforestation leakage belt in aboveground biomass and litter pools in forest stratum i (t CO$_2$e ha^{-1})

$\Delta C_{AB\_tree,i}$ = Emissions from carbon stock change in the aboveground tree biomass pool in forest stratum i (t CO$_2$e ha^{-1})

$\Delta C_{AB\_nontree,i}$ = Emissions from carbon stock change in the aboveground non-tree biomass pool in stratum i (t CO$_2$e ha^{-1})

$\Delta C_{LI,i}$ = Emissions from carbon stock change in the litter pool in forest stratum i (t CO$_2$e ha^{-1})

$C_{WP,i}$ = Carbon stock entering the wood products pool in forest stratum i (t CO$_2$e ha^{-1})

i = 1, 2, 3, …, M forest stratum

$$\Delta Cc_{LB,BB-DW,i} = \Delta C_{BB\_tree,i} + \Delta C_{BB\_nontree,i} + \Delta C_{DW,i}$$

(16)

Where:

$\Delta C_{LB,BB-DW,i}$ = Estimated emissions from annual carbon stock change in the unplanned deforestation leakage belt in belowground biomass and dead wood pools in forest stratum i (t CO$_2$e ha^{-1})

$\Delta C_{BB\_tree,i}$ = Emissions from carbon stock change in the belowground tree biomass pool in forest stratum i (t CO$_2$e ha^{-1})

$\Delta C_{BB\_nontree,i}$ = Emissions from carbon stock change in the belowground non-tree biomass pool in forest stratum i (t CO$_2$e ha^{-1})

$\Delta C_{DW,i}$ = Emissions from carbon stock change in the dead wood pool in forest stratum i (t CO$_2$e ha^{-1})

i = 1, 2, 3, …, M forest stratum

$$\Delta C_{LB,SOC\_WP,i} = \Delta C_{SOC,i} + C_{WP100,i}$$

(17)

Where:

$\Delta C_{LB,\,SOC\_WP,i}$ = Estimated emissions from carbon stock change over a 20-year period in the unplanned deforestation leakage belt in the soil organic carbon and wood products pools in forest stratum i (t CO$_2$e ha^{-1})

$\Delta C_{SOC,i}$ = Emissions from carbon stock change in the soil organic carbon pool in forest stratum i (t CO$_2$e ha^{-1})

| $C_{WP100,i}$ | = | Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100 years in forest stratum i (t CO_2e ha^{-1}) |
| i | = | 1, 2, 3, …, M forest stratum |

Step 6: Estimation of Annual Baseline Emissions from Carbon Stock Changes

The sum of emissions projected to take place in the UDef PA are estimated using the area of AD and the emissions from the carbon stock changes resulting from unplanned deforestation.

Stock changes in the aboveground and litter carbon pools are assumed to be emitted at the time of land use transition. Following the land use transition, emissions from the belowground, dead wood, SOC, and wood products pools are assumed to take place gradually over time; those from the belowground biomass and dead wood pools at an annual rate of 1/10 of the stock change, while those from SOC and wood products at an annual rate of 1/20 of the stock change. For a given year t (the year for which emissions are to be estimated), emissions from unplanned deforestation are summed from the project start date up to t^* (for SOC and wood products).

For carbon pools in UDef PA:

$$\Delta C_{BSL,PA-UDef,i,t} = \left(AD_{BSL,PA-UDef,i} \times \Delta Cc_{AB-LI,i} \right)$$
$$+ \frac{1}{10} \times \sum_{t-10}^{t} (AD_{BSL,PA-UDef,i,t} \times \Delta Cc_{BB-DW,i,t})$$
$$+ \frac{1}{20} \times \sum_{t-20}^{t} (AD_{BSL,PA-UDef,i,t} \times \Delta Cc_{BSL,SOC\_WP,i,t}) \tag{18}$$

Where:

$\Delta C_{BSL,PA-UDef,i,t}$	=	Cumulative emissions from the baseline carbon stock change in all carbon pools in forest stratum i within the unplanned deforestation project area in year t (t CO_2e)
$AD_{BSL,PA-UDef,i,t}$	=	Unplanned deforestation activity data in the baseline scenario allocated to forest stratum i in the unplanned deforestation project area in the baseline validity period associated with year t (ha y^{-1})
$\Delta Cc_{AB-LI,i}$	=	Conservatively estimated emissions from annual carbon stock change in the unplanned deforestation project area in aboveground biomass and litter pools in forest stratum i, estimated for the baseline validity period associated with year t (t CO_2e ha^{-1})
$\Delta Cc_{BB-DW,i,t}$	=	Conservatively estimated emissions from annual carbon stock change in the unplanned deforestation project area in belowground biomass and dead

wood pools in forest stratum i, estimated for the baseline validity period associated with year t (t CO_2e ha^{-1})

$\Delta Cc_{BSL,SOC\_WP,i,t}$ = Conservatively estimated emissions from carbon stock change over a 20-year period in the unplanned deforestation project area in the soil organic carbon and wood products pools in forest stratum i, estimated for the baseline validity period associated with year t (t CO_2e ha^{-1})

i = 1, 2, 3, ..., M forest stratum

t = 1, 2, 3, ..., t^* years elapsed since the start of the unplanned deforestation project

For carbon pools in UDef LB strata:

$$
\begin{aligned}
\Delta C_{BSL,LB-UDef,i,t} = \; & (AD_{BSL,LB-UDef,i} \times \Delta C_{BSL,LB,AB-LI,i}) \\
& + \frac{1}{10} \times \sum_{t-10}^{t} (AD_{BSL,LB-UDef,i,t} \times \Delta C_{BSL,LB,BB-DW,i,t}) \\
& + \frac{1}{20} \times \sum_{t-20}^{t} (AD_{BSL,LB-UDef,i,t} \times \Delta C_{BSL,LB,SOC\_WP,i,t})
\end{aligned}
\tag{19}
$$

Where:

$\Delta C_{BSL,LB-UDef,i,t}$ = Cumulative emissions from the baseline carbon stock change in all carbon pools in forest stratum i within the unplanned deforestation leakage belt in year t (t CO_2e)

$AD_{BSL,LB-UDef,i,t}$ = Unplanned deforestation activity data in the baseline scenario allocated to forest stratum i in the unplanned deforestation leakage belt in the baseline validity period associated with year t (ha y^{-1})

$\Delta C_{BSL,LB,AB-LI,i}$ = Estimated emissions from annual carbon stock change in the unplanned deforestation leakage belt in aboveground biomass and litter pools in forest stratum i, estimated for the baseline validity period associated with year t (t CO_2e ha^{-1})

$\Delta C_{BSL,LB,BB-DW,i}$ = Estimated emissions from annual carbon stock change in the unplanned deforestation leakage belt in belowground biomass and dead wood pools in forest stratum i, estimated for the baseline validity period associated with year t (t CO_2e ha^{-1})

$\Delta C_{BSL,LB,SOC\_WP,i,t}$ = Estimated emissions from carbon stock change over a 20-year period in the in the unplanned deforestation leakage belt in soil organic carbon and wood products pools in forest stratum i, estimated for the baseline validity period associated with year t (t CO_2e ha^{-1})

i = 1, 2, 3, ..., M forest stratum

| t | = | 1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project |

5.3.1.4 Estimation of Other Baseline GHG Emissions

Any other GHG emissions that would take place in the baseline scenario within the UDef PA must be estimated. See modules *E-FCC, E-BPB* and *E-NA* for calculation of $E_{BSL,FC,I,t}$, $E_{BSL,BiomassBurn,i,t}$, and $N_2O_{BSL,direct-N,i,t}$, respectively. The other GHG emissions within the UDef PA are estimated as:

$$GHG_{BSL_{PA}-UDef,E}$$
$$= \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(E_{BSL,FC,i,t} + E_{BSL,BiomassBurn,i,t} + N_2O_{BSL,direct-N,i,t} \right) \tag{20}$$

Where:

$GHG_{BSL\_PA-UDef,E}$	=	Cumulative other greenhouse gas emissions resulting from unplanned deforestation within the unplanned deforestation project area in the baseline in year t (t CO_2e)
$E_{BSL,FC,i,t}$	=	Net emissions from fossil fuel combustion in forest stratum i in the unplanned deforestation project area in year t (t CO_2e)
$E_{BSL,BiomassBurn,i,t}$	=	Non-CO_2 emissions due to biomass burning as part of unplanned deforestation activities in forest stratum i in year t (t CO_2e)
$N_2O_{BSL,direct-N,i,t}$	=	Direct N_2O emission as a result of nitrogen application on an alternative land use in forest stratum i in year t (t CO_2e)
i	=	1, 2, 3, …, M forest stratum
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

5.3.1.5 Estimation of Net Baseline Emissions

Net emissions under baseline conditions for the project area are calculated as:

$$\Delta C_{BSL,PA-UDef} = \left(\sum_{t=1}^{t*} \sum_{i=1}^{M} \Delta C_{BSL,PA-UDef,i,t} \right) + GHG_{BSL\_PA-UDef,E} \tag{21}$$

Where:

| $\Delta C_{BSL,PA\text{-}UDef}$ | = | Cumulative net greenhouse gas emissions in the baseline within the unplanned deforestation project area since project start in year t (t CO_2e) |

| $GHG_{BSL\_PA\text{-}UDef,E}$ | = | Cumulative other greenhouse gas emissions resulting from unplanned deforestation within the unplanned deforestation project area in the baseline in year t (t CO_2e) |

| $\Delta C_{BSL,PA\text{-}UDef,i,t}$ | = | Sum of the baseline emissions from carbon stock change in all carbon pools in forest stratum i within the unplanned deforestation project area in year t (t CO_2e) |

| i | = | 1, 2, 3, …, M forest stratum |

| t | = | 1, 2, 3, …, t^* years elapsed since the start of the avoided unplanned deforestation project |

Net emissions under baseline conditions for the leakage belt are calculated as:

$$\Delta C_{BSL,LB-UDef} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \Delta C_{BSL,LB-UDef,i,t}$$

(22)

Where:

| $\Delta C_{BSL,LB\text{-}UDef}$ | = | Cumulative net greenhouse gas emissions in the baseline within the unplanned deforestation leakage belt since project start in year t (t CO_2e) |

| $\Delta C_{BSL,LB\text{-}UDef,i,t}$ | = | Sum of the baseline emissions from carbon stock change in all carbon pools in forest stratum i within the unplanned deforestation leakage belt in year t (t CO_2e). |

| i | = | 1, 2, 3, …, M forest stratum |

| t | = | 1, 2, 3, …, t^* years elapsed since the start of the avoided unplanned deforestation project |

5.3.1.6 Area Cap at Baseline Reassessment

Through the life of the project the sum of allocated deforestation in any given stratum cannot exceed the total area of each stratum. Thus:

$$\sum_{t=1}^{t*} AD_{BSL,PA-UDef,i,t} \quad \text{must be} \le A_i$$

In any circumstance where

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NOT TO BE USED FOR VALIDATION OR VERIFICATION

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$$\sum_{t=1}^{t*} AD_{BSL,PA-UDef,i,t}$$ is > A_i then baseline deforestation must be allocated to an alternate stratum in the same risk class, or if no other strata exist with remaining area for potential deforestation, then deforestation must be allocated to the immediately succeeding risk class r.

If at any time

$$\sum_{i=1}^{M}\sum_{t=1}^{t*} AD_{BSL,PA-UDef,i,t}$$ > $A_{PA-UDef}$ (with the subtraction of any identified exclusions) then no further issuance of VCUs may occur.

Where:

$AD_{BSL,PA-UDef,i,t}$ = Unplanned deforestation activity data in the baseline scenario allocated to forest stratum i in the unplanned deforestation project area in the baseline validity period associated with year t (ha y^{-1})

A_i = Area of stratum i (ha)

$A_{PA-UDef}$ = Area of project where activities aimed at avoiding unplanned deforestation will take place (ha)

i = 1, 2, 3, …, M forest stratum

t = 1, 2, 3, …, $t*$ years elapsed since the start of the unplanned deforestation project

Where baseline renewal represents the first use of this methodology after the project's prior use of VM0006, VM0007, VM0009, VM0015 or VM0037 then the relevant parameters should be replaced in the expressions above as detailed in Table 4.

Table 4. Parameters associated with the area cap and the applicable parameters in prior REDD methodologies

Parameter in this module	Parameter is previously valid REDD methodology
$AD_{BSL,PA-UDef,i,t}$	VM0006: $D_{projectArea,baselineScenario,DF}(t)$ VMD0007: $A_{BSL,PA,unplanned,t}$ VM0009: $A_{B\Delta PAA}^{[m]}$ VM0015: $ABSLPA_{i,t}$ VM0037: $(LT(1-2)_{y2-y1,rate}*S_{REDD,i}$
A_i	VM0006: $area(t,CSi)$ VMD0007: $A_{unplanned,i,t}$ VM0009: A_k VM0015: $ABSLPA_i$ VM0037: $S_{REDD,i}$

A_PA-UDef	VM0006: $size_{projectArea}$
	VM0007: PA
	VM0009: PAA
	VM0015: PA
	VM0037: PA

5.3.2 Project Emissions

The key steps to be undertaken by the project proponent to estimate project emissions are summarized in Figure 2.

Figure 2: Steps to estimate project emissions

Estimate ex-ante emission reductions anticipated by the project

⬇

Determine AD per stratum per monitoring period

⬇

Multiply AD by emission factors

⬇

Sum with estimated other project emissions
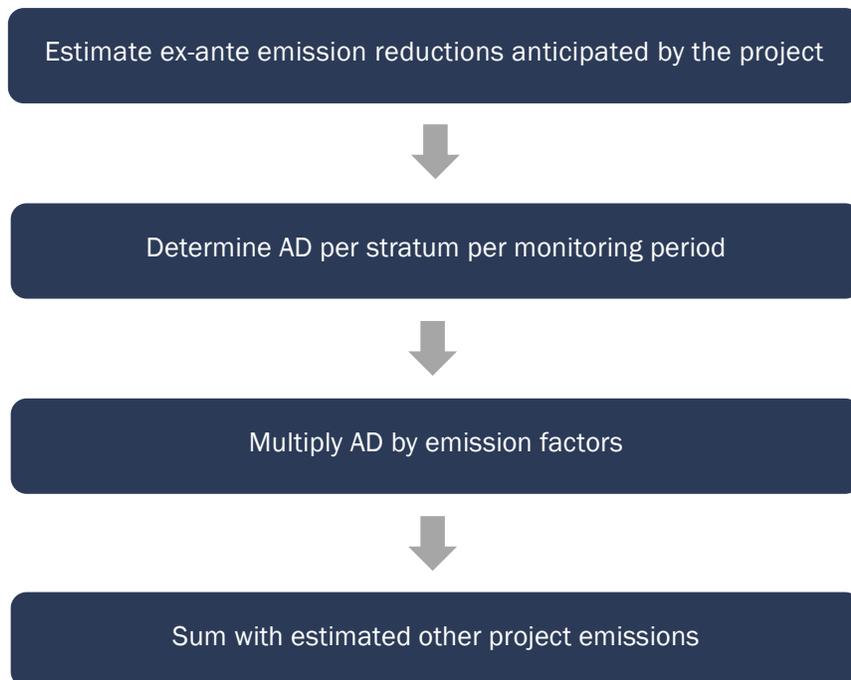
5.3.2.1 Ex Ante Estimations of Emission Reductions

Ex ante estimates must use the baseline deforestation allocation as provided by Verra and emission factors as calculated in Section 5.3.1.3. For ex ante estimation of emission reductions beyond the initial BVP, the ex ante estimation of the annual allocation is not permitted to increase and instead must be held constant (or decrease). A value for ex ante effectiveness ($EA_{EF,t}$) must be detailed for each year reflecting the percentage by which the project expects to reduce deforestation against the baseline. $EA_{EF,t}$ should be applied to estimate annual emission reductions during the project validity period. Estimated ex ante effectiveness must be consistent with the analysis of agents and drivers of deforestation (Section 5.2.3), as well as

with the measures implemented to reduce deforestation. It must not include ex ante leakage that are calculated separately (see Section 5.2.1).

5.3.2.2 UDef PA and LB Deforestation Data for the Monitoring Period

Monitoring period[9] AD must be estimated using a sample-based approach that uses human interpretation of high-resolution imagery (10 m or finer spatial resolution) within sample plots[10] distributed in a representative manner across the project activities region. Where available, in situ observations may be used to supplement the visual interpretation of sample plots. Other spatial data may be used to increase the sampling design efficiency or aid interpretation of the images. The AD must be conservatively inflated based on the estimated statistical uncertainty. A stratified sampling design must be employed that accounts for each location's baseline risk of deforestation, forest carbon stocks and inclusion in either the UDef PA or UDef LB.

Step 1: Develop a Land Cover/Land Cover Change Dataset

The sample-based method yields an estimate of the area of unplanned deforestation for the monitoring period. Standard operating procedures (SOPs) must be developed and employed and must include, at a minimum: sample design, response design and data sources, data collection and data analysis. The SOPs should also include detailed guidance on quality management during all these steps.

Collected sample data are used to identify the land cover conditions at the start and end date of the monitoring period within the UDef PA and LB and to assign a change (deforestation or forest regrowth) or no change (stable forest or stable non-forest) result to each observation.

Sample Design

Project sampling frame

Sampling takes place within the project sampling frame. The project sampling frame encompasses both the UDef PA and LB, minus any areas mapped as identified exclusions in the most recent jurisdictional map of identified exclusions. The area of the project sampling frame is denoted A_{PSF}.

Where additional areas of "identified exclusion – natural disturbance" or "identified exclusion – planned deforestation" are detected as having occurred during the monitoring period, those

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[9] Project proponents should align monitoring periods with the start and end dates of the BVP. Where a monitoring period must extend over multiple BVPs, all baseline and monitoring calculations must be undertaken and presented separately for the portion of the monitoring period that falls into each BVP.

[10] For a fuller treatment of best practices regarding plot-based AD development, see Section 4.2 of GFOI (2020). *Integration of remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests, Edition 3.0*. Available at: https://www.fs.usda.gov/rm/pubs_journals/2020/rmrs_2020_espejo_a001.pdf

areas may be spatially delineated and removed from the project sampling frame. For project monitoring, an identified exclusion must meet a minimum contiguous size of 100 ha (as opposed to 1000 ha for the jurisdiction). Descriptions of identified exclusions are provided in of Appendix 1.

Wherever such areas are delineated, the allocation of baseline AD must be set to zero (see Section 5.3.1.2).

Any carbon credits previously issued from these areas must be accounted for as a reversal.

Estimation of Project Emissions through Forest Degradation in the PA

The UDef PA must be monitored for evidence of anthropogenic forest degradation. Degradation monitoring must include two components:

1) Full evaluation of the UDef PA for the presence of new roads (defined here as continuous bare ground with a width of at least 2 m); and

2) Examination in stratified samples (see Section 5.3.2.2) for sample sites with a decrease in canopy cover of ≥50 percent but not qualifying as deforestation.

Where such areas are recorded, new degradation impact areas must be determined and delineated:

- For new roads, degradation impact areas will be determined and delineated in all instances equal to an expanse of 500 m either side of the new road.

- For recorded decreases in canopy cover of ≥50 percent but not qualifying as deforestation, the area immediately surrounding the sampling point must be examined in imagery with a resolution of 10 m or finer. Where the area over which the average canopy cover has decreased is equal to or greater than 1 ha, this area must be delineated as a degradation impact area. A decrease in canopy cover is calculated as the difference between canopy cover at the start and end of the monitored period.

These delineated areas must be withdrawn from REDD reporting for the monitored period, involves temporarily treating forest carbon stocks as zero. The areas must be treated as new strata and reincorporated once field measurement has occurred with new (decreased) emission factors for recording project emissions and future avoided unplanned deforestation emissions. When these areas are reincorporated in a subsequent monitoring period, both baseline and monitored emissions must be recalculated beginning from the first year the new forest stratum was defined, taking into account the revised emission factor and the activity data originally allocated to the stratum in the associated BVP.

Stratification

The sampling design must ensure that sample plots yield a representative sample of the UDef PA and UDef LB. A stratified sample design is required for monitoring. The following stratifications of the project sampling frame must be included:

1) Aboveground carbon stock of forests (forest strata);

2) Carbon accounting area (UDef PA or UDef LB); and

3) Likelihood of observing deforestation.

Each forest stratum used by the project for project emissions accounting must also be used as a sampling stratum. Note that Sections 5.3.2.3 and refer to cases where new forest strata may be defined within the UDef PA due to degradation events that occurred after the beginning of the monitored period. Natural (but not human-caused) large scale degradation may be similarly delineated in the UDef LB. Such forest strata must be incorporated in the sampling design for monitoring deforestation area, but the strata are omitted from emissions accounting until revised carbon stocks can be estimated.

Stratification by the anticipated likelihood of observing deforestation in sample plots must be undertaken to ensure that areas of higher deforestation risk are subject to sufficient sampling intensity. Projects should use a minimum of three sampling strata representing expected differences in the likelihood of observing deforestation. These sampling strata may be defined either by allocated baseline deforestation risk (as defined by the jurisdictional deforestation risk map), by project-generated land cover change maps of the monitoring period or by other factors that the project proponent justifies as being associated with deforestation risk.

The number of sample observations made in each sampling stratum should be sufficient such that the final estimate of deforestation has an uncertainty (defined as a half-width of the 90 percent confidence interval) that is within ±10 percent of the estimate of the mean; otherwise the estimate will be subject to conservative adjustment. Projects should demonstrate that the sample observations result in a minimum number collected from each sampling stratum, and that sample plots are allocated to strata proportionally to the total area of deforestation anticipated from each sampling stratum (area of stratum multiplied by anticipated percentage of deforestation over the monitoring period).

Data Sources

Sample data are developed through the interpretation of high-resolution imagery[11]. Maps may be employed in the design of efficient sampling strategies. Other data sources, such as airborne and spaceborne active and passive remote sensing, and ground observation, may also be used to supplement the interpreters' observation of high-resolution imagery.

Data Collection

Visual interpretation is used to assign each sample unit to a change or no-change classification. Each sample plot observation is recorded with reference to the sampling stratum (*ss*), forest stratum (*i*) and project accounting area (UDef PA and LB) in which the sample plot is

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[11] Unless otherwise stated, high-resolution imagery in this module means 10 m or finer.

located. Note that while project accounting areas and forest strata must be used as sampling strata, each retains a separate subscript in several parameters to facilitate estimation of different rates for accounting areas and forest strata (see Table 5 below).

Table 5: Example of stratum naming convention

Accounting Area	Forest Strata (i)	Risk Class	Sampling Strata (ss)
PA	Forest type A	1	PA-A-1
PA	A	2	PA-A-2
PA	A	3	PA-A-3
PA	B	1	PA-B-1
PA	B	2	PA-B-2
PA	B	3	PA-B-3
LB	A	1	LB-A-1
LB	A	2	LB-A-2
LB	A	3	LB-A-3
LB	B	1	LB-B-1
LB	…	…	…

Detailed procedures for quality management during the interpretation process must be formulated and described in the SOP for image interpretation. Typically, these procedures will include cross-validation among interpreters, at least for a subset of sample units assessed by all interpreters, and rules for dealing with disagreements on class identification between analysts. Such SOPs must include:

1) Sample plot design and spatial plot allocation to the sampling frame;

2) Data sourcing and pre-processing;

3) Visual interpretation of forest and non-forest land covers;

4) Recording dates of imagery collection;

5) Minimum qualifications of analysts, including familiarity with jurisdiction-specific land cover interpretation; and

6) Cross-checks among analysts and rules for resolving disagreements.

Data Analysis

The sample-based approach produces counts of observations of sample units within each sampling stratum (ss). Note that forest strata (i) and project accounting areas (PA and LB) are used as mandatory sampling stratification and are accounted for within the ss subscript in Equations (23) and (26).

Such sample unit counts are denoted as $Count_{CHC,ss}$ for change categories (CHC) deforestation, regrowth, stable forest and stable non-forest observed in the ss sampling strata. The total samples observed within each sampling stratum ss ($Count_{ss}$) must be summarized following the format of Table 6.

Table 6: Format for recording plot observations, with reference to associated parameter names

| Sampling Stratum (ss) | Change Categories (CHC) | | | | Stratum Total |
	Unplanned Deforestation (UDef)	Stable Forest (SF)	CHC	CHC	
$ss = 1$	$Count_{UDef,ss=1}$	$Count_{SF,ss=1}$	…	…	$Count_{ss=1}$
$ss = 2$	$Count_{UDef,ss=2}$	$Count_{SF,ss=2}$	…	…	$Count_{ss=2}$
$ss = 3$	$Count_{UDef,ss=3}$	$Count_{SF,ss=3}$	…	…	$Count_{ss=SS}$

Sampling stratum weights ws_{ss} must be calculated for the 1, 2, 3, …, SS sampling strata by dividing the mapped area of each stratum (A_{ss}) by the total area of the sampling frame (Table 7 below). Note that areas of identified exclusions are not considered part of the project sampling frame, so A_{ss} should not reflect the portions of any sampling strata that would otherwise extend into the identified excluded areas.

Table 7: Calculation of sample stratum weights

Sampling Stratum (ss)	Sampling Stratum Area (ha)	Sampling Stratum Weight (ratio)
$ss = 1$	$A_{ss=1}$	$ws_{ss=1} = A_{ss=1} / A_{PSF}$
$ss = 2$	$A_{ss=2}$	$ws_{ss=2} = A_{ss=2} / A_{PSF}$
$ss = SS$	$A_{ss=SS}$	$ws_{ss=SS} = A_{ss=SS} / A_{PSF}$

Sampling Stratum (*ss*)	Sampling Stratum Area (ha)	Sampling Stratum Weight (ratio)
Sampling strata total (*SS*)	A_{PSF}	1

Where:

A_{ss}	=	Area of sampling stratum ss in the project sampling frame (ha)
A_{PSF}	=	Area of project sample frame (ha).
ss	=	1, 2, 3, …, SS sampling stratum

The counts of sample units of change classes *CHC* (deforestation (UDef), stable forest (SF), stable non-forest (SNF) and reforest (Ref) observed within each sampling stratum ss ($Count_{CHC,ss}$), and the strata weights (ws_{ss}) are used to estimate the proportion of the area classified as each change category *CHC* ($Prop_{CHC,ss}$).

For each sampling stratum, the area-weighted proportion of the total area of each change category *CHC* must be calculated by multiplying the weight of the stratum (ws_{ss}) by the number of observations of *CHC* per sampling stratum, and by dividing by the total observation count for the respective stratum, as follows:

$$Prop_{CHC,ss} = ws_{ss} \times Count_{CHC,ss} / Count_{ss}$$

(23)

Where:

$Prop_{CHC,ss}$	=	Weighted proportion of A_{PSF} that falls into sampling stratum ss and is classified as change category *CHC* (dimensionless)
ws_{ss}	=	Weight of sampling stratum ss (dimensionless)
$Count_{CHC,ss}$	=	Count of the sample units within the project sampling frame that fall into sampling stratum ss and are classified as change category CHC (sample units)
$Count_{ss}$	=	Total count of sample units in sampling stratum *ss* (sample units)
CHC	=	Change category: unplanned deforestation (*UDef*), stable forest (*SF*), stable non-forest (*SNF*), regrowth (*Reg*)
ss	=	1, 2, 3, …, SS sampling strata

The resulting proportions must be summarized as illustrated in Table 8.

Table 8: Format for recording estimated jurisdiction proportions, with reference to associated parameter names

| Sampling Stratum (*ss*) | Change Category (CHC) | | | Stratum Total |
	Deforestation (UDef)	Stable Forest (SF)	Change Category	
Stratum 1	$Prop_{UDef,ss=1}$	$Prop_{SF,ss=1}$	...	$WS_{ss=1}$
Stratum 2	$Prop_{UDef,ss=2}$	$Prop_{SF,ss=2}$	...	$WS_{ss=2}$
Stratum SS	$Prop_{UDef,ss=SS}$	$Prop_{SF,ss=SS}$	...	$WS_{ss=3}$
CHC total	$Prop_{UDef}$	$Prop_{SF}$	...	1

Step 2: Calculate Total Area of Each AD Category

Estimate the area within the project sampling frame (monitoring case) classified under each change category *CHC*. Summation of $Prop_{CHC,ss}$ occurs across sampling strata *ss*, except those that represent either forest strata (*i*) or project accounting areas (UDef PA or LB). Note that subscripts PA/LB and *i* are excluded from previous steps in this section for clarity, but are added here to facilitate disaggregation by project accounting area and forest strata.

For UDef PA:

$$A_{PA,CHC,i} = A_{PSF} \times \sum_{ss=1}^{SS} Prop_{PA,CHC,ss}$$

(24)

Where

$A_{PA,CHC,i}$ = Area of the unplanned deforestation project area classified as change category *CHC* over the monitoring period (ha)

$Prop_{PA,CHC,i,ss}$ = Weighted proportion of $A_{PA,i}$ that falls into sampling stratum *i ss* and is classified as change category *CHC* (dimensionless)

A_{PSF} = Area of project sampling frame (ha)

CHC = Change category: unplanned deforestation (*UDef*), stable forest (*SF*), stable non-forest (*SNF*), regrowth (*Reg*)

i = 1, 2, 3, ..., *M* forest stratum

ss = 1, 2, 3, ..., SS sampling strata

For UDef LB:

$$A_{LB,CHC,i} = A_{PSF} \times \sum_{ss=1}^{SS} Prop_{LB,CHC,i,ss}$$

(25)

Where

$A_{LB,CHC,i}$	=	Area of the unplanned deforestation leakage belt classified as change category *CHC* over the monitoring period (ha)
$Prop_{LB,CHC,i,ss}$	=	Weighted proportion of $A_{LB,i}$ that falls into samping stratum *i* ss and is classified as change category *CHC* (dimensionless)
A_{PSF}	=	Area of project sampling frame (ha)
CHC	=	Change category: unplanned deforestation (*UDef*), stable forest (*SF*), stable non-forest (*SNF*), regrowth (*Reg*)
i	=	1, 2, 3, …, *M* forest stratum
ss	=	1, 2, 3, …, SS sampling strata

Estimated areas of deforestation must be conservatively inflated based on their assessed uncertainty (see Steps 3–4 below).

Step 3: Calculate the Uncertainty of the Estimated Areas of Each Change Category

Calculate the standard error of the proportions:

$$S(Prop_{CHC}) = \sqrt{\sum_{ss=1}^{SS} \frac{ws_{ss}^2 \times \frac{Count_{CHC,ss}}{Count_{ss}} \times \left(1 - \frac{Count_{CHC,ss}}{Count_{ss}}\right)}{Count_{ss} - 1}} \tag{26}$$

Where:

$S(Prop_{CHC})$	=	Standard error of the proportion of the project sampling frame in change category *CHC* (dimensionless)
$Prop_{CHC}$	=	Proportion of the proportion of the project sampling frame in change category *CHC* (dimensionless)
ws_{ss}	=	Weight of sampling stratum ss (dimensionless)
$Count_{CHC,ss}$	=	Count of the sample units within the project sampling frame that fall into sampling stratum ss and are classified as change category CHC (sample units)
$Count_{ss}$	=	Total count of sample units in sampling stratum ss (sample units)
CHC	=	Change category: unplanned deforestation (*UDef*), stable forest (*SF*), stable non-forest (*SNF*), regrowth (*Reg*)
ss	=	1, 2, 3, …, SS sampling strata

Calculate the standard error of the areas:

$$S(A_{CHC}) = S(Prop_{CHC}) \times A_{PSF} \tag{27}$$

Where:

$S(A_{CHC})$ = Standard error of the estimated area of change category *CHC* within the project sampling frame over the monitoring period (ha)

$S(Prop_{CHC})$ = Standard error of the proportion of the project sampling frame in change category *CHC* (dimensionless)

A_{PSF} = Area of project sampling frame (ha)

CHC = Change category: unplanned deforestation (*UDef*), stable forest (*SF*), stable non-forest (*SNF*), regrowth (*Reg*)

Calculate the percentage uncertainty of the estimated area. The percentage uncertainty is defined as the half-width of the two-sided 90 percent confidence interval, expressed as a percentage of the estimated area.

$$U\%(A_{CHC}) = t_{alpha=10\%} \times \frac{S(A_{CHC})}{\sum_{i=1}^{M} A_{PA,CHC,i} + \sum_{i=1}^{M} A_{LB,CHC,i}} \times 100 \tag{28}$$

Where:

$U\%(A_{CHC})$ = Percentage uncertainty of the estimated area of change category *CHC* within the project sampling frame over the monitoring period (%)

$S(A_{CHC})$ = Standard error of the estimated area of change category *CHC* within the project sampling frame over the monitoring period (ha)

$A_{PA,CHC,i}$ = Area of the unplanned deforestation project area classified as change category *CHC* over the monitoring period (ha)

$A_{LB,CHC,i}$ = Area of the unplanned deforestation leakage belt classified as change category *CHC* over the monitoring period (ha)

$t_{alpha=10\%}$ = Value of the t-distribution for a two-sided 90 percent confidence interval (a value of 1.6449 may be used for activity data analyses)

CHC = Change category: unplanned deforestation (*UDef*), stable forest (*SF*), stable non-forest (*SNF*), regrowth (*Reg*)

i = 1, 2, 3, …, *M* forest stratum

Step 4: Conservatively Inflate the Estimated Area of Unplanned Deforestation

The estimated total area of unplanned deforestation (*CHC* = UDef) within the project sampling frame is inflated based on its uncertainty level. Where the percentage uncertainty of the estimated unplanned deforestation area is less than or equal to 10 percent, the estimate may be used without modification, and the inflation factor is 0. Where the percentage uncertainty is greater than 10 percent[12] the area estimate must be scaled up by inflation factor *IF*$_{UDef}$.

The inflation factor, *IF* is calculated as follows:

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[12] Uncertainty may not exceed the maximum acceptable uncertainty as set by the VCS Program.

$$IF_{UDef} = \frac{U\%\left(A_{UDef}\right)}{100 \times t_{alpha=10\%}} \times t_{alpha=66.66\%}$$

(29)

Where:

IF_{UDef} = Inflation factor for unplanned deforestation area (%)

$U\%(A_{UDef})$ = Percentage uncertainty of the estimated area of unplanned deforestation (where CHC=UDef) within the project sampling frame over the monitoring period (%)

$t_{alpha=10\%}$ = Value of the t-distribution for a two-sided 90 percent confidence interval (a value of 1.6449 may be used for activity data analyses)

$t_{alpha=66.6\%}$ = Value of the t-distribution for a one-sided 66.66% confidence interval (a value of 0.4307 may be used for activity data analyses)

Using the estimated area and the inflation factors, calculate the final AD values for UDef PA:

$$A_{PA,inflated,UDef,i} = A_{PA,UDef,i} \times \left(1 + IF_{UDef}\right)$$

(30)

Where:

$A_{PA,inflated,UDef,i}$ = Area of unplanned deforestation within forest stratum *i* of the project area over the monitoring period, conservatively inflated for uncertainty (ha)

$A_{PA,UDef,i}$ = Uninflated area of unplanned deforestation (*where CHC=UDef*) within forest stratum *i* within the project area over the monitoring period (ha)

IF_{UDef} = Inflation factor for unplanned deforestation area (%)

i = 1, 2, 3, …, *M* forest stratum

Using the estimated area and the inflation factors, calculate the final AD values for UDef LB:

$$A_{LB,inflated,UDef,i} = A_{LB,UDef,i} \times \left(1 + IF_{UDef}\right)$$

(31)

Where:

$A_{LB,inflated,UDef,i}$ = Area of unplanned deforestation within forest stratum *i* of the leakage belt over the monitoring period, conservatively inflated for uncertainty (ha)

$A_{LB,UDef,i}$ = Uninflated area of unplanned deforestation (*where CHC=UDef*) within forest stratum *i* within the leakage belt over the HRP (ha)

IF_{UDef} = Inflation factor for unplanned deforestation area (%)

i = 1, 2, 3, …, *M* forest stratum

Step 5: Determine the AD for Unplanned Deforestation

The annualized emissions per stratum in the UDef PA and UDef LB are equal to AD calculated for the monitoring period divided by the number of years in the monitoring period (termed MPL).

For UDef PA:

$$AD_{MP,PA-UDef,i,t} = \frac{A_{PA,inflated,UDef,i}}{MPL}$$

(32)

Where:

$AD_{MP,PA-UDef,i,t}$	=	Unplanned deforestation activity data in the unplanned deforestation project area in forest stratum *i* in year *t* (ha)
$A_{PA,inflated,UDef,i}$	=	Area of unplanned deforestation within forest stratum *i* of the project area over the monitoring period, conservatively inflated for uncertainty (ha)
MPL	=	Length of monitoring period (years)
t	=	1, 2, 3, …, *t** years elapsed since the start of the unplanned deforestation project
i	=	1, 2, 3, …, *M* forest stratum

For UDef LB:

$$AD_{MP,LB-UDef,i,t} = \frac{A_{LB,inflated,UDef,i}}{MPL}$$

(33)

Where:

$AD_{MP,LB-UDef,i,t}$	=	Unplanned deforestation activity data in the unplanned deforestation leakage belt in forest stratum *i* in year *t* (ha)
$A_{LB,inflated,UDef,i}$	=	Area of unplanned deforestation within forest stratum *i* of the leakage belt over the monitoring period, conservatively inflated for uncertainty (ha)
MPL	=	Length of monitoring period (years)
t	=	1, 2, 3, …, *t** years elapsed since the start of the unplanned deforestation project
i	=	1, 2, 3, …, *M* forest stratum

5.3.2.3 Estimation of Carbon Stock Changes per Stratum

Emissions resulting from deforestation in the project case must be estimated using the same conservatively discounted estimates of carbon stock differences established for the baseline scenario (Section 5.3.1.3). However, in the event of a large-scale natural disturbance that does not result in a transition to non-forest, additional forest strata may be defined.

5.3.2.4 Estimation of Annual Emissions from Carbon Stock Changes

Changes in carbon stocks in the project case must be estimated using the same conservatively discounted estimates of carbon stock differences that were established for the baseline (Section 5.3.1.3).

Aboveground biomass, belowground biomass, dead wood and litter carbon pools are assumed to be emitted at the time of deforestation. Following deforestation, emissions from SOC and wood products are assumed to occur over time at an annual rate of 1/20 of the stock change. Thus, for a given year t, emissions for SOC and wood products are summed across areas of each land use transition class from time $t = 1$ (i.e., start of baseline validity period) to time t^* (the year for which emissions are to be estimated).

For carbon pools in UDef project activities:

$$
\begin{aligned}
\Delta C_{MP,PA-UDef,i,t} \\
&= (AD_{MP,PA-UDef,i,t} \times \Delta Cc_{MP,AB-LI,i}) \\
&+ \frac{1}{10} \times \sum_{t-10}^{t} (AD_{MP,PA-UDef,i,t} \times \Delta Cc_{MP,BB-DW,i,t}) \\
&+ \frac{1}{20} \times \sum_{t-20}^{t} (AD_{MP,PA-UDef,i,t} \times \Delta Cc_{MP,SOC\_WP,i,t})
\end{aligned}
\tag{34}
$$

Where:

$\Delta C_{MP,PA-UDef,i,t}$	=	Total emissions from carbon stock change in all pools in forest stratum i in the unplanned deforestation project area in year t (t CO$_2$e)
$AD_{MP,PA-UDef,i,t}$	=	Unplanned deforestation activity data in the unplanned deforestation project area in forest stratum i in year t (ha) (ha)
$\Delta Cc_{MP,AB-LI,i}$	=	Conservatively estimated emissions from annual carbon stock change in the unplanned deforestation project area in aboveground biomass and litter pools in forest stratum i in year t (t CO$_2$e ha^{-1})
$\Delta Cc_{MP,BB-DW,i,t}$	=	Conservatively estimated emissions from annual carbon stock change in the unplanned deforestation project area in belowground biomass and dead wood pools in forest stratum i in year t (t CO$_2$e ha^{-1})
$\Delta Cc_{MP,SOC\_WP,i,t}$	=	Conservatively estimated emissions from carbon stock change over a 20-year period in the unplanned deforestation project area in the soil organic carbon and wood products pools in forest stratum i in year t (t CO$_2$e ha^{-1})
i	=	1, 2, 3, …, M forest stratum
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

For carbon pools in UDef LB:

$$
\begin{aligned}
\Delta C_{MP,LB-UDef,i,t} &= (AD_{MP,LB-UDef,i,t} \times \Delta C_{MP,LB,AB-LI,i}) \\
&+ \frac{1}{10} \times \sum_{t-10}^{t} (AD_{MP,LB-UDef,i,t} \times \Delta C_{MP,LB,BB-DW,i,t}) \\
&+ \frac{1}{20} \times \sum_{t-20}^{t} (AD_{MP,LB-UDef,i,t} \times \Delta C_{MP,LB,SOC\_WP,i,t})
\end{aligned}
\tag{35}
$$

Where:

$\Delta C_{MP,LB\text{-}UDef,t}$	=	Total emissions from carbon stock change in all pools in the unplanned deforestation leakage belt in year t (t CO$_2$e)
$\Delta C_{MP,LB\text{-}UDef,i,t}$	=	Total emissions from carbon stock change in all pools in forest stratum i in the unplanned deforestation leakage belt in year t (t CO$_2$e)
$AD_{MP,LB\text{-}UDef,i,t}$	=	Unplanned deforestation activity data in the unplanned deforestation leakage belt in forest stratum i in year t (ha)
$\Delta C_{MP,LB,AB\text{-}LI,i}$	=	Estimated emissions from annual carbon stock change in the unplanned deforestation leakage belt in aboveground biomass and litter pools in forest stratum i in year t (t CO$_2$e ha^{-1})
$\Delta C_{MP,LB,BB\text{-}DW,i}$	=	Estimated emissions from annual carbon stock change in the unplanned deforestation leakage belt in belowground biomass and dead wood pools in forest stratum i in year t (t CO$_2$e ha^{-1})
$\Delta C_{MP,LB,SOC\_WP,i,t}$	=	Estimated emissions from carbon stock change over a 20-year period in the in the unplanned deforestation leakage belt soil organic carbon and wood products pools in forest stratum i in year t (t CO$_2$e ha^{-1})
i	=	1, 2, 3, …, M forest stratum
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

For total emissions from carbon stock change in UDef PA:

$$
\Delta C_{MP,PA-UDef,t} = \sum_{i=1}^{M} \Delta C_{MP,PA-UDef,i,t}
\tag{36}
$$

Where:

$\Delta C_{MP,PA\text{-}UDef,t}$	=	Total emissions from carbon stock change in all pools in the unplanned deforestation project area in year t (t CO$_2$e)
$\Delta C_{MP,PA\text{-}UDef,i,t}$	=	Total emissions from carbon stock change in all pools in forest stratum i in the unplanned deforestation project area in year t (t CO$_2$e)

| i | = | 1, 2, 3, …, M forest stratum |
| t | = | 1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project |

For total emissions from carbon stock change in UDef LB :

$$\Delta C_{MP,LB-UDef,t} = \sum_{i=1}^{M} \Delta C_{MP,LB-UDef,i,t} \tag{37}$$

Where:

$\Delta C_{MP,LB-UDef,t}$	=	Total emissions from carbon stock change in all pools in the unplanned deforestation leakage belt in year t (t CO_2e)
$\Delta C_{MP,LB-UDef,i,t}$	=	Total emissions from carbon stock change in all pools in forest stratum i in the unplanned deforestation leakage belt in year t (t CO_2e)
i	=	1, 2, 3, …, M forest stratum
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

5.3.2.5 Estimation of Other Greenhouse Gas Emissions

Any other GHG emissions that occur due to project activities in the UDef PA must be estimated using the following equation:

$$GHG_{MP\_PA-UDef,E}$$
$$= \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(E_{MP,FC,i,t} + E_{MP,BiomassBurn,i,t} \right.$$
$$\left. + N_2 O_{MP,direct-N,i,t} \right) \tag{38}$$

Where:

| $GHG_{MP\_PA-UDef,E}$ | = | Cumulative other greenhouse gas emissions as a result of unplanned deforestation activities in the unplanned deforestation project area in year t (t CO_2e) |
| $E_{MP,FC,i,t}$ | = | Net monitored emissions from fossil fuel combustion in forest stratum i in year t (t CO_2e) |

$E_{MP,BiomassBurn,i,t}$ = Non-CO_2 monitored emissions due to biomass burning as part of unplanned deforestation activities in forest stratum i in year t (t CO_2e)

$N_2O_{MP,direct-N,i,t}$ = Direct monitored N_2O emission as a result of nitrogen application on an alternative land use in forest stratum i in year t (t CO_2e)

i = 1, 2, 3, ..., M forest stratum

t = 1, 2, 3, ..., t^* years elapsed since the start of the unplanned deforestation project

5.3.2.6 Estimated Net Project Emissions

The net project emissions for UDef PA are then calculated as:

$$\Delta C_{MP,PA-UDef,t} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(\Delta C_{MP,PA-UDef,i,t} \right) + GHG_{MP\_PA-UDef,E}$$

(39)

Where:

$\Delta C_{MP\_PA-UDef,t}$ = Cumulative net greenhouse gas emissions in the unplanned deforestation project area in year t (t CO_2e)

$\Delta C_{MP,PA-UDef,i,t}$ = Total emissions from carbon stock change in all pools in forest stratum i in the unplanned deforestation project area in year t (t CO_2e)

$GHG_{MP\_PA-UDef,E}$ = Cummulative other greenhouse gas emissions as a result of unplanned deforestation activities in the unplanned deforestation project area up to year t (t CO_2e)

i = 1, 2, 3, ..., M forest stratum

t = 1, 2, 3, ..., t^* years elapsed since the start of the unplanned deforestation project

The net project emissions for UDef LB are then calculated as:

$$\Delta C_{MP,LB-UDef,t} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(\Delta C_{MP,LB-UDef,i,t} \right)$$

(40)

Where:

$\Delta C_{MP\_LB-UDef,t}$ = Cumulative greenhouse gas emissions in the unplanned deforestation leakage belt in year t (t CO_2e)

$\Delta C_{MP,LB-UDef,i,t}$ = Total emissions from carbon stock change in all pools in forest stratum i in the unplanned deforestation leakage belt in year t (t CO_2e)

i	=	1, 2, 3, …, *M* forest stratum
t	=	1, 2, 3, …, *t** years elapsed since the start of the unplanned deforestation project

5.3.3   Leakage

Four types of leakage must be assessed:

1) Activity shifting by geographically mobile agents;

2) Activity shifting by geographically constrained agents;

3) Market-effects leakage; and

4) Leakage prevention emissions.

Emissions from these sources are summed to yield an estimate of the total leakage emissions for the UDef activity over the monitoring period.

- Leakage due to activity shifting by geographically mobile agents is estimated on the basis of:
  a) The net reduction (displacement) of deforestation from the baseline to the end of the monitoring period within the combined area of the PA and LB;
  b) The proportion of geographically mobile agents of deforestation projected in the baseline;
  c) The proportion of internal migration resulting in settlement in urban areas; and
  d) Area-weighted emission factors for areas accessible to geographically mobile deforestation agents outside of the UDef LB.

- **Leakage due to activity shifting by geographically constrained agents** is monitored within the LB. Baseline unplanned deforestation allocated within the LB is compared to the deforestation monitored ex post*.*

- **Market-effects leakage** occurs where in the baseline case commodities were produced for regional, national or international markets. Market-effects leakage is estimated using module *LK-ME*.

- **Emissions due to leakage prevention activities** correspond to non-CO_2 GHG emissions from biomass burning or fertilizer use, and must be quantified.

5.3.3.1 Roles in Development of Leakage Estimates

The procedures to estimate leakage rely on a combination of data and steps to be taken by the Verra and the project proponent (Table 9 below). Processes and criteria to develop jurisdictional data are described in Appendix 1.

Table 9: Roles in development of leakage estimate

Step	Responsible	Frequency
Definition of LB (UDef LB) boundaries	Verra (UDef LB to be adjusted by the project proponent where applicable – see Section 5.1.3)	Once prior to start of each jurisdictional BVP
Definition of jurisdictional emission factor for areas outside the LB subject to deforestation from activity shifting by geographically mobile agents	Verra	Once prior to start of each jurisdictional BVP
Assessing emissions from activity shifting due to displacement of unplanned deforestation to the LB	Project proponent	Once per monitoring event
Assessing emissions from activity shifting due to displacement of unplanned deforestation to areas outside the LB	Project proponent	Once per monitoring event
Assessing emissions from leakage prevention activities	Project proponent	Once per monitoring event
Estimation of total leakage due to the displacement of unplanned deforestation	Project proponent	Once per monitoring event

Figure 3 summarizes the key leakage estimation steps to be undertaken by the project proponent.

Figure 3: Leakage estimation steps

| Estimate leakage by geographically constrained agents |
| Estimate leakage by geographically mobile agents |
| Estimate market-effects leakage |
| Sum with emissions from leakage prevention activities |
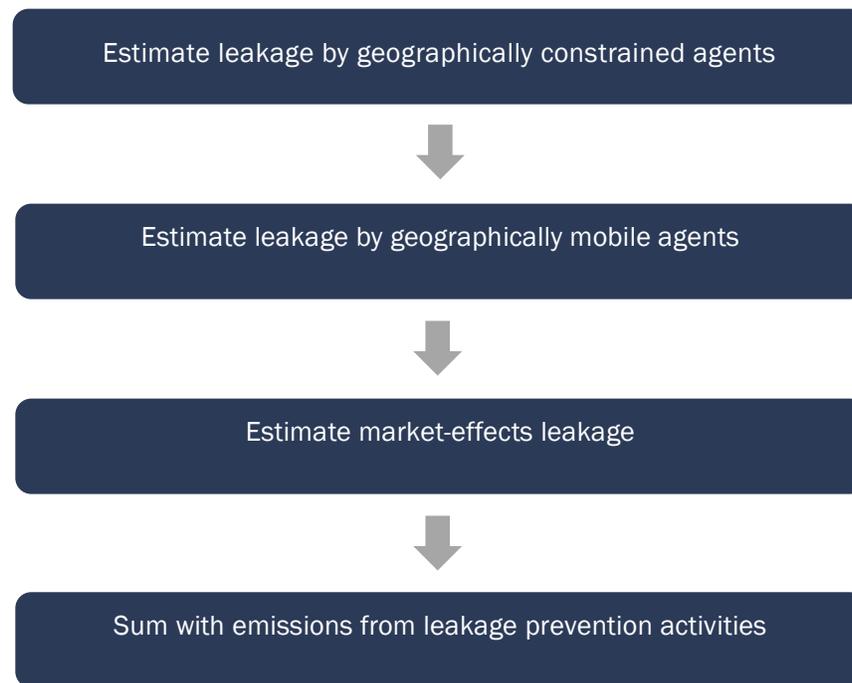
5.3.3.2 Ex ante Estimation of Leakage

Ex ante, activity displacement leakage may only be estimated based on the anticipated combined effectiveness of the proposed leakage prevention measures and project activities.

This must be done by multiplying the estimated baseline carbon stock changes for the UDef PA by a "displacement leakage factor" (DLF) representing the percentage of deforestation expected to be displaced outside the project boundary. Where deforestation agents identified in Section 5.2.1 do not participate in and/or benefit from leakage prevention measures, the displacement factor is 100 percent. Where leakage prevention activities are implemented, the factor is equal to the proportion of the baseline agents estimated to be given the opportunity to participate in leakage prevention activities and project activities.

Where emissions from forest fires have been included in the baseline, the ex ante emissions from forest fires due to activity displacement leakage will be calculated by multiplying baseline forest fire emissions in the PA by the same DLF used to estimate the decrease in carbon stocks.

5.3.3.3 Emissions From Displacement of Geographically Constrained Activities in the LB

Net Carbon Stock Difference in the LB During the Monitoring Period Versus the Baseline Scenario

The difference in carbon stocks between the baseline scenario and the monitoring period within the LB since the project start date to year t is calculated as $\Delta C_{LK\text{-}net\text{-}LB}$.

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

$$\Delta C_{LK-net-LB} = \Delta C_{BSL,LB-UDef,t} - \Delta C_{MP,LB-UDef,t} \tag{41}$$

Where:

$\Delta C_{LK\text{-}net\text{-}LB,t}$ = Difference in cumulative net greenhouse gas emissions between the baseline and monitoring period within the unplanned deforestation leakage belt due to unplanned deforestation in year t (t CO_2e)

$\Delta C_{BSL,LB\text{-}UDef,t}$ = Cumulative net greenhouse gas emissions in the baseline within the unplanned deforestation leakage belt since project start in year t (t CO_2e)

$\Delta C_{MP,LB\text{-}UDef,t}$ = Cumulative net monitored greenhouse gas emissions within the unplanned deforestation leakage belt since project start in year t (t CO_2e)

t = 1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

Other Deforestation Emissions Within the LB During the Monitoring Period

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

Fossil-fuel related and non-CO_2 greenhouse gas emissions per unit area resulting from land cover transition in the UDef LB are assumed to equal those estimated for the baseline period in the UDef PA. These emissions are calculated by summing the total emissions over the baseline period for each forest stratum across the UDef PA and then dividing this by the sum of AD per forest stratum and land cover transition over the baseline period using Equation (42). These average emissions per unit area are then applied to the difference in AD between the baseline and monitoring period within the UDef LB in Equation (42).

$$GHG_{LB,E,i,t} = \frac{\sum_{t=1}^{t*} \left(E_{BSL,FC,i,t} + E_{BSL,BiomassBurn,i,t} + N_2O_{BSL,direct-N,i,t} \right)}{\sum_{t=1}^{t*} AD_{BSL,PA-UDef,i,t}} \tag{42}$$

Where:

$GHG_{LB,E,i,t}$	=	Annual per hectare other greenhouse gas emissions in the leakage belt as a result of deforestation activities in forest stratum i in year t (t CO_2e ha^{-1})
$AD_{BSL,PA-UDef,i,t}$	=	Unplanned deforestation activity data in the baseline scenario allocated to forest stratum i in the unplanned deforestation project area in the baseline validity period associated with year t (ha y^{-1})
$E_{BSL,FC,i,t}$	=	Net emissions from fossil fuel combustion in forest stratum i in year t (t CO_2e)
$E_{BSL,BiomassBurn,i,t}$	=	Non-CO_2 emissions due to biomass burning as part of unplanned deforestation activities in forest stratum i in year t (t CO_2e)
$N_2O_{BSL,direct-N,i,t}$	=	Direct N_2O emission as a result of nitrogen application on an alternative land use in forest stratum i in year t (t CO_2e)
i	=	1, 2, 3, …, M forest stratum
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

$$GHG_{MP,LK-UDef,E,t} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(\left(AD_{BSL,LB-UDef,i,t} - AD_{MP,LB-UDef,i,t} \right) \times GHG_{LB,E,i,t} \right) \tag{43}$$

Where:

$GHG_{MP,LK-UDef,E,t}$	=	Cumulative other greenhouse gas emissions as a result of unplanned deforestation within the unplanned deforestation leakage belt during the monitoring period in year t (t CO_2e)
$AD_{BSL,LB-UDef,i,t}$	=	Unplanned deforestation activity data in the baseline scenario allocated to forest stratum i in the unplanned deforestation leakage belt in the baseline validity period associated with year t (ha y^{-1})
$AD_{MP,LB-UDef,i,t}$	=	Unplanned deforestation activity data in the unplanned deforestation leakage belt in forest stratum i in year t (ha)
$GHG_{LB,E,i,t}$	=	Annual per-hectare other greenhouse gas emissions in the leakage belt as a result of deforestation activities in forest stratum i in year t; t CO_2-e ha^{-1}
i	=	1, 2, 3, …, M forest stratum
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

Net GHG Emissions Within the LB During the Monitoring Period

The net greenhouse gas emissions are summed for the LB as:

$$\Delta C_{LK,LB,t} = \Delta C_{LK-net-LB,t} + GHG_{MP,LK-UDef,E,t}$$

(44)

Where:

$\Delta C_{LK,LB,t}$	=	Cumulative net greenhouse gas leakage emissions within the unplanned deforestation leakage belt during the monitoring period in year t (t CO_2e)
$\Delta C_{LK-net-LB,t}$	=	Difference in cumulative net greenhouse emissions between the baseline and monitoring period within the unplanned deforestation leakage belt due to unplanned deforestation in year t (t CO_2e)
$GHG_{MP,LK-UDef,E,t}$	=	Cumulative other greenhouse gas emissions as a result of unplanned deforestation within the unplanned deforestation leakage belt during the monitoring period in year t (t CO_2e)
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

5.3.3.4 Emissions from Activity Shifting Due to Displacement of Unplanned Deforestation to Areas Outside the LB

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

Randomly sample households within two km of or inside the UDef PA to determine the proportion that meets the following criteria:

1) Migrated into the area within the last five years; and

2) Engages in land use activities identified as a baseline driver of deforestation.

The proportion of sampled households meeting these criteria is termed $PROP_{IMM}$.

The minimum sample size must be at least 200 households. Where the total number of households is less than 250, the sample size must be at least 80 percent of the households. For sampling requirements, refer to the latest version of *Guideline: Sampling and surveys for CDM project activities and programmes of activities*.[13]

This assessment must be repeated within two years prior to the start of each new BVP and the estimated proportions will be assumed to remain constant for the BVP.

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[13] Available at: https://cdm.unfccc.int/sunsetcms/storage/contents/stored-file-20151023152925068/Meth_GC48_%28ver04.0%29.pdf

Total Area of Activity Shifting to Outside the LB

It is conservatively assumed that geographically mobile agents of unplanned deforestation recently settled in the PA are primarily driven by a need to secure agricultural land. The amount of leakage to areas outside the LB is taken as the total area of avoided land cover transition in the PA, scaled by the proportion of recent immigrants ($PROP_{IMM}$).

$$AD_{AS-OLB,t} = PROP_{IMM,t} \times \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(AD_{BSL,PA-UDef,i,t} - AD_{MP,PA-UDef,i,t} \right) \quad (45)$$

Where:

$AD_{AS\text{-}OLB,t}$	=	Cumulative area outside the leakage belt experiencing land cover conversion due to activity shifting in year t (ha)
$PROP_{IMM,t}$	=	Proportion of households living in the project activities region that are recent migrants and are engaging in land use activities identified as a baseline driver of unplanned deforestation, as calculated for the baseline validity period associated with year t (proportion)
$AD_{BSL,PA\text{-}UDef,i,t}$	=	Unplanned deforestation activity data in the baseline scenario allocated to forest stratum i in the unplanned deforestation project area in the baseline validity period associated with year t (ha y^{-1})
$AD_{MP,PA\text{-}UDef,i,t}$	=	Unplanned deforestation activity data in the unplanned deforestation project area in forest stratum i in year t (ha)
i	=	1,2,3, …, M forest stratum
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

Where, at any point in time, $\sum_{t=1}^{t} AD_{AS-OLB,t} \geq A_{Available}$ [14], then $AD_{AS\text{-}OLB,t}$ will be equal to zero for the remainder of the baseline validity period.

Emissions from Activity Shifting to Areas Outside the LB

The area of deforestation that is displaced from the PA ($AD_{AS\text{-}OLB,t}$) is assumed to result in land cover conversion of an equal extent outside the LB.

$$\Delta C_{LK,OLB,t} = AD_{AS-OLB,t} \times \Delta C_{OLB} \quad (46)$$

Where:

---

[14] $A_{Available}$ is the area potentially available for outside leakage belt activity shifting and is determined by Verra (see Appendix 2).

$\Delta C_{LK,OLB,t}$ = Cumulative total emissions from carbon stock change due to activity shifting to areas available outside the leakage belt in year t (t CO_2e)

$AD_{AS\text{-}OLB,t}$ = Cumulative area outside the leakage belt experiencing land cover transition due to activity shifting in year t (ha)

$\Delta C_{OLB,t}$ = Emissions from carbon stock change due to land cover transition in areas available for activity shifting outside the leakage belt, as calculated for the baseline validity period associated with year t (t CO_2e ha^{-1})

t = 1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

5.3.3.5 Estimation of Total Leakage from Displacement of Unplanned Deforestation

Total activity shifting leakage emissions are the sum of leakage from within and outside the LB. Where total leakage is calculated to be less than zero, $\Delta C_{LKAS,t}$ is assigned a value of zero.

$$\Delta C_{LK\text{-}AS,t} = \Delta C_{LK,LB,t} - \Delta C_{LK,OLB,t}$$

(47)

Where:

$\Delta C_{LK\text{-}AS,t}$ = Cumulative net greenhouse gas leakage emissions due to the displacement of unplanned deforestation activities in year t (t CO_2e)

$\Delta C_{LK,LB,t}$ = Cumulative net greenhouse gas leakage emissions within the unplanned deforestation leakage belt during the monitoring period in year t (t CO_2e)

$\Delta C_{LK,OLB,t}$ = Cumulative total emissions from carbon stock change due to activity shifting to areas available outside the leakage belt in year t (t CO_2e)

t = 1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

5.3.3.6 Emissions from Market-Effects Leakage

Where deforestation in the baseline involves wood harvesting for commercial markets (timber, fuel wood or charcoal), emissions from market-effects leakage must be estimated using module *LK-ME*, resulting in parameter $\Delta C_{LK\text{-}ME,t}$.

5.3.3.7 Emissions from Leakage Prevention Activities

Leakage prevention activities must be implemented. Where such activities result in significant increase in emissions from carbon stock changes, biomass burning and increased fertilizer usage, they must be counted and conservatively included in their entirety as emissions caused by project implementation.

The project description must list the planned leakage prevention measures, locate them (i.e., define leakage management areas) and identify areas where leakage prevention measures will impact carbon stocks. For these areas, calculate the net carbon stock changes in above and

belowground tree biomass that the planned leakage prevention measures are expected to cause during the fixed baseline period using conservative growth projections.

- Where the net sum of carbon stock changes within the leakage management areas over the monitoring period is more than zero, the net increase is conservatively ignored in the calculation of net GHG emission reductions of the UDef project activity.

- Where the net sum is negative and for emissions associated with biomass burning and fertilizer usage, determine the significance using T-SIG. Where the emission is significant, it may be accounted in the ex ante estimation of leakage, and emissions in the land units where leakage prevention measures are implemented will be subject to monitoring, reporting and verification (MRV). Where the emission is not significant, it is not accounted and carbon stock changes in the LMA will not be subject to MRV.

$$GHG_{LK,E,t} = \sum_{t=1}^{t^*} \sum_{i=1}^{M} \big(E_{Cstocks,LMA,t} + E_{MP,FC,i,t} + E_{MP,BiomassBurn,i,t} + N_2O_{MP,direct-N,i,t} \big)$$

(48)

Where:

$GHG_{LK,E,t}$	=	Cumulative other greenhouse gas emissions as a result of leakage prevention activities in year t (t CO$_2$e)
$E_{Cstocks,LMA,t}$	=	Net CO$_2$e emissions from carbon stock changes in live above and belowground tree biomass in the leakage management area resulting from the implementation of leakage prevention measures in year t (t CO$_2$e)
$E_{MP,FC,i,t}$	=	Net monitored emissions from fossil fuel combustion in forest stratum i in year t (t CO$_2$e)
$E_{MP,BiomassBurn,i,t}$	=	Non-CO$_2$ monitored emissions due to biomass burning as part of unplanned deforestation activities in forest stratum i in year t (t CO$_2$e)
$N_2O_{MP,direct-N,i,t}$	=	Direct N$_2$O monitored emissions as a result of nitrogen application on an alternative land use in stratum i in year t (t CO$_2$e)
i	=	1, 2, 3, …, M forest stratum
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

5.3.3.8 Estimation of Summed Leakage Emissions

Total leakage emissions are equal to the summed emissions from activity shifting, market effects and GHG emissions associated with leakage prevention activities.

$$\Delta C_{LK-UDef,t} = \Delta C_{LK-AS,t} - \Delta C_{LK-ME,t} - GHG_{LK,E,t}$$

(49)

Where:

$\Delta C_{LK\text{-}UDef,t}$	=	Cumulative net greenhouse gas emissions due to leakage from the unplanned deforestation project activity in year t (t CO_2e)
$\Delta C_{LK\text{-}AS,t}$	=	Cumulative net greenhouse gas leakage emissions due to the displacement of unplanned deforestation activities in year t (t CO_2e)
$\Delta C_{LK\text{-}ME,t}$	=	Cumulative net greenhouse gas emissions due to market-effects leakage in year t, from module $LK\text{-}ME$ (t CO_2e)
$GHG_{LK,E,t}$	=	Cumulative other greenhouse gas emissions as a result of leakage prevention activities in year t (t CO_2e)
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

5.3.4 Net GHG Emission Reductions and Removals

The project proponent must present conservative ex ante estimations of the total net GHG emissions reductions of the project activity.

For ex ante estimations of specific parameters, refer to the parameter tables in the appropriate modules.

The total net GHG emissions reductions of the avoiding UDef project activity are calculated as follows:

$$NER_{UDef,t} = \Delta C_{BSL,PA-UDef,t} - \Delta C_{MP,PA-UDef,t} - \Delta C_{LK-UDef,t} \qquad (50)$$

Where:

$NER_{UDef,t}$	=	Cumulative total net greenhouse gas emission reductions of the unplanned deforestation project activity in year t (t CO_2e)
$\Delta C_{BSL,PA\text{-}UDef,t}$	=	Cumulative net greenhouse gas emissions in the baseline within the unplanned deforestation project area in year t (t CO_2e)
$\Delta C_{MP,PA\text{-}UDef,t}$	=	Total emissions from carbon stock change in all pools in the unplanned deforestation project area in year t (t CO_2e)
$\Delta C_{LK\text{-}UDef,t}$	=	Cumulative net greenhouse gas emissions due to leakage from the unplanned deforestation project activity in year t (t CO_2e)
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

5.3.4.1 Calculation of AFOLU Pooled Buffer Account Contribution

The number of credits to be held in the AFOLU pooled buffer account is determined as a percentage of the total carbon stock benefits. For UDef project activities, this is equal to the net emissions in the baseline minus emissions from fossil fuel use and fertilizer use, minus the net emissions in the project case minus emissions from fossil fuels and fertilizer use. Leakage emissions do not factor into the buffer calculations.

$$Buffer_{Total,t} = (\Delta C_{BSL-UDef,t} - \Delta C_{MP,PA-UDef,t}) \times Buffer\%$$

(51)

Where:

$Buffer_{Total,t}$	=	Cumulative total permanence risk buffer withholding in year t (t CO_2e)
$\Delta C_{BSL-UDef,t}$	=	Cumulative net greenhouse gas emissions in the unplanned deforestation baseline scenario in year t (t CO_2e)
$\Delta C_{MP,PA-UDef,t}$	=	Total emissions from carbon stock change in all pools in the unplanned deforestation project area in year t (t CO_2e)
$Buffer\%$	=	Buffer withholding percentage, from VCS AFOLU Non-Permanence Risk Tool (%)
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

5.3.4.2 Calculation of Verified Carbon Units

To calculate the number of Verified Carbon Units (VCUs) in years in which monitoring has been conducted and submitted for verification, this methodology uses the following equation:

$$VCU_{AUDef,t} = (NER_{UDef,t} - NER_{UDef,t-1})$$
$$- (Buffer_{Total,t} - Buffer_{Total,t-1})$$

(52)

Where:

$VCU_{AUDef,t}$	=	Number of Verified Carbon Units generated in year t (VCU)
$NER_{UDef,t}$	=	Cumulative total net GHG emission reductions of the unplanned deforestation project activity in year t (t CO_2e)
$NER_{UDef,t-1}$	=	Cumulative total net GHG emission reductions of the unplanned deforestation project activity in year t-1 (t CO_2e)
$Buffer_{Total,t}$	=	Cumulative total permanence risk buffer withholding in year t (t CO_2e)
$Buffer_{Total,t-1}$	=	Cumulative total permanence risk buffer withholding in year t-1 (t CO_2e)
t	=	1, 2, 3, …, t^* years elapsed since the start of the unplanned deforestation project

Where this equation results in a decimal number, the number must be rounded down.

6 DATA AND PARAMETERS

6.1 Data and Parameters Available at Validation

Data/Parameter	$A_{PA\text{-}UDef}$
Data unit	ha
Description	Area of project where activities aimed at avoiding unplanned deforestation will take place
Equations	Section 5.3.1.6
Source of data	Calculated within a GIS
Value applied	To be determined by project
Justification of choice of data or description of measurement methods and procedures applied	Accuracy of mapped coordinates must be demonstrated
Purpose of data	Calculation of project emissions
Comments	None

Data/Parameter	AJ
Data unit	ha
Description	Area of the jurisdiction
Equations	(54), (56)
Source of data	Digital map of jurisdictional boundaries
Value applied	To be determined by Verra
Justification of choice of data or description of measurement methods and procedures applied	Prior to the start of each BVP

Purpose of data	Calculation of baseline emissions
Comments	AJ should be calculated using the same the projected coordinate system as the digital map of jurisdictional boundaries

Data/Parameter	*Buffer%*
Data unit	%
Description	Buffer withholding percentage
Equations	(51)
Source of data	Tool VCS AFOLU Non-Permanence Risk Tool
Value applied	To be determined by project
Justification of choice of data or description of measurement methods and procedures applied	See Tool VCS AFOLU Non-Permanence Risk Tool
Purpose of data	Calculation of VCUs
Comments	None

Data/Parameter	*DLF*
Data unit	%
Description	Displacement leakage factor
Equations	N/A
Source of data	Estimated and justified by project proponent
Value applied	To be determined by project
Justification of choice of data or description of measurement methods and procedures applied	Project proponent to determine based on the extent of implementation of deforestation mitigation activities and the expected impact of activities on leakage

Purpose of data	Calculation of ex ante emission reductions
Comments	Must be tied to $EA_{EF,t}$

Data/Parameter	$EA_{EF,t}$
Data unit	%
Description	Ex ante effectiveness of halting baseline emissions in year t
Equations	N/A
Source of data	Estimated and justified by project proponent
Value applied	To be determined by project
Justification of choice of data or description of measurement methods and procedures applied	Project proponent to determine based on the extent of implementation of deforestation mitigation activities and the expected impact of activities on baseline deforestation
Purpose of data	Calculation of ex ante emission reductions
Comments	None

Data/Parameter	$t_{alpha=10\%}$
Data unit	unitless
Description	Value of the Student's t-distribution for a two-sided 90 percent confidence interval
Equations	(11), (28), (29), (57), (58)
Source of data	Common statistical tables or software
Value applied	A value of 1.6449 may be used for analyses involving large samples (for instance, activity data estimates); the t value corresponding to the number of degrees of freedom should be used for cases involving small samples (e.g., carbon stock estimates). Determined by project.
Justification of choice of data or description of measurement methods and procedures applied	Based on the central limit theorem, sample estimates are assumed to approach a normal distribution, from which a confidence interval can be constructed. The Student's t distribution is used to allow for small sample sizes.
Purpose of data	Calculation of baseline emissions; Calculation of project emissions
Comments	None

Data/Parameter	$t_{alpha=66.6\%}$
Data unit	unitless
Description	Value of the Student's t-distribution for a one-sided 66.66 percent confidence interval
Equations	(11), (29), (58)
Source of data	Common statistical tables or software
Value applied	A value of 0.4307 may be used for analyses involving large samples (for instance, activity data estimates); the t value corresponding to the number of degrees of freedom should be used for cases involving small samples (e.g., carbon stock estimates). Determined by project.
Justification of choice of data or description of measurement methods and procedures applied	Based on the central limit theorem, sample estimates are assumed to approach a normal distribution, from which a confidence interval can be constructed. The Student's t distribution is used to allow for small sample sizes.
Purpose of data	Calculation of baseline emissions; Calculation of project emissions
Comments	None

6.2   Data and Parameters Monitored

Under Source of Data the table gives the responsible party – Verra or project.

Data/Parameter	$A_{Available}$
Data unit	ha
Description	Area of jurisdiction mapped as available for activity shifting outside the LB
Equations	N/A
Source of data	Verra (Appendix 2 A2.1 Step 1)
Description of measurement methods and procedures to be applied	Digital map of land available for activity shifting
Frequency of monitoring/recording	Every six years at baseline renewal

QA/QC procedures to be applied	N/A
Purpose of data	Calculation of leakage
Calculation method	In GIS
Comments	None

Data/Parameter	A_i
Data unit	ha
Description	Area of stratum i
Equations	Section 5.3.1.6
Source of data	Project (determined during spatial analysis)
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emissions
Comments	None

Data/Parameter	A_{PSF}
Data unit	ha
Description	Area of project sampling frame
Equations	), (25), (27)
Source of data	Project (determined during spatial analysis)

Description of measurement methods and procedures to be applie	N/A
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emissions
Comments	None

Data/Parameter	$A_{LB\text{-}UDef,r,i}$
Data unit	ha
Description	Area of forest in the UDef LB at the start of BVP in risk class r in forest stratum i
Equations	(2)
Source of data	Project (spatially explicit map of forest strata developed by project proponent and spatial subset of the jurisdictional deforestation risk map associated with this BVP)
Description of measurement methods and procedures to be applied	In GIS
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of leakage
Calculation method	Spatial overlay of the FCBM, the jurisdictional deforestation risk map and a FSM
Comments	None

Data/Parameter	$A_{PA\text{-}UDef,r,i}$
Data unit	ha
Description	Area of forest in the UDef PA at the start of BVP in risk class r in forest stratum i
Equations	)
Source of data	Project (spatially explicit map of forest strata developed by project proponent and spati)al subset of the jurisdictional deforestation risk map associated with this BVP
Description of measurement methods and procedures to be applied	Calculated in GIS
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of baseline emissions
Calculation method	Spatial overlay of the FCBM, the jurisdictional deforestation risk map and a project-developed FSM
Comments	None

Data/Parameter	$AD_{LB\text{-}UDef,r}$
Data unit	ha y^{-1}
Description	Activity data allocated to the unplanned deforestation leakage belt in risk class r
Equations	(2), Section 5.3.1.2, Appendix 1 A1.4.3 Step 3
Source of data	Verra (*UDef-AP* and Appendix 1)
Description of measurement methods	*UDef-AP* and Appendix 1)

and procedures to be applied	
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of Leakage
Calculation method	Application of and UDef-AP by Verra
Comments	None

Data/Parameter	A_{ss}
Data unit	ha
Description	Area of sampling stratum ss in the project sampling frame (ha)
Equations	N/A
Source of data	Project (calculated in a GIS from spatial stratification of the project sampling frame)
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	None

Data/Parameter	$AD_{PA\text{-}UDef,r}$

Data unit	ha y^{-1}
Description	Activity data allocated to the unplanned deforestation project area in risk class r in the jurisdiction (ha y-1)
Equations	(1)
Source of data	Verra (through the AD Baseline Allocation Report (*UDef-AP*))
Description of measurement methods and procedures to be applied	Approach to be determined and applied by activity data provider as selected by Verra
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of baseline emissions
Calculation method	Application of APPENDIX 1: Determination of Jurisdictional Data for Project AD Allocation by Verra
Comments	None

Data/Parameter	$C_{p,i}$
Data unit	t CO_2 ha^{-1}
Description	Estimated carbon stock in pool *p* of forest stratum *i*
Equations	(3), (4), (5)
Source of data	Project (pools modules: *CP-AB, CP-D, CP-L, CP-S*)
Description of measurement methods and procedures to be applied	See modules *CP-AB, CP-D, CP-L, CP-S*
Frequency of monitoring/recording	Every six years at baseline renewal

DRAFT FOR VVB ASSESSMENT AND PUBLIC REFERENCE; EXPECTED TO CHANGE BEFORE PUBLICATION

NOT TO BE USED FOR VALIDATION OR VERIFICATION

QA/QC procedures to be applied	See module *CP-AB, CP-D, CP-L, CP-S*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See modules *CP-AB, CP-D, CP-L, CP-S*
Comments	Note in equation (5) C*p,i* is replaced by the parameters specific to individual pools as detailed in Table 2.

Data/Parameter	$C_{p,post,i}$
Data unit	$t\ CO_2e\ ha^{-1}$
Description	Estimated carbon stock in post-deforestation pool p in forest stratum i
Equations	(5)
Source of data	Project (Published and/or peer-reviewed studies selected from the following, in descending order of preference: 1. Within 5 km of the avoiding UDef project boundary 2. Subnational jurisdiction 3. National jurisdiction 4. National data from neighboring countries with similar conditions 5. Global 6. Where these data are inadequate or not appropriate, field sampling may take place within the jurisdiction. Field sampling design must result in an estimate that produces conservative estimates of the carbon stocks.)
Description of measurement methods and procedures to be applied	See modules *CP-AB, CP-D, CP-L, CP-S*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-AB, CP-D, CP-L, CP-S*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage

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Calculation method	Stock estimates of each non-forest land use class represented must be equal to the long-term average stocks (time-weighted average of stocks in cyclical post-deforestation land-use systems such as shifting agriculture with fallow).
Comments	Note in equation (3) $C_{p,post,i}$ is replaced by the parameters specific to individual pools as detailed in Table 2.

Data/Parameter	$C_{AB\_nontree,i}$
Data unit	t CO_2e ha^{-1}
Description	Forest carbon stock in aboveground non-tree vegetation in stratum i
Equations	(12), (15); also indirectly in (3) and (4)
Source of data	Project (field measurements as delineated in $CP\text{-}AB$)
Description of measurement methods and procedures to be applied	See module $CP\text{-}AB$
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module $CP\text{-}AB$
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See module $CP\text{-}AB$
Comments	None

Data/Parameter	$C_{AB\_nontree,post,i}$
Data unit	t CO_2e ha^{-1}
Description	Post-land use transition carbon stock in aboveground non-tree vegetation in stratum i
Equations	Indirectly in (3) and (4)

| Source of data | Project

(Published and/or peer-reviewed studies selected from the following, in descending order of preference:

1. Within 5 km of the avoiding UDef project boundary
2. Subnational jurisdiction
3. National jurisdiction
4. National data from neighboring countries with similar conditions
5. Global
6. Where these data are inadequate or not appropriate, field sampling may take place within the jurisdiction. Field sampling design must result in an estimate that produces conservative estimates of the carbon stocks.) |
|---|---|
| Description of measurement methods and procedures to be applied | See module *CP-AB* |
| Frequency of monitoring/recording | Every six years at baseline renewal |
| QA/QC procedures to be applied | See module *CP-AB* |
| Purpose of data | Calculation of baseline emissions, calculation of project emissions, calculation of leakage |
| Calculation method | Stock estimates of each non-forest land use class represented must be equal to the long-term average stocks (time-weighted average of stocks in cyclical post-deforestation land-use systems such as shifting agriculture with fallow). |
| Comments | None |

Data/Parameter	$C_{AB\_tree,I}$
Data unit	t CO_2e ha^{-1}
Description	Forest carbon stock in aboveground tree biomass in stratum *i*
Equations	(12), (15); also indirectly in (3) and (4)
Source of data	Project *(CP-AB)*

Description of measurement methods and procedures to be applied	See module *CP-AB*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-AB*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See module *CP-AB*
Comments	None

Data/Parameter	$C_{AB\_tree,post,i}$
Data unit	t CO_2e ha^{-1}
Description	Post-land use transition carbon stock in aboveground tree biomass in stratum *i*
Equations	Indirectly in (3) and (4)
Source of data	Project (Published and/or peer-reviewed studies selected from the following, listed in descending order of preference: 1. Within 5 km of the avoiding UDef project boundary 2. Sub-national jurisdiction 3. National jurisdiction 4. National data from neighboring countries with similar conditions 5. Global 6. Where these data are inadequate or not appropriate, field sampling may take place within the jurisdiction. Field sampling design must result in an estimate that produces conservative estimates of the carbon stocks.)
Description of measurement methods and procedures to be applied	See module *CP-AB*

Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-AB*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	Stock estimates of each non-forest land use class represented must be equal to the long-term average stocks (time-weighted average of stocks in cyclical post-deforestation land-use systems such as shifting agriculture with fallow).
Comments	None

Data/Parameter	$C_{BB\_nontree,i}$
Data unit	t CO_2e ha^{-1}
Description	Forest carbon stock in the belowground non-tree biomass pool in stratum i
Equations	(13), (16); also indirectly in (3) and (4)
Source of data	Project (field measurements as delineated in module *CP-AB*)
Description of measurement methods and procedures to be applied	See module *CP-AB*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-AB*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See module *CP-AB*
Comments	None

Data/Parameter	$C_{BB\_nontree,post,i}$
Data unit	t CO_2e ha^{-1}
Description	Post-land use transition carbon stock in the belowground non-tree biomass pool in stratum i
Equations	Indirectly in (3) and (4)
Source of data	Project (Published and/or peer-reviewed studies selected from the following, in descending order of preference: 1. Within 5 km of the avoiding UDef project boundary 2. Subnational jurisdiction 3. National jurisdiction 4. National data from neighboring countries with similar conditions 5. Global 6. Where these data are inadequate or not appropriate, field sampling may take place within the jurisdiction. Field sampling design must result in an estimate that produces conservative estimates of the carbon stocks.)
Description of measurement methods and procedures to be applied	See module *CP-AB*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-AB*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	Stock estimates of each non-forest land use class represented must be equal to the long-term average stocks (time-weighted average of stocks in cyclical post-deforestation land-use systems such as shifting agriculture with fallow).
Comments	None

Data/Parameter	$C_{BB\_tree,i}$

Data unit	t CO_2e ha^{-1}
Description	Forest carbon stock in belowground tree biomass in stratum i
Equations	(13), (16); also indirectly in (3) and (4)
Source of data	Project (field measurements as delineated in module *CP-AB*)
Description of measurement methods and procedures to be applied	See module *CP-AB*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-AB*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See module *CP-AB*
Comments	None

Data/Parameter	$C_{BB\_tree,i,post}$
Data unit	t CO_2e ha^{-1}
Description	Post-land use transition carbon stock in belowground tree biomass in stratum i
Equations	Indirectly in (3) and (4)
Source of data	Project (Published and/or peer-reviewed studies selected from the following, listed in descending order of preference: 1. Within 5 km of the avoiding UDef project boundary 2. Subnational jurisdiction 3. National jurisdiction 4. National data from neighboring countries with similar conditions 5. Global 6. Where these data are inadequate or not appropriate, field sampling may take place within the jurisdiction. Field sampling design must

	result in an estimate that produces conservative estimates of the carbon stocks.)
Description of measurement methods and procedures to be applied	See module *CP-AB*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-AB*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	Stock estimates of each non-forest land use class represented must be equal to the long-term average stocks (time-weighted average of stocks in cyclical post-deforestation land-use systems such as shifting agriculture with fallow).
Comments	None

Data/Parameter	$C_{DW,i}$
Data unit	t CO_2e ha^{-1}
Description	Forest carbon stock in the dead wood pool in stratum *i*
Equations	(13), (16); also indirectly in (3) and (4)
Source of data	Project (field measurements as delineated in module *CP-D*)
Description of measurement methods and procedures to be applied	See module *CP-D*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-D*

Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See module *CP-D*
Comments	None

Data/Parameter	$C_{DW,post,i}$
Data unit	$t\ CO_2e\ ha^{-1}$
Description	Post-deforestation carbon stock in the dead wood pool in stratum *i*
Equations	Indirectly in (3) and (4)
Source of data	Project (Published and/or peer-reviewed studies selected from the following, listed in descending order of preference: 1. Within 5 km of the avoiding UDef project boundary 2. Subnational jurisdiction 3. National jurisdiction 4. National data from neighboring countries with similar conditions 5. Global 6. Where these data are inadequate or not appropriate, field sampling may take place within the jurisdiction. Field sampling design must result in an estimate that produces conservative estimates of the carbon stocks.)
Description of measurement methods and procedures to be applied	See module *CP-D*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-D*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage

Calculation method	Stock estimates of each non-forest land use class represented must be equal to the long-term average stocks (time-weighted average of stocks in cyclical post-deforestation land-use systems such as shifting agriculture with fallow).
Comments	None

Data/Parameter	$C_{LI,i}$
Data unit	t CO_2e ha^{-1}
Description	Forest carbon stock in the litter pool in stratum i
Equations	(12), (15); also indirectly in (3) and (4)
Source of data	Project (field measurements as delineated in module CP-L)
Description of measurement methods and procedures to be applied	See module CP-L
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module CP-L
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See module CP-L
Comments	None

Data/Parameter	$C_{LI,post,i}$
Data unit	t CO_2e ha^{-1}
Description	Post-deforestation carbon stock in the litter pool in stratum i
Equations	Indirectly in (3) and (4)

Source of data	Project
	(Published and/or peer-reviewed studies selected from the following, listed in descending order of preference:
	1. Within 5 km of the avoiding UDef project boundary
	2. Subnational jurisdiction
	3. National jurisdiction
	4. National data from neighboring countries with similar conditions
	5. Global
	6. Where these data are inadequate or not appropriate, field sampling may take place within the jurisdiction. Field sampling design must result in an estimate that produces conservative estimates of the carbon stocks.)
Description of measurement methods and procedures to be applied	See module *CP-L*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-L*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	Stock estimates of each non-forest land use class represented must be equal to the long-term average stocks (time-weighted average of stocks in cyclical post-deforestation land-use systems such as shifting agriculture with fallow)
Comments	None

Data/Parameter	$C_{SOC,i}$
Data unit	t CO_2e ha^{-1}
Description	Forest carbon stock in the soil organic carbon pool in stratum *i*
Equations	(14), (17); also indirectly in (3) and (4)
Source of data	Project (field measurements as delineated in module *CP-S*)

Description of measurement methods and procedures to be applied	See module *CP-S*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-S*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See module *CP-S*
Comments	None

Data/Parameter	$C_{SOC,post,i}$
Data unit	t CO_2e ha^{-1}
Description	Post-deforestation carbon stock in the soil organic carbon pool in stratum *i*
Equations	Indirectly in (3) and (4)
Source of data	Project (Published and/or peer-reviewed studies selected from the following, listed in descending order of preference: 1. Within 5 km of the avoiding UDef project boundary 2. Subnational jurisdiction 3. National jurisdiction 4. National data from neighboring countries with similar conditions 5. Global 6. Where these data are inadequate or not appropriate, it is allowable for field sampling to take place within the jurisdiction. Field sampling design must result in an estimate that produces conservative estimates of the carbon stocks.)
Description of measurement methods and procedures to be applied	See module *CP-S (equivalent to $C_{SOC,PD-BSL,I}$ in CP-S*

Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-S*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	Stock estimates of each non-forest land use class represented must be equal to the long-term average stocks (time-weighted average of stocks in cyclical post-deforestation land-use systems such as shifting agriculture with fallow).
Comments	None

Data/Parameter	$C_{WP,i}$
Data unit	t CO$_2$e ha^{-1}
Description	Mean carbon stocks entering the wood products pool at the time of deforestation from forest stratum *i*
Equations	(14), (17); also indirectly in (3) and (4)
Source of data	Project (as delineated in module *CP-W*)
Description of measurement methods and procedures to be applied	See module *CP-W*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-W*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See module *CP-W*
Comments	None

Data/Parameter	$C_{WP100,i}$
Data unit	t CO_2e ha^{-1}
Description	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100 years from forest stratum i
Equations	(14), (17); also indirectly in (3) and (4)
Source of data	Project (as delineated in module *CP-W*)
Description of measurement methods and procedures to be applied	See module *CP-W*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-W*
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	See module *CP-W*
Comments	None

Data/Parameter	*MPL*
Data unit	years
Description	Length of monitoring period
Equations	(32), (33)
Source of data	Project (metadata of imagery used to undertake plot interpretation for project monitoring)
Description of measurement methods and procedures to be applied	N/A

Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emissions
Calculation method	Calculated as the difference between the average dates of imagery used to assess sample plots at the start and end of the monitored period.
Comments	None

Data/Parameter	$\Delta C_{LK\text{-}ME,t}$
Data unit	t CO_2e
Description	Cumulative net greenhouse gas emissions due to market-effects leakage in year t
Equations	(49)
Source of data	Project (module $LK\text{-}ME$)
Description of measurement methods and procedures to be applied	See module $LK\text{-}ME$
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	See module $LK\text{-}ME$
Purpose of data	Calculation of leakage
Calculation method	See module $LK\text{-}ME$
Comments	Summed across net greenhouse gas emissions due to market-effects leakage up to year t

Data/Parameter	$\Delta C_{OLB,t}$
Data unit	t CO_2e ha^{-1}

Description	Emissions from carbon stock change due to land cover transition in areas available for activity shifting outside the leakage belt, as calculated for the baseline validity period associated with year *t*
Equations	(46)
Source of data	Verra (see Appendix 2 A2.2 Step 2; derived by Verra from average carbon stocks in pixels available for deforestation from a global carbon stock map (where relevant with addition of belowground biomass from IPCC root-to-shoot ratios))
Description of measurement methods and procedures to be applied	See Appendix 2 A2.2 Step 2
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of leakage
Calculation method	See Appendix 2 A2.2 Step 2
Comments	None

Data/Parameter	$CountJ_{CHC,ss}$
Data unit	Sampling units
Description	Total count of the sample units that fall into sampling stratum *ss* and change category *CHC* (*UDef/SF/SNF/Reg*)
Equations	(53), (56)
Source of data	Verra (interpretation of high-resolution satellite imagery and/or ground measurements)
Description of measurement methods and procedures to be applied	See Appendix 1
Frequency of monitoring/recording	Every six years at baseline renewal

QA/QC procedures to be applied	**Imagery Interpretation Method** The interpretation and recordkeeping approach must be documented through SOPs, allowing the process to be reproduced by individuals not involved in the initial data generation. The methods employed must meet the following minimum characteristics: • The interpretation approach should provide sufficient objective criteria so interpreters independently and consistently produce similar interpretations for the same samples. Interpretation criteria should relate to the physical definitions of land cover classes, as far as those criteria may be interpreted from high-resolution imagery. • Multiple analysts should be employed to interpret each plot through blindly repeated observations or team-based interpretation. • Observation should focus on identifying the class of the sample at each of two single points in time, the beginning and end of the HRP. The change must be determined as a difference between the start and end classes. • Where there is analyst disagreement over the interpretation of a sample, an objective process must be put in place to either a) adjudicate the dispute and resolve the plot to a single class or b) reject the plot as unclear. Adjudication must always be attempted before rejection. Information on all rejected plots must be retained, and it must be demonstrated that the rejection of plots does not bias the results.
Purpose of data	Calculation of baseline emissions, calculation of project emissions, calculation of leakage
Calculation method	As above
Comments	$CHC = UDef$, SF, SNF, Reg (unplanned deforestation, stable forest, stable nonforest, regrowth)

Data/Parameter	$Count_{ss}$
Data unit	Sample units
Description	Total count of sample units in sampling stratum ss
Equations	(23), (26)
Source of data	Project (interpretation of high-resolution satellite imagery and ground measurements)
Description of measurement methods and procedures to be applied	See Appendix 1

Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	As described in Standard Operating Procedures for Sample Plot Interpretation
Purpose of data	Calculation of project emissions, calculation of leakage
Calculation method	Approach must comply with all relevant requirements of 0.
Comments	None

Data/Parameter	$Count_{CHC,ss}$
Data unit	Sample units
Description	Count of the sample units within the project sampling frame that fall into sampling stratum ss and are classified as change category CHC (*UDef/SF/SNF/Reg*)
Equations	(23), (26)
Source of data	Project (interpretation of high-resolution satellite imagery and ground measurements)
Description of measurement methods and procedures to be applied	See Appendix 1
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	As described in Standard Operating Procedures for Sample Plot Interpretation
Purpose of data	Calculation of project emissions, calculation of leakage
Calculation method	Approach must comply with all relevant requirements of Appendix 1.
Comments	*CHC = UDef, SF, SNF, Reg* (unplanned deforestation, stable forest, stable nonforest, regrowth)

Data/Parameter	$E_{BSL,BiomassBurn,i,t}$

Data unit	t CO$_2$e
Description	Non-CO$_2$ emissions due to biomass burning as part of unplanned deforestation activities in forest stratum *i* in year *t*
Equations	(20), (42)
Source of data	Project (module *E-BPB*)
Description of measurement methods and procedures to be applied	Module *E-BPB*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	Module *E-BPB*
Purpose of data	Calculation of baseline emissions
Calculation method	Module *E-BPB*
Comments	None

Data/Parameter	$E_{MP,BiomassBurn,i,t}$
Data unit	t CO$_2$e
Description	Non-CO$_2$ monitored emissions due to biomass burning as part of unplanned deforestation activities in forest stratum *i* in year *t*
Equations	(38), (48)
Source of data	Project (module *E-BPB*)
Description of measurement methods and procedures to be applied	Module *E-BPB*
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years

QA/QC procedures to be applied	Module *E-BPB*
Purpose of data	Calculation of project emissions
Calculation method	Module *E-BPB*
Comments	None

Data/Parameter	$E_{Cstocks,LMA,t}$
Data unit	t CO_2e
Description	Net CO_2e emissions from carbon stock changes due to the implementation of leakage prevention measures in the LMA in year *t*
Equations	(48)
Source of data	Project (module *CP-AB*)
Description of measurement methods and procedures to be applied	See module *CP-AB*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *CP-AB*
Purpose of data	Calculation of leakage
Calculation method	Module *CP-AB*
Comments	None

Data/Parameter	$E_{BSL,FC,i,t}$
Data unit	t CO_2e
Description	Net emissions from fossil fuel combustion in forest stratum *i* in year *t* of the baseline

Equations	(20), (22), (42)
Source of data	Project (Ex ante: Default values from IPCC 2006 (including 2019 Refinement) or peer reviewed literature Ex post: Module *E-FFC*)
Description of measurement methods and procedures to be applied	See module *E-FFC*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See module *E-FFC*
Purpose of data	Calculation of baseline emissions, calculation of leakage
Calculation method	Module *E-FFC*
Comments	None

Data/Parameter	$E_{MP,FC,i,t}$
Data unit	t CO_2e
Description	Net monitored emissions from fossil fuel combustion in forest stratum *i* in year *t*
Equations	(38), (48)
Source of data	Project (Ex ante: Default values from IPCC 2006 (including 2019 Refinement) or peer reviewed literature Ex post: Module *E-FFC*)
Description of measurement methods and procedures to be applied	See module *E-FFC*

Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	See module *E-FFC*
Purpose of data	Calculation of project emissions
Calculation method	Module *E-FFC*
Comments	None

Data/Parameter	$N_2O_{BSL,direct-N,i,t}$
Data unit	t CO_2e
Description	Direct N_2O emissions as a result of nitrogen application on an alternative land use in stratum *i* in year *t* of the baseline
Equations	(20), (42)
Source of data	Project (module *E-NA*)
Description of measurement methods and procedures to be applied	See Module *E-NA*
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	See Module *E-NA*
Purpose of data	Calculation of baseline emissions, calculation of leakage
Calculation method	See Module *E-NA*
Comments	None

Data/Parameter	$N_2O_{MP,direct-N,i,t}$
Data unit	t CO_2e

Description	Direct monitored N_2O emissions as a result of nitrogen application on an alternative land use in stratum i in year t
Equations	(38), (48)
Source of data	Project (module *E-NA*)
Description of measurement methods and procedures to be applied	See Module *E-NA*
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	See Module *E-NA*
Purpose of data	Calculation of project emissions
Calculation method	See Module *E-NA*
Comments	None

Data/Parameter	$PROP_{IMM}$
Data unit	Proportion
Description	Proportion of households living in the project activities region that are recent migrants and are engaging in land use activities identified as a baseline driver of unplanned deforestation
Equations	(45)
Source of data	Project (Participatory Rural Appraisal)
Description of measurement methods and procedures to be applied	For sampling requirements refer to CDM *Guideline: Sampling and surveys for CDM project activities and programmes of activities*.
Frequency of monitoring/recording	Every six years at baseline renewal
QA/QC procedures to be applied	For sampling requirements refer to CDM *Guideline: Sampling and surveys for CDM project activities and programmes of activities*.
Purpose of data	Calculation of leakage

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NOT TO BE USED FOR VALIDATION OR VERIFICATION

Calculation method	Survey
Comments	None

Data/Parameter	$t_{start,ss,s}$
	$t_{end,ss,s}$
Data unit	Decimal year
Description	Date of image used to interpret the start and end dates of sample s classified in sampling stratum ss
Equations	(60), (61)
Source of data	Project (Metadata provided with high resolution imagery used in sample plot interpretation. For ground observations, date of field visit.)
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Monitoring must be conducted at least every five years, or prior to each verification event if less than five years
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emissions, calculation of leakage
Calculation method	N/A
Comments	For images that are composites of multiple imaging dates, the midpoint of the time period represented in the composite must be taken as the collection date.

7 REFERENCES

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APPENDIX 1: DETERMINATION OF JURISDICTIONAL DATA FOR PROJECT AD ALLOCATION

A1.1 General

The AD baseline for unplanned deforestation is the jurisdictional average annual UDef rate. The jurisdictional baseline AD must be updated at the end of each BVP.

Verra will establish jurisdictional baselines and allocate them to projects; it is responsible for all of the actions in this Appendix 1.

Project allocations will be documented in an *AD Baseline Allocation Report.* This report includes the following:

1) Definition of forest used in FCBM construction;

2) Definition of deforestation used in AD estimation;

3) Start and end date of the HRP;

4) Start and end date of the BVP;

5) Table containing the total AD allocation to each risk class for the PA and LB over the BVP;

6) The jurisdictional FCBM;

7) The (independently assessed for appropriateness and methodological soundness) jurisdictional deforestation risk map, including the name of the DSP that developed it, data layers and type of statistical model used, prediction ability statistics, and the relevant digital GIS files;

8) The spatial boundaries of any registered AFOLU carbon projects, associated LBs, projects in the VCS project pipeline;[15] and

9) The jurisdictional emission factor due to land cover transition in areas available for activity shifting outside the LB.

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[15] Limited to projects that use this module.

The application of this procedure employs activity-based accounting.[16]

A1.2 Boundaries

A1.2.1 Jurisdictional Boundaries

The location description of the jurisdiction must include the following information:

1) Name of the jurisdiction;

2) Vectorized digital file (e.g., shapefile, kmz, geojson) of the jurisdiction boundaries, including information on the projection and datum used;

3) Geodetic coordinates of the vertices of the jurisdiction boundary, provided in the format specified in the *VCS Standard*; and

4) Total terrestrial area covered by the jurisdiction in hectares, calculated in a GIS program using an equal area projection in meters.

The jurisdictional boundary must be defined using one of the following cases:

- The national boundaries may always be used as the jurisdiction.

- Where there is a clear expression of government intent to use alternative boundaries in developing jurisdictional REDD programs (e.g., those included in a submission of a FREL to the UNFCCC or a submission to the Forest Carbon Partnership Facility's Carbon Fund, the BioCarbon Fund Initiative for Sustainable Forest Landscapes (ISFL) or to The Architecture for REDD+ Transactions (ART) REDD+ Environmental Excellence Standard (TREES), the boundaries of a government's jurisdictional REDD+ programme may be used. Only in this case may boundaries be defined using non-administrative boundaries (e.g., biomes, ecozones, watersheds).

- The boundaries of one or several contiguous jurisdictions at either second or third level (i.e., administrative level below the national level) may be used if these, taken together, cover at least 2.5 million hectares. If the area amounts to more than half of the country area, the whole country must be included.

The jurisdiction may include forest and non-forest lands and must consist of the full spatial extent of the selected administrative unit. The boundaries of a jurisdiction must not spatially

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[16] The activity-based approach to emissions estimation consists of identifying specific activities occurring on the land that influence GHG fluxes and focusing on the project activities, allowing for differentiation between activities. See Chapter 2.2.3 in Iversen, P., Lee, D., & Rocha, M. (2014). *Understanding Land Use in the UNFCCC* for more information.

overlap with any other jurisdictional boundary defined by Verra or with any registered JNR jurisdictional FREL or program.

Where the above criteria defining jurisdictional boundaries are not achievable due to the presence of other jurisdictions for which a valid VCS jurisdictional AD baseline or JNR program and FREL exist, the jurisdiction must be defined as the remaining area within the national boundary.

Where an existing PA or LB intersects more than one administrative jurisdiction, an approved *AD Baseline Allocation Report* will be developed by Verra for the portion of the PAs or LBs outside the selected jurisdiction in case no valid BVP AD exists for such jurisdiction. AD must be allocated to the respective portion of the UDef PA from each jurisdiction.

A1.2.2 LB Boundaries

The spatial extent of each project's UDef LB must be delineated as the forest area (as depicted on the jurisdictional FCBM) within a 10 kilometer wide buffer around the UDef PA, excluding:

1) Areas that fall outside the national boundary; and

2) Areas mapped as identified exclusions (see Section A1.4.1 Step 1).

Where, following the aforementioned exclusions of forests, the remaining forest area within a 10 km wide buffer exceeds the extent of the UDef PA at the project start date, the buffer width must be reduced so that the area of forest in the UDef LB is equal to the UDef PA at the project start date. The minimum UDef LB buffer width must in all cases be 2 km.

Where the UDef PA includes non-contiguous forest patches or where a grouped project is composed of multiple project activity instances (PAI), each patch or PAI is considered as a separate "PA segment" for the purpose of LB delineation. PA segments whose boundaries are separated by no more than 4 km must be grouped into a single PA segment prior to LB delineation. Multiple small segments may thus be aggregated into one or a small number of PA segments and the LB buffer width is determined based on the combined forest area within the aggregated segment.

As detailed in Section 5.1.3, further actions must be taken by project proponents to discount from UDef LB the overlapping PAs and LBs of other VCS AFOLU registered and active projects.

A1.3 AD Categories for Which Historical AD Estimates Are Required

The following categories must be explicitly defined in the *AD Baseline Allocation Report*:

1) Forest to non-forest (deforestation);

2) Stable forest;

3) Non-forest to forest[17] (i.e., forest regrowth, which includes afforestation, reforestation and natural regeneration of forests); and

4) Stable non-forest.

Deforestation must be disaggregated into at least: small-scale and large-scale unplanned deforestation. Other categories do not require disaggregation (see Table 10).

Table 10: Change category inclusion criteria

Required change category	Required classes
Deforestation	Large-scale deforestation; Unplanned deforestation
Forest regrowth	Forest regrowth
Stable forest	Stable forest
Stable non-forest	Stable non-forest

A1.4 Compilation and Allocation of Unplanned Deforestation AD

Verra will follow the following procedures to compile jurisdictional deforestation AD and allocate this to PAs and LBs (Figure 4).

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[17] Where trees meeting the threshold parameters of the definition of "forest" appear on lands that were not "forest" in previous years, these lands should be considered "temporarily stocked" (i.e., not "forest"). It takes at least 10 consecutive years for such lands to become "forest" and therefore it is not possible for them to be deforested earlier.

Figure 4: Allocation of jurisdictional deforestation AD to PAs and LBs

> Estimate areas of unplanned deforestation that took place in the jurisdiction during the HRP

Historical land cover change is estimated using a sample of high-resolution imagery. Uncertainty of the estimate is assessed and used to determine whether the resulting AD must be conservatively discounted.

A1.4.1 Estimate Areas of Unplanned Deforestation that Took Place in the Jurisdiction During the HRP

Historical AD refers to the total area of the jurisdiction that experienced deforestation over the HRP. Historical AD must be estimated using a sample-based approach that uses human-interpretation of high-resolution imagery within sample plots[18] distributed in a representative manner across the jurisdiction. Where available, in situ observations may be used to supplement the visual interpretation of sample plots but are not required. Other spatial data may be used to increase the sampling design efficiency or aid interpretation of the images.

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[18] For a fuller treatment of best practices regarding plot-based AD development, see Section 4.2 of GFOI (2020). *Integration of remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests, Edition 3.0.*

The historical AD must be conservatively discounted based on the estimated statistical uncertainty and then annualized. The uncertainty-discounted average annual historical AD estimate will be used to project future AD over the BVP and develop the jurisdictional AD baseline for unplanned deforestation.

Development of wall-to-wall forest, land cover or land cover change maps is not a requirement for estimating AD. However, wall-to-wall maps from any source may be used to develop efficient stratified sampling strategies for estimating historical AD. Any sampling strategy that is spatially representative of the jurisdiction and supported by current best practices may be used as long as its use assists in producing estimates that meet accuracy requirements.

Step 1: Develop a Historical Land Cover/Land Cover Change Dataset

Historical AD should be estimated using a sample-based approach. The sample-based method yields an estimate of the area of unplanned deforestation for the HRP, together with an evaluation of statistical uncertainty, as expressed by confidence intervals.

SOPs must be developed and employed and must include, at a minimum: sample design, response design and data sources, data collection and data analysis. The SOPs should also include detailed guidance on quality management during all these steps and should be annexed to the *AD Baseline Allocation Report*.

Jurisdictional Sampling Frame and Areas of Identified Exclusions

AD sampling must be carried out over the entire jurisdiction, except for areas determined to be "identified exclusions." lists the categories of identified exclusions and the conditions under which they must be mapped. Locations of irrefutably identified and bounded exclusions must be spatially delineated and excluded from the jurisdictional sampling frame.

Table 11: Description of maps of identified exclusions

Data Product	Description of Identified Exclusions	Requirement for Producing Data Product
Map of Identified Exclusion - Intertidal Zone	Coastal or riverine areas subject to regular inundation by tides	**Required** where 1000 ha of mangrove forests are known to exist in the jurisdiction **Optional** in all other cases

Data Product	Description of Identified Exclusions	Requirement for Producing Data Product
Map of Identified Exclusion – Commercial Plantations	Forests meeting the following conditions: • Currently managed primarily with an objective to earn revenue through timber harvesting; • Harvesting practices involve clear cuts, patch cuts, seed trees, continuous thinning, group selection or related practices; and • Wood is harvested to supply commercial markets.[19]	**Required** where commercial plantations larger than 1000 ha are known to exist in the jurisdiction **Optional** in all other cases
Map of Identified Exclusion – Natural Disturbances	Deforestation during the HRP caused by known infrequent, large-scale natural disturbance	**Required** where all of the following conditions are met: • Any individual natural disturbance is known to have resulted in more than 1000 ha of deforestation; and • It is possible to spatially delineate deforestation attributable to a natural disturbance from other potential causes of deforestation with high confidence using available datasets. **Optional** in all other cases
Map of Identified Exclusion– Planned Infrastructure	Deforestation during the HRP caused by large-scale infrastructure projects	**Required** where all of the following conditions are met: • Any individual infrastructure project is known to have resulted in more than 1000 ha of deforestation • It is possible to spatially delineate deforestation attributable to an infrastructure project from other potential causes of deforestation with high confidence using available datasets. **Optional** in all other cases

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[19] Commercial markets here are defined as sale of products to end users and public and private companies with sales conducted distant (more than 50 km) from the PA.

Data Product	Description of Identified Exclusions	Requirement for Producing Data Product
Map of Identified Exclusion– Planned Deforestation	Deforestation during the HRP caused by large scale planned deforestation cleared by a single agent	**Required** where all of the following conditions are met: • Any individual planned deforestation is known to have resulted in more than 1000 ha of deforestation cleared by a single agent; and • Meets all other VCS definitions for planned deforestation. **Optional** in all other cases
Map of Identified Exclusion– Water	Permanent bodies of water incapable of sustaining forests	**Optional** in all cases

The spatially delineated areas excluded from sampling within the jurisdiction (and excluded from any required 10 km buffer) must be provided as a series of identified exclusion maps. The area in hectares of all lands that fall within one or more identified exclusions is termed $AJ_{-excluded}$. The entire area of the jurisdiction including "identified exclusions" is termed AJ.

AD sampling must only be undertaken within areas not identified as excluded. The remaining area of the jurisdiction once identified exclusions have been removed is termed the jurisdictional sampling frame. Figure 5 illustrates the process of developing the AD sampling frame.

Figure 5: Conceptual illustration of the development identified exclusion area maps and jurisdictional sampling frame
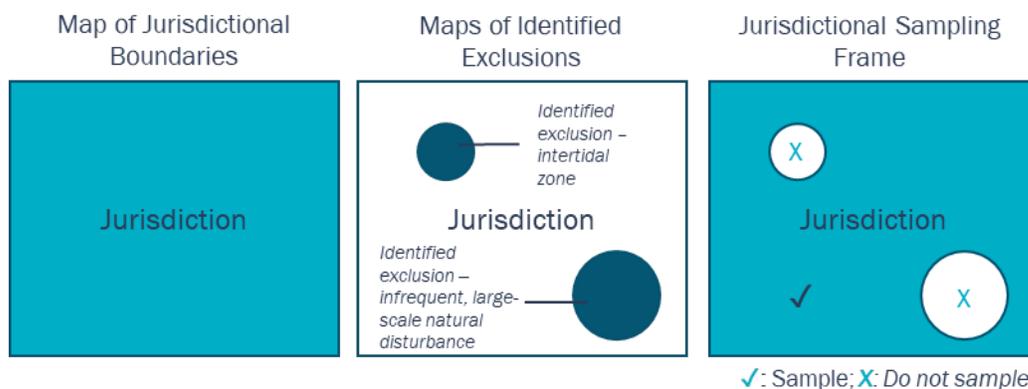
The purpose of this step is not to exhaustively identify all cases of allowable categories for exclusion but rather to limit sample effort and improve the accuracy of the sample-based AD

estimates described in A1.4.1 Estimate Areas of Unplanned Deforestation that Took Place in the Jurisdiction During the Step 1 subsection Data Collection.

The maps of identified exclusions are also used to reclassify apparent deforestation, as is further described in Section A1.4.3 Step 1. The excluded areas are assigned a deforestation risk category of zero in certain circumstances, as described in Section A1.4.3 Step 2.

Sample Design

The sampling design must ensure that sample plots will be distributed across the entire jurisdictional sampling frame, yielding a representative sample of the landscape considering the spatial patterns of deforestation. Sampling designs may be systematic, random, stratified random sampling or any other design supported by current best practices. The sampling strategy method should ensure that the uncertainty (defined as a half-width of the 90 percent confidence interval) of the final estimate of deforestation is within ±10 percent of the estimate of the mean, otherwise the estimate is subject to a conservative discounting.

Any relevant spatial criterion may be employed to stratify the jurisdictional sampling frame, including observed land cover change in an ancillary wall-to-wall map, areas of hypothesized high versus low risk of deforestation or any other criterion that assists in limiting interpretation effort to meet the uncertainty targets of the estimated AD.

Where a stratified sampling design is not employed, the entire jurisdictional sampling frame must be considered to constitute a single sampling stratum.

Areas excluded from the jurisdictional sampling frame (areas mapped as identified exclusions) must not be included in any sampling stratum or be incorporated in the calculations of area (ha) of any sampling stratum.

Response Design

Collected sample data are used to identify the land cover conditions at the start date and the end date of the HRP within the jurisdiction spatial boundary and to assign a change (deforestation or forest regrowth) or no change (stable forest or stable non-forest) result to each observation. Evidence of intermediary land cover[20] changes occurring between the start date and end date of the HRP should be used to inform the classification of a sample unit. Only one result may be identified per location per HRP.

Rules for determining the evidence and interpretation guidance that should be employed must be described in the SOP for image interpretation and may rely on a combination of imagery, secondary remote sensing data and ancillary spatial or non-spatial data.

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[20] The term "land cover" should be understood to encompass both land cover and land use.

For each sample unit where change is observed, the date on which change is observed must be identified and recorded using the satellite imagery time series.

Data Sources

Sample data are developed through the interpretation of a time series of high-resolution imagery spanning a period within ±365 days of the start and end date of the HRP. For the primary imagery dataset, a spatial resolution of 10 m or finer must be used for all time periods.. Where suitable/usable images are not available, the time series may be supplemented with imagery from a wider time range to help interpret observations. Maps may be employed in the design of efficient sampling strategies. Other data sources, such as airborne and spaceborne active and passive remote sensing, and ground observation, may also be used to supplement the interpreters' observation of high-resolution imagery. Imagery should be orthorectified to minimize the effect of spatial error between images from different acquisition dates or terrain distortions.

Data Collection

Visual interpretation is used to assign each sample unit to a change or non-change classification. Where a stratified sampling design is employed, each sample plot observation is recorded with reference to the sampling stratum in which the sample plot is located.

Detailed procedures for quality management during the interpretation process must be formulated and described in the Standard Operating Procedures for Sample Plot Interpretation. Typically, these procedures will include cross-validation among interpreters, at least for a subset of sample units assessed by all interpreters, and rules for dealing with disagreements on class identification between analysts. Such SOPs will vary by jurisdiction and AD collection instance but must include:

1) Sample plot design and spatial plot allocation to the sampling frame;

2) Data sourcing and pre-processing;

3) Visual interpretation of forest and non-forest land covers;

4) Recording dates of imagery collection;

5) Description of the jurisdiction-specific characteristics of large-scale planned deforestation, and associated interpretation guidance;

6) Guidance for assessing whether observed deforestation is likely occurred on land already in an established management system involving clearing and replanting of trees on a short (less than 10 years) cycle

7) Minimum qualifications of analysts, including familiarity with jurisdiction-specific land cover interpretation; and

8) Cross-checks among analysts, recording of analyst certainty around each plot interpretation, and rules for resolving disagreements.

Where deforestation is observed in plots, assess whether the deforestation meets either of the following two conditions:

a) Likely occurred on land already in an established management system involving clearing and replanting of trees on a short (less than 10 years) cycle.

   i) Where the deforestation event likely meets the criteria for identified exclusion – commercial plantation, it should be delineated and added to the map of identified exclusions. Such plots are eliminated from the sampling design.

   ii) Where the deforestation event does not meet the criteria for identified exclusion – commercial plantation, the plot should be considered non-forest at the start of the HRP and the associated change category for that plot recorded accordingly. Examples of land use categories that may meet this condition, depending on the context of a jurisdiction, include but are not limited to smallholder wood lots, agroforestry, tree crops and agricultural fallows.

b) Occurred as part of a large-scale deforestation event. Where the deforestation observation is located within a larger deforestation event of 100 contiguous hectares or more, and where that deforestation event appears likely to be by a single agent (as opposed to an aggregation of many small-scale agents), the analyst must make the following determination:

   i) Where the deforestation event is unambiguously large-scale planned deforestation (unambiguously meeting the VCS definition of planned deforestation and exceeding 1000 contiguous hectares[21]), it should be spatially delineated and added to the map of identified exclusions (identified exclusion – planned deforestation or identified exclusion – planned infrastructure). Such plots are eliminated from the sampling design.

   ii) Where the deforestation event does not unambiguously meet the definition of planned deforestation, the plot observation should be recorded as change category deforestation. An additional record must be made for such plots identifying them as "large-scale deforestation."

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[21] To guide this step, a description of the jurisdiction-specific characteristics of planned deforestation must be developed and documented in the Standard Operating Procedure for Sample Plot Interpretation. The analyst should consider the local context and apply a jurisdiction-specific decision tree for identifying planned and unplanned deforestation.

Data Analysis

The sample-based approach produces counts of observations of sample units within each sampling stratum.

Such sample unit counts are denominated as $CountJ_{CHC,ss}$ for the CHC change categories deforestation, reforestation, stable forest and stable non-forest in the SS sampling strata. The counts of classified sample units must be summarized following the format in Table 12.

Table 12: Format for recording plot observations, with reference to associated parameter names

		Change Categories (CHC)				
		Unplanned Deforestation	Stable Forest	Stable Non-Forest	Forest Regrowth	*ss* Total
Sampling Stratum (*SS*)	ss = 1	$CountJ_{deforestation,ss=1}$	$CountJ_{stable-forest,ss=1}$	...	...	$CountJ_{ss=1}$
	ss = 2	$CountJ_{deforestation,ss=2}$	$CountJ_{stable-forest,ss=2}$	...	...	$CountJ_{ss=2}$
	ss = 3	$CountJ_{deforestation,ss=3}$	$CountJ_{stable-forest,ss=3}$	...	...	$CountJ_{ss=SS}$
	Totals	$CountJ_{deforestation}$	$CountJ_{stable-forest}$			[table total]
	CHC totals	$CountJ_{deforestation}$	$CountJ_{stable forest}$	...	...	$CountJ$

Parameters for stable non-forest and forest regrowth follow the pattern of deforestation in but are omitted for space.

The count of sample unit observations made in each sampling stratum ss is denoted as $CountJ_{ss}$.

Sampling stratum weights ws_{ss} must be calculated for the 1, 2, 3, …, SS strata by dividing the mapped area of each sampling stratum (AJ_{ss}) by the total area of the jurisdiction (AJ). Because sampling strata are only defined for the sampling frame, AJ_{ss} should not include any areas from the jurisdiction with an identified exclusion (Table 13).

Table 13: Calculation of sample stratum weights

Sampling stratum (SS)	Sampling stratum area (hectares)	Stratum weight (ratio)
Stratum 1	$AJ_{ss=1}$	$ws_{ss=1} = AJ_{ss=1} / AJ$
Stratum 2	$AJ_{ss=2}$	$ws_{ss=2} = AJ_{ss=2} / AJ$

Sampling stratum (SS)	Sampling stratum area (hectares)	Stratum weight (ratio)
Stratum SS	$AJ_{ss=SS}$	$ws_{ss=SS} = AJ_{ss=SS} \, / \, AJ$
Total	$AJ - AJ_{excluded}$	$1 - (AJ_{-excluded} \, / \, AJ)$

Sample strata weights (ws_{ss}) sum to one minus the fraction of the jurisdiction covered by identified exclusions.

The counts of sample units observed within each sampling stratum ($CountJ_{ss}$), counts of sample units classified as deforestation, stable forest, stable non-forest and reforest ($CountJ_{UDef,ss}$, $CountJ_{SF,ss}$, $CountJ_{SNF,ss}$, $CountJ_{Ref,ss}$) and the strata weights (ws_{ss}) are used to estimate the proportion of the jurisdiction classified as deforestation, stable forest, stable non-forest and reforest ($PropJ_{UDef,ss}$, $PropJ_{SF,ss}$, $PropJ_{SNF,ss}$, $PropJ_{Ref,ss}$). For each stratum weight, the area proportions must be calculated by multiplying by the weight of the stratum and by dividing by the total count for the respective stratum, as follows, with an example shown for deforestation:

$$PropJ_{CHC,ss} = ws_{ss} \times CountJ_{CHC,ss} \, / \, CountJ_{ss}$$

(53)

Where:

$PropJ_{CHC,ss}$ = Weighted proportion of AJ that falls into sampling stratum ss and is classified as change category CHC (dimensionless)

ws_{ss} = Weight of sampling stratum ss (dimensionless)

$CountJ_{CHC,ss}$ = Total count of sample units that fall into sampling stratum ss and change category CHC (sample units)

$CountJ_{ss}$ = Total count of sample units in stratum ss (sample units)

CHC = Change category: unplanned deforestation ($UDef$), stable forest (SF), stable non-forest (SNF), regrowth (Reg)

ss = 1, 2, 3, …, SS sampling stratum

The resulting proportions must be summarized as illustrated in Table 14.

Table 14: Format for recording the estimated proportions of jurisdiction, with reference to associated parameter names

Strata (*ss*)	Change Categories (CHC)			Stratum total
	Change Category 1 (e.g., deforestation)	Change Category 2 (e.g., stable forest)	Change Category	Stratum total
Stratum 1	$PropJ_{CHC=1,ss=1}$	$PropJ_{CHC=2,ss=1}$	...	$WS_{ss=1}$
Stratum 2	$PropJ_{CHC=1,ss=2}$	$PropJ_{CHC=2,ss=2}$	...	$WS_{ss=2}$
Stratum SS	$PropJ_{CHC=1,ss=SS}$	$PropJ_{CHC=2,ss=SS}$	...	$WS_{ss=SS}$
CHC total	$PropJ_{CHC=1}$	$PropJ_{CHC=2}$	...	

Parameters for stable non-forest and forest regrowth follow the pattern of deforestation in , but are omitted for space.

Step 2: Calculate the Total Historical Area of Each Change Category

Estimate the area within the jurisdiction classified under each change category using the column totals for the proportions estimated in , summing across sampling strata and change categories as follows:

$$AJ_{CHC} = \sum_{ss=1}^{SS} PropJ_{CHC,ss} \times AJ \tag{54}$$

Where:

AJ_{CHC} = Area of the jurisdiction classified as change category CHC[22] over the HRP (ha)

$PropJ_{CHC,ss}$ = Weighted proportion of *AJ* that falls into sampling stratum *ss* and is classified as change category *CHC* (dimensionless)

AJ = Area of the jurisdiction (ha)

CHC = Change category: unplanned deforestation (*UDef*), stable forest (*SF*), stable non-forest (*SNF*), regrowth (*Reg*)

ss = 1, 2, 3, ..., SS sampling strata

---

[22] Represents the parameter associated with each change category i.e. AJ_{UDef}, AJ_{SF}, AJ_{SNF} and AJ_{Reg}

A conservative discounting should be applied to the estimated areas of historical deforestation based on their assessed uncertainty (see Steps 3–4 below).

Step 3: Calculate the Uncertainty of Estimated Historical Areas of Each Change Category

Calculate the standard error of the proportions and areas:

$$S(PropJ_{CHC}) = \sqrt{\sum_{ss=1}^{ss} \frac{ws_{ss}^2 \times \frac{CountJ_{CHC,ss}}{CountJ_{ss}} \times \left(1 - \frac{CountJ_{CHC,ss}}{CountJ_{ss}}\right)}{CountJ_{ss} - 1}} \tag{55}$$

$$S(AJ_{CHC}) = S(PropJ_{CHC}) \times AJ \tag{56}$$

Where:

$S(PropJ_{CHC})$	=	Standard error of the proportion of AJ with change category CHC (dimensionless)
$PropJ_{CHC}$	=	Proportion of AJ with change category CHC (dimensionless)
ws_{ss}	=	Weight of sampling stratum ss (dimensionless)
$CountJ_{CHC,ss}$	=	Total count of sample units that fall into sampling stratum ss and change category CHC (sample units)
$CountJ_{ss}$	=	Total count of sample units in stratum ss (sample units)
AJ_{CHC}	=	Area of the jurisdiction classified as change category CHC over the HRP (ha)
$S(AJ_{CHC})$	=	Standard error of the area with change category CHC (ha)
AJ	=	Area of the jurisdiction (ha)
CHC	=	Change category: unplanned deforestation ($UDef$), stable forest (SF), stable non-forest (SNF), regrowth (Reg)
ss	=	1, 2, 3, …, SS sampling stratum

The remaining steps in Section A1.4 Compilation and Allocation of Unplanned Deforestation AD

are undertaken on for the change category (CHC) unplanned deforestation (UDef). All remaining equations expressing a UDef subscript in place of CHC, and can be understood as CHC=UDef.

Calculate the percentage uncertainty of the estimated area. The percentage uncertainty is defined as the half-width of the two-sided 90 percent confidence interval, expressed as a percentage of the estimated area.

$$U\%(AJ_{UDef}) = t_{alpha=10\%} \times \frac{S(AJ_{UDef})}{AJ_{UDef}} \times 100 \tag{57}$$

Where:

$U\%(AJ_{UDef})$ = Percentage uncertainty of the estimated area of unplanned deforestation (where CHC=UDef) within the jurisdiction over the HRP (%)

$S(AJ_{UDef})$ = Standard error of the estimated area of unplanned deforestation (where CHC=UDef) within the jurisdiction over the HRP (ha)

AJ_{UDef} = Undiscounted area of change category (CHC) unplanned deforestation (UDef) within the jurisdiction over the HRP (ha)

$t_{alpha=10\%}$ = Value of the t-distribution for a two-sided 90 percent confidence interval (a value of 1.6449 may be used for activity data analyses)

Step 4: Conservatively Discount the Estimated Area of Historical Unplanned Deforestation

The estimated historical area of unplanned deforestation is discounted based on its uncertainty level. Where the percentage uncertainty of the estimated transition area is less than or equal to 10 percent, the estimate is used without modification and the discount factor is 0. Estimates with uncertainty levels above 20 percent are not admissible. Where the percentage uncertainty is between 10 percent and 20 percent, the area estimate must be scaled down by discount factor *DF*.

The discount factor *DF* is calculated as follows:

$$DF_{UDef} = \frac{U\%(AJ_{UDef})}{100 \times t_{alpha=10\%}} \times t_{alpha=66.66\%} \tag{58}$$

Where:

DF_{UDef} = Discount factor for unplanned deforestation (%)

$U\%(AJ_{UDef})$ = Percentage uncertainty of the estimated area of unplanned deforestation (where CHC=UDef) within the jurisdiction over the HRP (%)

$t_{alpha=10\%}$ = Value of the t-distribution for a two-sided 90 percent confidence interval (a value 1.6449 may be used for activity data analyses)

$t_{alpha=66.6\%}$ = Value of the t-distribution for a one-sided 66.66% confidence interval (a value of 0.4307 may be used for activity data analyses)

Using the estimated area and the discount factors, calculate the final AD values:

$$AJc_{UDef} = AJ_{UDef} \times \left(1 - DF_{UDef}\right)$$

(59)

Where:

AJc_{UDef} = Area of unplanned deforestation within the jurisdiction over the HRP, conservatively discounted for uncertainty (ha)

AJ_{UDef} = Undiscounted area of change category (CHC) unplanned deforestation (UDef) within the jurisdiction over the HRP (ha)

DF_{UDef} = Discount factor for unplanned deforestation (%)

A1.4.2 Determine the Jurisdictional AD for Unplanned Deforestation

Areas of change are annualized by dividing the area experiencing change by the number of years elapsed from the start to the end date of the HRP.

The timespan between the start and end of the HRP must be based on the average acquisition dates of the images used to generate observations (or dates of field observations) and must be consistent with the start and end date reported in the *AD Baseline Allocation Report*.

Alignment between the BVP and the HRP is ensured as follows:

1. The HRP end date (HRP_end) should differ by no more than one year from the start date of the BVP; or

2. The historical period calculated as the difference between HRP_start and HRP_end should not be shorter or longer than half a year (i.e., ±6 months) from the nominal length of the HRP.

3. Where either of these conditions cannot be met due to data availability, Verra must determine which criterion will be modified.

$$HRP\_start = \sum_{ss=1}^{SS} \left(\frac{\sum_{s=1}^{S} t_{start,ss,s}}{CountJ_{ss}} \times ws_{ss} \right)$$

(60)

$$HRP\_end = \sum_{ss=1}^{SS} \left(\frac{\sum_{s=1}^{S} t_{end,ss,s}}{CountJ_{ss}} \times ws_{ss} \right)$$

(61)

Where:

HRP_start = Area-weighted average date of imagery used for interpretation of sample plots at the start of the HRP (decimal year)

HRP_end	=	Area-weighted average date of imagery used for interpretation of sample plots at the end of the HRP (decimal year)
$t_{start,ss,s}$	=	Acquisition date of image for sample s in sampling stratum ss (decimal year)
$t_{end,ss,s}$	=	Acquisition date of image for sample s classified in sampling stratum ss (decimal year)
CountJ$_{ss}$	=	Total count of sample units in stratum ss *(sample units)*
ws$_{ss}$	=	Weight of sampling stratum ss (dimensionless)
ss	=	1, 2, 3, …, SS sampling stratum
s	=	1, 2, 3, …, S sample unit

The estimated area of unplanned deforestation in the jurisdiction, conservatively discounted for uncertainty, is annualized by dividing by the number of years elapsed from the start to the end date of the HRP:

$$Annualized\ AJc_{UDef} = \frac{AJc_{UDef}}{HRP\_end - HRP\_start}$$

(62)

Where:

Annualized AJc$_{UDef}$		Average annual area of unplanned deforestation within the jurisdiction over the HRP, conservatively discounted for uncertainty (ha y^{-1})
AJc$_{UDef}$		Area of unplanned deforestation within the jurisdiction over the HRP, conservatively discounted for uncertainty (ha)
HRP_end	=	Area-weighted average date of imagery used for interpretation of sample plots at the end of the HRP (decimal year)
HRP_start	=	Area-weighted average date of imagery used for interpretation of sample plots at the start of the HRP (decimal year)

A1.4.3 Allocation of Jurisdictional Baseline AD for Unplanned Deforestation to PA and LB

The annualized jurisdictional AD is spatially distributed across the jurisdiction (including 10 km buffer where required) according to the risk of deforestation so that areas of high risk receive a higher allocation than areas of low risk. Therefore, a deforestation risk map must be constructed by applying the deforestation risk modeling and mapping procedure. This procedure requires an FCBM as input. Once the deforestation risk map is constructed and the AD is determined, *UDef-AP* is used to allocate portions of the jurisdictional AD to the PA and LB according to the risk classes within these areas. The project developer then distributes the AD portions allocated to each risk class across forest strata and multiplies the per forest stratum

AD with the corresponding average emission factors to calculate the emission baseline for unplanned deforestation in the PA and LB.

This entire process is developed by applying the following steps, summarized below. Step 1 is fully described here. Steps 2–3 are described but require application of the deforestation risk modeling and mapping procedure followed by the allocation tool. Steps 4–7 are listed here but are fully described in Section 5.3.2 where they are completed by the project proponent.

Undertaken by Verra:

Step 1. Create a jurisdictional FCBM for the HRP.

Step 2. Using the deforestation risk modeling and mapping procedure, stratify into categorical risk classes the areas of stable forest that exist at the end date of the HRP.

Step 3. Using the *UDef-AP* tool, allocate portions of the jurisdictional AD baseline for a given BVP to the risk classes that exist in the areas of stable forest in the PA and LB.

Undertaken by project proponent:

Step 4. Stratify the area of stable forest at the end of the HRP in the PA and LB by risk class as mapped in the jurisdictional deforestation risk map, and by project-developed forest strata.

Step 5. Distribute the AD for the BVP allocated to each risk class across forest strata proportionally to their area within the project and LB.

Step 6. Estimate average emission factors per forest stratum within the PA and LB.

Step 7. Determine the baseline for unplanned deforestation of the PA and LB by multiplying the allocated portions of the AD within the BVP per forest stratum by their corresponding emission factors.

Step 1: Construct Jurisdictional Forest Cover Benchmark Map

Conduct Jurisdictional Mapping

Verra will construct a jurisdictional raster FCBM covering the jurisdictional area, plus a buffer of at least 10 km outside the boundary of the jurisdiction (excluding areas outside of the national borders and areas mapped as identified exclusions), which is needed for using *UDef-RP* and *UDef-AP*. The spatial resolution of the raster file must be consistent with the minimum area threshold of the forest definition.

The FCBM is a single map that is constructed by first mapping the presence or absence of forests at the start, mid-point and end of the HRP, resulting in the eight unique combinations or

forest transitions listed in Table 15. For the primary imagery dataset, a spatial resolution of 30 m or finer must be used for all time periods.

These eight transitions are summarized into four simplified categories (stable non-forest, stable forest, deforestation in the first half of the HRP and deforestation in the second half of the HRP) for use with the deforestation risk modeling and mapping procedure, as follows:

- Areas mapped as non-forest at the start of the HRP are considered stable non-forest, regardless of subsequent land cover.

- Areas mapped as forest for all three periods are considered as stable forest.

- Areas mapped as forest at the start of the HRP and non-forest at the midpoint of the HRP are considered deforested in the first half of the HRP, regardless of subsequent land cover.

- Areas mapped as forest at the start and midpoint of the HRP and non-forest at the end of the HRP are considered deforested in the second half of the HRP.

Table 15: Interpretation of FCBM into simplified classes for use in *UDef-RP*

HRP Start Year Forest	HRP Midpoint Forest	HRP End Year Forest	Forest Transition Values	Interpreted Classes for Use in risk mapping Tool	Class Key for Use in risk mapping Tool
No	No	No	1	1	Stable non-forest
No	No	Yes	2	1	Stable non-forest
No	Yes	No	3	1	Stable non-forest
No	Yes	Yes	4	1	Stable non-forest
Yes	Yes	Yes	5	2	Stable forest
Yes	No	No	6	3	Deforested in first half of HRP
Yes	No	Yes	7	3	Deforested in first half of HRP
Yes	Yes	No	8	4	Deforested in second half of HRP

Accuracy Assessment of the Jurisdictional FCBM

The accuracy of areas of *FCBM_j* must be assessed by comparison against sample-based observations. Two components of accuracy must be assessed:

1) **Deforestation between the start and end of HRP**: the user's and producer's accuracies must each be 70 percent or greater for areas mapped as deforestation over the HRP.

2) **Forest at the end of the HRP:** user's and producer's accuracies must each be greater than 90 percent for areas mapped as forest at the end of the HRP.

Where it is demonstrated that 50 percent or more of the forest area of the jurisdiction has a canopy cover of less than 50 percent, the following accuracy standards may be applied:

1) **Deforestation between the start and end of HRP:** the user's and producer's accuracies must each be 60 percent or greater for areas mapped as deforestation over the HRP.

2) **Forest at the end of the HRP:** user's and producer's accuracies must each be greater than 80 percent for areas mapped as forest at the end of the HRP.

The eight forest transition values are summarized as three simplified categories: (1) Non-forest at the end of the HRP; (2) Forest at the end of the HRP; and (3) Deforested within the HRP (Table 16).

Table 16: Interpretation of FCBM into simplified classes for accuracy assessment

HRP Start Year Forest	HRP Midpoint Forest	HRP End Year Forest	Forest Transition Values	Interpreted Classes for Accuracy Assessment	Class Key for FCBM Accuracy Assessment
No	No	No	1	1	Non-forest at end of HRP
No	No	Yes	2	2	Forest at end of HRP
No	Yes	No	3	1	Non-forest remaining non-forest
No	Yes	Yes	4	2	Forest at end of HRP
Yes	Yes	Yes	5	2	Forest at end of HRP
Yes	No	No	6	3	Deforested within HRP
Yes	No	Yes	7	3	Deforested within HRP
Yes	Yes	No	8	3	Deforested within HRP

Accuracy assessment observations must follow the same protocol for imagery interpretation used in AD development.

To assess the accuracy of the two main classes (area of deforestation over the HRP and area of forest at end of the HRP), a minimum of 100 sample observations should be made of the target

and non-target classes (totaling a minimum of 200 observations per estimate). Observations should be spatially representative of the entire FCBM. A single observation may be used to inform both estimates.

The sample-based observations used for this accuracy assessment incorporate some of the sample observations collected for AD development. Additional sample observations may be taken to ensure that mapped classes reach the minimum required number or to achieve spatial representativeness of the $FCBM_j$.

Where Relevant, Integrate Project FCBMs into Jurisdictional FCBMs

During the development of jurisdictional FCBM ($FCBM_j$), all proponents of projects either currently active or in the VCS pipeline and anticipating validation within the BVP are allowed to submit project-specific FCBM ($FCBM_p$) encompassing the PAs and LBs associated with the same periods for which the jurisdictional FCBM is being developed.

For each $FCBM_p$ submission, the following assessment is undertaken:

- The accuracy of each submitted $FCBM_p$ must be assessed using the same accuracy criteria and minimum sampling size as are applied to the $FCBM_j$, and using the same SOP for image interpretation used to develop jurisdictional AD. A coordinated sampling effort may be designed to support AD development and accuracy assessment of $FCBM_p$. Where the mapped area of deforestation in an $FCBM_p$ is not sufficiently large to accommodate 100 sample points, the sample size may be reduced such that all sample points are delineated without overlapping one another.

- Simultaneously, accuracy of the jurisdictional FCBM within the spatial boundaries of the $FCBM_p$ must be assessed using the same sample.

- Where the $FCBM_p$ is shown to provide substantially more accurate estimates of the two main classes (area of deforestation over the HRP and area of forest at the end of HRP) than the jurisdictional FCBM, the $FCBM_p$ must replace the portions of the jurisdictional FCBM with which it intersects. "Substantially more accurate" is defined in this assessment as meeting both of the following conditions:

  i) The average of the user's and producer's accuracies of the forest area at the end of the HRP, as calculated from the $FCBM_p$, is greater by at least 5 percent than the same average calculated from the same spatial extent of the jurisdictional FCBM; and

  ii) The average of the user's and producer's accuracies of the area of deforestation over the HRP, as calculated from the $FCBM_p$, is greater by at least 5 percent than the same average calculated from the same spatial extent of the jurisdictional FCBM.

For example, where the jurisdictional FCBM, when assessed strictly within the boundaries of the $FCBM_p$, is found to have average user's and producer's accuracies of 65 percent, the

$FCBM_p$ must achieve average accuracies of 70 percent or greater to be incorporated. Note that the $FCBM_p$ accuracies are not compared to accuracies for the entire jurisdictional FCBM, but only to those areas of the jurisdictional FCBM that overlap spatially with the $FCBM_p$.

- An $FCBM_p$ meeting conditions i) and ii) must be incorporated directly into the $FCBM_j$ by replacing any mapped values with those depicted on the $FCBM_p$. An $FCBM_p$ failing either condition i) or ii) must not be incorporated directly into the jurisdictional FCBM. After all $FCBM_p$ have been assessed and any potential modifications to the jurisdictional FCBM have been made, the resulting modified map retains the name "jurisdictional FCBM." Projects wishing to submit $FCBM_p$ after a jurisdictional FCBM has been validated must wait until the commencement of data development for the subsequent BVP.

Reassign AD for Areas within Identified Exclusions

The final jurisdictional FCBM is subjected to a final adjustment to reassign specific AD that fall within areas mapped as identified exclusions. Any deforestation in identified exclusion areas (mapped as a forest to non-forest transition - interpreted classes 3 and 4 in Table 15) in the final jurisdictional FCBM are reassigned to stable non-forest. This reassignment ensures that these forest clearings are not used to inform the risk modeling of unplanned deforestation. The reassignment of classes of the FCBM is depicted in Table 17.

Table 17: Reassignment of FCBM class prior to application within *UDef-RP*

Area Mapped as Identified Exclusions	Identified Exclusion Category	Included in Juris. Sampling Frame	Include in FCBM	Interpreted Classes for Use in Risk Mapping (from Table 15)	Reassignment of Class for Use in Risk Mapping	Assigned Risk Class
Yes	Active commercial plantations Intertidal zone	No	Yes	1 – Stable non-forest	1 – Stable non-forest	N/A
				2 – Stable forest	2 – Stable forest	Zero
				3 – Deforested in first half of HRP	1 – Stable non-forest	N/A
				4 – Deforested in second half of HRP		
	Infrequent, large natural disturbances Large-scale infrastructure	No	Yes	3 – Deforested in first half of HRP	1 – Stable non-forest	N/A
				4 – Deforested in second half of HRP		
	Permanent bodies of water	No	Yes	1 – Stable non-forest	1 - Stable non-forest	N/A
No	N/A	Yes	Yes	Per	No reassignment	As modeled by *UDef-RP*

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Step 2: Develop a Jurisdictional Deforestation Risk Map Using the *Unplanned Deforestation Risk Mapping and Modeling Procedure*

A jurisdictional deforestation risk map – a digital map covering the extent of the jurisdiction that indicates, for every location mapped as forest, the relative risk of undergoing deforestation during the BVP – must be developed by employing the latest approved version of the deforestation risk modeling and mapping procedure and the $FCBM_j$ resulting from Step 1. The resulting risk map assigns a categorical risk class to each location mapped as stable forest in the final jurisdictional $FCBM_j$.

The risk map is then further adjusted by modifying the risk category assigned to areas of stable forest that fall within an identified exclusion area. These forests should be assigned a zero-deforestation risk to ensure that no AD is allocated to forests that are not eligible for avoiding UDef projects and were not sampled to generate UDef AD.

Step 3: Allocate Projected AD to Risk Classes within PA and LB Using the *Unplanned Deforestation Activity Data Allocation Procedure*

The latest approved version of the *UDef-AP* must be used to allocate portions of the AD over the BVP to the PAs and LBs of all existing VCS registered projects, projects in the VCS pipeline and any other planned projects for which the proponent has applied for a baseline AD allocation for unplanned deforestation.

The application of the *UDef-AP* will require the following:

- Digital map of jurisdictional boundaries;

- FCBMs ($FCBM_j$);

- Digital maps of PAs and LBs; and

- Jurisdictional deforestation risk map.

AD Baseline Allocation to UDef Pas and LBs

Application of the *UDef-AP* generates a table containing the AD baseline associated with each risk class intersecting each UDef PA and UDef LB.

Baseline AD allocations to project PA and LB are termed $AD_{PA,UDef,pr,r}$ and $AD_{LB,UDef,pr,r}$.

Where:

$AD_{PA,UDef,pr,r}$ = Portion of the jurisdictional unplanned deforestation activity data baseline allocated to unplanned deforestation project area of project *pr* in risk class *r* (ha)

$AD_{LB,UDef,pr,r}$ = Portion of the jurisdictional unplanned deforestation activity data baseline allocated to unplanned deforestation leakage belt of project *pr* in risk class *r* (ha)

pr = 1, 2, 3, ..., *PR* avoiding unplanned deforestation projects requesting allocation of a portion of the jurisdictional activity data

r = 1, 2, 3, ..., *R* risk class

LBs must not extend beyond national boundaries.

Where a portion of an LB extends beyond the boundary of the jurisdiction into another part of the country, AD are allocated to that portion of the leakage belt as follows.

- Where the portion of the LB outside of the jurisdiction falls into a separate VCS avoiding UDef jurisdiction from that to which the associated project belongs, that portion receives its AD allocation from the adjoining jurisdiction''s most recent jurisdictional deforestation risk map and AD. Where the adjoining VCS avoiding UDef jurisdiction's BVP ends prior to the end of the project jurisdiction's BVP, AD is allocated until the end of the project jurisdiction's associated BVP by assuming that the annualized AD allocation for the remaining years of the adjoining jurisdiction's BVP continues until the end of the project jurisdiction's BVP.

- Where the portion of the LB outside of the jurisdiction does not fall into a separate VCS avoiding UDef jurisdiction, then a separate risk class - "extra-jurisdictional" *exJ* - is defined to encompass this portion.

AD allocation is calculated as follows:

$$AD_{LB,UDef,pr,r=exJ} = \frac{A_{LB,UDef,pr,r=exJ}}{A_{LB,UDef,pr} - A_{LB,UDef,pr,r=exJ}} \times \sum_{r=1}^{R} AD_{LB,UDef,pr,r} \qquad (63)$$

Where:

$AD_{LB,UDef,pr,r=exJ}$ = Unplanned deforestation activity data baseline allocated to unplanned deforestation leakage belt of project *pr* in risk class *exJ* (ha)

$A_{LB,UDef,pr}$ = Area of the unplanned deforestation leakage belt of project *pr* (ha)

$A_{LB,UDef,pr,r=exJ}$ = Area of the unplanned deforestation leakage belt of project *pr* in risk class *exJ* (ha)

$A_{LB,UDef,pr,r}$ = Portion of the jurisdictional unplanned deforestation activity data baseline allocated to unplanned deforestation leakage belt of project *pr* in risk class *r* (ha)

pr = 1, 2, 3, ..., *PR* avoiding unplanned deforestation projects requesting allocation of a portion of the jurisdictional activity data

r = 1, 2, 3, ..., *R* risk class

Delivery of Data to Project Proponents in *AD Baseline Allocation Report*

AD will be provided to project proponents by Verra as a part of the *AD Baseline Allocation Report*, including:

1) The table containing the total AD allocation to each risk class for the PA and LB over the BVP;

2) The jurisdictional FCBM; and

3) The jurisdictional deforestation risk map.

The AD values contained in the project-specific tables are assigned the parameter names $AD_{PA\text{-}UDef,r}$ and $AD_{LB\text{-}UDef,r}$

Where:

$AD_{PA\text{-}UDef,r}$ = Activity data allocated to the unplanned deforestation project area in risk class r (ha y^{-1})

$AD_{LB\text{-}UDef,r}$ = Activity data allocated to the unplanned deforestation leakage belt in risk class r (ha y^{-1})

r = 1, 2, 3, ..., R risk class

A1.5 Updating the *AD Baseline Allocation Report*

The *AD Baseline Allocation Report* must be updated and revalidated prior to the start date of each subsequent BVP. Each updated *AD Baseline Allocation Report* will represent a new BVP.

Where compatible with the most recent version of this module, the updated *AD Baseline Allocation Report* must employ the same methods as those used in the initial *AD Baseline Allocation Report*, updated where needed (e.g., to enable the use of new satellite data sources).

APPENDIX 2: DEVELOPMENT OF JURISDICTIONAL DATA ON ACTIVITY SHIFTING BY GEOGRAPHICALLY MOBILE AGENTS FOR PROJECT LEAKAGE ESTIMATES

Note – these activities are undertaken by Verra at the start of each BVP.

Verra will estimate emissions from deforestation outside the LB are using a single emission factor encompassing all lands available for conversion to agricultural land use. This emission factor is approximated using area-weighted carbon stocks of all lands in the jurisdiction, forested and non-forested, that are assessed to be all of the following:

a) Physically accessible to geographically mobile deforestation agents;

b) Suitable for agriculture; and

c) Unprotected.

The following general steps are described in this section.

1. Spatially delineate all lands in the jurisdiction that are physically accessible to agents, suitable for agriculture, and unprotected.

2. Develop an area-weighted emission factor for activity shifting to outside the LB.

A2.1 Step 1: Spatially Delineate Land Available for Activity Shifting Outside the UDef PA and UDef LB

The area of forest and non-forest land within the jurisdictional boundaries that is available for leakage due to geographically mobile actors is determined by the spatial distribution of the following factors:

1) Suitability of land for agriculture;

2) Physical accessibility; and

3) Relative protection status.

Jurisdictional maps portraying each of these three factors must be constructed.

Suitability of Land for Agriculture

Using peer-reviewed and accuracy-assessed map-based sources, delineate the area of potentially arable land as follows. Lands currently managed under agricultural crop production must be excluded. All temperate and tropical natural forests are considered potentially arable excluding all areas with a slope in excess of 10 percent as well as forests on serpentine and flooded soils.

Other natural vegetation types 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 precipitation should be excluded from the estimation of potentially arable non-forest land. A minimum threshold of mean annual precipitation for rain-fed agriculture in the jurisdiction should be established and a map of mean annual precipitation should be used to conduct this analysis.

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."

Physical Accessibility

Potentially arable land must be physically accessible to transportation networks to be eligible for leakage due to geographically mobile actors. Physically accessible land is defined here as all potentially arable land within 10 km of an existing road.

The output of this analysis is a digital map of physically accessible land with all lands indicated to be either "accessible" or "inaccessible."

Relative Protection Status

The protection status of land limits its availability for migration. This module recognizes that the effective level of protection is often lower 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 to areas such as timber concessions and large privately held forests and non-forested land in which activities to exclude migrant settlement would typically be undertaken.

Protected lands should be considered to include all protected forests falling in IUCN categories I, II and III, all currently managed timber concessions and all existing UDef PAs and LBs associated with projects that have been validated or verified in the past five years.

The output of this analysis is a digital map of protection status with all lands assigned to be either "protected" or "unprotected."

The digital maps of potentially arable land, physically accessible land and protection status are combined into a single map. Lands indicated as either "not potentially arable," "inaccessible," or "protected" are considered "unavailable." All remaining lands are classified as "available."

The output of this analysis is a digital map of land available for activity shifting.

$A_{available}$ is then the calculated area of land "available."

A2.2 Step 2: Develop an Area-Weighted Emission Factor for Activity Shifting to Outside the LB

Emissions factors for lands subjected to activity shifting are estimated by conservatively assuming that activity shifting results in long-term agricultural land use.

For simplicity, the emission factor will represent the area-weighted carbon stock of available forests in the aboveground (*AB*) and belowground (*BB*) pools.

A carbon stratification map must be sourced to conduct a spatial overlay to identify the area of each jurisdictional carbon stratum that falls within the "available" category.

The carbon stratification map must be sourced from peer-reviewed forest carbon stock maps with consistent coverage of the jurisdiction. Overlaying the maps of "available" arable lands on the carbon stock maps will allow the derivation of the average stock across all relevant pixels. Where this stock is aboveground biomass only, belowground biomass should be added with a root-to-shoot ratio sourced from *IPCC Guidelines for National Greenhouse Gas Inventories*.

The output is a jurisdictional emission factor due to land cover transition in areas available for activity shifting outside the LB expressed as:

ΔC_{OLB} = Emissions from carbon stock change due to land cover transition in areas available for activity shifting outside the leakage belt (t CO_2e ha^{-1})

The jurisdictional emission factor due to land cover transition in areas available for activity shifting outside the LB will be estimated for each BVP and will be specified in the *AD Baseline Allocation Report*.

APPENDIX 3: THE PROJECT BASELINE DEVELOPMENT PROCESS

Development of an avoiding UDef project using this methodology requires the development of an emissions baseline using AD allocated to projects by Verra.

As described in Appendix 1 and Appendix 2, the jurisdictional average annual UDef rate and the jurisdictional emission factor for land cover transition in areas available for activity shifting outside the LB are produced by Verra and provided to project proponents. Project proponents then convert data for their projects into emission baselines using project-specific emission factors (as set out in Section 5.3.1.3).

Figure 6 and Figure 7 illustrate the high-level process for avoiding UDef projects applying this module.

**Figure 6: High-level baseline generation process for new projects**

Project proponent requests listing *under development*

↓

1. **Project proponent** submits *AD Allocation Request Form*

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2. **Verra** reviews submission in connection with registered JNR FRELs and programs

For a new jurisdiction or at the beginning of a baseline validity period

For a jurisdiction where there is an established baseline

3a. **Verra** collects activity data, develops risk maps, and proposes allocation to the project

3b. **Verra** proposes allocation to the project

4a. **Independent expert** assesses activity data, risk map and proposed allocations to projects

4b. **Independent expert** assesses proposed allocations to project

5. **Verra** issues *AD Baseline Allocation Report* to project proponent

6. **Project proponent** develops PD using baseline activity data allocation

↓

Project proponent requests listing *under validation*

Figure 7: High-level baseline generation process for registered projects
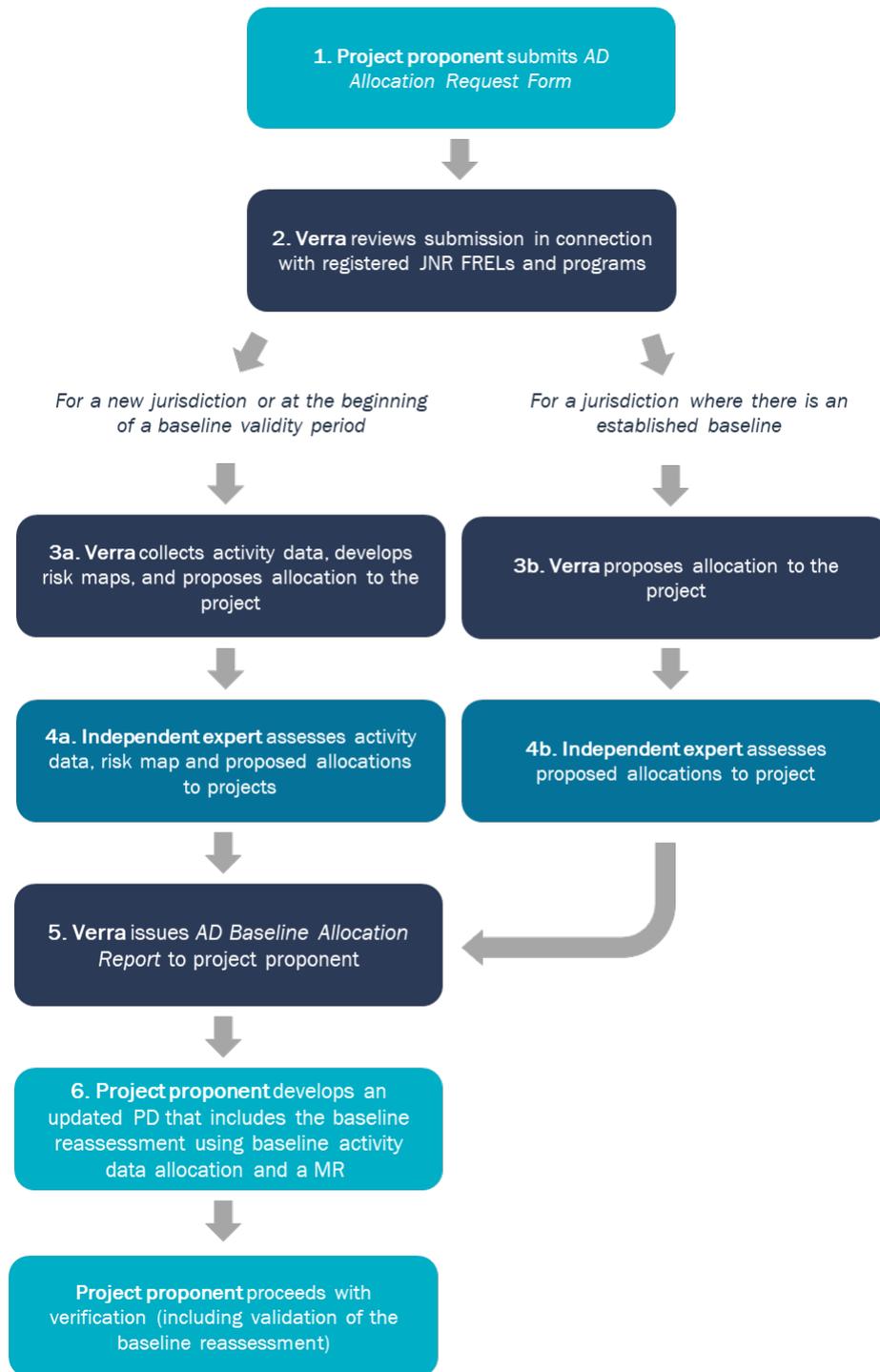
A3.1 Submission of Activity Data Baseline Allocation Request

To apply this module and develop a project description, project proponents must receive an *AD Baseline Allocation Report* from Verra. The report must be requested by submitting an *AD Baseline Allocation Request Form* via the Verra registry.

The request must contain the following for each PA or each project activity instance (in the case of grouped projects):

1) Name of the PA (e.g., compartment number, allotment number, local name, where relevant);

2) A KML file with geodetic polygons that precisely delineates the area where the project proponent has the legal right to control and operate project activities, as defined by the *VCS Standard*; and

3) The start date of the project or project activity instance.

Project proponents must request pipeline listing for a project as "under development" before or concurrently with submitting an *AD Baseline Allocation Request Form*. Project proponents are encouraged to request AD baseline allocation early in their development process but must submit an *AD Baseline Allocation Request Form* before they request pipeline listing as "under validation."

For grouped projects, an *AD Baseline Allocation Request Form* must be submitted each time a project activity instance is added to the project.

The *VCS Registration and Issuance Process* sets out the process for requesting and being allocated AD.

A3.2 Review of AD Baseline Allocation Requests

In reviewing the allocation request, Verra will consider the following:

1. Whether the project nests under a JNR Program:

   a) Where a project overlaps[23] fully with a program area of a registered JNR program, the project must nest according to the jurisdictional program's nesting scenario and follow the provisions of the program to establish its baseline. Unless the nesting

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[23] In this section, the overlap is to be understood as a geographical and temporal overlap. Temporal overlap means the project starts during the BVP.

provisions explicitly rely on Verra to allocate AD baseline, the AD baseline will directly be allocated by the jurisdictional program.[24]

b) Where a project partially overlaps with the boundaries of a registered JNR program, point a) above shall apply to the overlapping areas. Unless the nesting provisions of the JNR program rely on Verra to allocate AD baseline, AD will be allocated by the JNR program for the overlapping areas, and by Verra for the non-overlapping areas. Overlapping areas must nest under the JNR program according to the jurisdictional program's rules. Projects that partially overlap with a JNR program must be designed as *multiple project activities* and must refer to the related requirements in the most recent version of the *VCS Standard*.

c) Where a project overlaps with a JNR program in development (i.e., not yet registered), Verra will produce and allocate baseline AD for the overlapping area until the JNR program is registered, at which point projects will nest under the JNR program. The project's transition to the JNR nesting requirements is effective for the verification that follows the JNR program's registration, regardless of the number of years that are still valid under the Verra-allocated AD baseline.

2. Whether an existing jurisdictional baseline applies:

a) Where a project overlaps fully with a jurisdiction for which jurisdictional AD were previously developed by Verra, the project will receive its allocation in accordance with the previously developed data.

b) Where a project partially overlaps with a jurisdiction for which jurisdictional AD were previously developed by Verra, the project will be allocated baseline AD based on the previously developed data for the overlapping areas only. Verra will produce jurisdictional AD for the non-overlapping jurisdictions and allocate them to the relevant portion of the project.

c) Where no jurisdictional AD are available for a project, Verra will produce jurisdictional AD and allocate them to the project.

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[24] The project may still apply other portions of this methodology provided this is explicitly allowed by the JNR program.

A3.3 Process and Responsibilities for AD Baseline Allocation

A3.3.1 Allocation of Baseline AD to Project

Verra is responsible for allocating baseline AD to UDef PA and UDef LB[25] using the latest version of the *Unplanned Deforestation Activity Data Allocation Procedure (UDef-AP)*. As described in A1.4.3 Step 3 of Appendix 1, Verra posts an *AD Baseline Allocation Report* to the project's page on the Verra Registry.

The *AD Baseline Allocation Report* contains the information set out in Appendix 1 A1.1. Using this information, projects are responsible for allocating baseline AD to each forest strata of the UDef PA and UDef LB based on the relative area of each forest stratum within risk classes as described in Section 5.3.1.2 of this module. The results must be used to assess baseline GHG emissions and must be described in the project description.

Where the boundaries of the project area are altered during the validation or the registration process (e.g., as a result of a VVB corrective action request, or as a result of Verra's accuracy review), the project proponent must request a new AD baseline allocation using the corrected project area. Verra issues a revised *AD Baseline Allocation Report* that must be used to correct the baseline GHG emissions.

A3.3.2 Production of Jurisdictional AD Baseline

Jurisdictional AD baselines are produced by Verra following the procedures and requirements set out in Appendix 1.

AD baseline allocation requires prior production of jurisdictional AD baseline, jurisdictional FCBM and jurisdictional deforestation risk map. Project proponents, governments and other eligible stakeholders engaged in avoiding UDef project development in a jurisdiction may submit technical materials to Verra for review, consideration and potential incorporation into jurisdictional data products.

Once Verra has announced that AD will be produced for a given jurisdiction, a request for proposal (RFP) from potential DSPs will be issued publicly. Verra will select and contract a DSP considering their technical expertise, experience in the chosen jurisdiction, financial offer, and ability to deliver within the pre-determined timeframe.

DSPs act as agents of Verra; therefore, the work of the DSP is referred to as Verra's throughout this module.

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[25] See Section A1.2.1 and A1.2.2 to see how UDef PA and UDef LB are delineated by Verra based on the project area KML that will be provided by the project proponent when submitting the *AD Baseline Allocation Request Form*.

A3.3.3 Development of the Jurisdictional Deforestation Risk Map

The *Unplanned Deforestation Risk Modeling and Mapping Procedure (UDef-RP)*:

1. The benchmark risk mapping approach; and

2. The statistical methods for comparing the performance of alternative risk maps against the benchmark risk map.

Verra will apply procedures provided in the *UDef-RP* to develop a benchmark risk map and at least two alternative risk maps that incorporate identified risk factors. The best performing risk map will be adopted for use in the jurisdiction during the entirety of the respective validity period. Jurisdictional deforestation risk maps will be updated at the beginning of each subsequent validity period.

A3.3.4 Stakeholders' Contribution to Jurisdictional Products

Verra will take submissions of data products for a given jurisdiction related to AD collection and risk mapping. Stakeholders may submit materials, including datasets, maps, technical guidance, recommended definitions, and SOPs. A complete description of the types of technical materials permitted for submission and the duties of the data developer in responding to them are catalogued in Appendix 4.

Forest cover benchmark map data submissions may be jurisdictional in scope or restricted to the project areas and leakage belts of existing or proposed AUD projects.

Verra gives higher priority to the use of datasets from official government sources, such as those derived from national forest monitoring systems or REDD monitoring, reporting and verification platforms, provided those data sets and sources meet the standards and specifications described in Appendix 1.

A3.3.5 Expert Assessment of Jurisdictional Data

An independent expert will be contracted by Verra to assess the data and procedures used to construct the jurisdictional AD and deforestation risk map. The assessment process may require Verra to adjust the AD or risk map to ensure compliance with this methodology and associated modules and tools. Once validated, the jurisdictional AD and deforestation risk map will be adopted for allocation.

APPENDIX 4: DATA CONTRIBUTION BY STAKEHOLDERS

Verra is responsible for AD collection, risk map development and AD allocation. It will contract with data service providers (DSPs) to accomplish this.

Any stakeholder may provide data products related to AD collection and risk mapping for a given jurisdiction, provided these products meet the requirements set out in Table 18 below.

As a first step in the AD collection, risk mapping and allocation process, Verra will make a public announcement of a request for proposals for DSPs and submissions of supplementary materials. These roles are set out in Table 18 below.

Table 18: AD data collection, risk mapping and allocation roles

Primary Data Product	Submissions from Project Proponents, Governments, and Other Engaged Stakeholders	Data Service Provider Responsibilities
Jurisdictional Boundary Definition (Appendix 1 Section A1.2.1)	Proposed definition of jurisdiction and justification	None; final decision is made by Verra
Activity Data (Appendix 1 Sections A1.4.1 and A1.4.2)	Sample plot observations representative of the jurisdiction, including those developed for national FREL and by other groups that meet the standards described in Appendix 1 for sample plot observations, covering time period and resolution of source imagery. The imagery on which observations were made must be made available to the DSP to the highest degree feasible.	DSP must evaluate these materials and incorporate them to the highest degree feasible. Any observations that meet requirements must be retained. The DSP may collect additional plots to supplement national data for such purposes as reducing overall uncertainty to meet requirements and improving spatial representation of any areas not covered by national data.
	Supplementary materials, which may include any combination of: • Working definition of forest (where adjustments from official definition are needed for practical reasons); • Sample plot observations; • Spatial stratification of jurisdiction; • SOP for imagery interpretation;	DSP will: 1) Review all submissions. 2) Provide a response to each submission on whether and how the submission will be incorporated into the analysis plan. Where submissions represent official government data, the DSP should

	• Description of the jurisdiction-specific characteristics of planned deforestation; • SOP for identification of planned deforestation; and • Imagery data. Submissions must include a description of each item and the proposed application of the item within AD generation.	use these data where the data are shown to be of at least comparable fitness for purpose as other available data sources. Except in the case of official government data, DSP is not obligated to use any or all submissions in dataset generation.
Maps of Identified Exclusion Areas (Appendix 1 Section A1.4.1 Step 1)	Maps depicting any of the identified exclusion areas (active commercial plantations; intertidal zones; infrequent, large natural disturbances; large scale infrastructure; permanent bodies of water)	DSP will: 1) Review all submissions. 2) Provide a response to each submission on whether and how the submission will be incorporated into the analysis plan. Where submissions represent official government data, the DSP should use these data where the data are shown to be of at least comparable fitness for purpose as other available data sources. Except in the case of official government data, DSP is not obligated to use any or all submissions in dataset generation.
Map of Available Land for Activity Shifting (Appendix 1 Section A2.1)	May include any combination of: • Ancillary spatial data; • National carbon stock map; • Map of potentially arable land; • Map of protection status; and • Map of accessibility. Submissions must include a description of each item and the proposed application of the item within generation of the Map of Available Land for Activity Shifting.	DSP will: 1) Review all submissions. 2) Provide a response to each submission on whether and how the submission will be incorporated into the analysis plan. Where submissions represent official government data, the DSP should use these data where the data are shown to be of at least comparable fitness for purpose as other available data sources. Except in the case of official government data, DSP is not obligated to use any or all submissions in dataset generation.

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Forest Cover Benchmark Map (Appendix 1 Section A1.4.3)	May include any combination of: • Description of imagery classification approach; • Ancillary spatial data; • Calibration and validation points; • Delineation of planned deforestation areas; • Remote sensing data (e.g., imagery); • Land cover maps; and • Project-specific FCBM ($FCBM_p$). Submissions must include a description of each item, the proposed application of the item within FCBM generation and citations.	DSP will: 1) Review all submissions, including conducting an accuracy assessment on any $FCBM_p$s. 2) Provide a response to each submission on whether and how the submission will be incorporated into the analysis plan. Where submissions represent official government data, the DSP should use these data where the data are shown to be of at least comparable fitness for purpose as other available data sources. Except in the case of official government data, the DSP is not obligated to use any or all submissions in dataset generation.
Risk Map (*UDef-RP)*	Supplementary materials, including any combination of: • Description of drivers; • Spatial risk factor maps; and • Modeling algorithms. Submissions must include a description of each item and the proposed application of the item in risk map generation.	DSP will: 1) Review all submissions. 2) Provide a response to each submission on whether and how the submission will be incorporated into the analysis plan. Where submissions represent official government data, the DSP should use these data where the data are shown to be of at least comparable fitness for purpose as other available data sources. Except in the case of official government data, DSP is not obligated to use any or all submissions in dataset generation.
AD Allocation (Appendix 1 Section Step 3	None permitted	Conducted by the DSP unless a project proponent in the jurisdiction is the DSP. In that case, allocation will be conducted by Verra.