PV CLIMATE METHODOLOGY

PM00X

Coastal Blue Carbon Methodology

Version 0.7
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Developed by: Blue Ventures (blueventures.org), and the Plan Vivo Coastal Blue Carbon Methodology Working Group (www.planvivo.org)

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Contents

1 Summary

This methodology and its associated modules describe greenhouse gas (GHG) accounting procedures that can be used by locally-led[1] coastal 'blue carbon' projects wishing to generate Plan Vivo Certificates (PVCs). Given the modules currently available, this methodology is applicable to the following *Project Interventions*:

Restoration:

- Mangrove Restoration, assisted natural regeneration and/or afforestation

Protection:

- Mangrove Conservation (avoided Mangrove loss)

The methodology has been designed to allow expansion to other coastal blue carbon ecosystems (e.g. seagrasses) and *Project Interventions* through the development of additional modules.

To promote usability, this methodology and its associated modules use iconography and simple mathematical symbols rather than algebraic notation.

There are no geographical constraints to the application of this methodology. It is globally applicable and there is no maximum project size. However, individual modules may have geographical restrictions. Projects can only apply a module if they fulfil the applicability conditions of both this methodology and the module.

The modules developed for this methodology focus on the GHG accounting procedures for a particular *Project Intervention* (i.e. resource management activity). If a project includes multiple *Project Interventions* (e.g. Mangrove Restoration and Mangrove Conservation) then the project needs to follow the procedures in each module for each relevant *Project Intervention*. The modules walk projects through the steps necessary to calculate their gross (prior to adjustments for leakage, uncertainty, risk and the impact of sea-level rise) GHG emissions and/or removals. This methodology document brings together key outputs from the module(s) and enables projects to calculate their total *Carbon Benefit*. Figure 1 shows a decision tree that guides projects to the modules they should use, depending on the habitats and activities included in the project.

PU##b provides simplified, conservative GHG accounting procedures for Mangrove Restoration or rehabilitation projects. It allows for a tree counting method for baseline and project accounting, and requires the use of a conservative default value for soil organic carbon accumulation. Such procedures are suitable for projects that do not have the technical and/or financial capacity to undertake more complex assessments or monitoring procedures. Projects wishing to claim emission reductions, develop their own soil organic carbon accumulation rate, or use more advanced procedures for baseline and project accounting, will be able to use the alternative Mangrove Restoration module, PU##c, once it is developed.

The Mangrove Conservation module (PU##a) incorporates many of the procedures from the approved Plan Vivo Climate REDD tool, PT002, with the addition of specific requirements and default values for the Mangrove ecosystem.

Clear-cutting or even-aged management are not applicable project activities. However, it is recognised that Mangrove ecosystems are incredibly important habitats for coastal communities

[1] As per the requirements in Section 2.3 of version 5 of the Plan Vivo Climate Project Requirements

across the tropics, far beyond their capacity to sequester CO_2. Amongst their many benefits, Mangroves constitute an important source of wood for many coastal settlements. Therefore, projects that allow sustainable use through Partial (selective) Harvesting, including post-harvest burning of wood (e.g. for fuel or charcoal production), will be able to use this methodology by accounting for the associated GHG emissions through the sustainable wood management module (PU##d), once this module is developed,

Based on the tidal wetland activity list detailed and justified in the approved Verified Carbon Standard module VMD0052, all projects fulfilling the methodology's applicability conditions are deemed additional if they can demonstrate Regulatory Surplus. Regulatory surplus means that project activities are not mandated by any systematically enforced law, statute, or other regulatory framework.

The applicability conditions of this methodology and its associated modules enable the exclusion of all emission sources except soil methanogenesis (CH_4) and fossil fuel use (CO_2). Only projects that involve the movement of soil with machinery (e.g. through the Restoration of hydrology in aquaculture ponds) are required to account for fossil fuel use in the project scenario. All other projects are exempt from accounting for fossil fuel use. Only projects with activities that result in the flooding of dry land in areas where the salinity low point is below 18ppt are required to account for soil methanogenesis in the project scenario.

Projects can use this methodology to generate future, reported and verified Plan Vivo Certificates (fPVCs, rPVCs and vPVCs) for CO_2 removals. Reported and verified Plan Vivo Certificates (rPVCs and vPVCs) can be generated for GHG emission reductions. The modules and this methodology deal with CO_2 removals and GHG emission reductions separately, so the distinction is implicit in the procedures and projects do not necessarily need to understand the difference between reductions and removals.

To help guide projects through the procedures, worked examples are given for each step, using the results from the hypothetical projects used to illustrate the procedures in PU##a and PU##b.

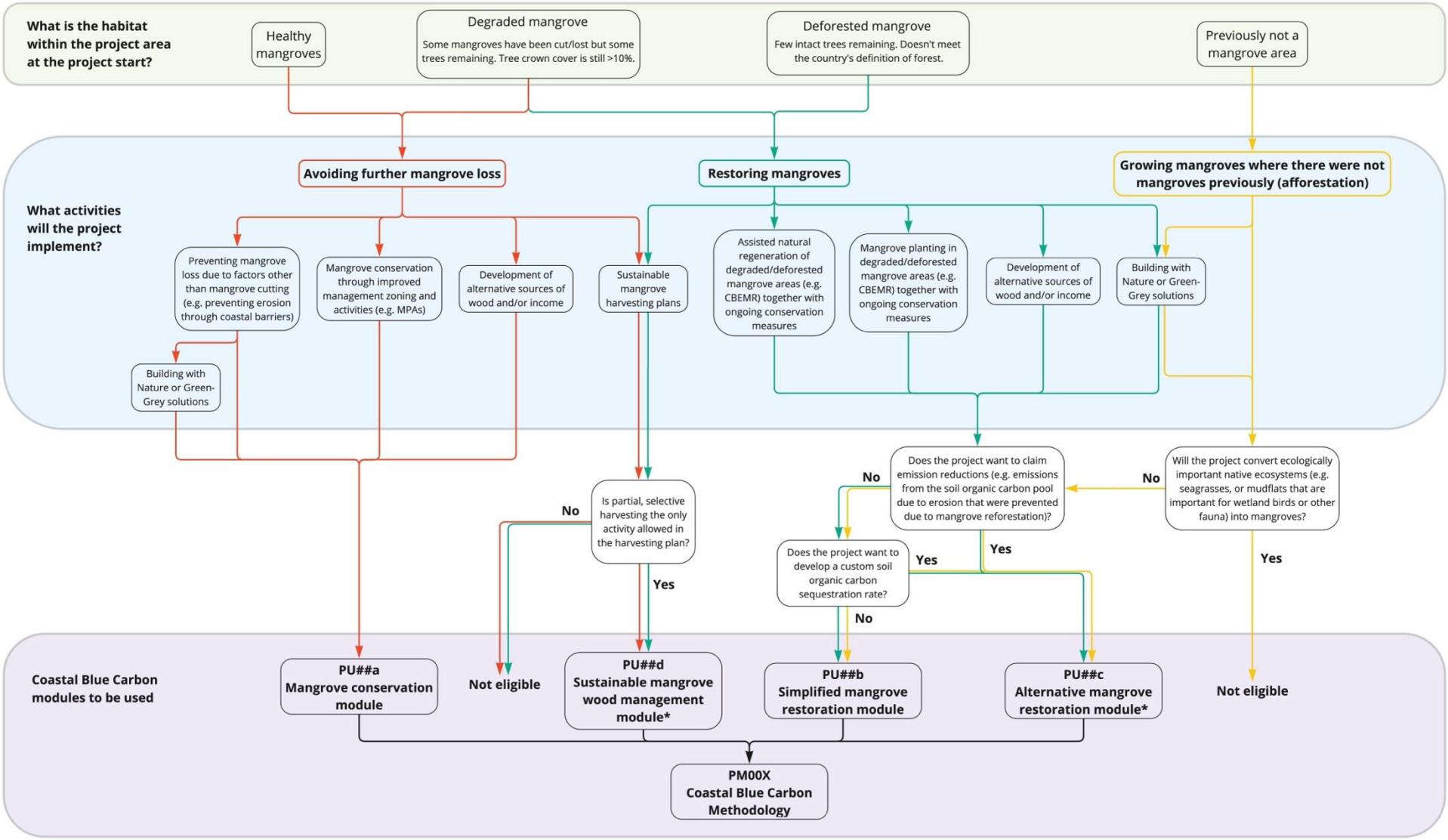


*Figure 1 – Decision tree to guide projects to the modules they should use, depending on the habitats and activities included by the project. Please note that not all the methodology's applicability conditions are included in this figure and all projects should carefully read Section 4 to ensure all applicability conditions are fulfilled. * Module to be developed at a later date.*

2 Sources

This methodology references or uses the following methodologies, modules and tools.

2.1 Referenced Methodologies

VM0033 version 2.1 – Methodology for Tidal Wetland and Seagrass Restoration.

2.2 Modules

PU##a version 1.0 – Mangrove Conservation module

PU##b version 1.0 – Simplified Mangrove Restoration module

PU004 version 1.0 – Estimation of GHG Emissions from Leakage in Plan Vivo Projects

PU005 version 1.0 – Estimation of Uncertainty of Carbon Benefit Estimates in Plan Vivo Projects

VMD0052 version 2.0 – Demonstration of Additionality of Tidal Wetland Restoration and Conservation Project Activities.

2.3 Tools

PT002 version 2.0 – Estimation of Climate Benefits from REDD in Community Managed Forest (Plan Vivo Climate tool)

PT##b version 1.0 – Calculation of the Uncertainty Adjustment for Projects using Tree Counts in PU##b

AR-TOOL02 version 1.0 – Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities (Clean Development Mechanism tool)

3 Definitions

Capitalised terms in this module are defined below. Terms that are both Capitalised and *italicised* are defined in the Plan Vivo Climate Glossary.

Conservation – The prevention of deforestation and/or ecosystem degradation. Note that this methodology and its associated modules currently only provides procedures for accounting for emission reductions due to avoided mangrove deforestation, not degradation.

GHG – Greenhouse gas(es)

Mangrove – A Mangrove is a tree, shrub, palm or ground fern, that normally grows above mean sea level in the intertidal Zone of marine coastal environments and estuarine margins. A Mangrove is also the tidal habitat comprising such trees and shrubs.

Partial Harvesting – A tree harvesting method in which only some of the trees in a stand are felled and removed, leaving the rest standing to maintain continuous forest cover or promote regeneration.

Photo Monitoring – The process of taking geolocated photos at the centre of each Project Plot.

Restoration – The process of assisting the recovery of an ecosystem from a degraded state.

VCS – The Verified Carbon Standard, a standard for the voluntary carbon market that is managed by Verra.

Vegetation and Soil *Carbon Pools* – the aboveground woody and non-woody biomass *Carbon Pools*, the belowground biomass *Carbon Pool* and the soil organic *Carbon Pool*.

Sea Level Rise Risk Adjustment – A unitless factor that determines how many additional PVCs a project must allocate to the *Future Risk Buffer* (fPVCs and rPVCs) or *Risk Buffer* (vPVCs) due to the risk that sea level rise poses to project carbon stocks.

Zone – Areas which have similar physical characteristics, as defined by the module(s) being used

4 Applicability Conditions

4.1 Project Interventions

This Coastal Blue Carbon methodology is applicable to any Plan Vivo Climate project that fulfils all the following criteria:

- *Project Interventions* include one or more of the following activities (as per the definition of Mangrove in Section 3): Mangrove Restoration, afforestation or assisted natural regeneration; Mangrove Conservation.

- *Project Interventions* do not convert ecologically important natural ecosystems (e.g. seagrasses, or mudflats that are important for wetland birds or other fauna) into Mangroves for the purpose of generating PVCs.

- *Project Interventions* do not result in changes to the water table or tidal flows to adjacent wetland ecosystems.

- *Project Interventions*, including leakage management activities, do not include the application of nitrogen fertilisers, such as chemical fertiliser or manure.

- *Project Interventions* do not include Mangrove forest burning, clear-cutting or even-aged management. These activities are allowed in the baseline scenario (i.e. in the absence of the project) but the non-CO_2 emissions resulting from the Mangrove forest burning are conservatively excluded in the methodology's calculations.

- *Project Interventions* that include Partial (selective) Harvesting or deadwood collection for fuelwood will be allowed, but only once the Sustainable Mangrove wood management module (PU##d) is developed, to enable projects to quantify the emissions associated with these activities. Until then, Partial Harvesting and deadwood collection are not eligible project activities.

There are no geographical or project size limitations to this methodology, but individual modules applied by the methodology may have such restrictions. Projects can only apply a module if they fulfil the applicability conditions of both this methodology and the module.

4.2 Certificate Types

Projects can use this methodology to generate future, reported and verified Plan Vivo Certificates (fPVCs, rPVCs and vPVCs) for CO_2 removals. Reported and verified Plan Vivo Certificates (rPVCs and vPVCs) can be generated for GHG emission reductions.

fPVCs can be claimed for up to 90% of the expected *Carbon Benefits* at any time during the *Crediting Period* (see Section 10.5.1). rPVCs can be claimed when *Carbon Benefits* are reported in an annual report to Plan Vivo (see Section 10.5.2). vPVCs can be claimed when *Carbon Benefits* have been verified (see Section 10.5.3). Further details and procedures for conversion between certificate types are described in Section 10.5.4 and the Plan Vivo Climate Procedures Manual.

5 Carbon Pools and Emission Sources

Figure 2 illustrates how the *Carbon Pools* covered by the Plan Vivo Climate Standard are situated in a Mangrove ecosystem. Aboveground woody biomass includes all the living woody material in Mangroves that is above the soil, including saplings and pneumatophores[2]. Aboveground non-woody biomass includes all living material in herbaceous vegetation, such as grasses and palms. This includes nipa palms (*Nypa fructicans*). Belowground biomass covers the living material that is within the soil, such as roots. Visible dead material that is in the soil is included in the soil organic pool, together with the other carbon stored in the soil/mud/sediment. The litter pool covers leaves and other dead, non-woody material on the ground. The woody material on the ground is covered by the deadwood pool. The wood products pool covers wood that it is no longer in the Mangrove ecosystem but has not been burned/destroyed, for instance wood made to build houses or boats.

[2] Aboveground prop roots (such as those of the *Rhizophora* species) are variably counted as aboveground and belowground biomass, depending on the allometric equation used to determine biomass stocks.

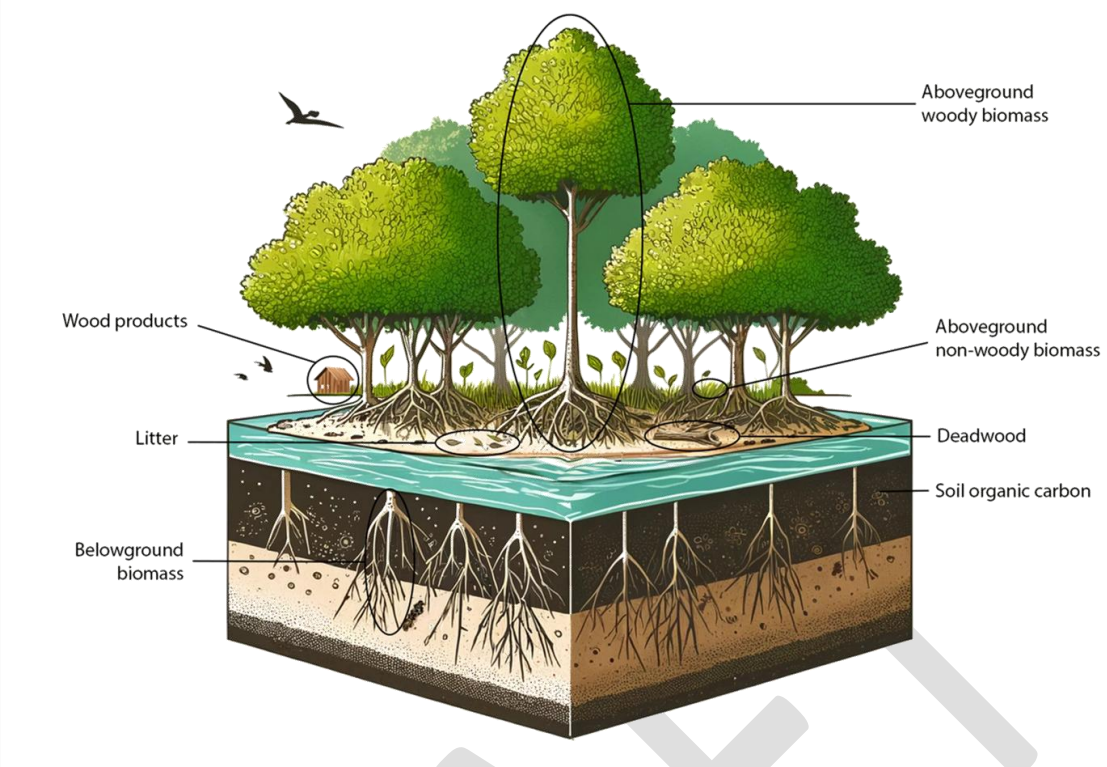


Figure 2 – An illustration of the Carbon Pools *included in the Plan Vivo Climate Standard within a Mangrove ecosystem.*

Table 1 details the *Carbon Pools* included in each of the modules used in this methodology.

Table 1 – The Carbon Pools *accounted for in each module of this methodology. * Module to be developed. ^ Icon to be developed with Sustainable management module.*

		Modules			
***Carbon Pool*:**		PU##a – Mangrove conservation module	PU##b – Simplified mangrove restoration module	PU##c – Alternative mangrove restoration module*	PU##d – Sustainable mangrove wood management module*
	Aboveground woody biomass	Yes	Yes	Yes	Yes
	Aboveground non-woody biomass	No	Yes	Yes	Optional
	Belowground biomass	Yes	Yes	Yes	Yes
	Soil organic carbon	Yes	Yes	Yes	No
N/A	Litter	No	No	No	No
^	Deadwood	No	No	No	Yes
^	Wood products	No	No	No	Optional

The aboveground woody biomass, belowground biomass and soil organic *Carbon Pools* are the major stores of carbon in Mangrove ecosystems. Thus, these are included in all modules, except for soil

organic carbon in the sustainable Mangrove wood management module, because Partial Harvesting does not significantly impact this *Carbon Pool*[3].

In the baseline scenario for all Mangrove *Project Interventions*, aboveground non-woody biomass stocks may decrease. It is conservative to exclude the accounting of this decrease. Through site preparation, Mangrove Restoration *Project Interventions* may cause aboveground non-woody biomass to decrease. Projects using PU##b are required to account for any emissions from this pool due to site preparation, and any increases due to *Project Interventions* are conservatively excluded. Projects using PU##c, once it is developed, will be able to account for increases in the aboveground non-woody biomass pool due to *Project Interventions* and will be required to monitor and account for any non-negligible negative changes in this pool due to *Project Interventions*.

This methodology and its modules refer to the the aboveground woody and non-woody biomass, belowground biomass and soil organic *Carbon Pools* collectively as the Vegetation and Soil *Carbon Pools*.

Whilst litterfall from Mangroves and its subsequent decomposition is an important mechanism in terms of productivity and nutrient cycle of the ecosystem, in terms of carbon it is a negligible pool in Mangrove systems and is likely to increase due to all *Project Interventions*, compared to the baseline scenario. Thus, it is conservatively excluded from this methodology.

Until PU##d is developed, projects that lead to an increase in deadwood harvesting for fuelwood compared to the baseline scenario cannot apply this methodology. Beyond fuelwood collection, *Project Interventions* will not result in significant changes to this pool. Thus, accounting for changes in the deadwood pool is excluded from all other modules.

Except for sustainable Mangrove management *Project Interventions* and Conservation *Project Interventions* where wood harvesting for timber is a driver of deforestation and the wood would have been used to create products that last more than 5 years, accounting for the wood products *Carbon Pool* is excluded. Once developed, PU##d must be used to account for the wood products *Carbon Pool*. Until PU##d is developed, such activities are not eligible under this methodology and its respective modules.

Table 2 shows the emission sources accounted for in each of the modules in this methodology.

*Table 2 – The emission sources covered by in each module of this methodology. * Module to be developed.*

	Module:			
Emission source:	PU##a – Mangrove conservation module	PU##b – Simplified Mangrove restoration module	PU##c – Alternative Mangrove restoration module*	PU##d – Sustainable Mangrove wood management module*
Nitrogen fertilisers (N_2O)	No	No	No	No
Nitrogen fixing species (N_2O)	No	No	No	No
Biomass burning (CH_4)	No	No	No	No

[3] Murdiyarso, D. et al. (2021): https://www.nature.com/articles/s41598-021-91502-x

Fossil fuel use (CO_2)	No	Yes	Yes	No
Enteric fermentation (CH_4)	No	No	No	No
Manure decomposition (CH_4, N_2O)	No	No	No	No
Soil methanogenesis (CH_4)	Yes	Yes	Yes	No

The applicability conditions of this methodology, which exclude any projects that involve forest burning or the addition of fertiliser, enable the exclusion of all emission sources except soil methanogenesis (CH_4) and fossil fuel use (CO_2). Only projects that involve the use of machinery (e.g. through the restoration of hydrology in aquaculture ponds) are required to account for fossil fuel use in the project scenario. All other projects are exempt from accounting for fossil fuel use.

Only projects with activities that result in the flooding of dry land or prevent the draining of land in areas where the salinity low point is below 18ppt are required to account for soil methanogenesis. Procedures to assess salinity levels are provided in the relevant modules.

6 Baseline Scenario and Additionality

6.1 Additionality

Based on the tidal wetland activity list detailed and justified in the approved VCS module VMD0052 (version 2.0)[4], all projects fulfilling the methodology's applicability conditions are deemed additional if they can prove regulatory surplus. Regulatory surplus means that *Project Interventions* are not mandated by any systematically enforced law, statute, or other regulatory framework. Justification of regulatory surplus must be included in the project's PDD.

Additionality needs to be reassessed every 10 years throughout the Project Period.

6.2 Baseline scenario

To define and describe the most likely land cover/use and land management in the absence of *Project Interventions*, all projects must use CDM AR-TOOL02 *Combined tool to identify the baseline scenario and demonstrate additionality for A/R CDM project activities* (version 1.0)[5]. Because additionality is dealt with separately (see Section 6.1), all references to additionality in AR-TOOL02 should be ignored.

This tool was designed for afforestation and reforestation projects using the Clean Development Mechanism. To correctly interpret the tool in the context of this methodology, refer to Table 3.

Also, Step 0 (paragraph 7) of the tool should be ignored.

[4] https://verra.org/methodologies/vmd0052-demonstration-of-additionality-of-tidal-wetland-restoration-and-conservation-project-activities-add-am-v1-0/
[5] https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-02-v1.pdf

Paragraph 9 should be replaced by the following text:

> *9. Identify realistic and credible land-use scenarios that would have occurred on the land within the proposed Project Area in the absence of the Project Interventions under the Plan Vivo Climate Standard. The scenarios should be feasible for the Project Area taking into account relevant national and/or sectoral policies and circumstances, such as historical land uses, practices and economic trends. The identified land use scenarios shall at least include:*
>
> *i) Continuation of the pre-project land use;*
>
> *ii) Project Interventions on the land within the Project Area boundary performed without being registered as the Plan Vivo Climate project;*
>
> *iii) If applicable, activities similar to the proposed Project Intervention on at least part of the land within the project boundary of the proposed Plan Vivo Climate project at a rate resulting from:*
>
> - *Legal requirements; or*
> - *Extrapolation of observed similar activities in the geographical area with similar socioeconomic and ecological conditions to the proposed Plan Vivo Climate project activity occurring in the period beginning ten years prior to the project start date.*

Paragraph 11 should be replaced by the following text:

> *11. All identified land use scenarios must be credible. All land-uses within the boundary of the proposed Plan Vivo project that are currently existing or that existed at some time in the period beginning ten years prior to the project 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.*

AR-TOOL02 must be applied for each *Project Intervention*. Projects that include both Mangrove Restoration and Conservation must apply the tool separately to both the Restoration and Conservation scenarios.

Table 3 – Interpretation guide for applying the CDM AR-TOOL02 in this module

Where CDM AR-TOOL02 says:	Interpret this to mean:
CDM	Plan Vivo Climate
A/R	Mangrove Restoration/Conservation
Afforestation or reforestation	Mangrove Restoration/Conservation
project activity	*Project Intervention*

Using the procedures outlined above, the baseline scenario needs to be reassessed every 10 years throughout the *Project Period* to incorporate the impacts of any material changes that affect the most likely land use and land management scenario in the absence of *Project Interventions*, e.g. policy or legal changes, or new developments that affect the *Project Region*.

7 Carbon Baseline

7.1 Expected carbon baseline

At the start of a project, or for the purposes of generating fPVCs, baseline emissions and/or removals must be estimated for each year of the *Crediting Period* (rPVCs and vPVCs) or *Crediting Period* (fPVCs) by applying the module(s) relevant to the *Project Interventions* (PU##a for Mangrove Conservation and PU##b for Mangrove Restoration).

The following parameters are calculated in the module(s):

= Total expected baseline CO_2 removals in the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period*.

= Total expected baseline CO_2 emissions from the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period*

= Total expected baseline emissions from all emission sources across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period.*

At the end of each *Verification Period*, projects wishing to claim rPVCs in future *Reporting Periods* must either update the parameters above or demonstrate their continued applicability, using the procedures outlined in the module(s) relevant to the *Project Intervention*(s).

Module PU##a estimates baseline removals and emissions for each year of the consequent *Verification Period*. At the start of the project, to estimate baseline removals and emissions in each year of the *Crediting Period* it can be assumed that the following parameters from PU##a are applicable across the entire *Crediting Period*:

= Average proportion of the Mangroves in each Zone of the Reference Area that was deforested in each year of the Reference Period

Worked example – Section 7.1

The hypothetical projects detailed in PU##a and PU##b are part of the same locally-managed marine area, with the same *Project Coordinator*. Therefore, they are **treated as one project with separate *Project Interventions***. This methodology can be used to calculate the total *Carbon Benefit* from both of these *Project Interventions*. The *Crediting Period* for both interventions is 20 years.

The expected baseline emissions and removals for the hypothetical Mangrove Conservation project referenced in PU##a can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/17BKNxzGnQbI_fW0y4ur27vrUlX2GQlbeqXfHOdRAXUs/edit?usp=sharing; see 'Expected' sheet). The *Project Area* only has one Zone: Mangrove forest.

The same value for 

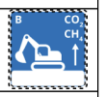
is assumed to be applicable across the whole *Crediting Period*.

Because 

= 5, this means that the expected baseline emissions remain the same from year 5 onwards. The applicability conditions of PU##a mean that there are no baseline CO_2 removals in the Vegetation and Soil *Carbon Pools*.

The expected baseline emissions and removals for the hypothetical Mangrove restoration project referenced in PU##b can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/1F3Vg1WYde7PX_KgBQZIDCDHY7IArH0VDWRVDLlCEZyE/edit?usp=sharing; see 'Expected' sheet). The *Project Area* has six Zones. PU##b conservatively assumes there are no emissions from either the Vegetation and Soil *Carbon Pools* or emission sources in the baseline scenario.

Using the values in these sheets, the required parameters for this section are as follows:

	Mangrove restoration			Mangrove conservation		
Year						
1	119	0	0	0	25,531	0
2	268	0	0	0	29,534	0
3	418	0	0	0	33,537	0
4	625	0	0	0	37,540	0
5	777	0	0	0	41,543	0
6	777	0	0	0	41,543	0
7	777	0	0	0	41,543	0
8	777	0	0	0	41,543	0
9	777	0	0	0	41,543	0
10	777	0	0	0	41,543	0
11	777	0	0	0	41,543	0
12	777	0	0	0	41,543	0
13	777	0	0	0	41,543	0
14	777	0	0	0	41,543	0
15	777	0	0	0	41,543	0
16	777	0	0	0	41,543	0
17	777	0	0	0	41,543	0
18	777	0	0	0	41,543	0
19	777	0	0	0	41,543	0
20	777	0	0	0	41,543	0

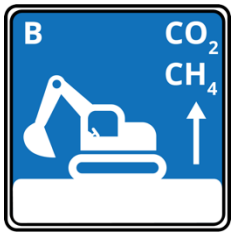
7.2 Actual carbon baseline

At the end of each *Verification Period*, actual baseline emissions and/or removals must be estimated for each year of the *Verification Period* by applying the module(s) relevant to the *Project Interventions*.

The following parameters are calculated in the module(s):

= Total actual baseline CO_2 removals in the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period*.

= Total actual baseline CO_2 emissions from the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period*



= Total actual baseline emissions from all emission sources across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period.*

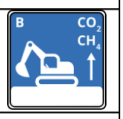
Worked example – Section 7.2

The hypothetical projects detailed in PU##a and PU##b are part of the same locally-managed marine area, with the same *Project Coordinator*. Therefore, they are **treated as one project with separate *Project Interventions***. This methodology can be used to calculate the total *Carbon Benefit* from both of these *Project Interventions*. The first *Verification Period* for both interventions is 5 years.

The actual baseline emissions and removals for the hypothetical Mangrove Conservation project referenced in PU##a over the *Verification Period* can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/17BKNxzGnQbI_fW0y4ur27vrUlX2GQlbeqXfHOdRAXUs/edit?usp=sharing; see 'Actual' sheet). The *Project Area* only has one Zone: Mangrove forest. The applicability conditions of PU##a mean that there are no baseline CO_2 removals in the Vegetation and Soil *Carbon Pools*.

The actual baseline emissions and removals for the hypothetical Mangrove restoration project referenced in PU##b can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/1F3Vg1WYde7PX_KgBQZIDCDHY7IArH0VDWRVDLlCEZyE/edit?usp=sharing; see 'Actual' sheet). The *Project Area* has six Zones. PU##b conservatively assumes there are no emissions from either the Vegetation and Soil *Carbon Pools* or emission sources in the baseline scenario.

Using the values in these sheets, the required parameters for this section are as follows:

	Mangrove restoration			Mangrove conservation		
Year						
1	119	0	0	0	42,552	0
2	269	0	0	0	49,224	0
3	418	0	0	0	55,896	0
4	623	0	0	0	62,568	0
5	777	0	0	0	62,240	0

8 Project Emissions and Removals

8.1 Expected project emissions and removals

At the start of a project, or for the purposes of generating fPVCs, project emissions and/or removals must be estimated for each year of the *Crediting Period* (rPVCs and vPVCs) or *Crediting Period* (fPVCs) by applying the module(s) relevant to the *Project Interventions* (PU##a for Mangrove Conservation and PU##b for Mangrove Restoration).

The following parameters are calculated in the module(s):

= Total expected project CO_2 removals in the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period*.

= Total expected project CO_2 emissions from the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period*

= Total expected project emissions from all emission sources across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period.*

Module PU##a estimates project removals and emissions for each year of the consequent *Verification Period*, for the purpose of claiming rPVCs. At the start of the project, to estimate project removals and emissions in each year of the *Crediting Period* it can be assumed that the following parameters from PU##a are applicable across the entire *Crediting Period*:

= Average proportion of the Mangroves in each Zone of the Reference Area that was deforested in each year of the Reference Period

= An estimate of **expected effectiveness of project activities** in reducing emissions from Mangrove deforestation, expressed as a proportion of baseline scenario emissions that can conservatively be expected to be avoided as a result of project activities.

At the end of each *Verification Period*, projects wishing to claim rPVCs in future *Reporting Periods* must either update the parameters above or demonstrate their continued applicability, using the procedures outlined in the module(s) relevant to the *Project Intervention*(s).

Worked example – Section 8.1

The hypothetical projects detailed in PU##a and PU##b are part of the same locally-managed marine area, with the same *Project Coordinator*. Therefore, they are **treated as one project with separate *Project Interventions***. This methodology can be used to calculate the total *Carbon Benefit* from both of these *Project Interventions*. The *Crediting Period* for both interventions is 20 years.

The expected project emissions and removals for the hypothetical Mangrove Conservation project referenced in PU##a can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/17BKNxzGnQbI_fW0y4ur27vrUlX2GQlbeqXfHOdRAXUs/edit?usp=sharing; see 'Expected' sheet). The *Project Area* only has one Zone: Mangrove forest.

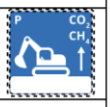
The same values for 

and  are assumed to be applicable across the whole *Crediting Period*. Because 

= 5, this means that the expected project emissions remain the same from year 5 onwards. PU##a conservatively assumes there are no CO_2 removals in the Vegetation and Soil *Carbon Pools* in the project scenario.

The expected project emissions and removals for the hypothetical Mangrove restoration project referenced in PU##b can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/1F3Vg1WYde7PX_KgBQZIDCDHY7IArH0VDWRVDLlCEZyE/edit?usp=sharing; see 'Expected' sheet). The *Project Area* has six Zones. In one Zone of the hypothetical project, channels will be created to enable rehabilitation. The project uses PT##a (Estimation of Emissions from the Soil Organic *Carbon Pool* due to Channel Digging in Mangroves) to estimate the emissions associated with channel creation and the results are included in the table below.

The required parameters for this section are as follows:

	Mangrove restoration			Mangrove conservation		
Year						
1	888	708	0	0	4,340	0
2	1,999	708	0	0	5,021	0
3	3,111	354	0	0	5,701	0
4	4,650	0	0	0	6,382	0
5	5,795	0	0	0	7,062	0
6	5,795	0	0	0	7,062	0
7	5,795	0	0	0	7,062	0
8	5,795	0	0	0	7,062	0
9	5,795	0	0	0	7,062	0
10	5,795	0	0	0	7,062	0
11	5,795	0	0	0	7,062	0
12	5,795	0	0	0	7,062	0
13	5,795	0	0	0	7,062	0
14	5,795	0	0	0	7,062	0
15	5,795	0	0	0	7,062	0
16	5,795	0	0	0	7,062	0
17	5,795	0	0	0	7,062	0
18	5,795	0	0	0	7,062	0
19	5,795	0	0	0	7,062	0
20	5,795	0	0	0	7,062	0

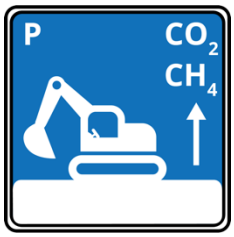
8.2 Actual project emissions and removals

At the end of each *Verification Period*, actual project emissions and/or removals must be estimated for each year of the *Verification Period* by applying the module(s) relevant to the *Project Interventions* (PU##a for Mangrove Conservation and PU##b for Mangrove Restoration).

The following parameters are calculated in the module(s):

= Total actual project CO_2 removals in the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period*.

= Total actual project CO_2 emissions from the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period*



= Total actual project emissions from all emission sources across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period.*

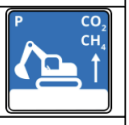
Worked example – Section 8.2

The hypothetical projects detailed in PU##a and PU##b are part of the same locally-managed marine area, with the same *Project Coordinator*. Therefore, they are **treated as one project with separate *Project Interventions***. This methodology can be used to calculate the total *Carbon Benefit* from both of these *Project Interventions*. The first *Verification Period* for both interventions is 5 years.

The actual project emissions and removals for the hypothetical Mangrove Conservation project referenced in PU##a over the *Verification Period* can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/17BKNxzGnQbI_fW0y4ur27vrUlX2GQlbeqXfHOdRAXUs/edit?usp=sharing; see 'Actual' sheet). The *Project Area* only has one Zone: Mangrove forest. PU##a conservatively assumes there are no CO_2 removals in the Vegetation and Soil *Carbon Pools* in the project scenario.

The actual project emissions and removals for the hypothetical Mangrove restoration project referenced in PU##b can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/1F3Vg1WYde7PX_KgBQZIDCDHY7IArH0VDWRVDLlCEZyE/edit?usp=sharing; see 'Actual' sheet). The *Project Area* has six Zones. In one Zone of the hypothetical project, channels will be created to enable rehabilitation. The project uses PT##a (Estimation of Emissions from the Soil Organic *Carbon Pool* due to Channel Digging in Mangroves) to estimate the emissions associated with channel creation and the results are included in the table below.

Using the values in these sheets, the required parameters for this section are as follows:

	Mangrove restoration			Mangrove conservation		
Year						
1	838	708	0	0	7,092	0
2	1,906	708	0	0	8,204	0
3	2,955	354	0	0	9,316	0
4	4,380	0	0	0	10,428	0
5	5,504	0	0	0	11,540	0

9 Leakage

9.1 Potential leakage emissions

At the start of a project, or for the purposes of generating fPVCs, potential leakage emissions must be estimated for each year of the *Crediting Period* (rPVCs and vPVCs) or *Crediting Period* (fPVCs).

For **protection** *Project Interventions*, the procedures for estimating potential leakage emissions are explained in PU##a. The following parameters from PU##a are required by this methodology:

= Total potential CO_2 emissions from the Vegetation and Soil *Carbon Pools* due to leakage across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period.*

= Total potential emissions from all emission sources due to leakage across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period.*

Module PU##a estimates expected emissions due to leakage for each year of the consequent *Verification Period*, for the purpose of claiming rPVCs. At the start of the project, to estimate leakage emissions in each year of the *Crediting Period* it can be assumed that the following parameters from PU##a are applicable across the entire *Crediting Period*

= Average proportion of the Mangroves in each Zone of the Reference Area that was deforested in each year of the Reference Period

= An estimate of expected emissions from deforestation that result from displacement of activities from the *Project Area* to areas outside the *Project Area*, as a result of project activities. Expressed as a **proportion of *Carbon Benefits* that are expected to be lost because of leakage**.

At the end of each *Verification Period*, Conservation projects wishing to claim rPVCs in future *Reporting Periods* must update the parameters above using the procedures outlined in the PU##a.

Restoration *Project Interventions* that fulfil the following criteria are not required to account for leakage:

Prior to the project start date, the *Project Area*:

a) Is free of any land use that could be displaced outside the project area, as demonstrated by at least one of the following:

i) The project area has been abandoned for two or more years prior to the project start date; or

ii) Use of the project area for commercial purposes (i.e., trade) is not profitable because of salinity intrusion, market forces or other factors. In addition, timber harvesting in the baseline scenario within the project area does not occur; or

iii) Degradation of additional wetlands for new agricultural sites within the country will not occur or is prohibited by enforced law.

OR

b) Is under a land use that will continue at a similar level of service or production during the project crediting period (e.g., collection of fuelwood, subsistence harvesting).

Restoration *Project Interventions* that do not fulfil these criteria must use the procedures in Section 5.2.1 of Plan Vivo Climate module PU004 to estimate potential and actual leakage. Equations 4 and/or 5 from PU004 must be calculated for each year of the *Crediting Period*.

From PU004:

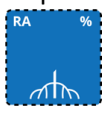
$= pLE_{CP,a}$

$= pLE_{\mathrm{ES},a}$

Worked example – Section 9.1

The hypothetical projects detailed in PU##a and PU##b are part of the same locally-managed marine area, with the same *Project Coordinator*. Therefore, they are **treated as one project with separate *Project Interventions***. This methodology can be used to calculate the total *Carbon Benefit* from both of these *Project Interventions*. The *Crediting Period* for both interventions is 20 years.

The expected leakage for the hypothetical Mangrove Conservation project referenced in PU##a can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/1df05DKCxfSVkF26coZjvqnjJWBVOe3FoaKIsvzbPdXc/edit?usp=sharing; see 'Expected' sheet). The *Project Area* only has one Zone: Mangrove forest.

The same values for 

and 

are assumed to be applicable across the whole *Crediting Period*. Because 

= 5, this means that the expected project emissions remain the same from year 5 onwards.

The land within the *Project Area* of hypothetical Mangrove restoration project referenced in PU##b has been abandoned for 3 years. Thus, the project fulfils the leakage exemption conditions listed in Section 9.1 of this methodology and does not need to account for leakage emissions due to Mangrove restoration.

Therefore, the parameters required for this section are as follows:

	Mangrove restoration		Mangrove conservation	
Year				
1	0	0	2,967	0
2	0	0	3,432	0
3	0	0	3,897	0
4	0	0	4,362	0
5	0	0	4,827	0
6	0	0	4,827	0
7	0	0	4,827	0
8	0	0	4,827	0
9	0	0	4,827	0
10	0	0	4,827	0
11	0	0	4,827	0
12	0	0	4,827	0
13	0	0	4,827	0
14	0	0	4,827	0
15	0	0	4,827	0
16	0	0	4,827	0
17	0	0	4,827	0
18	0	0	4,827	0
19	0	0	4,827	0
20	0	0	4,827	0

9.2 Actual leakage emissions

At the end of each *Verification Period*, actual leakage emissions must be estimated for each year of the *Verification Period*.

For **protection** *Project Interventions*, the procedures for estimating actual leakage emissions are explained in PU##a. The following parameters from PU##a are required by this methodology:

= Total actual CO_2 emissions from the Vegetation and Soil *Carbon Pools* due to leakage in all Zones of the Leakage Area (tCO_2e) for each year of the *Verification Period.*

= Total actual emissions from all emission sources due to leakage in all Zones of the Leakage Area (tCO_2e) for each year of the *Verification Period.*

Restoration *Project Interventions* that fulfil the criteria in Section 9.1 of this module are not required to account for leakage. All other Restoration projects must use the procedures in Section 5.2.1 of Plan Vivo Climate module PU004 to estimate potential and actual leakage. Equations 4 and/or 5 from PU004 must be calculated for each year of the *Verification Period*.

From PU004:

$= pLE_{CP,a}$

$= pLE_{\mathrm{ES},a}$

In the descriptions of the variables in Section 5.2.1 of PU004, for the purposes of estimating actual leakage the tense used in the descriptions should be changed to past tense[6].

Worked example – Section 9.2

The hypothetical projects detailed in PU##a and PU##b are part of the same locally-managed marine area, with the same *Project Coordinator*. Therefore, they are **treated as one project with separate *Project Interventions***. This methodology can be used to calculate the total *Carbon Benefit* from both of these *Project Interventions*. The first *Verification Period* for both interventions is 5 years.

The actual leakage emissions for the hypothetical Mangrove Conservation project referenced in PU##a over the *Verification Period* can be found in this Google Sheet (https://docs.google.com/spreadsheets/d/17BKNxzGnQbI_fW0y4ur27vrUlX2GQlbeqXfHOdRAXUs/edit?usp=sharing; see 'Actual' sheet). The Leakage Area has two Zones: Mangrove forest and Non-Mangrove forest.

[6] For instance, for parameter Arp_p the description would read: *Extent of the project area that experienced reduced use, production or harvesting of wood, animals, agricultural crops or non-timber forest products p as a result of project activities (ha).*

The land within the *Project Area* of hypothetical Mangrove restoration project referenced in PU##b has been abandoned for 3 years. Thus, the project fulfils the leakage exemption conditions listed in Section 9.1 of this methodology and does not need to account for leakage emissions due to Mangrove restoration.

Therefore, the parameters required for this section are as follows:

	Mangrove restoration		Mangrove conservation	
Year				
1	0	0	4,255	0
2	0	0	4,922	0
3	0	0	5,589	0
4	0	0	6,256	0
5	0	0	6,293	0

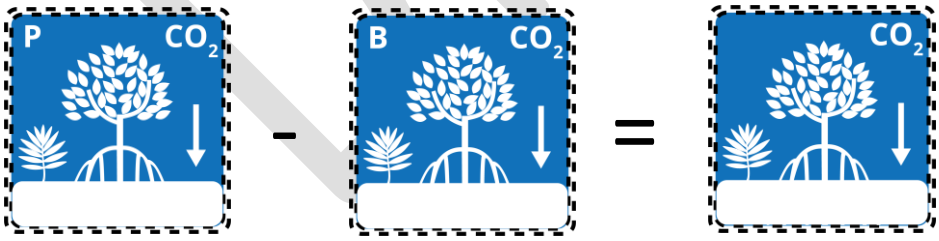
10 Calculation of Carbon Benefits

10.1 Expected Carbon Benefits

At the start of the project, expected *Carbon Benefits* must be estimated for each year of the *Crediting Period*. Projects wishing to claim fPVCs must calculate expected *Carbon Benefits* over their *Crediting Period*. Projects wishing to claim rPVCs must calculate expected Carbon Benefits over their *Reporting Period*. See Sections 10.5.1 and 10.5.2 below.

Expected *Carbon Benefits* from *Carbon Pool* removals are calculated as follows:

Equation 1:



Where:

= Expected *Carbon Benefit* from *Carbon Pool* removals across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period, Crediting Period* or *Reporting Period*.

Expected *Carbon Benefits* from *Carbon Pool* emissions are calculated as follows:

Equation 2:

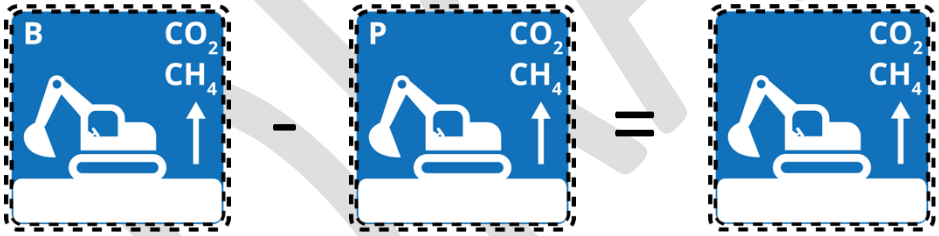
Where:

= Expected *Carbon Benefit* from *Carbon Pool* emissions across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period, Crediting Period* or *Reporting Period*

If a project emits more CO_2 from *Carbon Pools* in the project scenario compared to the baseline scenario – for instance if extensive aboveground non-woody biomass is cleared for site preparation in a Mangrove Restoration project – this parameter will be negative.

Expected *Carbon Benefit* from emissions sources are calculated as follows:

Equation 3:

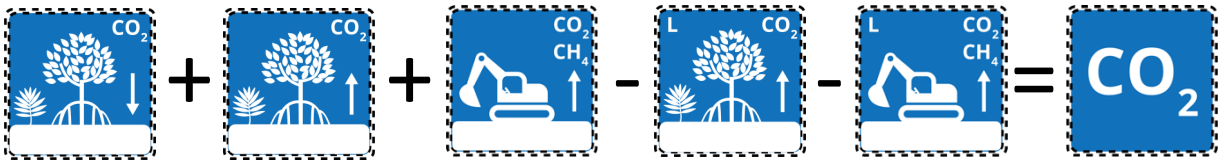


Where:

= Expected *Carbon Benefit* from emissions sources across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period, Crediting Period* or *Reporting Period*

Total expected *Carbon Benefit* is calculated as follows:

Equation 4:



Where:

= **Total expected *Carbon Benefit* across all Zones of the *Project Area* (tCO_2e) for each year of the *Crediting Period*, *Crediting Period* or *Reporting Period***

Worked example – Section 10.1

The hypothetical projects detailed in PU##a and PU##b are part of the same locally-managed marine area, with the same *Project Coordinator*. Therefore, they are **treated as one project with separate *Project Interventions***. This methodology can be used to calculate the total *Carbon Benefit* from both of these *Project Interventions*. The *Crediting Period* for both interventions is 20 years.

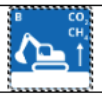
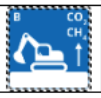
The variables detailed in the working examples in Sections 7.1, 8.1 and 9.1 can be used to calculate the total expected *Carbon Benefit* for both *Project Interventions*. The following table shows the calculation of expected *Carbon Benefit* from ***Carbon Pool* removals** across the *Crediting Period*:

	Mangrove restoration			Mangrove conservation		
Year						
			Equation 1			*Equation 1*
1	888	119	888 - 119 = 769	0	0	0 - 0 = 0
2	1,999	268	1999 - 268 = 1731	0	0	0 - 0 = 0
3	3,111	418	3111 - 418 = 2693	0	0	0 - 0 = 0
4	4,650	625	4650 - 625 = 4025	0	0	0 - 0 = 0
5	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
6	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
7	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
8	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
9	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
10	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
11	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
12	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
13	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
14	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
15	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
16	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
17	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
18	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
19	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
20	5,795	777	5795 - 777 = 5018	0	0	0 - 0 = 0
		Total:	**89,506**		**Total:**	**0**

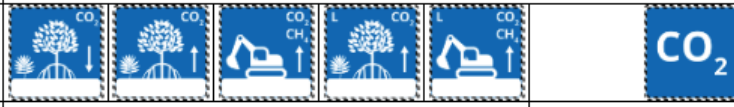
The following table shows the calculation of expected *Carbon Benefit* from ***Carbon Pool*** **emissions** across the *Crediting Period*:

	Mangrove restoration			Mangrove conservation		
Year						
			Equation 2			*Equation 2*
1	0	708	0 - 708 = -708	25,531	4,340	25531 - 4340 = 21191
2	0	708	0 - 708 = -708	29,534	5,021	29534 - 5021 = 24513
3	0	354	0 - 354 = -354	33,537	5,701	33537 - 5701 = 27836
4	0	0	0 - 0 = 0	37,540	6,382	37540 - 6382 = 31158
5	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
6	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
7	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
8	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
9	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
10	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
11	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
12	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
13	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
14	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
15	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
16	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
17	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
18	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
19	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
20	0	0	0 - 0 = 0	41,543	7,062	41543 - 7062 = 34481
		Total:	**-1,770**		**Total:**	**656,394**

The following table shows the calculation of expected *Carbon Benefit* from **emission sources** across the *Crediting Period*:

	Mangrove restoration			Mangrove conservation		
Year						
			Equation 3			*Equation 3*
1	0	0	0 - 0 = 0	0	0	0 - 0 = 0
2	0	0	0 - 0 = 0	0	0	0 - 0 = 0
3	0	0	0 - 0 = 0	0	0	0 - 0 = 0
4	0	0	0 - 0 = 0	0	0	0 - 0 = 0
5	0	0	0 - 0 = 0	0	0	0 - 0 = 0
6	0	0	0 - 0 = 0	0	0	0 - 0 = 0
7	0	0	0 - 0 = 0	0	0	0 - 0 = 0
8	0	0	0 - 0 = 0	0	0	0 - 0 = 0
9	0	0	0 - 0 = 0	0	0	0 - 0 = 0
10	0	0	0 - 0 = 0	0	0	0 - 0 = 0
11	0	0	0 - 0 = 0	0	0	0 - 0 = 0
12	0	0	0 - 0 = 0	0	0	0 - 0 = 0
13	0	0	0 - 0 = 0	0	0	0 - 0 = 0
14	0	0	0 - 0 = 0	0	0	0 - 0 = 0
15	0	0	0 - 0 = 0	0	0	0 - 0 = 0
16	0	0	0 - 0 = 0	0	0	0 - 0 = 0
17	0	0	0 - 0 = 0	0	0	0 - 0 = 0
18	0	0	0 - 0 = 0	0	0	0 - 0 = 0
19	0	0	0 - 0 = 0	0	0	0 - 0 = 0
20	0	0	0 - 0 = 0	0	0	0 - 0 = 0
		Total:	**0**		**Total:**	**0**

Lastly, the following table shows the calculation of the **total expected *Carbon Benefit*** across the *Crediting Period*:

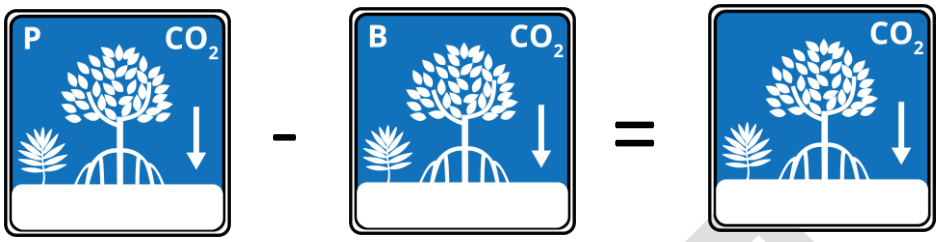
	Mangrove restoration						Mangrove conservation					
Year						CO_2						CO_2
						Equation 4						*Equation 4*
1	769	-708	0	0	0	769 + -708 + 0 - 0 - 0 = 61	0	21,191	0	2,967	0	0 + 21191 + 0 - 2967 - 0 = 18224
2	1,731	-708	0	0	0	1731 + -708 + 0 - 0 - 0 = 1023	0	24,513	0	3,432	0	0 + 24513 + 0 - 3432 - 0 = 21081
3	2,693	-354	0	0	0	2693 + -354 + 0 - 0 - 0 = 2339	0	27,836	0	3,897	0	0 + 27836 + 0 - 3897 - 0 = 23939
4	4,025	0	0	0	0	4025 + 0 + 0 - 0 - 0 = 4025	0	31,158	0	4,362	0	0 + 31158 + 0 - 4362 - 0 = 26796
5	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
6	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
7	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
8	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
9	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
10	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
11	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
12	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
13	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
14	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
15	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
16	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
17	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
18	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
19	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
20	5,018	0	0	0	0	5018 + 0 + 0 - 0 - 0 = 5018	0	34,481	0	4,827	0	0 + 34481 + 0 - 4827 - 0 = 29654
					Total:	**87,736**					**Total:**	**564,504**

Across the two Project Interventions the total *Carbon Benefit* across the *Crediting Period* is 87,736 + 564,504 = **652,240** tCO_2e.

10.2 Actual Carbon Benefits

At the end of each *Verification Period*, actual *Carbon Benefits* must be estimated for each year of the *Verification Period*. Actual *Carbon Benefits* from *Carbon Pool* removals are calculated as follows:

Equation 5:



Where:

= Actual *Carbon Benefit* from *Carbon Pool* removals across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period*

Actual *Carbon Benefits* from *Carbon Pool* emissions are calculated as follows:

Equation 6:

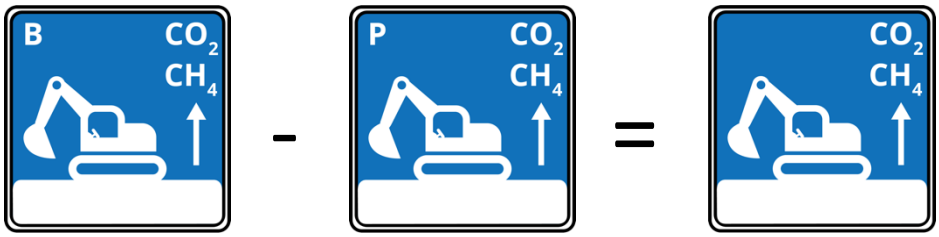
Where:

= Actual *Carbon Benefit* from *Carbon Pool* emissions across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period*

If a project emits more CO_2 from *Carbon Pools* in the project scenario compared to the baseline scenario – for instance if extensive aboveground non-woody biomass is cleared for site preparation in a Mangrove Restoration project – this parameter will be negative.

Actual *Carbon Benefit* from emissions sources are calculated as follows:

Equation 7:

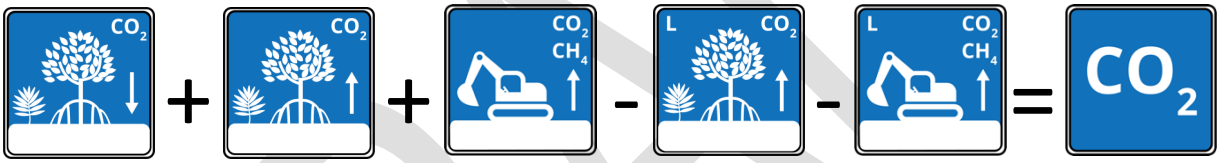


Where:

= Actual *Carbon Benefit* from emissions sources across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period*

Total Actual *Carbon Benefit* is calculated as follows:

Equation 8:



Where:

= **Total actual *Carbon Benefit* across all Zones of the *Project Area* (tCO_2e) for each year of the *Verification Period***

Worked example – Section 10.2

The hypothetical projects detailed in PU##a and PU##b are part of the same locally-managed marine area, with the same *Project Coordinator*. Therefore, they are **treated as one project with separate *Project Interventions***. This methodology can be used to calculate the total *Carbon Benefit* from both of these *Project Interventions*. The first *Verification Period* for both interventions is 5 years.

The variables detailed in the working examples in Sections 7.2, 8.2 and 9.2 can be used to calculate the total actual *Carbon Benefit* for both *Project Interventions*.

The following table shows the calculation of actual *Carbon Benefit* from ***Carbon Pool*** **removals** across the *Crediting Period*:

	Mangrove restoration			Mangrove conservation		
Year						
			Equation 5			*Equation 5*
1	838	119	838 - 119 = 719	0	0	0 - 0 = 0
2	1,906	269	1906 - 269 = 1637	0	0	0 - 0 = 0
3	2,955	418	2955 - 418 = 2537	0	0	0 - 0 = 0
4	4,380	623	4380 - 623 = 3757	0	0	0 - 0 = 0
5	5,504	777	5504 - 777 = 4727	0	0	0 - 0 = 0
		Total:	**13,377**		**Total:**	**0**

The following table shows the calculation of expected *Carbon Benefit* from ***Carbon Pool*** **emissions** across the *Crediting Period*:

	Mangrove restoration			Mangrove conservation		
Year						
			Equation 6			*Equation 6*
1	0	708	0 - 708 = -708	42,552	7,092	42552 - 7092 = 35460
2	0	708	0 - 708 = -708	49,224	8,204	49224 - 8204 = 41020
3	0	354	0 - 354 = -354	55,896	9,316	55896 - 9316 = 46580
4	0	0	0 - 0 = 0	62,568	10,428	62568 - 10428 = 52140
5	0	0	0 - 0 = 0	62,240	11,540	62240 - 11540 = 50700
		Total:	**-1,770**		**Total:**	**225,900**

The following table shows the calculation of expected *Carbon Benefit* from **emission sources** across the *Crediting Period*:

	Mangrove restoration			Mangrove conservation		
Year						
			Equation 7			*Equation 7*
1	0	0	0 - 0 = 0	0	0	0 - 0 = 0
2	0	0	0 - 0 = 0	0	0	0 - 0 = 0
3	0	0	0 - 0 = 0	0	0	0 - 0 = 0
4	0	0	0 - 0 = 0	0	0	0 - 0 = 0
5	0	0	0 - 0 = 0	0	0	0 - 0 = 0
		Total:	**0**		**Total:**	**0**

Lastly, the following table shows the calculation of the **total actual *Carbon Benefit*** across the *Crediting Period*:

	Mangrove restoration						Mangrove conservation					
Year						CO_2						CO_2
						Equation 8						*Equation 8*
1	719	-708	0	0	0	719 + -708 + 0 - 0 - 0 = 11	0	35,460	0	4,255	0	0 + 35460 + 0 - 4255 - 0 = 31205
2	1,637	-708	0	0	0	1637 + -708 + 0 - 0 - 0 = 929	0	41,020	0	4,922	0	0 + 41020 + 0 - 4922 - 0 = 36098
3	2,537	-354	0	0	0	2537 + -354 + 0 - 0 - 0 = 2183	0	46,580	0	5,589	0	0 + 46580 + 0 - 5589 - 0 = 40991
4	3,757	0	0	0	0	3757 + 0 + 0 - 0 - 0 = 3757	0	52,140	0	6,256	0	0 + 52140 + 0 - 6256 - 0 = 45884
5	4,727	0	0	0	0	4727 + 0 + 0 - 0 - 0 = 4727	0	50,700	0	6,293	0	0 + 50700 + 0 - 6293 - 0 = 44407
					Total:	**11,607**					**Total:**	**198,585**

Across the two Project Interventions the total *Carbon Benefit* across the *Verification Period* is 11,607 + 198,585 = **210,192** tCO_2e.

10.3 Uncertainty Adjustment

Projects that use this methodology together with PU##b and follow PATHWAY ONE in PU##b can use PT##b to understand whether an uncertainty adjustment is needed for the Restoration *Project Intervention* and, if necessary, calculate the uncertainty adjustment.

All other projects must use PU005 to assess uncertainty.

All default values provided by the modules listed in Figure 1 are exempt from uncertainty adjustments.

= **Uncertainty adjustment for all *Project Interventions* (unitless).**

If using PU005:

Equation 9:

= 1 - UD_T

10.4 Sea Level Rise Risk Adjustment

Coastal projects are unique because of their exposure to the risk associated with sea level rise. Therefore, all projects must use the procedures in this section to assess the risk posed to project carbon stocks due to sea level risk and, if necessary, contribute additional PVCs to the *Future Risk Buffer* (fPVCs and rPVCs) or the *Risk Buffer* (vPVCs).

The default Sea Level Rise Risk Adjustment is 0.8. This is explained and justified in Annex One.

= Sea Level Rise Risk Adjustment (default = 0.8)

However, projects can use the risk matrix shown in Table 3 to modify the default adjustment according to the values in Table 3. See Annex One for further explanation and two worked examples.

If a project includes multiple *Project Interventions* (i.e., there is both a Conservation and Restoration component), a Sea Level Rise Risk Adjustment must be established for each intervention.

The Sea Level Rise Risk Adjustment must be updated at the end of each *Verification Period*.

Table 3 – The matrix that can be used to adjust the Sea Level Rise Risk Adjustment, depending on the tidal inundation frequency (as a proxy for elevation ranges across the Project Area*) and the potential for landward migration.*

		Risk due to potential for landward migration		
		High	Medium	Low
Risk due to land elevation	High	0.8	0.9	0.95
	Medium	0.85	0.95	0.98
	Low	0.95	0.98	1

To use this matrix, projects must provide evidence to justify their selected risk category (high, medium or low). When estimating inundation frequency and the risk of landward adjustment, all assumptions must be clearly documented in the *PDD* and supported with evidence. The following evidence requirements apply:

Risk due to land elevation being close to mean sea level (using inundation frequency as a proxy):

Low risk = Flooded by the tide on average less than 15 times per lunar month (high elevation)
Medium risk = Flooded by the tide on average between 15-27 times per lunar month (moderate elevation)
High risk = Flooded by the tide on average more than 27 times per lunar month, including permanently flooded land (low elevation)

The inundation frequency must be calculated by observing how many times the most seaward Mangroves and most landward Mangroves are flooded, and **taking the average**. See the worked examples below.

Risk due to potential for landward migration:

Low risk = No obstacles to landward migration and there is a participatory adaptation plan (high potential for landward migration)
Medium risk = Obstacles to landward migration exist but there is a participatory adaptation plan (moderate potential for landward migration)
High risk = Obstacles to landward migration exist and no adaptation plan (low potential for landward migration)

Evidence required:

- Topographic map(s) (such as those available in Google Maps) showing that steep topography is not a barrier to inland Mangrove migration
  AND

- Participatory mapping of land use inland from the *Project Area* that demonstrates that there are no barriers (e.g. natural barriers such as dunes or berms, or anthropogenic barriers such as settlements, roads, seawalls or agricultural land) to landward migration of Mangroves.
  AND
- Documented participatory adaptation plan demonstrating that there is a strategy to ensure Mangrove can migrate inland as sea levels rise

Additional potential adjustment

If a project is restoring or ensuring the protection of a range of species that are tolerant to different salinity levels, 0.02 can be added to the risk adjustment.

Evidence required:

- Rehabilitation/planting plans
  AND/OR
- Rehabilitation/planting results
  AND/OR
- Participatory maps of Mangrove species within the *Project Area*

The risk adjustment cannot be greater than 1.

10.5 Plan Vivo Certificates

10.5.1 Future PVCs

Future *Plan Vivo Certificates* (fPVCs) issued in each year of a Crediting Period are calculated with Equation 10. The proportion of expected *Carbon Benefits* withheld to mitigate the risk of underperformance (the *Achievement Reserve*) is 10%, and the proportion of Plan Vivo Certificates set aside in the *Future Risk Buffer* for future contributions to the *Risk Buffer* is 20%, for all projects.

Only Restoration *Project Interventions* can claim fPVCs.

Equation 10:

$$CO_2 \times \text{  } \times 0.9 \times 0.8 = fPVCs$$

Where:

fPVCs = **Total number of future *Plan Vivo Certificates* issued in each year of the *Crediting Period***

10.5.2 Reported PVCs

Reported *Plan Vivo Certificates* (fPVCs) issued in each year of a *Reporting Period* are calculated with Equation 10 (Restoration *Project Interventions*) and/or Equation 11 (Conservation *Project Interventions*). The proportion of expected *Carbon Benefits* withheld to mitigate the risk of underperformance (the *Achievement Reserve*) is 10%, and the proportion of Plan Vivo Certificates set aside in the *Future Risk Buffer* for future contributions to the *Risk Buffer* is 20%, for all projects.

For Restoration *Project Interventions*:

Projects using PU##b can claim rPVCs if they complete the Photo Monitoring detailed in PU##b and successfully report on their *Progress Indicators* during the *Reporting Period*. To calculate the parameters used in Equation 4, the actual areas in each Zone that are undergoing Restoration must be used (ha).

Equation 11:

$$CO_2 \times U? \times \text{wave} \times 0.9 \times 0.8 = rPVCs$$

Where:

rPVCs = **Total number of reported *Plan Vivo Certificates* issued in each year of the *Reporting Period***

For Conservation *Project Interventions*:

Projects using PU##a can claim rPVCs if they successfully report on their *Progress Indicators* during the *Reporting Period*.

Equation 12:

$$(CO_2 + CO_2 - L\ CO_2) \times U? \times \text{wave} \times 0.9 \times 0.8$$

$$+ (CO_2\ CH_4 - L\ CO_2\ CH_4) \times U? \times 0.9 = rPVCs$$

Where:

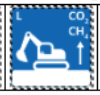
= **Total number of reported *Plan Vivo Certificates* issued in each year of the *Reporting Period***

Worked example – Sections 10.5.1 and 10.5.2

The hypothetical Mangrove restoration project detailed in PU##b has a medium risk due to land elevation and a low risk due to potential for landward migration. Therefore, it has a Sea Level Rise Risk Adjustment of 0.98. It zoned its Project Area well, so the Zones capture the majority of the variability in number of Mangrove Trees and Saplings. Therefore, no uncertainty adjustment is required. These variables, together with the total expected *Carbon Benefit* results calculated in Section 10.1, can be used to calculate the number of fPVCs available over the a Crediting Period of 20 years and the number of rPVCs available for each annual *Reporting Period* over the first 5 years of the project:

	Mangrove restoration				
	CO_2	U?		fPVCs	rPVCs
Year				*Equation 10*	*Equation 11*
1	61	1	0.98	61 x 0.98 x 0.9 x 0.8 = 43	61 x 1 x 0.98 x 0.9 x 0.8 = 43
2	1,023	1	0.98	1023 x 0.98 x 0.9 x 0.8 = 722	1023 x 1 x 0.98 x 0.9 x 0.8 = 722
3	2,339	1	0.98	2339 x 0.98 x 0.9 x 0.8 = 1650	2339 x 1 x 0.98 x 0.9 x 0.8 = 1650
4	4,025	1	0.98	4025 x 0.98 x 0.9 x 0.8 = 2840	4025 x 1 x 0.98 x 0.9 x 0.8 = 2840
5	5,018	1	0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	5018 x 1 x 0.98 x 0.9 x 0.8 = 3541
6	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
7	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
8	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
9	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
10	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
11	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
12	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
13	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
14	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
15	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
16	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
17	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
18	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
19	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
20	5,018		0.98	5018 x 0.98 x 0.9 x 0.8 = 3541	
			Total:	**61,907**	**8,796**

The hypothetical Mangrove Conservation project detailed in PU##a has a medium risk due to land elevation and a medium risk due to potential for landward migration. Therefore, it has a Sea Level Rise Risk Adjustment of 0.95. Using PU005, an uncertainty adjustment of 0.93 is calculated. These variables, together with the expected *Carbon Benefit* results calculated in Section 10.1 and the potential leakage emissions derived in Section 9.1, can be used to calculate the number rPVCs available for each annual *Reporting Period* over the first 5 years of the project:

	Mangrove conservation							
								
Year								*Equation 12*
1	0	21,191	2,967	0	0	0.93	0.95	(0 + 21191 - 2967) x 0.93 x 0.95 x 0.9 x 0.8 + (0 - 0) x 0.93 x 0.9 = 11593
2	0	24,513	3,432	0	0	0.93	0.95	(0 + 24513 - 3432) x 0.93 x 0.95 x 0.9 x 0.8 + (0 - 0) x 0.93 x 0.9 = 13410
3	0	27,836	3,897	0	0	0.93	0.95	(0 + 27836 - 3897) x 0.93 x 0.95 x 0.9 x 0.8 + (0 - 0) x 0.93 x 0.9 = 15228
4	0	31,158	4,362	0	0	0.93	0.95	(0 + 31158 - 4362) x 0.93 x 0.95 x 0.9 x 0.8 + (0 - 0) x 0.93 x 0.9 = 17045
5	0	34,481	4,827	0	0	0.93	0.95	(0 + 34481 - 4827) x 0.93 x 0.95 x 0.9 x 0.8 + (0 - 0) x 0.93 x 0.9 = 18864
							Total:	**76,140**

10.5.3 Verified PVCs

Verified *Plan Vivo Certificates* (vPVCs) issued in each year of a *Verification Period* are calculated with Equation 12 (Restoration *Project Interventions*) and/or Equation 13 (Conservation *Project Interventions*). The proportion of Plan Vivo Certificates contributed to the *Risk Buffer* is 20%, for all projects.

For Restoration *Project Interventions*:

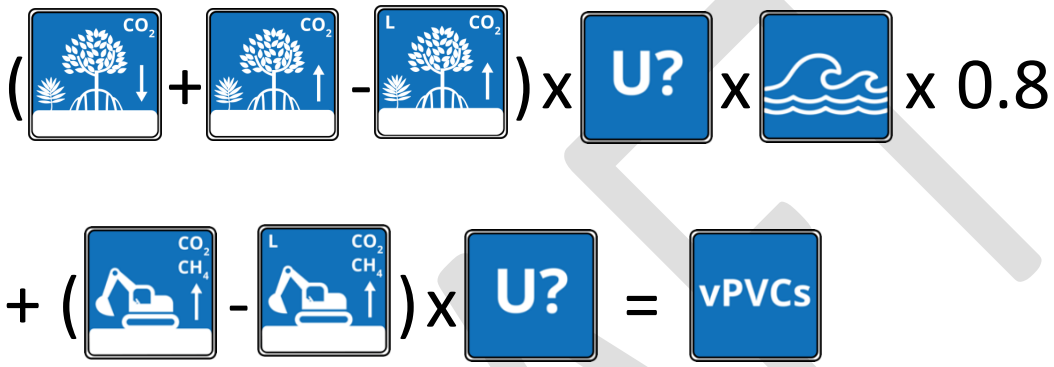
Equation 13:

Where:

= **Total number of verified *Plan Vivo Certificates* issued in each year of the *Verification Period***

For Conservation *Project Interventions*:

Equation 14:



Where:

= **Total number of verified *Plan Vivo Certificates* issued in each year of the *Verification Period***

Worked example – Section 10.5.3

The hypothetical Mangrove restoration project detailed in PU##b has a medium risk due to land elevation and a low risk due to potential for landward migration. Therefore, it has a Sea Level Rise Risk Adjustment of 0.98. It zoned its Project Area well, so the Zones capture the majority of the variability in number of Mangrove Trees and Saplings. Therefore, no uncertainty adjustment is required. These variables, together with the total actual *Carbon Benefit* results calculated in Section 10.2, can be used to calculate the number of vPVCs eligible for issuance for each year of the 5-year *Verification Period*:

	Mangrove restoration			
Year	CO_2	U?		vPVCs
				Equation 13
1	11	1	0.98	11 x 1 x 0.98 x 0.8 = 9
2	929	1	0.98	929 x 1 x 0.98 x 0.8 = 728
3	2,183	1	0.98	2183 x 1 x 0.98 x 0.8 = 1711
4	3,757	1	0.98	3757 x 1 x 0.98 x 0.8 = 2945
5	4,727	1	0.98	4727 x 1 x 0.98 x 0.8 = 3706
			Total:	**9,100**

The hypothetical Mangrove Conservation project detailed in PU##a has a medium risk due to land elevation and a medium risk due to potential for landward migration. Therefore, it has a Sea Level Rise Risk Adjustment of 0.95. Using PU005, an uncertainty adjustment of 0.93 is calculated at *Verification*. These variables, together with the actual *Carbon Benefit* results calculated in Section 10.2 and the actual leakage emissions derived in Section 9.2, can be used to calculate the number vPVCs eligible for issuance for each year of the 5-year *Verification Period*:

	Mangrove conservation							
Year						U?		vPVCs
								Equation 14
1	0	35,460	4,255	0	0	0.93	0.95	(0 + 35460 - 4255) x 0.93 x 0.95 x 0.8 + (0 - 0) x 0.93 = 22056
2	0	41,020	4,922	0	0	0.93	0.95	(0 + 41020 - 4922) x 0.93 x 0.95 x 0.9 x 0.8 + (0 - 0) x 0.93 x 0.9 = 25514
3	0	46,580	5,589	0	0	0.93	0.95	(0 + 46580 - 5589) x 0.93 x 0.95 x 0.9 x 0.8 + (0 - 0) x 0.93 x 0.9 = 28972
4	0	52,140	6,256	0	0	0.93	0.95	(0 + 52140 - 6256) x 0.93 x 0.95 x 0.9 x 0.8 + (0 - 0) x 0.93 x 0.9 = 32431
5	0	50,700	6,293	0	0	0.93	0.95	(0 + 50700 - 6293) x 0.93 x 0.95 x 0.9 x 0.8 + (0 - 0) x 0.93 x 0.9 = 31387
							Total:	**140,360**

10.5.4 PVC Conversion

If a project has been issued with fPVCs, these must be converted to rPVCs or vPVCs before any additional rPVCs or vPVCs are issued.

If a project has been issued with rPVCs, these must be converted to vPVCs before any additional vPVCs are issued.

11 Parameters

11.1 Data and parameters available at validation

Data/Parameter	
Units	tCO_2e
Description	Total expected baseline CO_2 removals in the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* for each year of the *Crediting Period*.
Equations	1
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 7.1.
Purpose of Data	Estimating total expected emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total expected baseline CO_2 emissions in the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* for each year of the *Crediting Period*.
Equations	2
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 7.1.
Purpose of Data	Estimating total expected emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total expected baseline emissions from all emission sources across all Zones of the *Project Area* for each year of the *Crediting Period*.
Equations	3
Source	PU##a and/or PU##b

Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 7.1.
Purpose of Data	Estimating total expected emissions and removals across all Zones.
Comments	N/A

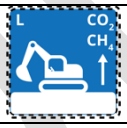
Data/Parameter	
Units	tCO_2e
Description	Total expected baseline CO_2 removals in the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* for each year of the *Crediting Period*.
Equations	1
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 8.1.
Purpose of Data	Estimating total expected emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total expected project CO_2 emissions from the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* for each year of the *Crediting Period*.
Equations	2
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 8.1.
Purpose of Data	Estimating total expected emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e

Description	Total expected project CO_2 emissions from all emission sources across all Zones of the *Project Area* for each year of the *Crediting Period*.
Equations	3
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 8.1.
Purpose of Data	Estimating total expected emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total potential CO_2 emissions from the Vegetation and Soil *Carbon Pools* due to leakage across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	4, 12
Source	PU##a and/or PU004
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 9.1.
Purpose of Data	Estimating total potential leakage across all Zones.
Comments	N/A

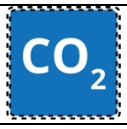
Data/Parameter	
Units	tCO_2e
Description	Total potential emissions from all emission sources due to leakage across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	4, 12
Source	PU##a and/or PU004
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 9.1.
Purpose of Data	Estimating total potential leakage across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Expected *Carbon Benefit* from *Carbon Pool* removals across all Zones of the *Project Area* for each year of the *Crediting Period, Crediting Period* or *Reporting Period*.
Equations	1, 4, 12
Source	See Section 10.1.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.1.
Purpose of Data	Estimating total expected *Carbon Benefit*.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Expected *Carbon Benefit* from *Carbon Pool* emissions across all Zones of the *Project Area* for each year of the *Crediting Period, Crediting Period* or *Reporting Period*.
Equations	2, 4, 12
Source	See Section 10.1.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.1.
Purpose of Data	Estimating total expected *Carbon Benefit*.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Expected *Carbon Benefit* from emission sources across all Zones of the *Project Area* for each year of the *Crediting Period, Crediting Period* or *Reporting Period*.
Equations	3-4, 12
Source	See Section 10.1.
Value	N/A
Justification of choice of data or description of	See Section 10.1.

measurement methods and procedures applied	
Purpose of Data	Estimating total expected *Carbon Benefit*.
Comments	N/A

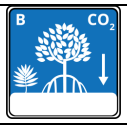
Data/Parameter	
Units	tCO_2e
Description	Expected *Carbon Benefit* across all Zones of the *Project Area* for each year of the *Crediting Period, Crediting Period* or *Reporting Period*.
Equations	4, 10-11
Source	See Section 10.1.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.1.
Purpose of Data	Estimating total expected *Carbon Benefit*.
Comments	N/A

Data/Parameter	
Units	Unitless
Description	Uncertainty adjustment for all *Project Interventions*.
Equations	9, 11-14
Source	PT##b and/or PU005.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See PT##b and/or PU005.
Purpose of Data	Calculation of uncertainty deduction.
Comments	Estimated prior to validation and measured throughout the *Crediting Period*.

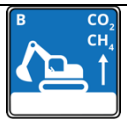
Data/Parameter	
Units	Unitless
Description	Sea Level Rise Risk Adjustment for each *Project Intervention*.
Equations	10-14
Source	See Section.
Value	N/A

Justification of choice of data or description of measurement methods and procedures applied	See Section 10.4 and Annex One.
Purpose of Data	Calculation of risk adjustment due to sea level rise.
Comments	Estimated prior to validation and measured throughout the *Crediting Period*.

11.2 Data and parameters monitored

Data/Parameter	
Units	tCO_2e
Description	Total actual baseline CO_2 removals in the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	5
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 7.2.
Purpose of Data	Estimating total actual emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total actual baseline CO_2 emissions from the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	6
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 7.2.
Purpose of Data	Estimating total actual emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total actual baseline CO_2 emissions from all emission sources across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	7
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 7.2.
Purpose of Data	Estimating total actual emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total actual baseline CO_2 removals in the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	5
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 8.2.
Purpose of Data	Estimating total actual emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total actual project CO_2 emissions from the Vegetation and Soil *Carbon Pools* across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	6
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section **Error! Reference source not found.**.

Purpose of Data	Estimating total actual emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total actual project CO_2 emissions from all emission sources across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	7
Source	PU##a and/or PU##b
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 8.2.
Purpose of Data	Estimating total actual emissions and removals across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total actual CO_2 emissions from the Vegetation and Soil *Carbon Pools* due to leakage across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	8, 14
Source	PU##a and/or PU004.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 9.2.
Purpose of Data	Estimating total actual leakage emissions across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Total actual emissions from all emission sources due to leakage across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	8, 14
Source	PU##a and/or PU004.
Value	N/A

Justification of choice of data or description of measurement methods and procedures applied	See Section 9.2.
Purpose of Data	Estimating total actual leakage emissions across all Zones.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Actual *Carbon Benefit* from *Carbon Pool* removals across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	5, 8, 14
Source	See Section 10.2.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.2.
Purpose of Data	Estimating total actual *Carbon Benefit*.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Actual *Carbon Benefit* from *Carbon Pool* emissions across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	6, 8, 14
Source	See Section 10.2.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.2.
Purpose of Data	Estimating total actual *Carbon Benefit*.
Comments	N/A

Data/Parameter	
Units	tCO_2e
Description	Actual *Carbon Benefit* from emission sources across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	7-8, 14
Source	See Section 10.2.

Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.2.
Purpose of Data	Estimating total actual *Carbon Benefit*.
Comments	N/A

Data/Parameter	CO_2
Units	tCO_2e
Description	Expected *Carbon Benefit* across all Zones of the *Project Area* for each year of the *Verification Period*.
Equations	8, 13
Source	See Section 10.2.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.2.
Purpose of Data	Estimating total actual *Carbon Benefit*.
Comments	N/A

Data/Parameter	fPVCs
Units	tCO_2e
Description	Total number of future *Plan Vivo Certificates* issued in each year of the *Future Crediting Period*.
Equations	10
Source	See Section 10.5.1.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.5.1.
Purpose of Data	Calculating the eligible number of future *Plan Vivo Certificates*.
Comments	N/A

Data/Parameter	rPVCs
Units	tCO_2e
Description	Total number of reported *Plan Vivo Certificates* issued in each year of the *Reporting Period*.
Equations	11-12

Source	See Section 10.5.2.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.5.2.
Purpose of Data	Calculating the eligible number of reported *Plan Vivo Certificates*.
Comments	N/A

Data/Parameter	**vPVCs**
Units	tCO_2e
Description	Total number of verified *Plan Vivo Certificates* issued in each year of the *Verification Period*.
Equations	13-14
Source	See Section 10.5.3.
Value	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Section 10.5.3.
Purpose of Data	Calculating the eligible number of verified *Plan Vivo Certificates*.
Comments	N/A

12 References

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Plan Vivo Climate Glossary version 1.3. Available from: https://www.planvivo.org/pv-climate-documentation

PU004 version 1.0 – Estimation of GHG Emissions from Leakage in Plan Vivo Projects (Plan Vivo Climate module). Available from: https://www.planvivo.org/pv-climate-methodologies

PU005 version 1.1 – Estimation of Uncertainty of Carbon Benefit Estimates in Plan Vivo Projects (Plan Vivo Climate module). Available from: https://www.planvivo.org/pv-climate-methodologies

PU##a version 1.0 – Mangrove Conservation module (Plan Vivo Climate module)

PU##b version 1.0 – Simplified Mangrove Restoration module (Plan Vivo Climate module)

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PT##b version 1.0 – Calculation of the Uncertainty Adjustment for Projects using Tree Counts in PU##b

VM0033 version 2.1 – Methodology for Tidal Wetland and Seagrass Restoration (Verified Carbon Standard methodology). Available from: https://verra.org/program-methodology/vcs-program-standard/vcs-program-methodologies-active/

VMD0052 version 2.0 – Demonstration of Additionality of Tidal Wetland Restoration and Conservation Project Activities (Verified Carbon Standard module). Available from: https://verra.org/program-methodology/vcs-program-standard/active-modules-and-tools/

Annex One – Sea Level Rise Risk Adjustment

Context

Requirement 3.11.1 of the Plan Vivo Climate Project Requirements (v5.3) states that:

"*Risks to the maintenance of the Carbon Benefits for a period of at least 50-years must be identified and significant risks must be mitigated.*"

To manage these risks across the PVC portfolio, requirement 3.11.3 states that:

"20% of all vPVCs issued to a Project must be transferred to the Risk Buffer."

Coastal projects face a risk that is not as relevant for terrestrial projects: rising sea levels due to our warming planet. To align with Requirement 3.11.1 above, as well as best-practice across the sector, this risk should be accounted for by coastal PV Climate projects. However, the technicalities of detailed project-level sea level rise (SLR) assessments are likely to prove prohibitive to the smallholder and community-led initiatives that PVC is designed for. Thus, a default adjustment and a simple risk adjustment matrix focused on the two primary factors that affect Mangroves' resilience to SLR - elevation and space for landward migration - is proposed for use in the PV Climate Coastal Blue Carbon Methodology (PM00x). This annex explains and justifies the default adjustment and the matrix.

Background and Default Adjustment

Due to their ability to build up vertically through sediment accretion, Mangroves have the capacity to adapt to and, in some cases, thrive due to SLR (e.g. Friess et al., 2020; Lovelock and Reef, 2020; Rogers, 2021). However, if the relative rate of SLR exceeds the accretion rate of Mangroves, and Mangroves are low in the intertidal Zone with limited elevation capital (elevation above mean sea level), Mangrove loss can occur (e.g. Lovelock et al., 2015; Santilan et al., 2023).

Sediment accretion rates are one of more complex variables to quantify and model. Several studies have incorporated sediment accretion rates in localised or regional modelling exercises (e.g. Lovelock et al., 2015; Duncan et al., 2018).

A global study by Saintilan et al., 2020 indicates with high probability (90%) that historical vertical accretion in Mangroves could not keep pace with relative SLR rates exceeding 6.1 mm/year, although the time (years) to mortality once these rates of SLR are reached is uncertain. **There is a scarcity of global research quantifying the potential future impact of sea level rise and interacting factors on Mangrove area and/or carbon storage.**

However, Schuerch et al., 2018 modelled global-scale changes in coastal wetland areas under different IPCC Representative Concentration Pathways (RCPs), accounting for sediment accretion. This publication provides a data set that can be used to define the potential impact of SLR on Mangrove extent in the future, accounting for the hard to constrain sediment accretion variable.

The analysis of the Schuerch et al.'s supplementary information can be found here. Accounting for sediment accretion alone, between 2025-2075 (the 50-year PVC permanence period of a project starting in 2025) **30% of wetlands may be lost under RCP scenario 8.5** ('high emissions' or 'worst case scenario' and **17% under RCP scenario 4.5** ('moderate scenario').

Based on this dataset, **a default SLR risk adjustment of 0.8** is proposed. This adjustment is applied to the **net number of PVCs**. If feasible, this adjustment can then be modified using the risk matrix explained below. Meaning that, unless a lower risk due to sea-level rise can be demonstrated based on elevation capital and capacity for landward migration, as explained below, projects must allocate an additional 20% of their PVCs to the relevant risk buffer.

= SLR risk adjustment (default = 0.8)

This is a conservative approach, given the study by Schuerch et al., looked at Mangrove extent and not carbon stocks. SLR doesn't necessarily affect all carbon pools in Mangroves equally. MacKenzie et al., 2016, Lovelock et al., 2017 and Rogers and Krauss, 2019 all demonstrate that, with the exception of erosional environments, soil carbon stocks are significantly less affected by SLR compared to biomass carbon stocks. The soil organic carbon pool is the dominant pool in Mangroves. Thus, applying the same value, which assumes total loss, to this pool as well as the biomass carbon pools is conservative.

This adjustment is only be applied to the *Carbon Benefit* from *Carbon Pools*, not emission sources, as the latter are exempt from permanence risk adjustments because they cannot be reversed.

SLR Risk Matrix and Refined Adjustments

Beyond the rate of sea-level change relative to sediment accumulation rates, which is dealt with in default risk adjustment, Santilan et al., 2023, Alongi, 2022 and others identify three main factors that affect Mangrove resistance (capacity for maintained functioning with the existing distribution) and resilience (capacity for maintained areal coverage, for instance through landward migration) to SLR:

1. The elevation of the site in the intertidal Zone, relative to mean sea level.
2. The physiographic setting, including the slope of the adjoining inland area relative to that of the land the Mangroves currently occupy, and the presence/absence of obstacles to landward migration
3. Species composition

Factor 1 deals with the concept of "elevation capital", which is the elevation range above mean sea level where Mangroves can grow. For instance, if a project is situated at 1 m above mean sea level - and mean sea level is generally the lowest elevation at which Mangrove species can recruit and grow well - and the relative rate of SLR is 10 mm/year, it will take about 100 years before the Mangroves begin to drown. Meaning the project has relatively extensive elevation capital, compared to if the project was situated at mean sea level.

Elevation of land is complex to measure quantitatively. However, it can broadly be inferred from the frequency of inundation (i.e. flooding by the tides). Xin et al., 2013 modelled the relationship between elevation and inundation frequency in a tidal marsh environment and, in this simplistic modelled environment, found a largely linear correlation between elevation and inundation frequency (Figure 1). This study suggests that inundation frequency can be used as a proxy for elevation.

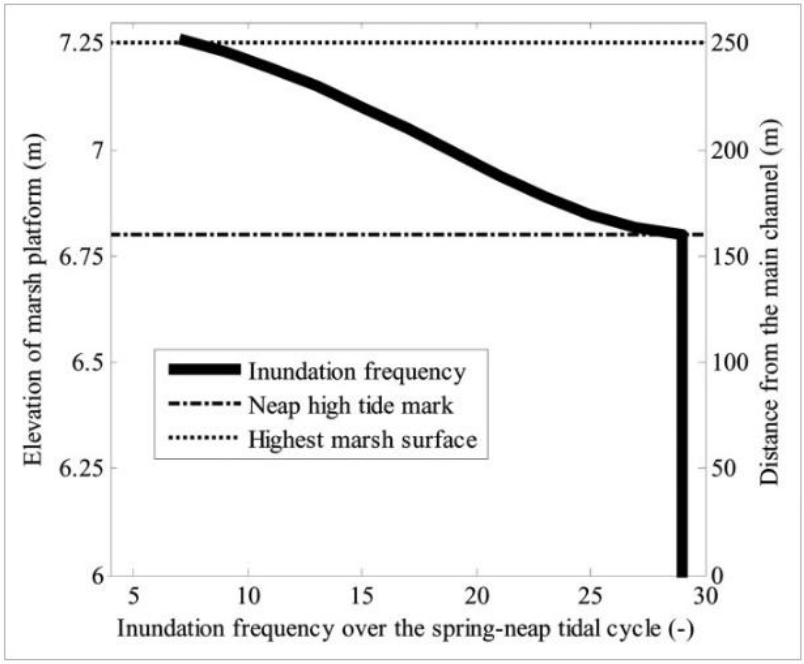

Figure A1. *Inundation frequency in terms of numbers of inundation events per spring-neap tidal cycle, from Xin et al., 2013.*

Factor 2 relates to Mangroves' capacity to migrate inland, as higher elevation land is brought within tidal ranges that are suitable for Mangrove growth. Figure 2 illustrates this concept. Schuerch et al., 2018 and Lovelock and Reef, 2020 both demonstrate that under all RCP scenarios, if Mangroves have the capacity to migrate inland, areal losses and consequent emissions can be prevented and increases in Mangrove area and carbon stocks can occur. Thus, if a project can demonstrate that there is high capacity for landward migration of Mangroves, they should be able to apply a relatively high risk reduction.

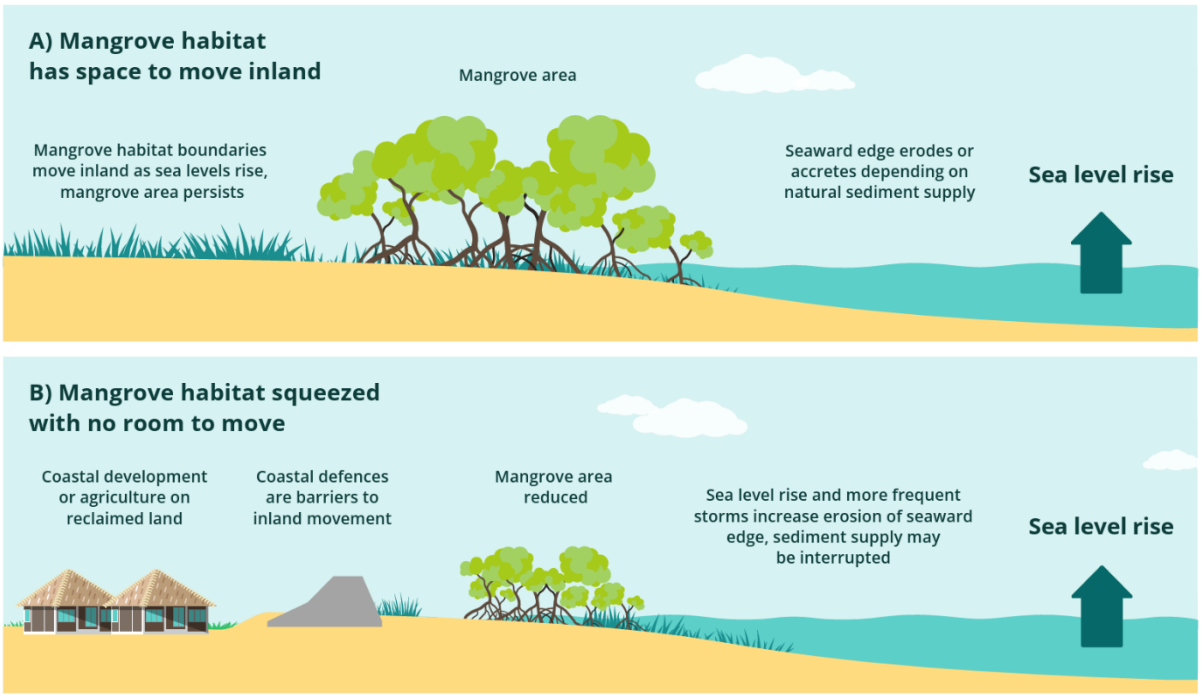

Figure A2*. Illustration showing the concept of space for inland migration (from Beeston et al., 2024).*

Based on these factors, the following **optional** risk adjustment matrix is proposed:

		**Risk due to potential for landward migration**		
		High	Medium	Low
Risk due to land elevation	High	0.8	0.9	0.95
	Medium	0.85	0.95	0.98
	Low	0.95	0.98	1

To use this matrix, projects must provide evidence regarding which risk category (high, medium or low) their project aligns with, using the following evidence requirements:

Risk due to land elevation being close to mean sea level (using inundation frequency as a proxy):

Low risk = Flooded by the tide on average less than 15 times per lunar month (high elevation)

Medium risk = Flooded by the tide on average between 15-27 times per lunar month (moderate elevation)

High risk = Flooded by the tide on average more than 27 times per lunar month, including permanently flooded land (low elevation)

The inundation frequency must be calculated by observing how many times the most seaward Mangroves and most landward Mangroves are flooded, and **taking the average**. See the worked examples below.

Risk due to potential for landward migration:

Low risk = No obstacles to landward migration and there is a participatory adaptation plan (high potential for landward migration)

Medium risk = Obstacles to landward migration exist but there is a participatory adaptation plan (moderate potential for landward migration)

High risk = Obstacles to landward migration exist and no adaptation plan (low potential for landward migration)

Evidence required:

- Topographic map(s) (such as those available in Google Maps) showing that steep topography is not a barrier to inland Mangrove migration
  AND

- Participatory mapping of land use inland from the *Project Area* that demonstrates that there are no barriers (e.g. natural barriers such as dunes or berms, or anthropogenic barriers such as settlements, roads, seawalls or agricultural land) to landward migration of Mangroves.
  AND
- Documented participatory adaptation plan demonstrating that there is a strategy to ensure Mangrove can migrate inland as sea levels rise

Additional potential adjustment

Related to factor 3 above, changes in mean sea level can lead to changes in salinity levels in the *Project Area*. Each Mangrove species has evolved to cope with certain ranges in salinity. Thus, areas with higher species diversity are likely to be more resilient to changes in sea level and salinity.

If a project is restoring or ensuring the protection of a range of species that are tolerant to different salinity levels, 0.02 can be added to the risk adjustment.

Evidence required:

- Rehabilitation/planting plans
  AND/OR
- Rehabilitation/planting results
  AND/OR
- Participatory maps of Mangrove species within the *Project Area*

The risk adjustment cannot be greater than 1.

Demonstration of application

Example One:

The most seaward edge of a Mangrove rehabilitation *Project Area* is inundated 18 times per lunar month and the landward edge of the *Project Area* is inundated 10 times per lunar month. The average inundation frequency is thus (18+10)/2 = 14. Therefore, it is classified as **low** risk from the perspective of elevation.

The project can also demonstrate that there are no obstacles to landward migration and there is a participatory adaptation plan in place. Thus, it is also classified as **low** risk from the perspective of potential for landward migration.

		Risk due to potential for landward migration		
		High	Medium	Low
Risk due to land elevation	High	0.8	0.9	0.95
	Medium	0.85	0.95	0.98
	Low	0.95	0.98	**1**

From the risk matrix, the project has a SLR risk adjustment of 1.

The project can also demonstrate that it is restoring a range of species that are tolerant to different salinity levels. Thus, it is eligible for an additional 0.02 risk reduction (1+0.02 = 1.002). However, the SLR risk adjustment cannot be greater than 1. Therefore:

 = 1

and the project doesn't need to contribute any additional PVCs to the *Risk Buffer* due to SLR.

Example Two:

The most seaward edge of a Mangrove rehabilitation *Project Area* is inundated 26 times per lunar month and the landward edge of the *Project Area* is inundated 22 times per lunar month. The average inundation frequency is thus (26+22)/2 = 24. Therefore, it is classified as **high** risk from the perspective of elevation.

However, the project can also demonstrate that there are no obstacles to landward migration and there is a participatory adaptation plan in place. Thus, it is classified as **low** risk from the perspective of potential for landward migration.

		Risk due to potential for landward migration		
		High	Medium	Low
Risk due to land elevation	High	0.8	0.9	**0.95**
	Medium	0.85	0.95	0.98
	Low	0.95	0.98	1

From the risk matrix, the project has a SLR risk adjustment of 0.95.

The project can also demonstrate that it is restoring a range of species that are tolerant to different salinity levels. Thus, it is eligible for an additional 0.02 risk reduction (0.95+0.02 = 0.97). Therefore:

= 0.97

and the project must contribute an additional 3% of its PVCs to the *Risk Buffer* due to SLR.