American Carbon Registry®
Trusted solutions for the carbon market

American Carbon Registry® Methodology for REDD—*Avoiding Planned Deforestation*

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CONTENTS

INTRODUCTION

The American Carbon Registry® (ACR) is a voluntary, online greenhouse gas (GHG) registration and emissions tracking system used by members to transparently register verified, project-based emissions reductions and removals as serialized offsets; record the purchase, sale, banking and retirement of tradable offsets, branded Emission Reduction Tons ("ERTs"); and optionally report, in a separate account, verified GHG inventories. ACR was founded in 1996 by the Environmental Resources Trust, and joined Winrock International in 2007.

The Winrock International Institute for Agricultural Development, a non-profit public benefit corporation founded in 1984, works with people in the U.S. and around the world to empower the disadvantaged, increase economic opportunity, and sustain natural resources. Key to this mission is building capacity for climate change mitigation and adaptation and leveraging the power of environmental markets. Since the 1990s, Winrock has been working to develop science-based GHG measurement and monitoring protocols, in particular in the area of Reducing Emissions from Deforestation and Degradation (REDD).

Purpose

REDD is an eligible project activity under the *ACR Forest Carbon Project Standard.* REDD is defined as the reduction in GHG emissions from the avoided conversion of forest to non-forest use or avoided degradation of forests remaining as forests.

This methodology is applicable only to the REDD sub-category Avoiding Planned Deforestation (APD). Separate ACR methodologies address other types of REDD such as avoiding unplanned deforestation and avoiding forest degradation through fuelwood and charcoal production.

Project Proponents wishing to register a REDD-APD project on ACR should follow this methodology and comply with the ACR *Forest Carbon Project Standard.* Proponents must submit a GHG Project Plan for certification by ACR and secure independent validation of the GHG Project Plan, and verification of GHG assertions, by an ACR-approved third-party verifier.

Project Proponents and other interested parties should refer to www.americancarbonregistry.org for the latest version of this methodology, the *ACR Standard,* ACR sector standards, and other relevant methodologies, tools, and templates. All ACR methodologies, whether developed by external parties or by Winrock, are approved for use on ACR only after a rigorous public consultation and scientific peer review process. Documentation of this process is posted at www.americancarbonregistry.org along with the methodology.

Outline

This REDD-APD methodology is organized as follows:

- **Chapter I** defines the overall scope of the methodology, definitions, applicability conditions that must be met in order to use the methodology, and criteria to demonstrate eligibility.
- **Chapter II** provides guidance for defining project boundaries, including geographic, temporal, and the GHG assessment boundary, and for significance testing to determine

whether some carbon pools and emission sources may be excluded from the GHG assessment boundary.

- **Chapter III** provides requirements for demonstrating additionality.
- **Chapter IV** provides a baseline methodology.
- **Chapter V** provides requirements for monitoring the with-project scenario.
- **Chapter VI** addresses permanence, describing requirements to assess reversal risk and mitigate reversals.
- **Chapter VII** provides procedures for *ex ante* estimation of total net GHG emission reductions and removals, including leakage and uncertainty deductions where required, and for the *ex ante* calculation of ERTs.
- **Chapter VIII** provides procedures for *ex post* calculation of ERTs.

A separate **Annex 1** provides an alphabetized reference for all data and parameters used in the methodology.

A separate ACR **Tool for Estimation of Stocks in Carbon Pools and Emissions from Emission Sources** (herein abbreviated **CPES**) is referenced in this methodology. CPES provides procedures for the estimation of carbon stocks and GHG emissions for each of those pools and emission sources identified as significant and selected for inclusion in the GHG assessment boundary. CPES provides parameters for both the baseline methodology (Chapter IV) and with-project scenario (Chapter V).

Cross-references throughout the document are provided in bold, referring to chapters within this document, to **Annex 1** for parameters, or to **CPES** for calculations of carbon pools and emission sources.

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I. SCOPE, DEFINITIONS, APPLICABILITY AND ELIGIBILITY

A. Scope

This methodology is applicable to all project activities that fall within the AFOLU project category REDD, as defined in the latest version of the *ACR Forest Carbon Project Standard*, and subcategory Avoiding Planned Deforestation (APD) as defined below. Gains in carbon stock are accounted in areas that are deforested in the baseline.

The methodology includes eligibility and additionality requirements as well as methods that provide for the development of the baseline and with-project scenarios; monitoring of carbon pools, emissions sources and leakage; quantification of the uncertainty and required uncertainty deductions; reversal risk mitigation; and *ex ante* and *ex post* calculation of ERTs.

REDD activities that avoid unplanned deforestation, or avoid emissions from forest degradation through fuelwood or charcoal production, are addressed in separate ACR methodologies.

B. Definitions

All definitions in the *Forest Carbon Project Standard* apply. Additional definitions used here are:

Reference Period refers to the historical period prior to the project Start Date that serves as the source of data for defining the baseline.

Avoiding Planned Deforestation (APD) refers to an activity that reduces GHG emissions by stopping deforestation on forest lands that are legally authorized and documented to be converted to non-forest land, and enhances carbon stocks of degraded and secondary forests (if present in the project area) that would be deforested in the absence of the project activity.

Note that illegal deforestation along a new legal road would be classed as unplanned deforestation. If resettlement schemes involve legal parcelization and legal ownership of land and clearance, this type of deforestation would be classed as planned.

Peat shall be defined as organic soils with at least 65% organic matter and a minimum thickness of 50 cm.[1] In the case of REDD, this situation is typically represented by peat swamp forests or mangrove forests.

C. Applicability Conditions

The following conditions must be met for this methodology to be used:

[1] Rieley, J.O. and S.E Page. 2005. Wise Use of Tropical Peatland: Focus on Southeast Asia. Alterra, Wageningen, The Netherlands. 237 p.

- Land in the project area must qualify as "forest," as defined in the *Forest Carbon Project Standard*, for at least 10 years before the project Start Date.[2]

- Project Proponents must be able to show control over the project area and ownership of carbon rights for the project area. Land tenure must be clear and uncontested; however, it is not required that the Project Proponent retains land ownership.

- All land areas registered under any other voluntary or regulatory carbon trading scheme must be transparently reported and excluded from the project area. The exclusion of land in the project area from any other carbon trading scheme shall be monitored over time and reported in the monitoring reports.

- Leakage avoidance activities shall not include agricultural lands that are flooded to increase production (e.g. paddy rice), nor intensifying livestock production through use of feed-lots[3] or manure lagoons.[4]

- Conversion of forest lands to a deforested condition must be legally permitted.

- Credible evidence and documentation must show that project lands would have been converted to non-forest use if not for the APD project.

- The total wood volume[5] to be extracted (as timber or for fuel or charcoal) in the baseline must be known.

[2] Per the *Forest Carbon Project Standard*, Project Proponents shall use a nationally approved "forest" definition for the country where the project activity occurs. For projects in Kyoto Protocol CDM countries, Proponents shall use the Kyoto Protocol definition, with the relevant Designated National Authority (DNA) selections for minimum land area, crown cover and tree height:

> *A minimum area of land of [0.05 – 1.0 hectares] with a minimum tree crown cover (or equivalent stocking level) of [10 – 30 percent] with trees, and with the potential to reach a minimum height of [2 – 5 meters] at maturity in situ. A forest may consist either of closed forest formations, where trees of various heights and undergrowth cover a large portion of the ground, or open forest. The definition includes young natural stands and all plantations that have yet to reach a crown density of [10 – 30 percent] or tree height of [2 – 5 meters], as well as areas that usually form part of the forest area but that are temporarily unstocked because of human intervention (e.g., harvesting) or natural causes, but likely will revert to forest.*

DNA selections for minimum land area, crown cover and tree height are at http://cdm.unfccc.int/DNA/allCountriesARInfos.html. If the project is in a country that has not yet designated a DNA or whose DNA has not yet made selections, the Proponent may propose another nationally approved forest definition.

For projects applying this methodology to avoided conversion of forest to non-forest in the United States, the applicable "forest" definition from the ACR *Forest Carbon Project Standard* shall be used.

[3] 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.

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

[5] Wood volumes shall be based on round wood/logs.

- If areas projected to be deforested in the baseline are not being converted to an alternative use but will be allowed to naturally regrow, this methodology shall not be used.

II. DEFINING PROJECT BOUNDARIES AND SELECTING POOLS AND SOURCES

The project boundary includes the geographic implementation area, temporal boundaries, GHG assessment boundary (carbon pools and emission sources significantly affected), and sources of potential leakage.

A. Geographic Boundaries

The boundary of the APD activity shall include only lands qualifying as "forest"[6] for a minimum of 10 years prior to the Start Date. Project lands shall be under the control of the Project Proponent.

Proponents shall clearly define the spatial boundaries of a project so as to facilitate accurate measuring, monitoring, accounting, and verifying of the project's emissions reductions and removals. The project activity may contain more than one discrete area of land.

When describing geographic boundaries, the following information shall be provided for each area:

- Name of the project area (e.g., compartment number, allotment number, local name);
- Unique ID for each discrete parcel of land;
- Map(s) of the area, preferably in digital format;
- Geographic coordinates of each polygon vertex along with documentation of accuracy, preferably obtained from a GPS or geo-referenced digital map. Error must be ≤ 30 m;
- Total land area;
- Details of forestland rights holder and user rights.

Geographic boundaries of specific deforestation parcels are fixed *ex ante* and cannot change over the Crediting Period *ex post*. New deforestation parcels may be added ex post and will be subject to additionality and baseline validation at the time of the next verification.

For APD project activities, in addition to the project area, proxy area(s) must be defined for baseline monitoring purposes (see **IV.B**).

Where multiple baselines exist (planned deforestation, unplanned deforestation, forest degradation), the areas of each eligible activity shall be delineated separately and there shall be no overlap between areas appropriate to each of the baselines.[7] Separate ACR methodologies shall be applied for avoiding unplanned deforestation and degradation.

Methods for establishing the boundaries of areas subject to leakage from activity shifting are provided in **V.E**.

[6] Per the definition in the ACR *Forest Carbon Project Standard*; see footnote 2.
[7] For planned and unplanned the baseline is based on the reference area and for degradation the baseline is based on the project area.

B. Temporal Boundaries

The following temporal boundaries shall be defined in the GHG Project Plan:

- Start and end of the Reference Period

The Reference Period is the temporal domain from which information on historical deforestation is extracted, analyzed and projected into the future. The start date of this period shall be between 9 and 15 years in the past and the end date shall be within 2 years of project Start Date.

- Start and end of the Crediting Period

Per the *Forest Carbon Project Standard,* project Start Date is the date by which the Project Proponent began the project activity on project lands; for REDD, when the Project Proponent implemented the project action physically and/or legally.

Crediting Period is the finite length of time during which the project's GHG Project Plan is valid, and during which a project can generate offsets for registration on ACR against its baseline. Crediting Period is the period of baseline validity. The approved Crediting Period for all REDD projects is ten (10) years.

See **VI.C** for additional detail.

- Date at which the project baseline shall be revised

In general, the baseline must be revised in order to renew the Crediting Period. This revision must occur at fixed ten year intervals. Revision may be needed more rapidly in the case of a reversal, in which case per the *Forest Carbon Project Standard* the baseline (and project-specific risk assessment) must be updated.

In the case of REDD-APD, because all planned deforestation in the baseline scenario must be projected to occur within a defined period of time, and because planned deforestation can be avoided only once, there will be a limited number of 10-year Crediting Periods. Therefore Project Proponents are not required to monitor and verify, only to document project continuance, after the end of the final Crediting Period in which deforestation is projected in order to continue receiving periodic refunds of earlier buffer contributions in the event of no reversals.[8]

- Duration of monitoring periods

Issuance of ERTs is subject to monitoring and verification. Because the ACR *Forest Carbon Project Standard* requires field verification no less frequently than every five (5) years, monitoring must also be conducted at least every 5 years. Monitoring may be conducted more frequently.

Baseline projections shall be annual and be available for each proposed future verification date. Data on baseline deforestation rates shall be included in the GHG Project Plan.

[8] See *Forest Carbon Project Standard,* Chapter 5 Sections E and G.

C. GHG Assessment Boundary (Pools and Sources)

1. Carbon pools

The carbon pools included in or excluded from the GHG assessment boundary are shown below.

Table 1: Carbon pools in REDD APD Project Activities

Carbon pools	Included / Excluded	Justification / Explanation of choice
Aboveground	Included	At minimum, the stock change in the aboveground tree biomass shall be estimated. If the non-herbaceous non-tree aboveground carbon stocks are greater in the post-deforestation stratum than the pre-deforestation stratum they must be estimated in the post-deforestation stratum.
Belowground	Included	Should be included as it is always significant, but omission is conservative.
Dead wood	Included	Shall be included if increases more or decrease less in baseline than project scenario and significant, otherwise can be conservatively omitted.
Harvested wood products	Included	Shall be included if increases more or decrease less in baseline than project scenario and significant, otherwise can be conservatively omitted.
Litter	Generally excluded	Generally not significant so project proponents may decide to conservatively omit.
Soil organic carbon	Included	May be included if emissions are greater in baseline than project scenario and significant. Exclusion is always conservative.

The Proponent shall account for any significant decrease in carbon stocks that is reasonably attributable to project activities. Harvested wood products and dead wood shall be included when they increase more or decrease less in the baseline than in the project scenario, and are significant. The significance testing tool in **II.C.3** shall be used to determine whether carbon pools are significant. Insignificant pools can always be ignored.

If a carbon pool is included in the baseline accounting, it shall also be included in project scenario and leakage accounting. The selection of carbon pools, justification for choices, and application of the significance tool shall be presented in the GHG Project Plan.

2. Sources of greenhouse gases

The Proponent shall account for any significant increases in emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) that are reasonably attributable to the project activity. The GHG emission sources included in or excluded from the project boundary are shown below.

Table 2: Sources of emissions and associated GHGs in REDD APD Project Activities

Sources	Gas	Included/Excluded	Justification / Explanation of choice
Biomass burning	CO_2	Excluded	However, carbon stock decreases due to burning are accounted as a carbon stock change.
	CH_4	Included	It is conservative to exclude non-CO_2 gases emitted from woody biomass burning in the baseline, but these must be included in the project case if fire occurs in areas that were projected to be deforested in the baseline.
	N_2O	Included	
Combustion of fossil fuels	CO_2	Included	Can be neglected if excluded from baseline accounting.
	CH_4	Excluded	Potential emissions are negligibly small.
	N_2O	Excluded	Potential emissions are negligibly small.
Use of fertilizers	CO_2	Excluded	Potential emissions are negligibly small.
	CH_4	Excluded	Potential emissions are negligibly small.
	N_2O	Included	Can be neglected if excluded from baseline accounting.

The significance testing tool in **II.C.3** shall be used to determine whether an emissions source is significant. If a source is included in the estimation of baseline emissions[9], it shall also be included in the calculation of project and leakage emissions. The selection of emission sources, justification for choices, and application of the significance tool shall be presented in the GHG Project Plan.

3. Procedure to determine the significance of emissions sources and changes in carbon pools in REDD APD Project Activities

Project Proponents shall use this procedure to determine which GHG emissions and changes in carbon pools are insignificant and may be excluded from baseline and project accounting. The procedure designates certain sources and pools as *a priori* insignificant, and provides a procedure to determine which additional sources and pools may be considered insignificant and thus excluded.

[9] E.g. CH_4 or N_2O emission from agriculture that results from deforestation or fire to clear forest land.

a. *A priori* insignificant sources and pools

The following emissions sources and carbon pools may be considered insignificant *a priori* and excluded from baseline and monitoring methodologies and *ex ante* calculations.

Emissions sources:

- Fertilizer application
- Removal of herbaceous vegetation
- Transportation
- Fossil fuel combustion
- Collection of wood from non-renewable sources to be used for fencing of the project area
- Nitrous oxide (N_2O) emissions from decomposition of litter and fine roots from N-fixing trees

Carbon pools:

- Litter

b. Testing significance of pools and sources not deemed insignificant *a priori*

Except in the case of sources and pools deemed insignificant *a priori*, the project must account for any significant increase in emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4), or significant reduction in carbon stocks, that is attributable to the project activity. Project proponents may opt for the inclusion of all carbon pools, in which case this procedure will not be used.

This procedure *may* be used if the carbon stock in harvested wood products, dead-wood, litter, or soil organic carbon increases more or decreases less in the baseline case than in the project case, to determine whether they are significant. This procedure *shall* be used if emissions sources in the project case are enhanced compared to the baseline case, and if carbon stocks in the project case are reduced compared to the baseline case, and the Project Proponent wishes not to account for them as they are insignificant.

The procedure to be applied is the CDM "Tool for testing significance of GHG emissions in A/R CDM project activities."[10] The tool requires an *ex ante* calculation of total project GHG benefits for the 10-year fixed baseline period.

c. Other conditions

The sum of all combined pools and sources excluded from accounting, aside from exclusions for conservative reasons, shall be less than 3% of total net GHG emissions reductions as defined in the *ex ante* estimation.[11]

[10] http://cdm.unfccc.int/EB/031/eb31_repan16s.pdf.
[11] See *ACR Forest Carbon Project Standard*, Chapter 2.

Even if listed as *a priori* insignificant, or determined to be insignificant through application of the procedure, if at the Proponent's discretion a particular pool or source is selected for accounting in the baseline, that pool or source shall be accounted for in the with-project scenario as well.

D. Sources of Leakage

Activity shifting leakage and market effects leakage, where applicable, must be accounted for following the guidance in **V.E** and **V.F** respectively. Market effects shall be considered where the project leads to a decrease in the production of timber.

Leakage prevention activities may lead to an increase in combustion of fossil fuels or use of fertilizers; however, any increase in emissions is considered insignificant.

As per the applicability conditions in **I.C**, leakage prevention may not include the flooding of agricultural lands (e.g. for new rice paddies), nor the creation of livestock feedlots and/or manure lagoons.

The list of leakage sources included, with appropriate justification, shall be presented in the GHG Project Plan.

III. DEMONSTRATING ADDITIONALITY

Project Proponents shall demonstrate additionality using the methods in this chapter, which is consistent with and amplifies the "three-prong" additionality test in the *Forest Carbon Project Standard*. The demonstration of additionality shall be presented in the GHG Project Plan.

A. Regulatory Surplus Test

The Project Proponent shall apply the guidance in the *Forest Carbon Project Standard,* Chapter 4, to demonstrate that there is no existing and enforced law, regulation, statute, legal ruling, or other regulatory framework in effect as of the Start Date that effectively requires the APD activity and its associated GHG emissions reductions/removals.

B. Demonstration and Assessment of Additionality in REDD APD Project Activities

This tool provides a step-by-step approach to identify credible alternative land use scenarios, evaluate both the alternatives and the proposed project scenario, and demonstrate the additionality of the project scenario.

In verifying the application of this tool, the verifier will assess credibility of all data, rationales, assumptions, justifications and documentation provided by the Proponent to support the selection of the baseline and demonstration of additionality.[12]

1. Procedure

Project Proponents shall apply Steps 0, 1, 2, 3 and/*or* 4, and 5:

- STEP 0. Preliminary screening based on the Start Date of the REDD project activity;
- STEP 1. Identification and demonstration of validity of planned deforestation activity
- STEP 2. Identification of alternative land use scenarios to the REDD project activity;
- STEP 3. Investment analysis to determine that the proposed project activity is not the most economically or financially attractive of the identified land use scenarios; *or*
- STEP 4. Barriers analysis; *and*
- STEP 5. Common practice analysis.

STEP 0. Preliminary screening based on the Start Date of the REDD project activity

Per the *Forest Carbon Project Standard*, the earliest project Start Date generally recognized is 1 November 1997. For projects started after this date, the Proponent must demonstrate additionality but is not required to document GHG mitigation as an original project objective.

For projects with a Start Date earlier than 1 November 1997, the Project Proponent must verifiably demonstrate that the project was designed and implemented as a GHG mitigation project from its inception. This evidence shall be based on (preferably official, legal and/or other corporate)

[12] See also *ACR Verification Guideline, v1.0*.

documentation that was available to third parties at, or prior to, the Start Date.

STEP 1. Identification and demonstration of validity of planned deforestation activity

1.1 Identify the agent of planned deforestation in each baseline stratum

In the simplest scenario the agent is an already defined individual, organization or corporation. If the agent is not yet defined (i.e. the Government or an alternative agent currently controls the land and the exact agents of deforestation are yet to be determined, but will have government sanction) then the most likely "class of deforestation agents" shall be identified. Examples of deforestation agent classes include:

- Entities (individuals, companies, associations) practicing similar deforestation practices and post-deforestation land use practices such as:
    - Agribusinesses implementing industrial scale agriculture
    - Large scale agriculturalists practicing farming on parcels larger than 500 ha
    - Ethnic or religious groups pursuing large scale agriculture
- Individuals or entities implementing specific legal land use regulation(s)

The selection of class of agent must be justified through stratification of the region and demonstration with historical records that the identified class of agent is the most common purchaser of similar lands in the identified strata. Stratification shall follow **IV.A**.

For APD the deforestation agent or class of agents is by definition transparent. While the identified agent may be headquartered elsewhere, this is immaterial; what matters is the agent's sanctioned plan to conduct deforestation in the project area.

1.2 Demonstration of threat of deforestation

For all APD projects, there must be an immediate site-specific threat of deforestation that is concrete and would lead to deforestation within a defined period of time. This threat must be demonstrated by documentary proof of the following:

- Legal permissibility for deforestation[13];
- Suitability of project area for conversion to alternative non-forest land use[14];
- If applicable, evidence of likely transfer of ownership to baseline agent of deforestation or class of agent must be demonstrated by one of the following forms of evidence originating prior to the date of all evidence on pursuit of carbon finance/consideration of REDD:
    - *Bona fide* bidding process for the project area that reflects value of the area with the expressed intent to deforest;

[13] Permissibility shall be with reference to relevant laws and legal requirements. When considering legal permissibility the area of allowed deforestation shall be considered relative to total property areas including areas already deforested.
[14] Suitability should include accessibility to relevant markets, suitability of soils, topography and climate.

  - Purchase offer of the project area by an entity that is clearly dedicated to agricultural, grazing or urban development activities;
  - Other evidence that control of the project area would have been transferred to the baseline agent or class of agent in the absence of the project.

- If government approval is required for deforestation to occur, the intention to deforest within the project area must be demonstrated by evidence:
  - Recent approval from relevant government department (local to national) for conversion of forest to an alternative land use; or
  - Documentation that a request for approval has been filed with the relevant government department for permission to deforest and convert to alternative land use.

- Intent to deforest[15]: the intent to deforest must be demonstrated by the following form of evidence originating prior to the date of all evidence on pursuit of carbon finance/consideration of REDD:
  - Where deforestation is by an identified class of agent, a documented history (for example government data or maps) of similar planned deforestation activities by the class of agent, of planned deforestation within the five years previous to without-project deforestation.
  - Where a specific baseline agent has been identified, either a valid and verifiable land use management plan for deforesting the project area, or a documented history (for example government data or maps) of similar planned deforestation activities by the baseline agent within the five years previous to without-project deforestation.

STEP 2. Identification of alternative land use scenarios to the proposed REDD APD project activity

Identify realistic and credible land-use scenarios that would have occurred on the land within the project boundary in the absence of REDD project activity. The scenarios should be feasible for the Proponent or similar project developers taking into account relevant national and/or sectoral policies and circumstances, historical land uses, practices and economic trends. The list of scenarios should capture all reasonable project alternatives; this list will subsequently be tested through investment, barrier and common practice analysis as described below.

The identified land use scenarios shall include, at minimum:

- The projected planned deforestation as estimated using this methodology;
- Projected unplanned deforestation or forest degradation;
- Avoiding deforestation and/or forest degradation within the project boundary performed without being registered as a REDD project activity;
- If applicable, avoided deforestation activities on at least a part of the land within the project boundary of the proposed REDD project at a rate resulting from:
  - Legal requirements; or
  - Extrapolation of observed activities stopping deforestation in the geographical area with

[15] Intent to deforest by baseline agent of deforestation

similar socio-economic and ecological conditions to the proposed REDD project activity, occurring in the 10-year period before the Start Date.

To identify realistic and credible scenarios, land use records, field surveys, data and feedback from stakeholders, and information from other appropriate sources, including Participatory Rural Appraisal (PRA)[16] may be used as appropriate.

All land uses within the boundary of the proposed REDD project activity or the geographical area with similar socio-economic and ecological conditions to the proposed REDD project activity, that are currently existing or that existed at some time in the 10-year period before the Start Date but no longer exist, may be deemed realistic and credible. For all other land use scenarios, credibility shall be justified. The justification shall include elements of spatial planning information (if applicable) or legal requirements, and may include assessment of economic feasibility of the proposed land use scenario.

Outcome of Step 2: List of credible alternative land use scenarios that would have occurred on the land within the project boundary of the REDD project activity.

→ Proceed to Step 3 (Investment analysis) or Step 4 (Barrier analysis). Only one is required.

STEP 3. Investment analysis

Determine whether the proposed project activity, without carbon market-related revenues, is economically or financially less attractive than at least one of the other land use scenarios. Investment analysis may be performed as a stand-alone analysis or in combination with Barrier analysis (Step 4). To conduct the investment analysis, use the following sub-steps:

Sub-step 3a. Determine appropriate analysis method

Determine whether to apply simple cost analysis, investment comparison analysis, or benchmark analysis. If the REDD project activity generates no financial or economic benefits other than carbon market-related income, then apply the simple cost analysis (Option I). Otherwise, use investment comparison analysis (Option II) or benchmark analysis (Option III). Options I, II and III are mutually exclusive; only one of them can be applied.

Sub-step 3b – Option I. Simple cost analysis

Document the costs associated with the REDD project activity and demonstrate that the activity produces no financial benefits other than carbon market-related income.

[16] Participatory rural appraisal (PRA) is an approach to the analysis of local problems and the formulation of tentative solutions with local stakeholders. It makes use of a wide range of visualisation methods for group-based analysis to deal with spatial and temporal aspects of social and environmental problems. This methodology is, for example, described in:
Chambers R (1992): *Rural Appraisal: Rapid, Relaxed, and Participatory*. Discussion Paper 311, Institute of Development Studies, Sussex;
Theis J, Grady H (1991): *Participatory rapid appraisal for community development*. Save the Children Fund, London.

If activities stopping deforestation and/or forest degradation in the project area, or in the geographical area with similar socio-economic and ecological conditions to the proposed REDD project area, occurred in the 10-year period before the Start Date but have ceased, the Proponent shall identify incentives/reasons/actions that allowed for the past activities stopping deforestation and/or forest degradation, and demonstrate that the current legal/financial or other applicable regulations or socio-economic, ecological or other local conditions have changed to an extent that justifies the conclusion that the REDD project activity produces no financial benefits other than carbon market-related income.

→ If it is concluded that the proposed REDD project activity produces no financial benefits other than carbon market-related income, proceed to Step 5 (Common practice analysis).

Sub-step 3b – Option II. Investment comparison analysis

Identify the financial indicator, such as Internal Rate of Return (IRR)[17], Net Present Value (NPV), payback period, or cost-benefit ratio, most suitable for the project type and decision-making context.

Sub-step 3b – Option III. Benchmark analysis

Identify the financial indicator, such as IRR[18], NPV, payback period, cost-benefit ratio, or other – e.g. required rate of return (RRR) related to investments in agriculture or forestry, bank deposit interest rate corrected for risk inherent to the project, or the opportunity costs of land such as any expected income from land speculation – most suitable for the project type and decision context. Identify the relevant benchmark value, such as the RRR on equity. The benchmark is to represent standard returns in the market, considering the specific risk of the project type, but not linked to the subjective profitability expectation or risk profile of a particular Project Proponent. Benchmarks can be derived from:

- Government bond rates, increased by a suitable risk premium to reflect private investment and/or the project type, as substantiated by an independent financial expert;
- Estimates of the cost of financing and required return on capital (e.g. commercial lending rates and guarantees required for the country and the type of project activity concerned), based on bankers views and private equity investors/funds' required return on comparable projects;
- A company internal benchmark (e.g. weighted average capital cost of the company) if there is only one potential Project Proponent (e.g. when the proposed project land is owned or otherwise controlled by a single entity, physical person or a company, who is also the Proponent). The Proponent shall demonstrate that this benchmark has been consistently

[17] For the investment comparison analysis, IRRs can be calculated either as project IRRs or as equity IRRs. Project IRRs calculate a return based on project cash outflows and cash inflows only, irrespective the source of financing. Equity IRRs calculate a return to equity investors and therefore also consider amount and costs of available debt financing. The decision to proceed with an investment is based on returns to the investors, so equity IRR will be more appropriate in many cases. However, there will also be cases where a project IRR may be appropriate.

[18] For the benchmark analysis, the IRR shall be calculated as project IRR. If there is only one potential project developer (e.g. when the project activity upgrades an existing process), the IRR shall be calculated as equity IRR.

used in the past, i.e. that project activities under similar conditions developed by the same company used the same benchmark.

Sub-step 3c. Calculation and comparison of financial indicators (for options II and III)

Calculate the suitable financial indicator for the proposed REDD project activity without the financial benefits from carbon finance and, in the case of Option II above, for the other land use scenarios. Include all relevant costs (including, for example, investment cost and operation and maintenance costs) and revenues (excluding carbon market revenues, but including subsidies/fiscal incentives where applicable). Include, as appropriate, non-market cost and benefits in the case of public investors.

Present the investment analysis in a transparent manner and provide all the relevant assumptions in the GHG Project Plan, so that a reader can reproduce the analysis and obtain the same results. Clearly present critical economic parameters and assumptions (such as capital costs, lifetimes, and discount rate or cost of capital). Justify and/or cite assumptions in a manner that can be verified. In calculating the financial indicator, the project's risks can be included through the cash flow pattern, subject to project-specific expectations and assumptions (e.g. insurance premiums can be used in the calculation to reflect specific risk equivalents).

Assumptions and input data for the investment analysis shall not differ across the project activity and its alternatives, unless differences can be well substantiated.

Present in the GHG Project Plan a clear comparison of the financial indicator for the proposed REDD project activity without the financial benefits from carbon finance and:

- If Option II was selected, if one of the other land use scenarios has the better indicator (e.g. higher IRR), then the REDD project activity cannot be considered as financially attractive; or
- If Option III was selected, if the REDD project activity has a less favorable indicator (e.g. lower IRR) than the benchmark, then the REDD project activity cannot be considered as financially attractive.

→ If it is concluded that the proposed REDD project activity without the financial benefits from carbon finance is not financially most attractive, then proceed to Step 3d (Sensitivity Analysis).

Sub-step 3d. Sensitivity analysis

Provide a sensitivity analysis that shows whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions. The investment analysis provides a valid argument only if it consistently supports, for a realistic range of assumptions, the conclusion that the proposed REDD project activity without the financial benefits from carbon finance is unlikely to be financially attractive.

If activities stopping deforestation and/or forest degradation in the project area, or in the geographical area with similar socio-economic and ecological conditions to the proposed REDD project area, occurred in the 10-year period before the Start Date but have ceased, the Proponent shall demonstrate that incentives/reasons/actions that allowed for the past activities have changed to an extent that affects the financial attractiveness of such activities in the project area without being registered as the REDD project.

→ If after the sensitivity analysis it is concluded that the proposed REDD project activity without the financial benefits from carbon finance is unlikely to be financially most attractive under a realistic range of assumptions, then proceed directly to Step 5 (Common practice analysis).

→ If after the sensitivity analysis it is concluded that the proposed REDD project activity is likely to be financially most attractive, then the project activity cannot be considered additional by means of financial analysis. Step 4 (Barrier analysis) may still be used to prove that the proposed project activity faces barriers that do not prevent the baseline land use scenario(s) from occurring. If Step 4 (Barrier analysis) is not employed then the project activity cannot be considered additional.

STEP 4. Barrier analysis

Barrier analysis may be performed as a stand-alone analysis or as an extension of Step 3 Investment analysis. Barrier analysis is used to determine whether the proposed project activity faces barriers that prevent the implementation of the proposed project activity, and do not prevent the implementation of at least one of the alternative land use scenarios.

Sub-step 4a. Identify barriers that would prevent the implementation of the proposed project activity

Establish that there are barriers that would prevent the proposed project activity from being carried out if the project activity were not registered as a REDD activity. The barriers should not be specific to the Project Proponent. Such barriers may include, among others:

- Investment barriers, other than the economic/financial barriers in Step 3 above, *inter alia*:
  - For REDD APD Project Activities undertaken and operated by private entities: similar activities have only been implemented with grants or other non-commercial finance terms. In this context similar activities are defined as activities of a similar scale that take place in a comparable environment with respect to regulatory framework and are undertaken in the same country;
  - Debt funding is not available for this type of project activity;
  - No access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented, as demonstrated by the credit rating of the country or other country investment reports of reputed origin;
  - Lack of access to credit.

- Institutional barriers, *inter alia*:
  - Risk related to changes in government policies or laws;
  - Lack of enforcement of forest or land-use-related legislation.

- Technological barriers, *inter alia*:
  - Lack of access to planting materials (e.g. if plantations are a leakage avoidance strategy);
  - Lack of infrastructure for implementation of the technology.

- Barriers related to local tradition, *inter alia*:
  - Traditional knowledge or lack thereof, laws and customs, market conditions, practices;
  - Traditional equipment and technology.

- Barriers due to prevailing practice, *inter alia*:
  - The project activity is the "first of its kind": no project activity of this type is currently operational in the host country or region.

- Barriers due to social conditions, *inter alia*:
  - Social conflict among interest groups in the region where the project takes place;
  - Lack of skilled and/or properly trained labor force;
  - Lack of organization of local communities.

- Barriers relating to land tenure, ownership, inheritance, and property rights, *inter alia*:
  - Communal land ownership with a hierarchy of rights for different stakeholders that limits the incentives to undertake REDD activity;
  - Lack of suitable land tenure legislation and regulation to support the security of tenure;
  - Absence of clearly defined and regulated property rights in relation to natural resource products and services;
  - Formal and informal tenure systems that increase the risks of fragmentation of land holdings or prevent the solidification of land ownership rights.

The identified barriers are only sufficient grounds for demonstration of additionality if they would prevent potential Project Proponents from carrying out the proposed project activity if it was not expected to be registered as a REDD project activity.

Proponents shall provide transparent and documented evidence of the existence and significance of the identified barriers. Anecdotal evidence can be included, but alone is not sufficient proof of barriers. The type of evidence to be provided may include:

- Relevant legislation, regulatory information or environmental/natural resource management norms, acts or rules;
- Relevant (sectoral) studies or surveys (e.g. market surveys, technology studies, etc) undertaken by universities, research institutions, associations, companies, bilateral/multilateral institutions, etc;
- Relevant statistical data from national or international statistics;
- Documentation of relevant market data (e.g. market prices, tariffs, rules);
- Written documentation from the company or institution developing or implementing the REDD project activity, such as minutes from Board meetings, correspondence, feasibility studies, financial or budgetary information, etc.;
- Documents prepared by the Project Proponent, contractors or project partners in the context of the proposed project activity or similar previous project implementations;
- Written documentation of independent expert judgments from agriculture, forestry and other land-use related Government/nongovernmental bodies or individual experts, educational institutions (e.g. universities, technical schools, training centers), professional associations and others.

If activities stopping deforestation and/or forest degradation in the project area, or in the geographical area with similar socio-economic and ecological conditions to the proposed REDD project area, occurred in the 10-year period before the Start Date but have ceased, the Proponent shall identify incentives/reasons/actions/that allowed for the past activity and shall demonstrate that the current legal/financial or other applicable regulations, ecological or other local conditions have changed to the extent that they pose a barrier which allows for conclusion that repetition of the activity performed without being registered as the REDD project activity is not possible.

Sub-step 4b. Show that the identified barriers would not prevent the implementation of at least one of the alternative land use scenarios

If the identified barriers also affect other land use scenarios, explain how they are affected less strongly than is the proposed REDD project activity. Explain how the identified barriers are not preventing the implementation of at least one of the alternative land use scenarios. Any land use scenario that would be prevented by the barriers identified in Sub-step 3a is not a viable alternative, and shall be eliminated from consideration. At least one viable land use scenario shall be identified.

→ If both Sub-steps 4a and 4b are satisfied, then proceed directly to Step 5 (Common practice analysis).

→ If one of the Sub-steps 4a or 4b is not satisfied, then the project activity cannot be considered additional by means of barrier analysis. Step 3 (Investment analysis) may still be used to prove that the proposed REDD project activity without the financial benefits from carbon markets is unlikely to produce economic benefit (Option I) or to be financially attractive (Option II and Option III). If Step 3 is not employed then the project activity cannot be considered additional.

STEP 5. Common practice analysis

The previous steps shall be complemented with an analysis of the extent to which similar activities stopping deforestation and forest degradation have already diffused in the geographical area of the proposed REDD project activity. This test is a credibility check to demonstrate additionality that complements the investment analysis (Step 3) or the barriers analysis (Step 4). Although only either Step 3 or Step 4 is required, Step 5 is always required.

Provide an analysis of the extent to which activities similar to the proposed REDD project activity have been implemented previously or are currently underway. Similar activities are defined as those which are of similar scale, take place in a comparable environment (with respect to the regulatory framework and other factors) and are undertaken in the relevant geographical area. Other registered REDD APD Project Activities shall not be included in this analysis. Provide documented evidence and, where relevant, quantitative information. Limit considerations to the 10-year period prior to the Start Date.

If activities stopping deforestation and forest degradation similar to the proposed REDD project activity are identified, then compare the proposed project activity to the other similar activities and assess whether there are essential distinctions between them. Essential distinctions may include a fundamental and verifiable change in circumstances under which the proposed REDD project activity will be implemented when compared to circumstances under which similar activities were carried out. For example, new barriers may exist or promotional policies may have ended. If certain benefits rendered similar avoided deforestation activities financially attractive (e.g., subsidies or other financial flows), explain why the proposed REDD project activity cannot use the benefits. If applicable, explain why similar activities did not face barriers faced by the proposed REDD activity.

→ If Step 5 is not satisfied, i.e. similar activities can be observed and essential distinctions between the proposed REDD project activity and similar activities cannot be made, then the proposed REDD project activity cannot be considered additional. Otherwise, the proposed REDD project activity is not the baseline scenario and, hence, it is additional.

2. Summary

The proposed REDD activity is additional if it:

- Per STEP 0, has a Start Date after 1 November 1997 *OR*, if the Start Date is earlier, demonstrates in a manner acceptable to ACR and the verifier that GHG mitigation was a project objective from inception; *AND*

- Has, in STEP 1, identified and demonstrated the validity of the planned deforestation baseline activity; *AND*

- Has identified in STEP 2 credible alternative land use scenarios that would have occurred on the land within the project boundary of the REDD project activity; *AND*

- Has demonstrated via STEP 3 Investment Analysis that the proposed REDD project activity is not the most economically or financially attractive of the identified land use scenarios, by:

    - Demonstrating via Simple Cost Analysis (sub-step 3b Option I) that that the proposed REDD project activity produces no financial benefits other than carbon market-related income; *OR*

    - Demonstrating via Investment Comparison Analysis (sub-step 3b Option II) that one of the other land use scenarios has a better financial indicator, such that the REDD project activity cannot be considered financially attractive relative to other land use scenarios; *OR*

    - Demonstrating via Benchmark Analysis (sub-step 3b Option III) that the REDD project activity has a less favorable indicator than the benchmark, such that the REDD project activity cannot be considered as financially attractive relative to the benchmark; *AND*

    - Demonstrating via Sensitivity Analysis (sub-step 3d) that the conclusion of Options II or III is robust to reasonable variations in the critical assumptions.

AND/OR (in lieu of STEP 3):

- Has demonstrated via STEP 4 Barrier Analysis that the proposed REDD project activity faces barriers that do not prevent the baseline land use scenario(s) from occurring, by:

  - Identifying under sub-step 4a barriers that would prevent the implementation of the proposed project activity; _AND_

  - Demonstrating under sub-step 4b that the identified barriers would not prevent the implementation of at least one of the alternative land use scenarios.

AND (in addition to STEPS 0, 1, 2, and 3 *AND*/*OR* 4):

- Has demonstrated via STEP 5 Common Practice Analysis that similar activities stopping deforestation and forest degradation are not common practice in the geographical area of the proposed REDD project activity, either by showing there are no similar activities, or that essential distinctions between the proposed REDD project activity and observed similar activities can be made.

IV. BASELINE METHODOLOGY

The baseline of a REDD project activity is estimated *ex ante*. For APD, the baseline can be monitored in a proxy area for the purpose of periodically adjusting the baseline. *Ex ante* baseline estimations are therefore used in both the *ex ante* and *ex post* estimation of net GHG emission reductions and removals.

If carbon stocks in the project area are not homogeneous, stratification shall be carried per **IV.A**. Different methods for stratifying may be required for the baseline and project scenarios to achieve optimal accuracy and precision of the estimates of net GHG emissions reductions. Methods for estimating baseline carbon stock changes and GHG emissions are provided in **IV.B**.

A description of how the baseline scenario is identified and the description of the baseline scenario shall be given in the GHG Project Plan. The results of the estimations shall be presented in the GHG Project Plan.

A. Baseline Stratification

This section provides a procedure to stratify the project area into discrete, relatively homogeneous units to improve accuracy and precision of carbon stock and stock change estimates. If, on the basis of existing or pilot data, the mean biomass stock of any spatially discrete sub-population representing >10% of the project area differs from the population level mean by >20%, stratification must be used and the distinct sub-population(s) delineated.

Strata are only used for pre-deforestation forest classes, and are the same in baseline and project cases. Post-deforestation (conversion) land uses are not stratified, instead using average post-deforestation stock values.

The sampling framework, including sample size, plot size, plot shape, and determination of plot location must be specified in the GHG Project Plan. To determine the sample size and allocation among strata, Proponents shall use the latest version of the CDM "Tool for the calculation of the number of sample plots for measurements within A/R CDM project activities".[19] The targeted precision level for aboveground biomass estimation across the project is ±10% of the mean at a 90% confidence level. However, for this methodology, temporary plots are permissible in contrast to the CDM methodology.

1. Procedure

In the equations used throughout this methodology, the letter *i* is used to represent a stratum and the letter *M* for the total number of strata.

Pre-stratification (prior to inventory) of the project area is not required, but may serve to avoid requirements for post-measurement stratification and may reduce sampling costs by helping to avoid the over-sampling of some strata and under-sampling of others. It is not expected that Proponents will begin with high-resolution, spatially explicit biomass measurement information for

[19] http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.pdf.

the project area and leakage belt. Thus, it is acceptable to base strata on ancillary data that can serve as a proxy for potential biomass classes (e.g. vegetation class maps, interpretation of aerial photographs or high-resolution satellite imagery). The areas of strata delineated prior to allocation of inventory plots using stratified sampling are known exactly and require no accuracy assessment.

Strata may reflect biophysical parameters relating to forest productivity, or activity-driven parameters relating to risk or potential for conversion and/or distinct conversion practices. The latter are particularly important for stratifying the baseline. Illustrative parameters include:

- **Biophysical**: soil type, elevation, precipitation regime, temperature, slope and aspect, tree species composition, age class/disturbance history, stand density, etc.
- **Activity-related**: conversion practice, end land use, distance to transportation networks (roads, rivers), distance to deforested land or forest edge, distance to towns and villages, rural population density, protection status, etc.

Further stratification beyond the parameters given above is not usually warranted, and only a subset of the above is likely to be needed.

At the project start and whenever biomass stocks are re-measured (i.e. every 5 years), Proponents must demonstrate *after inventory* that within strata there are no discrete clusters of sample plots/points representing $\geq$ 10% of samples in a stratum that consistently differ (i.e. each sample plot/point estimate) from the stratum mean by ±20%. In the event that such a cluster of points is identified, a new stratum shall be delineated. Area limits of the new stratum encompassing the cluster can be determined on the basis of existing vegetation class maps, interpretation of aerial photographs, or high-resolution satellite imagery.

A map displaying the final delineation of strata must be included in the GHG Project Plan. Areas of individual strata should sum to the total project area; any discrepancies must be reconciled.

B. Estimation of Baseline Carbon Stock Changes and GHG Emissions

This section provides procedures to determine $\Delta C_{BSL,planned}$, or the net CO_2 emissions in the baseline case from planned deforestation.

This is based on an assessment of carbon stocks and GHG emissions within the project area for the 10-year Crediting Period for which the baseline is valid. It is applicable to estimating baseline emissions on forest lands (usually privately or government owned) that are legally authorized and documented to be converted to non-forest land.

1. Procedure

The baseline net GHG emissions for planned deforestation will be determined as:

$$\Delta C_{BSL,planned} = \sum_{t=1}^{t*} \sum_{i=1}^{M_B} \left(\left(\left(D\%_{planned,i,t} * A_{planned,i} * L - D_i \right) * \Delta C_{BSL,i} \right) + GHG_{BSL-E,i,t} \right) \quad (1)$$

Where:

$\Delta C_{BSL,planned}$	Net greenhouse gas emissions in the baseline from planned deforestation; t CO_2-e
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum *i* during year *t*. If actual annual proportion is known and documented (e.g. 25% per year for 4 years), set to proportion; if not known, use Eq. 2 to calculate; % $year^{-1}$
$A_{planned,i,}$	Total area of planned deforestation over the baseline period for stratum *i*; ha
$L\text{-}D_i$	Likelihood of deforestation for stratum *i*; %
$\Delta C_{BSL,i}$	Net carbon stock changes in all pools in the baseline stratum *i*; t CO_2-e ha^{-1}
$GHG_{BSL\text{-}E,i,t}$	Greenhouse gas emissions as a result of planned deforestation activities within the project boundary in the baseline stratum *i* at project year *t*; t CO_2-e $year^{-1}$
i	1, 2, 3 … M_B strata in the baseline scenario
t	1, 2, 3, … t^* years elapsed since the projected start of the project activity

The procedure is accomplished in three steps:

1) Calculating the baseline rate (annual area) of deforestation
2) Baseline carbon stocks
3) GHG emissions

STEP 1. Calculating annual area of land deforested

Step 1.1 Identify the agent of planned deforestation in each baseline stratum *i*

The selection of class of agent must be justified through stratification of the region and demonstration with historical records that the identified class of agent is the most common purchaser of similar lands in the identified strata. Stratification shall follow **IV.A**.

Step 1.2 Define area of deforestation $A_{planned,i}$

The proportion of the total parcel area planned to be deforested cannot exceed the legal mandate unless common practice in a proxy area (see criteria in section 1.3 below) shows that the mandates are not enforced.

1.3 Rate of deforestation $D\%_{planned,i,t}$

The methodology requires knowledge of the rate (area deforested per year) at which the planned areas will be deforested to give an area per stratum (*i*) per year (*t*) through the applicable Crediting Period.

Where a verifiable plan exists for rate at which deforestation is projected to occur, this rate shall be used. If no verifiable plan exists, the rate shall be established by examining proxy areas. Proxy areas may or may not be under the management of the baseline agent of deforestation or class of agent[20]. A minimum of four (4) proxy areas shall be included.

The following criteria for proxy areas for determination of deforestation rate must be met:

1. Land conversion practices shall be the same as those used by the baseline agent or class of agent.

2. The post-deforestation land use shall be the same in the proxy areas as expected in the project area under business as usual.

3. The proxy areas shall have the same management and type of land use rights as the proposed project area under business as usual.

4. If suitable proxy areas exist in the immediate area of the project these shall be used. If an insufficient number of sites exists in the immediate area, sites shall be identified elsewhere in the same country; if an insufficient number of sites exists in the country, sites shall be identified in neighboring countries (note that proxies in neighboring countries are not used to define additionality, merely rate of deforestation).

5. Agents of deforestation in proxy areas must have deforested their land under the same criteria that the project lands must follow (legally permissible and suitable for conversion).

6. Deforestation in the proxy area shall have occurred within the 10 years prior to the project Start Date.

7. The following conditions shall be met:

    - Forest types surrounding the proxy area or in the proxy area prior to deforestation shall be in the same proportion as in the project area (±25%);
    - Soil types that are suitable for the land-use practice used by the agent of deforestation in the project area must be present in the proxy area in the same proportion as the project area (±25%).
    - The ratio of slope classes "gentle" (slope<15%) to "steep" (slope ≥15%) in the proxy areas shall be the same as in the project area (±25%);
    - Elevation classes (500m classes) in the proxy area shall be in the same proportion as in the project area (±25%).

The proxy area will be used to estimate an average proportion of land that is cleared each year. A sufficient number of parcels are needed to be representative of the common practice in the proxy area, and hence also in the project area.

[20] Note the difference between baseline deforestation on proxy lands, that may or may not be managed by the agent/class of agent, and baseline deforestation in **V.E**, "WoPR," which is on land specifically managed by the agent/class of deforestation.

Examination of proxy areas may be through original data collection (field measurements and/or remote sensing analysis) or where appropriate use of directly applicable existing data generated from credible sources.

The annual rate shall be calculated with Equation 2:

$$D\%_{planned,i,t} = \sum_{pn=1}^{pn^*} \left(\frac{\left(D\%_{pn,i} / Yrs_{pn} \right)}{n} \right) \quad (2)$$

Where:

$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum *i* at year *t*. If actual annual proportion is known and documented (e.g. 25% per year for 4 years), set to proportion; % year^{-1}
$D\%_{pn,i}$	Percent of deforestation in land parcel[21] *pn* etc in stratum *i* of a proxy area as a result of planned deforestation as defined in this section; %
$Yrs_{pn,}$	Number of years over which deforestation occurred in land parcel *pn* in stratum *i* in proxy area; years
n	Total number of land parcels examined
pn	1, 2, 3 …n^* land parcels examined in proxy area
i	1, 2, 3 …M_B strata in the baseline scenario

If no proxy area exists under the same land use management/rights type, then representative areas under different land use right types shall be examined and documentation must be provided establishing that the lands are representative.

1.4 Likelihood of deforestation $L\text{-}D_i$

Where forest areas are under government control and the areas have been zoned for deforestation, a suitable representative sample of similar zoned areas must be examined to define the likelihood of deforestation occurring. The likelihood ($L\text{-}D_i$) will be equal to the proportion of similarly zoned proxy areas deforested within the previous five years within the appropriate stratum. The criteria for selection of proxy areas are given above.

For all other planned deforestation areas (i.e. areas not both under government control and zoned for deforestation), $L\text{-}D_i$ shall be equal to 1.

[21] Parcels are a unit of land area. A stratum may contain many parcels.

1.5 Risk of abandonment

Identify a minimum of 5 proxy areas (identified per the same criteria as above) deforested by the same “class of deforestation agent”[22] at least ten years previously. If any of the proxy areas have been abandoned to forest regrowth, then the APD activity is not eligible and this methodology shall not be used.

STEP 2. Baseline carbon stocks

This section provides procedures for estimating baseline carbon stocks. Baseline estimates shall be made for all pools included in the GHG assessment boundary per the procedure in **II.C**.

Net carbon stock changes in the baseline are equal to the baseline pre-deforestation stock minus the long-term carbon stock after planned deforestation, minus the baseline stock that is harvested and stored in long-term wood products.

$$\Delta C_{BSL,i} = C_{BSL,i} - C_{BSL,post,i} - C_{BSL,wp,i} \quad (3)$$

Where:

$\Delta C_{BSL,i}$	Net carbon stock changes in all pools in the baseline in stratum *i*; t CO_2-e ha^{-1}
$C_{BSL,i}$	Carbon stock in all pools in the baseline in stratum *i*; t CO_2-e ha^{-1}
$C_{BSL,post,i}$	Carbon stock in all pools in the baseline post-deforestation in stratum *i*; t CO_2-e ha^{-1}
$C_{BSL,WP,i}$	Carbon stock sequestered in wood products in the baseline in stratum *i,* calculated using the procedure in **CPES.E**[23]; t CO_2-e ha^{-1}
i	1, 2, 3 …M_B strata in the baseline scenario

With regard to emissions, instead of tracking annual emissions through burning and/or decomposition, this methodology employs the simplifying assumption that all carbon stocks are emitted in the year deforested and that no stocks are permanently sequestered (beyond 100 years after deforestation). This assumption applies regardless of whether burning is employed as part of the forest conversion process or as part of post-conversion land use activities.

2.1 Forest carbon stocks

$$C_{BSL,i} = C_{AB\_tree,i} + C_{BB\_tree,i} + C_{DW,i} + C_{LI,i} + C_{SOC,i} \quad (4)$$

[22] See Step 1.1. If the agent is an already defined individual, organization or corporation identify the class of agent the agent belongs to.
[23] Throughout this methodology the abbreviation **CPES** refers to the ACR *Tool for Estimation of Stocks in Carbon Pools and Emissions from Emission Sources*.

Where:

$C_{BSL,i}$	Carbon stock in all pools in the baseline in stratum *i*; t CO_2-e ha^{-1}
$C_{AB\_tree,i}$	Carbon stock in aboveground biomass in the baseline in stratum *i*, calculated per **CPES.A**; t CO_2-e ha^{-1}
$C_{BB\_tree,i}$	Carbon stock in belowground biomass in the baseline in stratum *i,* calculated per **CPES.A**; t CO_2-e ha^{-1}
$C_{DW,i}$	Carbon stock in dead wood in the baseline in stratum *i*, calculated per **CPES.B**; t CO_2-e ha^{-1}
$C_{LI,i}$	Carbon stock in litter in the baseline in stratum *i*, calculated per **CPES.C**; t CO_2-e ha^{-1}
$C_{SOC,i}$	Carbon stock in soil organic carbon in the baseline in stratum *i*, calculated per **CPES.D**; t CO_2-e ha^{-1}

Carbon pools excluded from the project can be accounted as zero. To determine which carbon pools must be included in the calculations, apply the significance testing procedure in **II.C**.

2.2 Post-deforestation carbon stocks

Post-deforestation carbon stocks should be the long-term average stocks on the land following planned deforestation. Post-deforestation carbon stocks can be measured in proxy areas or values may be taken from credible and representative literature sources (e.g. the peer-reviewed literature or data published by the IPCC or FAO). Where stocks accumulate through time the ultimate (highest) stock shall be used; where stocks are in a cycle[24] the mean stock across the cycle[25] shall be used.

$$C_{BSL,post,i} = C_{AB\_tree,i} + C_{BB\_tree,i} + C_{AB\_non-tree,i} + C_{BB\_non-tree,i} + C_{DW,i} + C_{LI,i} + C_{SOC-PD-BSL,i} \quad (5)$$

Where:

$C_{BSL,post,i}$	Carbon stock in all pools in the baseline post-deforestation in stratum *i*; t CO_2-e ha^{-1}
$C_{AB\_tree,i}$	Carbon stock in aboveground tree biomass in the baseline in stratum *i*, calculated per **CPES.A**; t CO_2-e ha^{-1}
$C_{BB\_tree,i}$	Carbon stock in belowground tree biomass in the baseline in stratum *i*, calculated per **CPES.A**; t CO_2-e ha^{-1}

[24] Examples include fallow-based agricultural systems (including slash and burn).
[25] Cycles shall not exceed 14 years. If a cycle exceeds 14 years then the highest stock in the cycle shall be used.

$C_{AB\_non\text{-}tree,i}$	Carbon stock in aboveground non-tree vegetation in the baseline in stratum *i*, calculated per **CPES.A**; t CO_2-e ha^{-1}
$C_{BB\_non\text{-}tree,i}$	Carbon stock in belowground non-tree vegetation in the baseline in stratum *i*, calculated per **CPES.A**; t CO_2-e ha^{-1}
$C_{DW,i}$	Carbon stock in dead wood in the baseline in stratum *i*, calculated per **CPES.B**; t CO_2-e ha^{-1}
$C_{LI,i}$	Carbon stock in litter in the baseline in stratum *i*, calculated per **CPES.C**; t CO_2-e ha^{-1}
$C_{SOC,PD\text{-}BSL,i}$	Mean post-deforestation stock in soil organic carbon in the post deforestation stratum *i*, calculated per **CPES.D**; t CO_2-e ha^{-1}

Carbon pools excluded from the project can be accounted as zero. To determine which carbon pools must be included in the calculations, apply the significance testing procedure in **II.C**. Herbaceous non-tree vegetation is considered to be *de minimis* in all instances.

STEP 3. Greenhouse gas emissions

The GHG emissions in the baseline within the project boundary shall be estimated as:

$$GHG_{BSL,E,i,t} = ET_{FC,t} + E_{BiomassBurn,t} + N_2O_{direct-N,t} \qquad (6)$$

Where:

$GHG_{BSL,E,i,t}$	Greenhouse gas emissions as a result of planned deforestation activities within the project boundary in the stratum *i* in year *t*; t CO_2-e
$ET_{FC,i,t}$	CO_2 emission from fossil fuel combustion in stratum *i* in year *t*, calculated per **CPES.G**; t CO_2-e $year^{-1}$
$E_{BiomassBurn,i,t}$	Non-CO_2 emissions due to biomass burning in stratum *i* in year *t*, calculated per **CPES.F**; t CO_2-e $year^{-1}$
$N_2O_{direct\text{-}N,i,t}$	Direct N_2O emission as a result of nitrogen application on the alternative land use within the project boundary in stratum *i* in year *t*, calculated per **CPES.H**; t CO_2-e $year^{-1}$
t	*1, 2, 3 …t^** years elapsed since the start of the project activity

To determine which emission sources must be included in the calculations, apply the significance testing procedure in **II.C**.

C. Estimation of Baseline Uncertainty

This section provides procedures for calculating $Uncertainty_{BSL}$ or the total uncertainty in estimations of baseline emissions and removals. See **V.G** on calculating with-project uncertainty and **VII.B** on calculating total project uncertainty.

The procedure is used for calculating *ex ante* and *ex post* a precision level and any required uncertainty deduction following project implementation and monitoring. The procedure may be used at the project planning phase to help to ensure that monitoring is of sufficient intensity to minimize uncertainty deductions.[26]

Where an uncertainty value is not known or cannot be simply calculated, then a project must justify that it is using an indisputably conservative number and an uncertainty of 0% may be used for this component.

1. Procedure

Estimated carbon emissions and removals arising from AFOLU activities have uncertainties associated with the measures/estimates of: area or other activity data, carbon stocks, biomass growth rates, expansion factors, and other coefficients. It is assumed that the uncertainties associated with the estimates of the various input data are available, either as default values given in IPCC Guidelines (2006), IPCC GPG-LULUCF (2003), expert judgment[27], or estimates based on sound statistical sampling (where sampling has been conducted uncertainty derived from the sampling must be used).

Alternatively, indisputably conservative estimates can be used instead of uncertainties, provided that they are based on verifiable literature sources or expert judgment. In this case the uncertainty is assumed to be zero. However, this section provides a procedure to combine uncertainty information and conservative estimates resulting in an overall *ex post* project uncertainty.

It is important that the process of project planning consider uncertainty. Procedures including stratification and the allocation of sufficient measurement plots can help ensure that low uncertainty in carbon stocks results and ultimately full crediting can result. It is good practice to apply this procedure at an early stage to identify the data sources with the highest uncertainty to allow the opportunity to conduct further work to diminish uncertainty.

STEP 1: Assess uncertainty in projection of baseline rate of deforestation or degradation

It is here assumed that there is zero uncertainty in baseline rate of deforestation or degradation where numbers are based on actual deforestation plans. In this specific case assume:

$Uncertainty_{BSL,RATE} = 0$

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[26] Per the *Forest Carbon Project Standard*, ACR sets a precision target of ±10% of the mean at 90% confidence, applied to the final calculation of emission reductions/sequestration. If the Project Proponent cannot meet the targeted ±10% of the mean at 90% confidence, then the reportable amount shall be the mean minus the lower bound of the 90% confidence interval, applied to the final calculation of emission reductions/sequestration.

[27] Justification should be supplied for all values derived from expert judgment.

In all other scenarios the uncertainty in rate shall be a component of net project uncertainty. where rate of deforestation is derived from measurements of proxy areas:

The uncertainty shall be equal to the 90% confidence interval as a percentage of the mean of the area deforested in each proxy ($D\%_{pn}$) divided by the number of years over which deforestation occurred in each proxy (Yrs_{pn}).

STEP 2: Assess uncertainty of emissions and removals in project area

This step provides procedures for estimating the uncertainty in calculations of each of the pools and GHG emission sources selected for accounting.

Uncertainty should be expressed as the 90% confidence interval as a percentage of the mean.

$$\text{Uncertainty}_{\text{BSL,SS,i}} = \frac{\sqrt{\left(U_{BSL,SS1,i} * E_{BSL,SS1,i}\right)^2 + \left(U_{BSL,SS2,i} * E_{BSL,SS2,i}\right)^2 + \ldots + \left(U_{BSL,SSn,i} * E_{BSL,SSn,i}\right)^2}}{E_{BSL,SS1,i} + E_{BSL,SS2,i} + \ldots + E_{BSL,SSn,i}} \quad (7)$$

Where:

$Uncertainty_{BSL,SS,i}$	Percentage uncertainty in the combined carbon stocks and GHG sources in the baseline case in stratum *i*; %
$U_{BSL,SS,i}$	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) for carbon stocks and GHG sources in the baseline case in stratum *i* (1,2…n represent different carbon pools and/or GHG sources); %
$E_{BSL,SS,i}$	Carbon stock or GHG sources (e.g. trees, down dead wood, soil organic carbon, emission from fertilizer addition, emission from biomass burning etc.) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) in the baseline case, as calculated per the procedures in **CPES.A through CPES.H**; t CO_2-e
i	1, 2, 3 …M_B strata in the baseline scenario

STEP 3: Estimate total uncertainty in baseline scenario

To assess uncertainty across combined strata:

$$\text{Uncertainty}_{\text{BSL}} = \frac{\sqrt{\left(\text{Uncertainty}_{\text{BSL,SSi1}} * E_{BSL,i1}\right)^2 + \left(\text{Uncertainty}_{\text{BSL,SSi2}} * E_{BSL,i2}\right)^2 + \ldots + \left(\text{Uncertainty}_{\text{BSL,SSM}} * E_{BSL,iM}\right)^2}}{E_{BSL,i1} + E_{BSL,i2} + \ldots + E_{BSL,iM}} \quad (8)$$

Where:

$Uncertainty_{BSL,SS}$	Total uncertainty in the combined carbon stocks and greenhouse gas sources in the baseline case; %

$Uncertainty_{BSL,SS,i}$ Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in stratum *i* in the baseline case; %

$E_{BSL,SS,i}$ Sum of combined carbon stocks and GHG sources (e.g. trees, down dead wood, soil organic carbon, emission from fertilizer addition, emission from biomass burning in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) multiplied by the area of stratum *i* (A_i) in the baseline case; t CO_2-e

i 1, 2, 3 …*M* strata

Incorporating rate uncertainty:

$$\text{Uncertainty}_{BSL} = \sqrt{\text{Uncertainty}_{BSL,RATE}^{2} + \text{Uncertainty}_{BSL,SS}^{2}} \quad (9)$$

Where:

$Uncertainty_{BSL}$ Uncertainty in baseline scenario in stratum *i*; %

$Uncertainty_{BSL,RATE}$ Percentage uncertainty in the rate of deforestation for areas through time; %

$Uncertainty_{BSL,SS}$ Total uncertainty in the combined carbon stocks and GHG sources in the baseline case; %

i 1, 2, 3 …M_B strata in the baseline scenario

V. MONITORING WITH-PROJECT SCENARIO

A. With-Project Stratification

Strata in the with-project scenario are determined *ex ante*, and shall be revised *ex post* in the with-project case. Re-assessment of strata, per application of the applicability criteria, must be conducted whenever biomass stocks are re-measured (i.e. every $\leq$ 10 years).

With-project stratification shall follow the same procedure as for baseline stratification in **IV.A**.

Ex post adjustments to with-project strata may be needed if unexpected disturbances occur during the Crediting Period (e.g. due to fire, pests or disease outbreaks), severely affecting different parts of an originally homogeneous stratum or stand, or when unexpected forest management (e.g. illegal harvesting) occurs. In such situations, the project area and/or leakage area affected by the disturbance and/or variation in forest management may be delineated as a separate stratum for the purpose of monitoring carbon stock changes.

Established project strata may be merged *ex post* if the reasons for their establishment as separate strata have disappeared or have proven irrelevant to key variables for estimating forest carbon stocks or changes in forest carbon stocks. However, merged strata must conform with all stratification requirements.

B. Monitoring Project Implementation

1. Required information in monitoring plan

Project Proponents shall include a monitoring plan in the GHG Project Plan, addressing the following tasks, which should be standard headers in the Monitoring Plan:

- Monitoring of actual carbon stock changes and GHG emissions
- Monitoring of leakage carbon stock changes and GHG emissions
- Estimation of *ex post* net carbon stock changes and GHG emissions.

For each of these tasks, the monitoring plan shall include the following sections:

a) Technical description of the monitoring task.
b) List of data and parameters to be collected.
c) Overview of data collection procedures.
d) Quality control and quality assurance procedures.
e) Data archiving.
f) Organization and responsibilities of the parties involved in all the above.

2. Monitoring of actual carbon stock changes and GHG emissions

Changes in forest cover in the APD project area shall be measured before each verification as part of monitoring. Methods used shall be those in **V.C** of this chapter and any technical guidance specified in the approved monitoring plan.

Carbon stocks in most cases will not have to be monitored during the Crediting Period, except where:

- The Proponent wishes to increase the accuracy and precision of the *ex ante* carbon stock estimates, which are also used for *ex post* calculations. Verifiable evidence shall be provided to the verifier that the accuracy and precision of the carbon stock estimates has improved compared to previous estimates. Any change in carbon stock densities will be subject to verification.

Where GHG emissions are included in the baseline, they shall be monitored in the project case, following the procedures described in **CPES.F through CPES.H**.[28]

The calculations of actual carbon stock changes and GHG emissions shall be reported using transparent procedures.

3. Monitoring of leakage

All significant sources of leakage identified in the GHG Project Plan are subject to monitoring. Methods used shall be those in **V.E and V.F** and any technical guidance specified in the approved monitoring plan. The calculations of leakage carbon stock changes and GHG emissions shall be reported.

4. *Ex post* total net greenhouse gas emission reductions

Ex post total net reductions shall be calculated using the equations in **VIII.A**, including leakage and uncertainty deductions if required.

5. Calculation of ERTs and of buffer contribution, if applicable

Calculation of ERTs shall be performed using the same equations as the *ex ante* assessment, with deductions as needed for uncertainty. See **VII.C** for *ex ante* and **VIII.A** for *ex post* calculation of ERTs.

The proportion of ERT_t to be contributed to the ACR buffer pool is to be determined using an ACR-approved tool per the *ACR Forest Carbon Project Standard*. If the Proponent elects to make the buffer contribution in ERTs from another project, or if the Project Proponent elects to mitigate the assessed reversal risk using an alternate risk mitigation mechanism approved by ACR, then the buffer contribution deducted from the project itself (*BUF*) is set equal to zero.

[28] Throughout this methodology the abbreviation **CPES** refers to the ACR *Tool for Estimation of Stocks in Carbon Pools and Emissions from Emission Sources*.

C. Monitoring of Carbon Stocks and GHG Emissions

This section provides procedures for *ex post* monitoring of GHG emissions and removals due to deforestation, forest degradation, and carbon stock enhancement that has been induced as a result of project implementation within the project area and leakage belt.

Monitoring is generally required at least every five (5) years, since it must precede the full field verification required no less often than every 5 years.

The procedure includes:

a. The area of forest land converted to non-forest land and associated changes in carbon stocks;
b. The area of forest land undergoing loss in carbon stock from degradation activities and associated changes in carbon stocks;
c. The area of forest land undergoing gain in carbon stock from enhancement activities and associated changes in carbon stocks.

1. Procedure

For the project area, net GHG emissions in the project case are equal to the sum of stock changes due to deforestation and degradation, plus the total GHG emissions, minus any eligible forest carbon stock enhancement:

$$\Delta C_P = \sum_{t=1}^{t}\sum_{i=1}^{M} \Delta C_{P,DefPA,i,t} + \Delta C_{P,Deg,i,t} + GHG_{P-E,i,t} - \Delta C_{P,Enh,i,t} \tag{10}$$

Where:

ΔC_P	Net CO_2 equivalent emissions within the project boundary in the project case; t CO_2-e
$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* at time *t*; t CO_2-e
$\Delta C_{P,Deg,i,t}$	Net carbon stock change as a result of degradation in the project case in stratum *i* at time *t*; t CO_2-e
$GHG_{P-E,i,t}$	GHG emissions as a result of deforestation and degradation activities within the project boundary in the project case in stratum *i* at project year *t*; t CO_2-e
$\Delta C_{P,Enh,i,t}$	Net carbon stock change as a result of forest growth and sequestration during the project in areas projected to be deforested in the baseline in stratum *i* at time *t*; t CO_2-e

i	1, 2, 3 …*M* strata in the project scenario
t	1, 2, 3, … *t* years elapsed since the projected start of the project activity

The calculation procedure is implemented by applying the following 3 steps:

STEP 1. Selection and analyses of sources of activity data

STEP 2. Interpretation and analyses

STEP 3. Documentation

STEP 1. Selection and analyses of sources of activity data

At a minimum, medium resolution remotely sensed spatial data shall be used[29] (30m x 30m resolution or less, such as Landsat, Resourcesat-1 or Spot sensor data). In general, the same source of remotely sensed data and data analysis techniques must be used throughout a period for which the baseline is fixed. If remotely sensed data have become available from new and higher resolution sources (e.g. from a different sensor system) during this period, it is possible to change the source of the remotely sensed data; and if the same source is no longer available (e.g. due to satellites or sensors going out of service) an alternate source may be used. A change in source data may occur only if the images based on interpretation of the new data overlap the images based on interpretation of the old data by at least 1 year and they cross-calibrate to acceptable levels based on commonly used methods in the remote sensing community.

The data collected and analyzed must cover the entire project area. Data shall be available for the year in which monitoring and verification is occurring.

1.1 Processing activity data

The remotely sensed data must be prepared for analysis. Minimum pre-processing involves geometric correction and geo-referencing and cloud and shadow detection and removal. Guidance for interpretation of remote sensing imagery is given in the GOFC-GOLD 2008[30] Sourcebook for REDD and shall be followed as appropriate.

1.2 Post-processing and accuracy assessment

[29] Guidance on the selection of data sources (such as remotely sensed data) can be found in Chapter 3A.2.4 of the IPCC 2006 GL AFOLU and in GOFC-GOLD. (2008), Reducing greenhouse gas emissions from deforestation and degradation in developing countries: a sourcebook of methods and procedures for monitoring, measuring and reporting, GOFC-GOLD Report version COP13-2, (GOFC-GOLD Project Office, Natural Resources Canada, Alberta, Canada) – available at: http://www.gofc-gold.uni-jena.de/redd/sourcebook/Sourcebook_Version_June_2008_COP13.pdf (Section 3.2.4).

[30] GOFC-GOLD, 2008, *Reducing greenhouse gas emissions from deforestation and degradation in developing countries: a sourcebook of methods and procedures for monitoring, measuring and reporting*, GOFC-GOLD Report version COP13-2, (GOFC-GOLD Project Office, Natural Resources Canada, Alberta, Canada). Available at:
http://www.gofc-gold.uni-jena.de/redd/sourcebook/Sourcebook_Version_June_2008_COP13.pdf

Post-processing is required to map area change detected in the imagery, and to calculate any area of deforestation within the project area.

a) At the end of each monitoring period, calculate the area of forest in the project area

b) Estimating activity data in cloud-obscured areas: calculating deforestation when maps have gaps due to cloud cover is a challenge. Multi-date images must be used to reduce cloud cover to no more than 10% of any image. If the areas of ≤10% cloud cover in either date in question in the area for which the rate is being calculated do not overlap exactly, then areas with cloud cover in both images shall be assumed to be deforested unless ground data can be produced verifying continued forest cover.

The overall classification accuracy of the outcome of the above steps must be 80% or more as demonstrated through ground truthing or use of high resolution imagery.

STEP 2. Interpretation and analyses

2.1 Monitoring deforestation

This step will produce an estimate of the emissions resulting from any deforestation that occurs within the project area ($\Delta C_{P,Def,i,t}$).

Many methods exist to detect and map deforestation using remotely sensed data. The method selected must be based on common good practice in the remote sensing field and will depend on available resources and the availability of image processing software. The same method should be used for the entire period for which the baseline is fixed. The key is that the method of analysis results in estimates of any deforestation that may occur in the project and leakage areas. See IPCC 2006 GL AFOLU, Chapter 3A.2.4 and the GOFC-GOLD 2008 Sourcebook for REDD for additional guidance.

The net carbon stock change as a result of deforestation is equal to the area deforested multiplied by the emission per unit area.

$$\Delta C_{P,DefPA,i,t} = \sum_{u=1}^{U} \left(A_{DefPA,u,i,t} * \Delta C_{pools,P,Def,u,i,t} \right) \tag{11}$$

Where:

$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project case in the project area in stratum *i* at time *t*; t CO_2-e
$A_{DefPA,u,i,t}$	Area of recorded deforestation in the project area stratum *i* converted to land use *u* at time *t*; ha
$\Delta C_{pools,Def,u,i,t}$	Net carbon stock changes in all pools in the project case in land use *u* in stratum *i*; t CO_2-e ha^{-1}

u	1, 2, 3, … U post-deforestation land uses
i	1, 2, 3 …M strata in the in the project case
t	1, 2, 3, … t years elapsed since the projected start of the project activity

The emission per unit area is equal to the difference between the stocks before and after deforestation minus any wood products created from timber extraction in the process of deforestation:

$$\Delta C_{pools,Def,u,i,t} = C_{BSL,i} - C_{P,post,u,i} - C_{P,wp,i} \tag{12}$$

Where:

$\Delta C_{pools,Def,u,i,t}$	Net carbon stock changes in all pools as a result of deforestation in the project case in land use u in stratum i; t CO_2-e ha^{-1}
$C_{BSL,i}$	Carbon stock in all pools in the baseline case in stratum i; t CO_2-e ha^{-1}
$C_{P,post,u,i}$	Carbon stock in all pools in the project case post-deforestation land use u in stratum i; t CO_2-e ha^{-1}
$C_{P,WP,i}$	Carbon stock sequestered in wood products in the project case in stratum i; t CO_2-e ha^{-1}
u	1, 2, 3, … U post-deforestation land uses
i	1, 2, 3 …M strata in the in the project case
t	1, 2, 3, … t years elapsed since the projected start of the project activity

For calculation of carbon stock sequestered in wood products, use the procedure **CPES.E**. It is conservative in the project case to assume no wood products are produced.

Instead of tracking annual emissions through burning and/or decomposition, this methodology employs the simplifying assumption that all carbon stocks are emitted in the year deforested and that no stocks are permanently sequestered (beyond 100 years after deforestation). This assumption applies regardless of whether burning is employed as part of the forest conversion process or as part of post conversion land use activities.

Changes in carbon stocks in the selected pools must be measured and estimated using the procedures in **CPES.A through CPES.E**. The methods used and the pools selected in the project case must be the same as those in the baseline case.

$$C_{post,u,i} = C_{AB\_tree,i} + C_{BB\_tree,i} + C_{AB\_non-tree,i} + C_{BB\_non-tree,i} + C_{DW,i} + C_{LI,i} + C_{SOC,PS-BSL,i} \tag{13}$$

Where:

$C_{P,post,u,i}$ Carbon stock in all pools in the project case post-deforestation land use *u* in stratum *i*; t CO_2-e ha^{-1}

$C_{AB\_tree,i}$ Carbon stock in aboveground tree biomass in the project case in stratum *i* calculated per the procedure in **CPES.A**; t CO_2-e ha^{-1}

$C_{BB\_tree,i}$ Carbon stock in belowground tree biomass in the project case in stratum *i* calculated per the procedure in **CPES.A**; t CO_2-e ha^{-1}

$C_{AB\_non\text{-}tree,i}$ Carbon stock in aboveground non-tree vegetation in the project case in stratum *i* calculated per the procedure in **CPES.A**; t CO_2-e ha^{-1}

$C_{BB\_non\text{-}tree,i}$ Carbon stock in belowground non-tree vegetation in the project case in stratum *i* calculated per the procedure in **CPES.A**; t CO_2-e ha^{-1}

$C_{DW,i}$ Carbon stock in dead wood in the project case in stratum *i* calculated per the procedure in **CPES.B**; t CO_2-e ha^{-1}

$C_{LI,i}$ Carbon stock in litter in the project case in stratum *i* calculated per the procedure in **CPES.C**; t CO_2-e ha^{-1}

$C_{SOC,PD\text{-}BSL,i}$ Mean post-deforestation stock in soil organic carbon in the post deforestation stratum *I,* calculated per the procedure in **CPES.D**; t CO_2-e ha^{-1}

i 1, 2, 3 …*M* strata in the in the project case

Carbon pools excluded from the project can be accounted as zero. Herbaceous non-tree vegetation is considered insignificant in all instances. To determine which carbon pools must be included in the calculations, follow the guidance on significance testing in **II.C**.

2.2 Monitoring degradation

2.2.1 Monitoring degradation through wood extraction

At the time of development of this methodology, remote sensing technology using optical sensors is not capable of direct measurements of biomass and changes thereof[31] but has some capability to identify forest strata that have undergone a change in biomass[32].

[31] However, technology is developing rapidly, including techniques such as RADAR, SAR, or LiDAR.

[32] For example, a multi-temporal set of remotely sensed data can be used to detect changes in the structure of the forest canopy. A variety of techniques, such as Spectral Mixture Analysis (Souza et al. 2005), SAR or LiDAR, can be used under this approach but no specific technology is prescribed here. Some of the newer technologies can estimate carbon contents of forest types, if supported by field information such as sample plots to calibrate the technology and fieldwork leading to allometric equations of key species. Project Proponents should use techniques that are suitable to their specific situation and that have been published in peer-reviewed papers.

The key is that the monitoring method results in estimates of any emissions from degradation that may occur in the project area ($\Delta C_{P,Deg,i,t}$). This degradation and thus reduction of forest carbon stocks will result from illegal extraction of trees for timber or for fuel and charcoal. As remote methods for monitoring degradation are not currently available, the following ground-based methods must be used.

The first step in addressing forest degradation is to complete a participatory rural appraisal (PRA) of the communities surrounding the project area to determine if there is the potential for illegal extraction of trees to occur. If this assessment finds no potential pressure for these activities then degradation ($\Delta C_{P,Deg,i,t}$) can be assumed to be zero and no monitoring is needed. The PRA must be repeated every 2 years.

If the results of the PRA suggest that there is a potential for degradation activities, then limited field sampling must be undertaken. First, the area that is potentially subject to degradation shall be delineated ($A_{Deg,i}$). An output of the PRA shall be a distance of degradation penetration from all access points (access buffer), such as roads and rivers or previously cleared areas, to the project area. The distance of degradation penetration will vary by form of degradation with a deeper penetration likely for illegal logging than for fuelwood/charcoal.

The area subject to degradation shall be delineated ($A_{Deg,i}$) based on a based on the distance of incursion from all access points, such as roads and rivers or previously cleared areas, to the project area, with a width equal to the distance of degradation penetration. $A_{Deg,i}$ shall be sampled by surveying several transects of known length and width across the access-buffer area (equal in area to at least 1% of $A_{Deg,i}$) to check whether new tree stumps are evident or not. If there is little to no evidence that trees are being harvested (see next paragraph on how to estimate emissions, and use the significance tool in **II.C** to determine if significant), then degradation can be assumed to be zero and no monitoring is needed. This limited sampling must to be repeated each time the PRA indicates a potential for degradation.

If limited sampling does provide evidence that trees are being removed in the buffer area, then a more systematic sampling must be implemented. The sampling plan must be designed using plots systematically placed over the buffer zone so that they sample at least 3% of the area of the buffer zone ($A_{Deg,i}$). The diameter of all tree stumps will be measured and conservatively assumed to be the same as the DBH. If the stump is a large buttress, identify several individuals of the same species nearby and determine a ratio of the diameter at DBH to the diameter of buttress at the same height above ground as the measured stumps. This ratio will be applied to the measured stumps to estimate the likely DBH of the cut tree. The above and below ground carbon stock of each harvested tree must be estimated using the same allometric regression equation and root:shoot ratio used in **CPES.A**[33]. The mean above and below ground carbon stock of the harvested trees is conservatively estimated to all be immediately emitted. This sampling procedure shall be repeated every 5 years and the results annualized by dividing the total emissions by five.

Where the PRA or the limited sampling indicate no degradation occurring:

[33] If species-specific equations are used in the baseline and species cannot be identified from stumps then it shall be assumed that the harvested species is the species most commonly harvested for the specific degradation purpose (e.g. fuelwood, charcoal or timber). A PRA shall be used to determine the most commonly harvested species.

$$\Delta C_{P,Deg,i,t} = 0$$

Where the PRA and the limited sampling indicate degradation is occurring:

$$\Delta C_{P,Deg,i,t} = A_{Deg,i} * \frac{C_{Deg,i,t}}{AP_i} \quad (14)$$

Where:

$\Delta C_{P,Deg,i,t}$	Net carbon stock changes as a result of degradation in stratum *i* at time *t*; t CO_2-e
$A_{Deg,i}$	Area potentially impacted by degradation processes in stratum *i*; ha
$C_{Deg,i,t}$	Biomass carbon of trees cut and removed through degradation process in stratum *i* at time *t*; t CO_2-e
AP_i	Total area of degradation sample plots in stratum *i*; ha
i	1, 2, 3 …*M* strata in the in the project case
t	1, 2, 3, … *t* years elapsed since the projected start of the project activity

2.2.2 Monitoring degradation through fire

Where fires occur *ex post* in the project area, the area burned shall be delineated. For planned deforestation all fires shall be considered as a project emission. The area burned ($A_{burn,i,t}$) shall be delineated and emissions calculated using the procedure in **CPES.F**.

2.3 Monitoring areas undergoing carbon stock enhancement

This sub-step is only applicable for project areas with a deforestation baseline.

If during initial stratification (per **IV.A**) the project contains forest areas that are both deforested in the baseline and assumed to be accumulating carbon, then their geographic boundaries will be known; this will be one or more of the strata. The system in place for monitoring the project area will be used for monitoring any changes that occur in this stratum or strata. Ground measurements will be used to monitor and calculate the change in carbon stocks using the procedures in **CPES.A through CPES.E**.

It is conservative to assume that no carbon stock enhancement is occurring. Projects may elect to set $\Delta C_{P,Enh,i,t} = 0$.

If any of the strata identified as accumulating carbon are subject to degrading activities described in 2.2 above, the emissions from these activities will be estimated according to the methods given in

2.2 and deducted from the amount estimated to be sequestered in the accumulation areas to generate a net estimation of carbon sequestration or emission.

$$\Delta C_{P,Enh,i,t} = \sum_{t=1}^{t} \sum_{i=1}^{M} \left(\left(C_{P,i,t} - C_{BSL,i} \right) * A_{Enh,PL,i,t} \right) \tag{15}$$

Where:

$\Delta C_{P,Enh,i,t}$	Net carbon stock changes as a result of forest carbon stock enhancement in stratum *i* at time *t*; t CO_2-e
$C_{P,i,t}$	Carbon stock in all pools in the project case in stratum *i* at time *t*; t CO_2-e
$C_{BSL,i}$	Carbon stock in all pools in the baseline in stratum *i*; t CO_2-e ha^{-1}
$A_{Enh,PL,i,t}$	Project area in stratum *i* in which carbon stocks are accumulating but that would have undergone planned deforestation in the baseline scenario at time *t*; ha
i	1, 2, 3 …*M* strata in the project scenario
t	1, 2, 3, … *t* years elapsed since the projected start of the project activity

The eligible area is determined from area due to be deforested in each year of the baseline, as estimated through the procedures in **IV.B**.

$$A_{Enh,PL,i,t} = D\%_{planned,i,t} * A_{planned,i,t} \tag{16}$$

Where:

$A_{Enh,PL,i,t}$	Project area in stratum *i* in which carbon stocks are accumulating but that would have undergone planned deforestation in the baseline scenario at time *t*; ha
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum *i* at year *t*; % $year^{-1}$
$A_{planned,i,}$	Total area of planned deforestation over the entire project lifetime for stratum *i*; ha

The carbon stock in the with-project case is equal to:

$$C_{P,i,t} = C_{AB\_tree,i} + C_{BB\_tree,i} + C_{AB\_non-tree.i} + C_{BB\_non-tree.i} + C_{DW,i} + C_{LI,i} + C_{SOC,i} \tag{17}$$

Where:

$C_{P,i,t}$	Carbon stock in all pools in the project case in stratum *i* at time *t*; t CO_2-e
$C_{AB\_tree,i}$	Carbon stock in aboveground tree biomass in the project case in stratum *i* calculated per the procedure in **CPES.A**; t CO_2-e ha^{-1}
$C_{BB\_tree,i}$	Carbon stock in belowground tree biomass in the project case in stratum *i* calculated per the procedure in **CPES.A**; t CO_2-e ha^{-1}
$C_{AB\_non\text{-}tree,i}$	Carbon stock in aboveground non-tree vegetation in the project case in stratum *i* calculated per the procedure in **CPES.A**; t CO_2-e ha^{-1}
$C_{BB,non\text{-}tree,i}$	Carbon stock in belowground non-tree vegetation in the project case in stratum *i* calculated per the procedure in **CPES.A**; t CO_2-e ha^{-1}
$C_{DW,i}$	Carbon stock in dead wood in the project case in stratum *i* calculated per the procedure in **CPES.B**; t CO_2-e ha^{-1}
$C_{LI,i}$	Carbon stock in litter in the project case in stratum *i* calculated per the procedure in **CPES.C**; t CO_2-e ha^{-1}
$C_{SOC,i}$	Carbon stock in soil organic carbon in the project case in stratum *i* calculated per the procedure in **CPES.D**; t CO_2-e ha^{-1}
i	1, 2, 3 …*M* strata in the in the project case

Carbon pools excluded from the project can be accounted as zero. Herbaceous non-tree vegetation is considered to be insignificant in all instances. To determine which carbon pools must be included in the calculations, follow the guidance on significance testing in **II.C**.

2.4 Monitoring project emissions

Where significant, non-CO_2 GHG emissions occurring within the project boundary must be evaluated. For example, where deforestation or degradation occur within the project boundaries and fire is used as a means of forest clearance, non-CO_2 emissions may be significant. To determine which emissions must be included in the calculations, follow the guidance on significance testing in **II.C**.

$$GHG_{P,E,i,t} = ET_{FC,i,t} + E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t} \qquad (18)$$

Where:

$GHG_{P,E}$	GHG emissions as a result of deforestation activities within the project boundary in the project case stratum *i* at project year *t*; t CO_2-e
$E_{FC,I,t}$	Emission from fossil fuel combustion in stratum *i* within the project area in year *t*, calculated per the procedure in **CPES.G**; t CO_2-e $year^{-1}$

$E_{P, BiomassBurn,t}$	GHG emissions due to biomass burning in stratum *i* in year *t*, calculated per the procedure in **CPES.F**; t CO_2-e year^{-1}
$N_2O_{P,direct-N,t}$	Direct N_2O emission as a result of nitrogen application on the alternative land use within the project boundary in stratum *i* in year *t*, calculated per the procedure in **CPES.H**; t CO_2-e year^{-1}
t	*1, 2, 3 …t* years elapsed since the start of the project activity

STEP 3. Documentation

A consistent time-series of data on land use-change, and emissions and removals of CO_2 must result from periodic monitoring. This is only possible if a consistent methodology is applied over time.

The methodological procedures used in steps 1 and-2 above must be documented. In particular, the following information must be provided when remotely sensed data are used:

a) Data sources and pre-processing: Type, resolution, source and acquisition date of the remotely sensed data (and other data) used; geometric, radiometric and other corrections performed, if any; spectral bands and indexes used (such as NDVI); projection and parameters used to geo-reference the images; error estimate of the geometric correction; software and software version used to perform tasks; etc.

b) Data classification: Definition of the classes and categories; classification approach and classification algorithms; coordinates and description of the ground-truth data collected for training purposes; ancillary data used in the classification, if any; software and software version used to perform the classification; additional spatial data and analysis used for post-classification analysis, including class subdivisions using non-spectral criteria, if any; etc.

c) Classification accuracy assessment: Accuracy assessment technique used; coordinates and description of the ground-truth data collected for classification accuracy assessment; and final classification accuracy assessment.

d) Changes in data sources and pre-processing / data classification: If in subsequent periods changes will be made to the original data or use of data:

- Each change and its justification should be explained and recorded including impact on previous calculations; and
- When data from new satellites are used documentation must follow a) to c) above

D. Monitoring of Leakage

All significant sources of leakage identified in the GHG Project Plan are subject to monitoring, following the procedures that follow. All relevant parameters shall be included in the monitoring plan.

The next two sections provide procedures to calculate ΔC_{LK}, or the sum of the carbon stock changes and GHG emissions due to leakage up to time t (t CO_2e) due to both activity shifting leakage and market effects leakage. The leakage deduction ΔC_{LK} is taken in the eventual calculation of net GHG emission reductions (**VII.C** for *ex ante*, **VIII.A** for *ex post*).

E. Estimation of Emissions due to Activity Shifting Leakage

This section provides a procedure for calculating $\Delta C_{LK\text{-}AS,planned}$, or the GHG emissions caused by activity shifting leakage through displacement of planned deforestation in APD projects.

Displacement of baseline activities can be controlled and measured directly by monitoring the baseline deforestation agents or class of agents.

1. Procedure

PART 1: WHERE THE SPECIFIC DEFORESTATION AGENT HAS BEEN IDENTIFIED

$$\Delta C_{LK-AS,planned} = \sum_{t=1}^{t^*}\sum_{i=1}^{M}\left(\left(LKA_{planned,i,t} * \Delta C_{BSL,i}\right) + GHG_{LK,E,i,t} + LK_{peat}\right) \quad (19)$$

Where:

$\Delta C_{LK\text{-}AS,planned}$	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation; t CO_2-e
$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum *i* at time *t*; ha
$\Delta C_{BSL,i}$	Net carbon stock changes in all pools in baseline stratum *i*; t CO_2-e ha^{-1}
$GHG_{LK,E,i,t}$	Greenhouse gas emissions as a result of leakage of avoided deforestation activities in stratum *i* in year *t*; t CO_2-e
$LK_{peat,t}$	Net greenhouse gas emissions due to leakage to peatlands as a result of implementation of a planned deforestation project at time *t*; t CO_2-e
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

The approach is to calculate the total area of deforestation forecast to occur across the land managed by the baseline agent of deforestation (including the baseline projected deforestation within the project boundaries). By calculating the total area of deforestation across all the lands managed by the agent it makes it possible to monitor possible activity shifting by agents to other areas under their management. The predicted deforestation within the project boundary is then subtracted from the total deforestation across all the land managed by the baseline agent/class. This subtraction gives the deforestation expected if no leakage occurs. If this deforestation is subtracted from the total area of deforestation by the baseline agent of deforestation the result is the area of leaked deforestation.

STEP 1: Determine the baseline rate of forest clearance for the deforestation agent

Two options exist for estimating the baseline rate of forest clearance by the deforestation agent. Only if a historic trend analysis (Option 1.1) is not feasible shall Option 1.2 be used:

Option 1.1: Baseline deforestation based on historic deforestation trend

With this approach, the baseline annual deforestation by the baseline deforestation agent can be estimated by extrapolating the historical annual trend using a linear regression. Survey the deforestation agent and examine official records[34] to determine the total area deforested by the deforestation agent each year over the previous five years within the country. To use this option, *annual* data for a minimum of five years and a maximum of ten years must be used to create linear regression. The results of the analysis must produce a statistically significant regression with a $p \leq 0.05$ and an adjusted r^2 of ≥ 0.75; otherwise Option 1.2 must be used.

$$WoPR_{i,t} = a + b * t \qquad (20)$$

Where:

$WoPR_{i,t}$	Deforestation by the baseline agent of the planned deforestation in the absence of the project in stratum *i* in year *t*; ha (Under Option 1.1 the rate will differ by year in the baseline period)
a	Estimated intercept of the regression line; ha
b	Slope of the linear regression; ha yr^{-1}
t	1, 2, 3, … t^* years elapsed since the projected start of the REDD project activity

Option 1.2: Baseline deforestation based on historic deforestation average

Under this approach, the baseline annual deforestation by the baseline deforestation agent is assumed to be equal to the average deforested area, during the 5 years prior to the project start date.

Survey the deforestation agent and, if available, examine official records[35] to determine the total area deforested by the deforestation agent each year over the previous five years within the country.

[34] Official records may include permits for concessions or permits to deforest for agricultural/commercial purposes
[35] Official records may include permits for concessions or permits to deforest for agricultural/commercial purposes

$$WoPR_{i,t} = \sum_{ag=1}^{ag} \frac{HistHa_{i,ag}}{5} \qquad (21)$$

Where:

$WoPR_{i,t}$	Deforestation by the baseline agent of the planned deforestation in the absence of the project in stratum *i* in year *t*; (Under Option 1.2 the same area of deforestation will be applied for each year of the baseline period)
$HistHa_{i,ag}$	The number of hectares of forest cleared by the baseline agent of the planned deforestation in the five years prior to project implementation in stratum *i* by agent *ag* within the country; ha
i	1, 2, 3 …*M* strata
ag	*1, 2, 3 ...ag* agents of deforestation
t	1, 2, 3, … t^* years elapsed since the projected start of the REDD project activity

Where there is no history of deforestation and no verifiable plans for controlled lands and future-controlled lands then *WoPR* should be set to planned baseline rate for the project ($D\%_{planned}$ * $A_{planned}$ from the planned deforestation baseline section).

STEP 2: Estimate new projection of forest clearance by the baseline agent of deforestation with project implementation if no leakage is occurring

Subtract the total project area of planned baseline deforestation from the historic area of deforestation to calculate the new area.

$$NewR_{i,t} = WoPR_{i,t} - \left(D\%_{planned,i,t} * A_{planned,i}\right) \qquad (22)$$

Where:

$NewR_{i,t}$	New calculated forest clearance in stratum *i* at time *t* by the baseline agent of the planned deforestation where no leakage is occurring; ha
$WoPR_{i,t}$	Deforestation by the baseline agent of the planned deforestation in stratum *i* in year *t* in the absence of the project; ha
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum *i* at year *t;* %
$A_{planned,i,}$	Total area of planned deforestation over the baseline period for stratum *i*; ha
i	1, 2, 3, …*M* strata

t	1, 2, 3, … t^* years elapsed since the projected start of the REDD project activity

STEP 3: Monitor all areas deforested by baseline agent of deforestation through the years in which planned deforestation was forecast to occur

All areas deforested by the baseline agent of deforestation should be monitored. Areas of deforestation may be anywhere in the host country. There is no requirement to track international leakage.

$$LKA_{planned,i,t} = A_{defLK,i,t} - NewR_{i,t} \quad (23)$$

Where:

$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum i at time t; ha
$NewR_{i,t}$	New calculated forest clearance by the baseline agent of the planned deforestation in stratum i at time t where no leakage is occurring; ha
$A_{defLK,i,t}$	The total area of deforestation by the baseline agent of the planned deforestation in stratum i at time, t; ha
i	1, 2, 3 …M strata
t	1, 2, 3, … t^* years elapsed since the start of the REDD project activity

If $NewR_{i,t}$ exceeds $A_{defLK,i,t}$ then $LKA_{planned,i,t}$ should be set as zero as positive leakage is not considered under the ACR.

STEP 4: Monitor greenhouse gas emissions outside the project boundary by baseline agent of deforestation

Where a specific agent of deforestation has been identified fertilizer use and biomass burning shall be monitored. Conservatively any emissions shall be counted as leakage regardless of whether the source was or was not included in baseline calculations:

$$GHG_{LK,E,i,t} = E_{BiomassBurn,i,t} + N_2O_{direct-N,i,t} \quad (24)$$

Where:

$GHG_{LK,E,i,t}$	Greenhouse gas emissions as a result of leakage of avoided deforestation activities in stratum i in year t; t CO_2-e
$E_{BiomassBurn,i,t}$	Non-CO_2 emissions due to biomass burning in stratum i in year t; t CO_2-e
$N_2O_{direct-N,i,t}$	Direct N_2O emission as a result of nitrogen application on the alternative land

use in stratum *i* in year *t*; t CO_2-e

i 1, 2, 3 …*M* strata

t *1, 2, 3 …t** years elapsed since the start of the REDD project activity

Where the baseline agent of deforestation is unwilling to share information on areas burned and quantity of fertilizer used the values shall be estimated based on common practice as defined by participatory rural appraisal (PRA).

PART 2: WHERE ONLY A CLASS OF DEFORESTATION AGENTS CAN BE IDENTIFIED

Where only a class of agents can be identified leakage can be most closely linked to the market demand for the commodity that would have been produced within the project area in the absence of the project.

STEP 1: Identify commodity produced by baseline class of agent

For many classes of agents it is likely that a single commodity will be associated (e.g. oil palm producers or cattle ranchers) and thus this commodity shall be used for the leakage analysis.

For other classes of agents the most likely commodity shall be assessed. This assessment shall include justification including information on commodity suitability and the commodities currently being produced by others in the same class of agent. If justifiable, different commodities may be assigned to different strata.

STEP 2: Assess proportion of available areas that are forested

Determine areas in the country currently potentially available for production of the commodity(ies) specified in STEP 1. The determination shall reference to soil type, elevation, precipitation and access to markets for the specified commodity(ies). Determine the proportion of this available area that is currently forested (PF_c).

STEP 3: Evaluate project area relative to other forested areas for commodity production in the country

3.1 Assess productivity of project area for commodity production

3.2 Assess productivity of alternative areas in the country for commodity production

Assessment of productivity shall include soil type, elevation and precipitation. Experts in the production of the specific commodity shall be consulted (e.g. Government Ministry of Agriculture).

STEP 4: Assess proportional leakage factor

If average productivity of alternative lands is the same ±15% as the relevant strata in the project area then:

$LK_{CP\text{-}ME,c,i}$ = 0.4

If average productivity of alternative lands is >15% **less** than the relevant strata in the project area then:

$LK_{CP\text{-}ME,c,i}$ = 0.7

If average productivity of alternative lands is >15% **more** than the relevant strata in the project area then:

$LK_{CP\text{-}ME,c,i}$ = 0.2

STEP 5: Calculate estimated leakage

$$\Delta C_{LK-AS,planned} = \sum_{t=1}^{t^*}\sum_{i=1}^{M}\sum_{c=1}^{C}\left(\left(\left(D\%_{planned,i,t} * A_{planned,i}\right) * \Delta C_{BSL,i}\right) * PF_c * LK_{CP-ME,c,i}\right) \quad (25)$$

Where:

$\Delta C_{LK\text{-}AS,planned}$	Net CO_2 emissions due to activity shifting leakage for projects preventing planned deforestation; t CO_2-e
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum *i* at year *t;* %
$A_{planned,i,}$	Total area of planned deforestation over the baseline period for stratum *i*; ha
$\Delta C_{BSL,i}$	Net carbon stock changes in all pools in baseline stratum *i*; t CO_2-e ha^{-1}
PFc	Proportion of available area for production of commodity *c* that is currently forested; dimensionless
$LK_{CP\text{-}ME,c,i}$	Leakage factor for displacement of class of planned deforestation agents; dimensionless
c	1, 2, 3, ...*C* commodities
i	1, 2, 3, …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

PART 3: THE SPECIAL CASE OF PEATLANDS

In countries with peatland and where the planned deforestation baseline land use is for a commodity that can be produced on drained peatland, the specific agent shall be identified and leakage to peatland shall, wherever possible, be prevented.

Thus, for example, in countries where oil palm is grown on drained peatland, a planned deforestation project may not have a baseline of oil palm production by a class of agent. In this case the specific agent must be identified and tracked through time to ensure that leakage to peatland does not occur.

It would be good practice to have a contract with the baseline agent to ensure that the rate of planting on drained peatland does not increase after the project start date.

Where leakage to peatlands does occur, the leakage emissions are conservatively estimated as five times[36] the average carbon stock of the project multiplied by the area of leakage. Emissions from peatland drainage occur every year that the peat is drained, typically several decades– conservatively all emissions calculated here are taken upfront.

$$LK_{peat,t} = A_{LK-peat,t} * \left(\sum_{i=1}^{M} \Delta C_{BSL,i} \Big/ M \right) * 5 \quad (26)$$

Where:

$LK_{peat,t}$	Net greenhouse gas emissions due to leakage to peatlands as a result of implementation of a planned deforestation project at time *t*; t CO_2-e
$A_{LK\text{-}peat,t}$	Area of leakage to peatland at time *t*; ha
$\Delta C_{BSL,i}$	Net carbon stock changes in all pools in baseline stratum *i*; t CO_2-e ha^{-1}
i	1, 2, 3 …*M* strata
M	The total number of strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

The area of leakage to peatland is equal to the increase in deforestation of peatland by the specific agent relative to business-as-usual. So if historic data shows X hectares of peatland deforestation by the focal agent each year over the past five years then any deforestation in excess of those X hectares each year after project implementation shall be counted as leakage.

36 This value is based on the following assumptions and data from Winrock's "Methodology for Conservation Projects that Avoid Planned Land-Use Conversion in Peat Swamp Forests" (VM0004). Drainage of tropical peatswamp areas emits about 0.9 t CO_2 per cm drained per year, typical drainage depth on conversion to non-forest use is 50 cm, emissions per year are 45 t CO_2/ha; average biomass of peatswamp forest is about 440 t CO_2/ha; and assume peat remains drained for 50 years; factor = 50*45/440 (= 5).

F. Estimation of Emissions due to Market Effects leakage

This section provides a procedure for calculating ΔC_{LK-ME}, or the GHG emissions caused by market-effects leakage where the project activity is anticipated to reduce levels of timber harvest substantially and permanently. When REDD APD Project Activities result in reductions in timber harvest, it is likely that production could shift to other areas of the country to compensate for the reduction.

1. Procedure

This procedure only addresses market effects leakage from lost timber harvest, considering that timber is an important marketed commodity that can result from planned deforestation projects.

Leakage due to market effects is equal to the baseline emissions from logging multiplied by a leakage factor:

$$\Delta C_{LK-ME} = LF_{ME} * AL_T \qquad (27)$$

Where:

ΔC_{LK-ME}	Total GHG emissions due to market-effects leakage; t CO_2-e
LF_{ME}	Leakage factor for market-effects calculations; dimensionless
AL_T	Summed emissions from timber harvest in the baseline case potentially displaced through implementation of carbon project; t CO_2-e

The amount of leakage is determined by where harvesting would likely be displaced to. If in the forests to which displacement would occur a lower proportion of forest biomass in commercial species is in merchantable material than in project area, then in order to extract a given volume higher emissions should be expected as more trees will need to be cut to supply the same volume. In contrast if a higher proportion of the total biomass of commercial species is merchantable in the displacement forest than in the project forests, then a smaller area would have to be harvested and lower leakage emissions would result.

Each project shall calculate within each stratum the proportion of total biomass in commercial species that is merchantable (PMP_i). This shall then be compared to mean proportion of total biomass that is merchantable for each forest type (PML_{FT}).

Merchantable biomass is defined as total gross biomass (including bark) of a tree 40 cm diameter at breast height (DBH) or larger from a 30 cm stump to a minimum 10 cm top of the central stem.

The following deduction factors (LF_{ME}) shall be used:

Where:

PML_{FT} is…	LF_{ME}
equal (± 15%) to PMP_i	0.4
> 15% less than PMP_i	0.7
> 15% greater than PMP_i	0.2[37]

Where:

LF_{ME}	Leakage factor for market-effects calculations; dimensionless
PML_{FT}	Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type; %
PMP_i	Merchantable biomass as a proportion of total aboveground tree biomass for stratum *i* within the project boundaries; %

The next step is to estimate the emissions associated with the displaced logging activity. This is based on the total volume that would have been logged in the baseline in the project area across strata and time periods:

$$AL = \sum_{t=1}^{t^*} \sum_{i=1}^{M_B} C_{BSL,XBT,i,t} \tag{28}$$

Where:

AL	Emissions from timber harvests displaced through implementation of project; t CO_2-e
$C_{BSL,XBT,i,t}$	Carbon emission due to displaced timber harvests in the baseline scenario in at time *t*; t CO_2-e
i	1, 2, 3 …M_B strata in the baseline scenario
t	1, 2, 3, … t^* years elapsed since the projected start of the project activity

The emission due to the displaced logging has two components: the biomass carbon of the extracted timber (see **CPES.E** which uses the same equation) and the biomass carbon in the forest damaged in the process of timber extraction:

$$C_{BSL,XBT,i,t} = \left(\left[V_{BSL,XE,i,t} * D_{mn} * CF\right] + \left[V_{BSL,XE,i,t} * LDF\right] + \left[V_{BSL,XE,i,t} * LIF\right]\right) * \frac{44}{12} \tag{29}$$

Where:

[37] Factors derived by B. Murray and B. Sohngen

$C_{BSL,XBT,i,t}$	Carbon emission due to timber harvests in the baseline scenario in at time *t*; t CO_2-e
$V_{BSL,EX,j,t}$	Volume of timber projected to be extracted from within the project boundary during the baseline in stratum *i* at time *t*; m^3
D_{mn}	Mean wood density of commercially harvested species; t d.m.m^{-3}. The value must be the same as that used in **CPES.E** if this pool is included in the baseline.
CF	Carbon fraction of biomass for commercially harvested species *j*; t C t d.m.$^{-1}$ The value must be the same as that used in **CPES.E** if this pool is included in the baseline.
LDF	Logging damage factor; t C m^{-3} (default 0.53 t C m^{-3} for broadleaf and mixed forests; 0.25 t C m^{-3} for coniferous forests).
LIF	Logging infrastructure factor; t C m^{-3} (default 0.29 t C m^{-3}). See **Annex 1**.
i	1, 2, 3 …M_B strata in the baseline scenario

The logging damage factor (LDF) is a representation of the quantity of emissions that will ultimately arise per unit of extracted timber (m^3). These emissions arise from the non-commercial portion of the felled tree (the branches and stump) and trees incidentally killed during tree felling. The default values given here come from the slope of the regression equation between carbon damaged and volume extracted based on 774 logging gaps measured by Winrock International in Bolivia, Belize, Mexico, the Republic of Congo, Brazil and Indonesia (see **Annex 1**), and 134 logging gaps in Mexico.

The logging infrastructure factor (LIF) is a representation of the quantity of emissions that will ultimately arise per unit of timber (m^3) from roads, skid trails and logging decks. The conservative default value is the upper confidence interval of the average emission from analyses conducted across 1,473 hectares in the Republic of Congo and 366 hectares in Brazil (see **Annex 1**).

G. Estimation of With-Project Uncertainty

This section provides procedures for calculating $Uncertainty_P$ or the total uncertainty in estimations of with-project sequestration, emissions and leakage. See also **IV.C** on calculating baseline uncertainty and **VII.B** on calculating total project uncertainty.

The procedure is used for calculating *ex ante* and *ex post* a precision level and any required uncertainty deduction following project implementation and monitoring. The procedure may be used at the project planning phase to help ensure that monitoring is of sufficient intensity to minimize uncertainty deductions.

Where an uncertainty value is not known or cannot be simply calculated, then a project must justify that it is using an indisputably conservative number and an uncertainty of 0% may be used for this component.

1. Procedure

The area of deforestation or degradation in the with-project scenario should be tracked directly using the same accuracy assessment criterion as used in the baseline (accuracy of 80% or more).

$$\text{Uncertainty}_{\text{P,i}} = \frac{\sqrt{\left(U_{P,SS1,i} * E_{P,SS1,i}\right)^2 + \left(U_{P,SS2,i} * E_{P,SS2,i}\right)^2 + \ldots + \left(U_{P,SSn,i} * E_{P,SSn,i}\right)^2}}{E_{P,SS1,i} + E_{P,SS2,i} + \ldots + E_{P,SSn,i}} \quad (27)$$

Where:

Uncertainty$_{P,i}$	Uncertainty in the with-project scenario in stratum *i*; %
$U_{P,SS,i}$	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) for carbon stocks, GHG sources and leakage emissions in the with-project case in stratum *i* (1,2…n represent different carbon pools and/or GHG sources); %
$E_{P,SS,i}$	Carbon stock, GHG sources or leakage emission type (e.g. trees, down dead wood, soil organic carbon, emission from fertilizer addition, emission from biomass burning, emission from leakage due to activity shifting etc.) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) in the with-project case, as calculated using the procedures in **CPES** for carbon stocks and GHG sources, or **V.E** and **V.F** for leakage emissions; t CO_2-e
i	1, 2, 3 …*M* strata in the project scenario

To assess uncertainty across combined strata:

$$\text{Uncertainty}_{\text{P}} = \frac{\sqrt{\left(\text{Uncertainty}_{\text{Pi1}} * E_{P,i1}\right)^2 + \left(\text{Uncertainty}_{\text{Pi2}} * E_{P,i2}\right)^2 + \ldots + \left(\text{Uncertainty}_{\text{P,iM}} * E_{P,iM}\right)^2}}{E_{P,i1} + E_{P,i2} + \ldots + E_{P,iM}} \quad (28)$$

Where:

Uncertainty$_P$	Total uncertainty in project scenario; %
Uncertainty$_{P,i}$	Uncertainty in baseline project in stratum *i*; %
$E_{P,SS,i}$	Sum of combined carbon stocks and GHG sources (e.g. trees, down dead wood, soil organic carbon, emission from fertilizer addition, emission from biomass burning in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) multiplied by the area of stratum *i* (A_i) in the with-project case; t

	CO_2-e
i	1, 2, 3 …*M* strata

VI. PERMANENCE REQUIREMENTS

Project Proponents must follow the requirements in the ACR *Forest Carbon Project Standard*, Chapter 5, to ensure that REDD APD Project Activities are effectively permanent and fungible with other offsets, emission reductions and allowances. This approach requires a project-specific assessment of risk conducted using an ACR-approved tool, and mitigation of all intentional and unintentional reversals through the ACR buffer pool, an ACR-approved insurance product, or other ACR-approved risk mitigation mechanism.

A. Project-Specific Risk Assessment

This section provides procedures to calculate *BUF*, or the percentage of project ERTs contributed to the ACR buffer pool, if applicable.

1. Procedure

Project Proponents shall conduct their risk assessment using the *ACR Tool for Risk Analysis and Buffer Determination.* Until the release of this tool, Proponents shall use the most updated version of the VCS Tool for AFOLU Non-Permanence Risk Analysis and Buffer Determination.[38]

The output of either tool is an overall risk category for the project, translating into a number of offsets that must be deposited in the ACR buffer pool to mitigate the risk of reversals (unless the Proponent elects another ACR-approved risk mitigation mechanism).

The Proponent shall include the risk assessment, overall risk category, and corresponding buffer percentage (if applicable) in the GHG Project Plan. ACR evaluates the proposed overall risk category and corresponding buffer percentage (if applicable). The verifier evaluates whether the risk assessment has been conducted correctly.

If no reversals occur, the project's risk category and buffer percentage (if applicable) remain unchanged for five years. An exception is in the event of a reversal, in which case the project baseline, risk category and buffer percentage (if applicable) shall be re-assessed and re-verified immediately.

B. Method of Assurance of Permanence

Per the *Forest Carbon Project Standard*, Chapter 5, the Proponent shall specify in the GHG Project Plan what mechanism shall be used for assurance of permanence and mitigation of reversals.

[38] The VCS Tool is available at http://www.v-c-s.org/docs/Tool%20for%20AFOLU%20Non-Permanence%20Risk%20Analysis%20and%20Buffer%20Determination.pdf. Project Proponents must also apply the update at http://v-c-s.org/docs/VCS%20Program%20Update,%20AFOLU%20Risk%20Tool%20Clarification,%2013APR2010.pdf. Upon release of the *ACR Tool,* Project Proponents must use this tool in lieu of the VCS Tool.

For Proponents electing a buffer contribution, the GHG Project Plan shall specify the percentage contribution and whether this contribution will be made using ERTs from the REDD project itself, or ERTs of another type and vintage.

For Proponents electing approved insurance, bonds, letters of credit or other financial assurances in lieu of a buffer contribution, the GHG Project Plan shall provide a description of the insurance product proposed, with sufficient detail for due diligence by ACR. For Proponents electing another ACR-approved risk mitigation mechanism, the GHG Project Plan shall indicate this. In such cases the Proponent shall not conduct the risk assessment or make a buffer contribution.

C. Documenting Project Continuance beyond the APD Crediting Period

For forest carbon project activities in general, ACR requires a Minimum Project Term longer than the Crediting Period. This Minimum Project Term is the time period over which the Project Proponent commits to project continuance, monitoring and verification.

In the case of REDD-APD, because all planned deforestation in the baseline scenario must be projected to occur within a defined period of time, and because planned deforestation can be avoided only once, there will be a limited number of 10-year Crediting Periods. Therefore Project Proponents are not required to monitor and verify, only to document project continuance, after the end of the final Crediting Period in which deforestation is projected, in order to continue receiving periodic refunds of earlier buffer contributions in the event of no reversals.[39]

After the end of the final Crediting Period, Project Proponents who provide, at least every five years, geo-referenced photo or satellite documentation that the forests where planned deforestation was prevented remain intact, with no losses or incursions exceeding a *de minimis* threshold of 3% of the project area, will continue to receive periodic refunds. If losses or incursions exceed this threshold, or Proponents fail to provide such documentation, ACR retains any remaining buffer contribution per the *Forest Carbon Project Standard* Chapter 5 Section F.

[39] See *Forest Carbon Project Standard,* Chapter 5 Sections E and G.

VII. *EX ANTE* ESTIMATION

This chapter provides a procedure for *ex ante* estimation of $C_{REDD,t}$, or total net GHG emission reductions and removals at time *t*. Per the *Forest Carbon Project Standard*, Net Emission Reductions are defined as GHG emission reductions or removals created by a project activity, minus the baseline scenario and any deductions for leakage and uncertainty. ERTs credited to the project are equal to (verified *ex post*) Net Emission Reductions minus a further deduction for the buffer contribution, if required.

A. Ex ante *calculation of* $C_{REDD,t}$

Project Proponents shall present in the GHG Project Plan conservative *ex ante* estimations of the total net GHG emissions reductions of the REDD project activity, which are calculated as follows:

$$C_{REDD,t} = \Delta C_{BSL,planned} - \Delta C_P - \Delta C_{LK} \qquad (29)$$

Where:

$C_{REDD,t}$ Total net GHG emission reductions at time *t*; t CO_2-e

$\Delta C_{BSL,planned}$ Sum of the carbon stock changes and GHG emissions under the baseline scenario up to time *t*; t CO_2-e (as calculated in **IV.B**)

ΔC_P Sum of the carbon stock changes and GHG emissions under the project scenario up to time *t*; t CO_2-e (as calculated in **V.C**)

ΔC_{LK} Sum of the carbon stock changes and GHG emissions due to leakage up to time *t*; t CO_2-e (from equation below)

$$\Delta C_{LK} = \Delta C_{LK-AS,planned} + \Delta C_{LK-ME} \qquad (30)$$

Where:

ΔC_{LK} Sum of the carbon stock changes and GHG emissions due to leakage up to time *t*; t CO_2-e

$\Delta C_{LK-AS,planned}$ Net CO_2 emissions due to activity shifting leakage; t CO_2-e (as calculated in **V.E**)

ΔC_{LK-ME} Total GHG emissions due to market-effects leakage; t CO_2-e (as calculated in **V.F**)

B. *Calculation of Total Project Uncertainty*

Project Proponents shall use the outputs of section **IV.C** (baseline uncertainty) and **V.G** (with-project uncertainty) to calculate total REDD project error C_{REDD_ERROR} and apply the applicable uncertainty deduction, if required.

This procedure is used for calculating a deduction for total project uncertainty. This is distinct from the buffer discount derived from an assessment of risk of reversals (see section **V**), which can periodically be refunded to the project over time if no reversals occur.

Total uncertainty for the REDD project activity is calculated as:

$$C_{REDD\_ERROR} = \sqrt{\text{Uncertainty}_{\text{BSL}}^{2} + \text{Uncertainty}_{\text{P}}^{2}} \qquad (31)$$

Where:

C_{REDD_ERROR}	Total uncertainty for REDD project activity; %
$Uncertaint\ y_{BSL}$	Total uncertainty in baseline scenario; %
$Uncertainty_{P}$	Total uncertainty in the with-project scenario; %

The allowable uncertainty under this methodology is ±10% of $C_{REDD,t}$ at the 90% confidence level. Where this precision level is met, then no deduction should result for uncertainty. Where uncertainty exceeds 10% of $C_{REDD,t}$ at the 90% confidence level, then the deduction shall be equal to the amount that the uncertainty exceeds the allowable level.

The adjusted value for $C_{REDD,\ t}$ to account for uncertainty shall be calculated as:

$$Adjusted\_C_{REDD,t} = C_{REDD,t} * \left(100\% - C_{REDD\_ERROR} + 10\%\right) \qquad (32)$$

Where:

$Adjusted\_\ C_{REDD,\ t}$	Total net GHG reductions at time *t* adjusted to account for uncertainty; t CO_2-e
$C_{REDD,\ t}$	Total net GHG emission reductions at time *t*; t CO_2-e
C_{REDD_ERROR}	Total uncertainty for REDD project activity; %

C. Ex Ante *Calculation of Emission Reduction Tonnes*

Project Proponents shall provide in the GHG Project Plan an *ex ante* calculation of Emission Reduction Tonnes (ERTs).

Net Emission Reductions are as calculated above, $C_{REDD,t}$, which includes a deduction for leakage ΔC_{LK} and the uncertainty deduction, if required.

ERTs are defined as Net Emission Reductions minus offsets set aside in the ACR buffer pool to mitigate reversal risk (in applicable). Thus the *ex ante* calculation of ERTs requires a further deduction for the buffer contribution, unless (1) the Proponent chooses to make the buffer contribution in non-project ERTs rather than setting aside ERTs from the project itself, or (2) the Proponent elects, and ACR approves, an alternate risk mitigation mechanism in lieu of a buffer contribution.

$$ERT_t = \left(Adjusted\_C_{REDD,t_2} - Adjusted\_C_{REDD-t_1}\right) * \left(1 - BUF\right) \quad (33)$$

Where:

ERT_t	Number of Emission Reduction Tonnes at time $t = t_2 - t_1$
$Adjusted\_C_{REDD,t2}$	Cumulative total net GHG emissions reductions up to time t_2, adjusted for uncertainty if required
$Adjusted\_C_{REDD,t1}$	Cumulative total net GHG emissions reductions up to time t_1, adjusted for uncertainty if required
BUF	Percentage of project ERTs contributed to the ACR buffer pool, if applicable

BUF is determined using an ACR-approved risk assessment tool, as described in **VI.A**.

If the Proponent elects to make the buffer contribution in non-project ERTs, or elects to mitigate the assessed reversal risk using an alternate risk mitigation mechanism approved by ACR, then *BUF* shall be set equal to zero.

VIII. *EX POST* CALCULATION OF ERTS

Ex post, Project Proponents shall calculate ERTs using formulas similar to those in the foregoing chapter for *ex ante* estimates. ACR only issues ERTs for verified *ex post* emission reductions.

A. Ex Post *Calculation of Emission Reduction Tonnes*

Per the *Forest Carbon Project Standard*, Net Emission Reductions are defined as GHG emission reductions or removals created by a project activity, minus the baseline scenario and any required deductions for leakage and uncertainty. Net Emission Reductions are as calculated above, $Adjusted\_C_{REDD,t}$, which includes a deduction for leakage ΔC_{LK} and the uncertainty deduction, if required.

ERTs credited to the project are equal to verified *ex post* Net Emission Reductions, minus a further deduction for the buffer contribution, unless (1) the Proponent chooses to make the buffer contribution in non-project ERTs rather than setting aside ERTs from the project itself, or (2) the Proponent elects, and ACR approves, an alternate risk mitigation mechanism in lieu of a buffer contribution.

1. Procedure

$$ERT_t = \left(Adjusted\_C_{REDD,t_2} - Adjusted\_C_{REDD-t_1}\right) * \left(1 - BUF\right) \quad (34)$$

Where:

ERT_t	Number of Emission Reduction Tonnes at time $t = t_2 - t_1$
$Adjusted\_C_{REDD,t2}$	Cumulative total net GHG emissions reductions up to time t_2, adjusted for uncertainty if required
$Adjusted\_C_{REDD,t1}$	Cumulative total net GHG emissions reductions up to time t_1, adjusted for uncertainty if required
BUF	Percentage of project ERTs contributed to the ACR buffer pool, if applicable

BUF is determined using an ACR-approved risk assessment tool, as described in **VI.A**.

If the Proponent elects to make the buffer contribution in non-project ERTs, or elects to mitigate the assessed reversal risk using an alternate risk mitigation mechanism approved by ACR, then *BUF* shall be set equal to zero.

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