WR Methodological Module

Estimation of uncertainty for Wetland Restoration of degraded deltaic wetlands (X-UNC)

I. SCOPE, APPLICABILITY AND PARAMETERS

Scope

This module allows for estimating uncertainty in the estimation of emissions and removals from Wetland Restoration (WR) activities implemented on degraded forested and non-forested wetlands in the Mississippi Delta ranging from fresh to saline conditions. This module assesses estimation of baseline and with-project uncertainty.

Applicability

This module is mandatory. It is applicable for estimating the uncertainty of estimates of emissions and removals of CO_2-e generated from wetland restoration activities. The module focuses on the following sources of uncertainty:

- Uncertainty in the rates of wetland loss.
- Uncertainty associated with estimation of stocks in carbon pools and changes in carbon stocks.
- Uncertainty in assessment of baseline and project emissions.

Where an uncertainty value is not known or cannot be accurately 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.

As indicated in the ACR Forest Carbon Project Standard, 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; a sufficient number of measurement plots should be included to achieve this precision level across the included carbon pools in order to avoid an uncertainty deduction.

Parameters

This module provides procedures to determine the following parameters:

Parameter	Description
UNC	Total project uncertainty; *%*
$Uncertainty_{BSL,SS,i}$	Percentage uncertainty of the combined carbon stocks and greenhouse gas

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

II. PROCEDURE

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 on sound statistical sampling. Uncertainties arising from the measurement and monitoring of carbon pools and the changes in carbon pools shall always be quantified.

Indisputably conservative estimates can also be used instead of uncertainties. 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 project scenario uncertainty.

To calculate uncertainty the following equation must be applied:

$$UNC = \sqrt{UNC_{BSL}^{\ 2} + UNC_{P}^{\ 2}} \quad (1)$$

where:

UNC Total project uncertainty; %

UNC_{BSL} Baseline uncertainty; %

UNC_P With-project uncertainty; %

The allowable uncertainty under this methodology is ±10% of $C_{ACR,t}$ at the 90% confidence level. Where this precision level is met, no deduction shall result for uncertainty. Where uncertainty exceeds 10% of $C_{ACR,t}$ at the 90% confidence level, then the deduction shall be equal to the amount that the uncertainty exceeds the allowable level, as indicated in Step 6 of WR-MF.

A. ESTIMATION OF BASELINE UNCERTAINTY

It is important that the process of project planning consider uncertainty. Procedures including stratification and the allocation of sufficient number of measurement plots can help ensure low uncertainty. It is good practice to consider uncertainty at an early stage to identify the data sources with the highest risk to allow the opportunity to conduct further work to diminish

1 Justification should be supplied for all values derived from expert judgment.

uncertainty. Estimation of uncertainty for pools and emissions sources for each measurement pool requires calculation of both the mean and the 90% confidence interval. In all cases, uncertainty should be expressed as the 90% confidence interval as a percentage of the mean.

The uncertainty in the baseline scenario should be defined as the square root of the summed errors in each of the measurement pools. For modeled results, use the confidence interval of the input inventory data. The errors in each pool can be weighted by the size of the pool so that projects may reasonably target a lower precision level for pools that comprise only a small proportion of the total stock. Therefore,

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

where:

$Uncertainty_{BSL,SS,i}$ Percentage uncertainty of the combined carbon stocks and greenhouse gas sources for 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) of carbon stocks and greenhouse gas sources for 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, dead wood, emission from oxidation of SOC during wetland loss) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) for the baseline case; t CO_2-e

i 1, 2, 3 …*M* strata

Uncertainty in projection of baseline rate of wetland loss:

Relevant modules:

BL-WR-WL	Estimation of baseline carbon stock changes from WR including projected wetland loss for the baseline scenario
BL-WR-HM-WL	Estimation of baseline carbon stock changes from WR including projected wetland loss for the baseline scenario where the project activity includes hydrologic management

Relevant parameters:

~~h~~H_o	BL-WR-WL

H_0 ~~h~~	BL-WR-HM-WL
H_y ~~$h_{i,t}$~~	BL-WR-WL
H_y ~~$h_{i,t}$~~	BL-WR-HM-WL

It is here assumed that there is zero uncertainty in the baseline rate of wetland loss where numbers are equal to a long-term average, or are based on actual wetland loss rate. In these specific cases assume:

$$Uncertainty_{BSL,RATE} = 0 \qquad (3)$$

Where the rate of wetland loss is derived from measurements of proxy areas (see modules BL-WR-WL or BL-WR-HM-WL):

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

Total uncertainty in baseline scenario:

To assess uncertainty across combined strata,

$$Uncertainty_{BSL,SS} = \frac{\sqrt{(Uncertainty_{BSL,SSi1} * E_{BSL,i1})^2 + (Uncertainty_{BSL,SSi2} * E_{BSL,i2})^2 + ... + (Uncertainty_{BSL,SSM} * E_{BSL,iM})^2}}{E_{BSL,i1} + E_{BSL,i2} + ... + E_{BSL,iM}} \qquad (4)$$

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. above ground biomass, soil organic carbon, emissions in stratum *i* (1,2…M represent different carbon pools and/or GHG sources) multiplied by the area of stratum *i* (Ai) in the baseline case; t CO2-e
i	1, 2, 3 …M strata

Incorporating rate uncertainty:

$$\text{Uncertainty}_{\text{BSL}} = \sqrt{\text{Uncertainty}_{\text{BSL,RATE}}{}^{2} + \text{Uncertainty}_{\text{BSL,SS}}{}^{2}} \tag{5}$$

where:

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

B. ESTIMATION OF WITH-PROJECT UNCERTAINTY

As with baseline uncertainty, it is important that the process of project planning consider uncertainty. Procedures including stratification and the allocation of sufficient number of measurement plots can help ensure low uncertainty. It is good practice to consider uncertainty at an early stage to identify the data sources with the highest risk to allow the opportunity to conduct further work to diminish uncertainty. Estimation of uncertainty for pools and emissions sources for each measurement pool requires calculation of both the mean and the 90% confidence interval. In all cases, uncertainty should be expressed as the 90% confidence interval as a percentage of the mean.

The uncertainty in the project scenario should be defined as the square root of the summed errors in each of the measurement pools. For modeled results, use the confidence interval of the input inventory data. The errors in each pool can be weighted by the size of the pool so that projects may reasonably target a lower precision level for pools that comprise only a small proportion of the total stock. Therefore,

$$\text{Uncertainty}_{\text{P,SS,i}} = \frac{\sqrt{\left(U_{P,SS1,i} * E_{P,SS1,i}\right)^2 + \left(U_{P,SS2,i} * E_{P,SS2,i}\right)^2 + \ldots + \left(U_{P,SSn,i} * E_{P,SSn,i}\right)^2}}{E_{P,SS1,i} + E_{P,SS2,i} + \ldots + E_{P,SSn,i}} \tag{6}$$

where:

$Uncertainty_{P,SS,i}$	Percentage uncertainty of the combined carbon stocks and greenhouse gas sources for the project scenario case in stratum *i*; %
$U_{P,SS,i}$	Percentage uncertainty (expressed as 90% confidence interval as a percentage of the mean where appropriate) of carbon stocks and

greenhouse gas sources for the project scenario 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, dead wood, emission from oxidation of SOC during wetland loss) in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) for the project scenario case; t CO_2-e
i	1, 2, 3 …*M* strata

Total uncertainty in project scenario:

To assess uncertainty across combined strata,

$$\text{Uncertainty}_{P} = \frac{\sqrt{(\text{Uncertainty}_{Pi1} * E_{P,i1})^2 + (\text{Uncertainty}_{Pi2} * E_{P,i2})^2 + ... + (\text{Uncertainty}_{P,iM} * E_{P,iM})^2}}{E_{P,i1} + E_{P,i2} + ... + E_{P,iM}} \quad (7)$$

where:

$Uncertainty_P$	Total uncertainty in project scenario; %
$Uncertainty_{P,i}$	Uncertainty in project scenario in stratum *i*; %
$E_{P,SS,i}$	Sum of combined carbon stocks and GHG sources (e.g. above ground biomass, soil organic carbon, emissions in stratum *i* (1,2…n represent different carbon pools and/or GHG sources) multiplied by the area of stratum *i* (Ai) in the with-project case; t CO2-e
i	1, 2, 3 …M strata

DATA AND PARAMETERS MONITORED

Data /parameter:	$E_{BSL\ SS}$
Data unit:	t CO_2-e
Used in equations:	3
Description:	Carbon stock of GHG sources (e.g. tree biomass, soil organic carbon, and emissions if determined significant) in the baseline case.
Source of data:	The terms denoting significant carbon stocks, or GHG emissions from baseline modules (BL-WR, BL-WR-HM, BL-WR-WL, BL-WR-HM-WL) used to calculate net emission reductions.

Measurement procedures (if any):	
Monitoring frequency:	The monitoring must occur within five years before the start of the project activity and when the baseline is revisited.
Quality Assurance / Quality Control	
Any comment:	Baseline stocks and sources are estimated *ex-ante* for each baseline period.

Data /parameter:	$E_{P, SS}$
Data unit:	t CO_2-e
Used in equations:	7
Description:	Carbon stock of GHG sources (e.g. tree biomass, soil organic carbon, and emissions if determined significant) in the with-project case.
Source of data:	The terms denoting significant carbon stocks, or GHG emissions used to calculate net emission reductions from the following relevant modules: CP-TB, CP-S, E-E.
Measurement procedures (if any):	
Monitoring frequency:	Monitoring frequency may range from 5 to 20 years and can be fixed to coincide with the crediting period.
Quality Assurance / Quality Control	
Any comment:	The *ex-ante* estimation shall be derived directly from the estimations originating in the relevant modules: CP-TB, CP-S, E-E.

Data /parameter:	$U_{BSL, SS}$
Data unit:	%
Used in equations:	3
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 in stratum *i* (1,2…n represent different carbon pools and/or GHG sources)
Source of data:	Calculations arising from field measurement data.
Measurement	Uncertainty in pools derived from field measurement with 90% confidence

procedures (if any):	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 emission sources and wetland loss conservative parameters should be used sufficient to allow the uncertainty to be set as zero.
Monitoring frequency:	The monitoring must occur within five years before the start of the project activity and when the baseline is revisited.
Quality Assurance / Quality Control	
Any comment:	Baseline stocks and sources are estimated *ex-ante* for each baseline period.

Data /parameter:	$U_{P, SS}$
Data unit:	%
Used in equations:	7
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 in stratum *i* (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 emission sources and wetland loss conservative parameters should be used sufficient to allow the uncertainty to be set as zero.
Monitoring frequency:	Monitoring frequency may range from 5 to 20 years and can be fixed to coincide with the crediting period.
Quality Assurance / Quality Control	
Any comment:	*Ex-ante* the uncertainty in the with-project carbon stocks and sources shall be equal to the calculated baseline uncertainty

PARAMETERS ORIGINATING IN OTHER MODULES

Data /parameter:	~~h~~H_o
Data unit:	ha ~~year^{-1}~~

Used in equations:	Uncertainty of baseline rate
Description:	Wetland project area at~~Baseline wetland loss per year in the project boundary projected over the life of the project in the absence of project implementation.~~ beginning of project activities.
Module parameter originates in:	BL-WR-WL, BL-WR-HM-WL
Any comment:	

Data /parameter:	H_y~~h%$_{pn}$~~
Data unit:	~~%~~ha
Used in equations:	Uncertainty in baseline rate
Description:	Wetland project area at year y.~~Percent of wetland loss in land parcel *pn* etc of a proxy area as a result of identified wetland loss factors~~
Module parameter originates in:	BL-WR-WL, BL-WR-HM-WL
Any comment:	

~~**Data /parameter:**~~	~~Yrs_{pn}~~
~~**Data unit:**~~	~~years~~
~~**Used in equations:**~~	~~Uncertainty in baseline rate~~
~~**Description:**~~	~~Number of years over which deforestation occurred in land parcel *pn* in proxy area; years~~
~~**Module parameter originates in:**~~	~~BL-WR-WL, BL-WR-HM-WL~~
~~**Any comment:**~~	