REDD Methodological Module

"Estimation of uncertainty for REDD project activities" – X-UNC

Version – April 2010

I. SCOPE, APPLICABILITY AND PARAMETERS

Scope

This module allows for estimating uncertainty in the estimation of emissions and removals in REDD project activities. The module shall also be used for project planning purposes. Use of the module while planning the project can assure the monitoring is of sufficient intensity to minimize uncertainty deductions. The purpose of the methodology is for calculating ex-ante and ex-post a precision level and any deduction in credits for lack of precision following project implementation and monitoring. The module assesses uncertainty in baseline estimations and in estimations of with-project sequestration, emissions and leakage.

Applicability

The module is mandatory, it is applicable for estimating the uncertainty of estimates of emissions and removals of CO_2-e generated from REDD project activities. The module focuses on the following sources of uncertainty:

- Determination of rates of deforestation and degradation
- Uncertainty associated with estimation of stocks in carbon pools and changes in carbon stocks
- Uncertainty in assessment of project emissions

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.

Guidance on uncertainty – a precision target of a 90% confidence interval equal to or less than 10% of the recorded value shall be targeted. This is especially important in terms of project planning for measurement of carbon stocks where sufficient measurement plots should be included to achieve this precision level across the measured stocks.

Required conditions

- Levels of uncertainty should be known for all aspects of baseline and project implementation and monitoring at the stratum level. Uncertainty will generally be known as the ±90% confidence interval expressed as a percentage of the mean.

- Where uncertainty is not known it should be demonstrated that the value used is indisputably conservative.

Parameters

This module provides procedures to determine the following parameter:

Parameter	SI Unit	Description
C_{REDD_ERROR}	%	Total uncertainty for REDD project activity

II. 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[1], or estimates based of sound statistical sampling.

Alternatively, (indisputably) conservative estimates can also 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 module provides a procedure to combine uncertainty information and conservative estimates resulting in an overall ex-post project uncertainty.

Planning to Diminish Uncertainty

It is important that the process of project planning consider uncertainty. Procedures including stratification (see Module X-STR), 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 module at an early stage to identify the data sources with the highest uncertainty to allow the opportunity to conduct further work to diminish uncertainty.

Part 1 – Uncertainty in Baseline Estimates

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

Relevant modules:

[1] Justification should be supplied for all values derived from expert judgement

BL-PL	"Estimation of baseline carbon stock changes and greenhouse gas emissions from planned deforestation"
BL-UR	"Estimation of the baseline rate of unplanned deforestation"
BL-DFW	"Estimation of baseline emissions from forest degradation caused by extraction of wood for fuel"

Relevant parameters:

$A_{BSL,RR,unplanned}$	BL-UR
FG_{BSL}	BL-DFW

Where rates are based on actual deforestation plans, as for instances of planned deforestation, assume:

$Uncertainty_{BSL,RATE} = 0$

In all other scenarios an error propagation should be conducted on the uncertainty in area of deforestation in each time period. The value of the accuracy assessment of remote sensing products that are used to determine the baseline rate of unplanned deforestation will be used to estimate uncertainty. For unplanned deforestation (from module BL-UR), assume

$Uncertainty_{BSL,RATE} = (100-AA_U)$

Where:

AA_U = the accuracy assessment of the rate of unplanned deforestation, %; equals 20% or less

Where deforestation rate is projected using regression equations of past deforestation rate versus an independent variable such as time, the uncertainty introduced by this analysis must be incorporated (see module BL-UR). Take the mean squared error (MSE) of the regression and apply a Monte Carlo statistical analysis to include this source of error into $Uncertainty_{BSL,RATE}$.

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

Relevant modules:

CP-AB	"Estimation of carbon stocks and changes in carbon stocks in the above-ground and below ground biomass carbon pool"
CP-D	"Estimation of carbon stocks and changes in carbon stocks in the dead-wood carbon pool"
CP-L	"Estimation of carbon stocks in the litter carbon pool"
CP-S	"Estimation of carbon stocks in the soil organic carbon pool"
CP-W	"Estimation of carbon stocks and changes in carbon stocks in the wood products carbon pool"
E-BB	"Estimation of non-CO2 emissions from biomass burning"
E-FFC	"Estimation of emissions from fossil fuel combustion"

E-NA	"Estimation of direct N2O emissions from nitrogen application"

Relevant parameters:

$C_{AB\text{-}tree}$	CP-AB
$C_{BB\text{-}tree}$	CP-AB
C_{DW}	CP-D
C_{LI}	CP-L
C_{SOC}	CP-S
C_{WP}	CP-W
$E_{BiomassBurn}$	E-BB
E_{FC}	E-FFC
$N_2O_{direct\text{-}N}$	E-NA

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

$$\text{Uncertainty}_{\text{BSL,SS,i}} = \sqrt{\frac{(U_{BSL,SS1,i} * E_{BSL,SS1,i})^2 + (U_{BSL,SS2,i} * E_{BSL,SS2,i})^2 \ldots + \ldots (U_{BSL,SSn,i} * E_{BSL,SSn,i})^2}{E_{BSL,SS1,i} + E_{BSL,SS2,i} \ldots + \ldots E_{BSL,SSn,i}}} \quad (1)$$

Where:

$Uncertainty_{BSL,SS,i}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas 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 greenhouse gas 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; t CO_2-e
i	1, 2, 3 …M_B strata in the baseline scenario

Step 3: Estimate total uncertainty in baseline scenario

$$\text{Uncertainty}_{\text{BSL,i}} = \sqrt{\text{Uncertainty}_{\text{BSL,RATE,i}}^{2} + \text{Uncertainty}_{\text{BSL,SS,i}}^{2}} \tag{2}$$

Where:

$Uncertainty_{BSL,i}$	Uncertainty in baseline scenario in stratum *i*; %
$Uncertainty_{BSL,RATE,i}$	Percentage uncertainty in the rate of deforestation for areas in stratum *i* through time; %
$Uncertainty_{BSL,SS,i}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in stratum *i* in the baseline case; %
i	1, 2, 3 …M_B strata in the baseline scenario

To assess uncertainty across combined strata:

$$\text{Uncertainty}_{\text{BSL}} = \sum_{i=1}^{M_B} \left(\text{Uncertainty}_{\text{BSL,i}}\right)^2 \tag{3}$$

Where:

$Uncertainty_{BSL}$	Total uncertainty in baseline scenario; %
$Uncertainty_{BSL,i}$	Uncertainty in baseline scenario in stratum *i*; %
i	1, 2, 3 …M_B strata in the baseline scenario

Part 2 – Uncertainty Ex-Post in the With-Project Scenario

Relevant modules:

CP-A	"Estimation of carbon stocks and changes in carbon stocks in the above-ground and below-ground biomass carbon pools"
CP-D	"Estimation of carbon stocks and changes in carbon stocks in the dead-wood carbon pool"
CP-L	"Estimation of carbon stocks in the litter carbon pool"
CP-S	"Estimation of carbon stocks in the soil organic carbon pool"
CP-W	"Estimation of carbon stocks and changes in carbon stocks in the wood products carbon pool"
E-BB	"Estimation of non-CO2 emissions from biomass burning"
E-FFC	"Estimation of emissions from fossil fuel combustion"
E-NA	"Estimation of direct N2O emissions from nitrogen application"

Relevant parameters:

$C_{AB\text{-}tree}$	CP-AB
$C_{BB\text{-}tree}$	CP-AB
C_{DW}	CP-D
C_{LI}	CP-L
C_{SOC}	CP-S
C_{WP}	CP-W
$E_{BiomassBurn}$	E-BB
E_{FC}	E-FFC
$N_2O_{direct\text{-}N}$	E-NA

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—see module BL-UR).

$$\text{Uncertainty}_{\text{P,i}} = \sqrt{\frac{(U_{P,SS1,i} * E_{P,SS1,i})^2 + (U_{P,SS2,i} * E_{P,SS2,i})^2 \ldots + \ldots (U_{P,SSn,i} * E_{P,SSn,i})^2}{E_{P,SS1,i} + E_{P,SS2,i} \ldots + \ldots E_{P,SSn,i}}} \quad (4)$$

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, greenhouse gas 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; t CO_2-e
i	1, 2, 3 …*M* strata in the project scenario

To assess uncertainty across combined strata:

$$\text{Uncertainty}_{\text{P}} = \sum_{i=1}^{M} (\text{Uncertainty}_{\text{P,i}})^2 \quad (5)$$

Where:

$Uncertainty_{BSL}$	Total uncertainty in project scenario; %
$Uncertainty_{BSL,i}$	Uncertainty in baseline project in stratum *i*; %
i	1, 2, 3 …*M* strata in the project scenario

Part 3 – Total Error in REDD Project Activity

$$C_{REDD\_ERROR} = \sqrt{\text{Uncertainty}_{\text{BSL}}{}^2 + \text{Uncertainty}_{\text{P}}{}^2} \qquad (6)$$

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; %

Part 4 – Implications for Project Accounting

If $C_{REDD\_ERROR} \leq 10\%$ of $C_{REDD,\,t}$ then no deduction should result for uncertainty

If $C_{REDD\_ERROR} > 10\%$ of $C_{REDD,\,t}$ then the modified value for $C_{REDD,\,t}$ to account for uncertainty should be:

$$= \frac{100 - C_{REDD\_ERROR}}{100} * C_{REDD,t} \qquad (7)$$

Where:

$C_{REDD,\,t}$	Net anthropogenic greenhouse emission reductions at time *t*; t CO_2-e
C_{REDD_ERROR}	Total uncertainty for REDD project activity; %

III. DATA AND PARAMETERS MONITORED

Data / parameter:	$E_{BSL\ SS}$

Data unit:	t CO_2-e
Used in equations:	1
Description:	Carbon stock or GHG sources (e.g. trees, dead wood, soil organic carbon, emission from fertilizer addition, emission from biomass burning etc.) in the baseline case
Source of data:	The terms denoting significant carbon stocks, GHG sources or leakage emissions from baseline modules (BL-DFW, BL-PL, BL-UP) used to calculate net emission reductions.
Measurement procedures (if any):	
Any comment:	Monitored once every ten years (when the baseline is revisited)

Data / parameter:	$E_{P,SS}$
Data unit:	t CO_2-e
Used in equations:	3
Description:	Carbon stock or GHG sources (e.g. trees, down dead wood, soil organic carbon, emission from fertilizer addition, emission from biomass burning etc.) in the with-project case
Source of data:	The terms denoting significant carbon stocks, GHG sources or leakage emissions used in calculating net emission reductions from the following relevant modules: CP-AB, CP-D, CP-L, CP-S, CP-W, LK-ASP, LK-ASU, LK-DFW, LK-ME, E-BB, E-FFC, E-NA.
Measurement procedures (if any):	
Any comment:	The ex-ante estimation shall be derived directly from the estimations originating in the relevant modules: CP-AB, CP-D, CP-L, CP-S, CP-W, LK-ASP, LK-ASU, LK-DFW, LK-ME, E-BB, E-FFC, E-NA.

Data / parameter:	$U_{BSL,SS}$
Data unit:	%
Used in equations:	1
Description:	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) for carbon stocks and greenhouse gas sources in the baseline case (1,2…n represent different carbon pools and/or GHG sources)

Source of data:	Calculations arising from field measurement data
Measurement procedures (if any):	*Uncertainty in pools derived from field measurement with 90% confidence interval calculated as the standard error of the averaged plot measurements in each stratum multiplied by the t value for the 90% confidence level.* *For wood products the uncertainty should be the confidence interval around the volume of timber extracted from the forest.* *For emission sources conservative parameters should be used sufficient to allow the uncertainty to be set as zero.*
Any comment:	Monitored once every ten years (when the baseline is revisited)

Data / parameter:	$U_{P,SS}$
Data unit:	%
Used in equations:	4
Description:	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) for carbon stocks and greenhouse gas sources in the with-project case (1,2…n represent different carbon pools and/or GHG sources)
Source of data:	Calculations arising from field measurement data
Measurement procedures (if any):	*Uncertainty in pools derived from field measurement with 90% confidence interval calculated as the standard error of the averaged plot measurements in each stratum multiplied by the t value for the 90% confidence level.* *For wood products the uncertainty should be the confidence interval around the volume of timber extracted from the forest.* *For emission sources conservative parameters should be used sufficient to allow the uncertainty to be set as zero.*
Any comment:	Ex-ante the uncertainty in the with-project carbon stocks and sources shall be equal to the calculated baseline uncertainty

IV. PARAMETERS ORIGINATING IN OTHER MODULES

Data / parameter:	AA_U
Data unit:	%

Used in equations:	Part 1, Step 1
Description:	The accuracy assessment of the rate of unplanned deforestation (equals 20% or less)
Module parameter originates in:	BL-UP
Any comment:	

Data / parameter:	$C_{REDD,t}$
Data unit:	t CO_2-e
Used in equations:	7
Description:	Net anthropogenic greenhouse emission reductions at time *t*; t CO_2-e
Module parameter originates in:	REDD-MF
Any comment:	