PLAN VIVO

PV Climate Tool

Concept Note

Logged to Protected Forest

Version 3.0

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Developed by:

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1 Summary

The proposed tool aims at providing a robust and conservative approach to quantify Carbon Benefits generated from Logged to Protected Forest (LtPF) project activities. The tool will be integrated into PV Climate Agriculture and Forestry Carbon Benefit Assessment Methodology (**PM001**). The tool is limited to tropical forests (see Section 3.1 for additional details).

LtPF projects involve the conservation of forests that could be legally and commercially logged. By providing financial incentives through carbon credits to local landowners, these projects offer a viable and more equitable management alternative that effectively prevents forest degradation.

Core components of the tool will be baseline scenario analysis and quantification as well as leakage, given that these components are rather different in LtPF compared to the activities currently in scope under **PM001**. The context of Melanesia (specifically Solomon Islands, Papua New Guinea and Fiji) is used as reference for the development of the tool as 2 projects developed by Nakau and TNC intend to use this methodology once it is validated.

The tool will be used to generate values for the following parameters that are used to estimate climate benefits following **PM001**:

$BR_{WB,a,y}$ Net GHG removals in aboveground woody biomass under the baseline scenario for project area a up to year y (t CO_2e)

$PR_{WB,a,y}$ Net GHG removals in aboveground woody biomass under the project scenario for project area a up to year y (t CO_2e)

$BR_{BG,a,y}$ Net GHG removals in belowground biomass under the baseline scenario for project area a up to year y (t CO_2e)

$PR_{BG,a,y}$ Net GHG removals in belowground biomass under the project scenario for project area a up to year y (t CO_2e)

$BE_{WB,a,y}$ Net GHG emissions from aboveground woody biomass under the baseline scenario for project area a up to year y (t CO_2e)

$PE_{WB,a,y}$ Net GHG emissions from aboveground woody biomass under the project scenario for project area a up to year y (t CO_2e)

$BE_{BG,a,y}$ Net GHG emissions from belowground biomass under the baseline scenario for project area a up to year y (t CO_2e)

$PE_{BG,a,y}$	Net GHG emissions from belowground biomass under the project scenario for project area a up to year y (t CO_2e)
$BE_{DW,a,y}$	Net GHG emissions from dead wood under the baseline scenario for project area a up to year y (t CO_2e)
$BE_{FF,a,y}$	Net GHG emissions from fossil fuel use under the baseline scenario for project area a up to year y (t CO_2e)
$PE_{BB,a,y}$	Net GHG emissions from biomass burning under the project scenario for project area a up to year y (t CO_2e)
$LD_{CP,a,}$	Leakage discount factor for carbon pools in project area a (t CO_2e)

The tool is expected to comply with all the requirements listed in PV Climate Methodology Requirements (v1.2) and detailed in the table below.

Table 1 – Justification of compliance with PV Climate Methodology Requirements v1.2

Methodology requirements	Justification of compliance
1.1 Methodology structure	The tool will be drafted based on the most recent PV Climate Tool template
1.2 Uncertainty	1.2.1 – Uncertainty is estimated at 90% confidence interval for each modelled and sampled parameter 1.2.2 – The tool will define how to combine uncertainty associated with each parameter that contribute towards the estimation of *Carbon Benefits* 1.2.3 – Uncertainty adjustment for *Carbon Benefits* will follow **PM001** and **PU005** requirements 1.2.4 – Sources that cannot be readily quantified are derived using best practice approaches, appropriate default parameters, and robust assumptions (see section 5) 1.2.5 – A conservative approach will be used to estimate *Carbon Benefits* (see section 5) 1.2.6 - Uncertainty adjustment for *Carbon Benefits* will follow **PM001** and **PU005** requirements and therefore are in line with international good practices.

1.3 Quantifying emissions and removals	1.3.1 – Approaches used for quantifying GHG will follow **PM001**, **PU001** and **PU002** and therefore are in line with international good practices 1.3.2 – GHG emissions and changes in carbon stocks are separately calculated for each relevant *Carbon Pool* (see section 5) 1.3.3 – All GHG emissions will be converted using CO_2 equivalents as required in **PM001** and **PU004** 1.3.4 – All data, parameters and assumption to estimate *Carbon Benefits* are discussed in detail in section 5 and will be clearly highlighted in the Tool
1.4 Measurements and sampling	1.4.1 – Methods use for data collection, analysis and uncertainty estimation will be clearly specified in the Tool for those parameters that require sampling.
1.5 Models, default factors and proxies	1.5.1 – The Tool does not currently intend to use of third-party models 1.5.2 – The Tool does not currently intend to use third-party default factors 1.5.3 – The Tool will include novel default factors to estimate damage to forest carbon stocks resulting from logging operations based on Ellis et al. (2019) (see section 5.1). Details on methods and data used will be disclosed in the Tool. 1.5.4 – The Tool will include *Project*-specific default factors to estimate damage to forest carbon stocks resulting from logging operations (see section 5.1). Details on approaches for establishing the default factor will be disclosed in the Tool.
2.1 Applicability conditions	2.1.1 – Applicable project intervention and geographical location are clearly specified alongside other requirements for *Logged to Protected Forest* activities (see section 3). The Tool will also adhere to the applicability conditions of **PM001** and relevant modules 2.1.2 – The types of Plan Vivo certificates for the project activity are specified in **PM001**
2.2 Carbon pools and emission sources	2.2.1 – Carbon pools and emissions sources are clearly identified (see section 3.3) 2.2.2 – Each of the indicated carbon pool and emission source are referenced and justification for their inclusion or exclusion provided (see section 3.3) 2.2.3 – Carbon pools and emission sources that are greater in the *Project Scenario* compared to the *Baseline Scenario* are included 2.2.4 – No carbon pools and emission sources that are greater in the *Project Scenario* compared to the *Baseline Scenario* are at present excluded

	2.2.5 – All the carbon pools and emission sources listed are assessed for quantifying *Carbon Baseline*, *Project Emissions* and *Removals*, and *Leakage*
2.3 Baseline scenario and additionality	2.3.1 – The Tool will follow the requirements listed in **PM001** and proposes the most likely land use and land management scenario in the absence of the project to be analysed (see section 4) 2.3.2 – The Tool will follow the requirements listed in **PM001** 2.3.3 – The Tool will follow the requirements listed in **PM001**
2.4 Carbon baseline	2.4.1 – The Tool describes approaches to estimate the *Carbon Baseline* for each carbon pool and emission source in each year of the crediting period (see section 5.1) 2.4.2 – The *Carbon Baseline* reflects the *Baseline Scenario*. The logging operations in the baseline scenario are modelled in order to develop a framework used to quantify the baseline emissions (see section 5.1) 2.4.3 – The *Baseline Scenario* might be developed using historical data or common practice to establish an average trend of the logging activities in the region, therefore impacting the quantification of the *Carbon Baseline*. The reference period is then set to start 10-years prior and end within 2-years from the start of the project activities as required 2.4.4 – Renewal of the *Carbon Baseline* is jointly performed together with *Baseline Scenario* renewal, every 10-years. At renewal, the key assumptions taken will be re-assessed to see if they remained valid.
2.5 Project emissions and removals	2.5.1 – The Tool describes approaches to estimate the *Carbon Benefits* for each carbon pool and emission source in each year of the crediting period (see section 5) 2.5.2 – fPVCs claims align with the requirement set in 1.2.5: conservative quantification of *Carbon Benefits* 2.5.3 – Indicators for claiming vPCVs are clearly identified and approaches to estimate *Project Emissions* and *Removals* achieved in *Verification Period* will be drafted
2.6 Harvesting	2.6.1, 2.6.2 and 2.6.3 – *Logged to Protected Forest* project intervention exclude the harvesting of tree biomass in the Project Scenario. Therefore, the requirements do not apply.
2.7 Leakage	2.7.1 and 2.7.2 – The tool will clearly describe the approach to estimate leakage emissions. A first proposition can be consulted in section 5.3.
2.8 Calculation of carbon benefits	2.8.1 and 2.8.2 – the tool will follow the procedures of **PM001**

2 Relationship to Existing Approaches

To date, Plan Vivo Standard does not offer a methodology to model baseline scenario and quantify the carbon baseline for LtPF project activities. While reviewing the **PT002** tool for REDD, we realised that it cannot be used to quantify the above components as the baseline scenario considered is substantially different. This is mainly because the baseline activities considered in **PT002** is illegal forest deforestation/degradation while for LtPF the degradation in the baseline scenario occurs in a planned manner and (tendentially) within legal frameworks. Furthermore, the market leakage estimation exemplified in **PT002** does not apply for LtPF given: 1) it is tailored to unplanned forest degradation activities or 2) allows for the quantification of a leakage discount factor which is based on the proportion of the project area experiencing reduced production (which for LtPF is 100%, translating into a 100% leakage).

The tool will operate within the framework of **PM001** and will use each of the existing quantification modules where applicable. The tool will be referenced in the following modules:

- **PU001** – Estimation of baseline and project GHG removals by carbon pools in Plan Vivo projects – v1.1
- **PU002** – Estimation of baseline and project GHG emissions from carbon pools in Plan Vivo projects – v1.0
- **PU003** – Estimation of baseline and project GHG emissions from emission sources in Plan Vivo projects
- **PU004** – Estimation of GHG emissions from leakage in Plan Vivo projects – v1.0
- **PU005** – Estimation of uncertainty of carbon benefit estimates in Plan Vivo projects – v1.1

The applicability of each quantification module is explained in Section 5.

2.1 Documentation reviewed and key references

In preparation of this concept note, we reviewed relevant documentation that could aid the development of methods to estimate emission reduction and removals in LtPF activities. Furthermore, we reviewed the Plan Vivo Standard methodological documents to understand where the tool in development would fit best and what existing quantification methods could be used. The table below lists the documentation reviewed which will serve as basis for the development of the new tool.

Verra methodology VM0010 is used as a core reference for the approach to estimate carbon benefits generated by LtPF activities. The objective of this tool is not to create something substantially different from VM0010, but to adapt the approach into the Plan Vivo Standard and to iron out some of the deficiencies of Verra's method, most notably: lack of guidance and complexity, data constraints and arbitrary leakage discounts for tropical forests.

Table 2 – list of documentation reviewed to develop the concept note

Document	Description
Nakau Technical Specifications	Technical specifications used by Nakau in their existing PV LtPF projects under PV v4.
Relevant Plan Vivo methodology, modules and tools	See complete list earlier in this paragraph.
Concept Note - Plan Vivo - Harvested Wood Products tool	Concept note of the to be developed PV tool - Estimation of baseline and project emissions from harvested wood products.
Verra VM0005 – IFM LtHF	Methodology for conversion from low-productive to high-productive forests. This methodology presents LtPF components of inspiration for the upcoming tool.
Verra VM0010 – New IFM LtPF	Core reference for the upcoming tool.
Verra VM0011 – Old IFM LtPF	Mostly obsolete methodology compared to VM0010 but still useful inspiration for some aspects.
Verra VM0035 – RIL	Methodology for reduced impact logging. This is taken as a reference for the estimation of damage to forest stocks due to conventional logging.
Verra VMD0011 – Market leakage	This module presents a slightly different leakage estimation approach compared to what is presented in VM0010, which consists in including leakage management during the calculation of the leakage discount factor.
Literature on logging damage	Emissions due to logging damage are at the core of an LtPF project impact. Several papers on the topic were reviewed to find out the best way to quantify logging damage and/or provide default factors.
Documents on logging practice in Solomon Islands and Barora Fa feasibility study	Policy briefs, environmental impact assessments and logging plan from Solomon Islands. These documents helped us understand the logging context in the island nation and to bound the tool to what level of information is available locally.
Literature on market leakage	Several scientific publications on market leakage related to improved forest management activities have been reviewed to determine the most straightforward leakage accounting approach.

3 Scope and Applicability

LtPF is a carbon project type which quantifies carbon benefits generated from preventing the logging of forests. It applies where the baseline scenario includes selective and commercial logging, and the project ensures forest use is limited to activities that do not result in commercial timber harvest or forest degradation. LtPF falls within the umbrella of the "Improved Forest Management" (IFM) carbon project type.

3.1 Applicability criteria

Below are listed the additional applicability criteria (i.e., not listed in **PM001**) that a project is expected to apply if the LtPF tool is to be used:

- The project area is viable for commercial selective logging operations (as demonstrated in the forest inventory and/or timber harvest plan). Artisanal and subsistence logging are not eligible baseline activities in this tool. Land parcels where artisanal and/or subsistence logging occur are therefore not eligible for Carbon Benefits accounting and are allowed activities for the communities.
- It is demonstrated that the project area is planned to be harvested or that likely there will be future intentions to log the forest. Examples of proof are sanctioned harvest plans, documentation of intent (e.g., exchanges between community and logging company, formalized concession boundaries, or expressions of interest), governmental approvals or court documents, or similar.
- The tool is applicable to undisturbed and degraded forests falling within the "Tropical and Subtropical Moist Broadleaf Forests" biome as defined by RESOLVE[1]. This is because tropical rainforests represent the forest ecosystems relevant to the spatial scope of this methodology. Also, substantial literature is available on conventional logging and related damages for these forest ecosystems, proving the additionality of the LtPF project interventions.
- The project area classifies as forest-remaining-as-forest in both the baseline and project scenario, in line with the forest definition of the relevant jurisdiction. This means that no large-scale deforestation, including clear cut commercial logging, is expected to occur in both scenarios.
- The tool is not applicable for forest plantations.
- The tool is not applicable for small-scale timber harvesting (i.e., selective tree felling for domestic and community purposes). Small scale harvesting is permitted in the project scenario as long as the harvesting areas and purposes are included within a sustainable

[1] RESOLVE map of ecoregion and biomes – https://ecoregions.world/. Publications available at – https://academic.oup.com/bioscience/article/67/6/534/3102935?login=false

community forestry management plan and the area designated for small-scale harvesting is excluded from the accounting area.
- The tool is not applicable for ecosystems presenting wetlands or peatlands.
- Activity-shifting leakage is not accounted for in this tool. The project proponent must demonstrate that activity shifting leakage does not occur (see Section 5.3).

3.2 Geographical boundaries

Geographical boundaries of an LtPF project are related to the project, the land parcel to be harvested, and the stratification based on forest type. These geographical boundaries consist of:

- **Forest strata:** localisation and delineation of forest types having different ecological features and biomass carbon stocks within the project area. This includes differentiation of forest conditions or levels of degradation in situations where (part of) the project area has been previously logged.
- **Land parcels:** as defined in the harvest plan (see section 4.1.1), these are the delineated parcels of forest within the project area that would have been harvested in the baseline scenario during the specified rotation period.
- **No harvest zones:** delineated zones within the project area which are not eligible for harvest activities due to environmental conditions (wetlands, steep slope, riparian buffers etc.), conservation easement or local legislation (for example above specific elevation).

The project proponent is expected to provide shapefiles/KLMs and maps of these geographical boundaries.

3.3 Carbon pools and GHG emission sources

In the tables below are listed the carbon pools and GHG emission sources that the project proponent is expected to account for and quantify.

Table 3 – list of carbon pools applicable to LtPF project activities

Carbon pools	Inclusion	Description
Aboveground woody biomass	Yes	Expected to change significantly because of logging activities
Aboveground non-woody biomass	No	Expected to not change significantly because of logging activities
Belowground woody biomass	Yes	Expected to change significantly because of logging activities as tree stumps and associated root systems are likely to die out and decay over time.

Belowground non-woody biomass	No	Expected to not change significantly because of logging activities
Deadwood (logging slash)	Yes	Included as damage to forest stocks and waste of non-merchantable parts of felled trees contributing to relevant emissions during logging operations
Harvested wood products	Yes	Included as higher in the baseline scenario compared to the project scenario
Litter	No	Carbon pool not expected to significantly change because of logging operations.
Soil organic carbon	No	Carbon pool not expected to significantly change because of logging operations.

Table 4 – list of GHG emission sources applicable to LtPF project activities

GHG sources	Inclusion	Description
Nitrogen fertilisers (N_2O)	No	The use of nitrogen fertilisers is not expected in both Baseline and Project Scenario.
Nitrogen fixing species (N_2O)	No	The planting of nitrogen fixing species is not expected in both Baseline and Project Scenario.
Burning of biomass (CH_4)	Yes	Burning of biomass must be considered in the case of fire event(s) affecting the project area during the Project Scenario.
Fossil fuel use (CO_2)	Optional	The exclusion of these emissions is deemed conservative as they only occur in the Baseline Scenario and not in the Project Scenario.
Enteric fermentation (CH_4)	No	Cattle are generally not present in the project area in both Baseline and Project Scenario, and the Tool does not focus on emission reduction in agriculture.
Manure deposition (CH_4, N_2O)	No	Cattle are generally not present in the project area in both Baseline and Project Scenario, and the Tool does not focus on emission reduction in agriculture
Soil methanogenesis (CH_4)	No	Peatlands and wetlands are excluded from accounting in this tool.

3.4 Projects that will apply the LtPF tool

Sections 3.1–3.3 prescribe the tool's scope and applicability criteria. The tool can be applied by any developer who wishes to certify LtPF activities, in any jurisdiction that fits within the scope and meeting those criteria. By way of illustration, current and upcoming projects of Nakau and TNC in Melanesia that are expected to apply the LtPF tool is, once it is released, are listed below:

Nakau

- Projects in the Babatana region, Solomon Islands (Sirebe, Siporae, Vuri, Padezaka, Garasa, Miqusava, Zoko, Lukolobere);
- Projects in other regions of Solomon Islands (Kira, Viru Harbour, Yato, East Rennell, Barora Fa);
- Projects in Fiji (Drawa).

The Nature Conservancy

- LtPF project Barora Fa, Isabel Province, Solomon Islands (~8,000 ha), currently entering Project Design phase in partnership with Nakau;
- LtPF project in Ali, Papua New Guinea (potential of >1 million ha), currently nearing the end of Feasibility Stage.

4 Baseline Scenario and Additionality

Baseline scenario and additionality must be determined using the existing AR-TOOL02 as mandated for Plan Vivo methodology **PM001**. The analysis should consider at minimum the following alternative land use scenarios:

- Logging activities in the project area are carried out as intended
- Forest protection measures within the project area are implemented without carbon finance incentives

To model the baseline scenario activities and resulting emissions, the project proponent must make use of a timber harvest plan or forest management plan detailing the logging operations that would have occurred in the absence of the project. The requirements for such plan are detailed in the next section.

For this tool, baseline scenario and additionality must be reassessed at least every 5 years. Having a shorter baseline renewal period will allow to reassess project baseline and additionality assumptions at each verification without the need of complex dynamic baselining. Using this approach, the project proponent is expected to demonstrate that logging activities are still likely to occur in the absence of the project and that the harvest plan for the project area submitted at validation still holds true.

Options were considered that would allow for dynamic baselining (as used in ACR IFM v2.1, VM0045 and Isometric). However, in the context of many tropical countries, that are dealing with opportunistic logging and poor governance, such an approach is less suitable because:

1. These IFM methodologies assume availability of data of sufficient quality and accuracy, such as regularly remeasured (sub-)national forest inventories, regularly updated remote sensing data sets (e.g. loss/gain, land cover), regularly available and updated cadastral data or other forest inventory data collected by concession holders or regulatory bodies. In most tropical countries this data either does not yet exist, or updates/ remeasurements are dependent on external capacity and financing with a risk of gaps in availability of up-to-date data and inconsistencies between datasets. Furthermore, the application of remote sensing and plot matching in forest-to-forest comparison is still subject to accuracy limitations due to saturation of optical and radar data[2], especially in the tropical context.
2. In regulated forestry systems like the US (only geographical scope where ACR IFM v2.1 and VM0045 are applicable), harvest behaviour is systematic and predictable, so proxy-based baselines can reliably infer counterfactual harvest. In most tropical countries such as the Solomon Islands, logging is opportunistic, irregular, and driven by governance and access dynamics rather than forest characteristics. Because of this, proxy areas may not consistently behave like the project area, making proxy-based baseline methods unreliable in this context.
3. The dynamic baseline approaches proposed in each of the methodologies mentioned are engineered to capture improved forest restocking and therefore carbon removals in project scenarios where harvesting is retained. None of these methodologies offers an approach to quantify dynamic baseline for LtPF activities, where logging in the project scenario is meant to not occur and where the avoidance of logging is the main component determining project's Carbon Benefits.

4.1 Harvest plan requirements

The project proponent must develop a harvest plan for the project area presenting all the necessary information listed later in this section. This plan is the key reference that is used to model emission reductions and removals in the baseline scenario and must be submitted alongside the project design document at validation.

The following cases may apply:

- If a legally sanctioned harvest plan presenting all the required information is available for the project area, the project proponent is expected to model the baseline scenario

[2] Tian, L., Wu, X., Tao, Y., Li, M., Qian, C., Liao, L., & Fu, W. (2023). Review of remote sensing-based methods for forest aboveground biomass estimation: Progress, challenges, and prospects. *Forests*, *14*(6), 1086.

emissions based on the available plan. If deviations from the plan are expected due to proven non-compliance with laws and regulations in the project region, the proponent can demonstrate such non-compliance as described in Section 4.1.2.

- In the case of incomplete harvest plans not presenting all the needed specifics, the project developer will be expected to determine such missing components by referencing regional common practices.
- In the case a harvest plan is not available, the proponent is expected to draft such a plan based on regional common practice while following the criteria established in this tool.

Analysis of common practice in the project region should consider a historical reference period that starts within 10-years and ends within 2-years of the project start date, as required by Plan Vivo Climate Methodology Requirements v1.2. The common practice in the region can also consider illegalities (i.e., over-harvesting, encroachment in no-harvest zones, tree harvest below/above the defined DBH threshold) if systematic non-compliance with existing laws and regulations is demonstrated.

All the documentation and data used to determine regional common practice must be submitted at validation along with the project design document.

4.1.1 Harvest Plan Criteria

Below are listed all the necessary information that a harvest plan should present in order to model baseline scenario emissions:

- **Sample-based forest inventory of merchantable volumes in the project area** – including all the tree species of economic interest and within the defined diameter threshold
- **Target species to be harvested** – Sample-based list of all the tree species of economic interest likely to be the target of harvest activities
- **Threshold of target diameter at breast height (DBH) for merchantable trees** – defined by laws and regulations or based on regional common practices.
- **Volumes to be harvested in the project area (commercial yield)** – based on commercial stock and harvest rate reported in the available harvest plan, rules and regulations or regional common practices..
- **Forest division in land parcels and harvest rotation** – division of the project area in land parcels and associated harvest rotation must be drawn from the legally sanctioned harvest

plan if available. If not available, regional common practices should be used to define the likely boundaries of the parcels and plausible harvest rotation for the project area.

- **No-harvest zones**– these are areas usually under a conservation easement (protection forest), located near rivers, on heavy slopes, or above certain elevations. The project proponent is expected to map the no-harvest zones within the project area and exclude them from carbon accounting. Local laws and regulations should be used to define the boundaries of no-harvest zones. Areas where small-scale harvesting is happening by local communities for subsistence should be discounted from accounting and considered as no-harvest zones.
- **Category of wood products produced from the harvested timber** – this is necessary to estimate the carbon sequestered in and emitted from the wood products pool. Categories of wood products can be deduced from local reports or regional/national forestry production overviews (such as FAOSTAT)[3], as well as expert opinion. The method to derive HWP categories in the tool and the quantification of carbon stored and emitted from HWP will be based on the HWP tool to be released from Plan Vivo in 2026 (see section 5.1.3).

4.1.2 Demonstration of non-compliance with laws and regulations

Whether laws and regulations for selective commercial logging exist but are not enforced and respected, the project proponent might choose to demonstrate systematic non-compliance with such laws and regulations. Eligible proofs of non-compliance are in hierarchical order:

- Peer-reviewed literature and/or articles from accredited journals;
- Studies conducted by the project proponent following the protocol provided below (only for non-compliance with legally sanctioned no harvest zones).

The project proponent can make use of experts' opinions to enrich the demonstration of non-compliance if deemed needed. The list of literature and articles gathered, and the proponent-led studies must be submitted at validation alongside the project design document.

For conservativeness, when non-compliance is considered in the common practice and harvest plan, the values generated by the common practice analysis (i.e., harvested and merchantable volumes,

[3] Link to the database: https://www.fao.org/faostat/en/#data

and area of encroachment in no harvest zones) must account for a fixed 10% uncertainty to be propagated when calculating the overall Carbon Benefits uncertainty discount.

Protocol for studies to demonstrate non-compliance with no harvest zones

To demonstrate non-compliance with laws and regulations regarding encroachment in no harvest zones, the proponent can perform a remote sensing base study following the approach here described. Further details and guidance on this protocol are to be provided during tool development. The following criteria are a first attempt to bound the exercise, and we ask the reviewer(s) to provide feedback on the approach proposed.

The project proponent is expected to investigate at least 5 logging concessions in the project region where activities were conducted in the last 10 years prior to the project start date. The proponent must source the following geospatial information:

- Boundaries of logging concessions;
- Boundaries of no harvest zones based on host country's laws and regulations (e.g., specific elevation limit or slope degree angle, buffer from streams and rivers, conservation areas, etc.);
- Digital elevation model of the project jurisdiction indicating altitude and slope;
- High resolution imagery timeseries ($\leq$10m) from the last 10 years prior to the project start date.

The reference logging concessions must adhere to the following requirements:

- Located in the same jurisdiction as the project area;
- Located in the same ecoregion and forest type as the project area;
- With similar distribution of elevation classes (±200 m) as the project area (±20%);
- Located in the immediate vicinity of the project area. The proponent must prioritize concessions which are spatially closer to the project area.

The project proponent must map no harvest zones in each reference logging concessions and determine whether encroachment occurred in the 10 years prior to the project initiation. Such determination is done by classifying satellite imagery to identify forest cover changes (forest to non-forest) due to selective logging activities within the examined concessions.

Then the rate of the encroachment in no harvest zones must be calculated using the following formula:

$$E_{rate} = (\sum_{rc}^{rc} AE_{rc} \div NZ_{rc}) \div n_{rc}$$

Where:

E_{rate}	Average rate of encroachment in no harvest zones in the project region (%)
AE_{rc}	Area of encroachment in the no harvest zones of reference logging concession rc (ha)
NZ_{rc}	Total area covered by no harvest zones in reference logging concession rc (ha)
n_{lc}	Number of reference logging concessions examined

E_{rate} can then be used to estimate the number of hectares in no harvest zones in the project area that would be encroached during logging operations in the baseline scenario. Once the area of encroachment is determined, the resulting hectarage must be evenly spread out to all land parcels in the project area.[4]

When the project area is enriched with the hectarage of potentially encroached no harvest zone, the project proponent must apply a fixed 10% uncertainty to the project area value, as per the conservativeness requirement described earlier in this section.

The proponent must submit the following documentation at project validation:

- Report describing the method used to determine no harvest zones and develop forest cover change maps, and findings;
- All satellite imageries, raster and vector layers used in the analysis;
- If relevant, all the scripts used in the analysis.

5 Quantification of Carbon Benefits

5.1 Carbon Baseline

The estimation and modelling of the Carbon Baseline for LtPF project activities should follow the timber harvest plan describing logging operations within the project area boundaries in the Baseline Scenario.

[4] Example: the total area that would have been encroached is 10 ha and there are 2 land parcels within the project area, then 5 hectares are added to each land parcels.

The name and acronyms of the parameters discussed in this section are not final and are likely change in the final draft of the Tool.

5.1.1 Volumes harvested and extracted

The first step is to calculate via a forest inventory the amount of merchantable volume (commercial stock) per forest type or stratum ($V_{MER,i}$). Quantification of tree volume should use preferably species-specific local allometric equations. If not available, generalized allometric equations from the "Tropical and Subtropical Moist Broadleaf Forests" biome can be used (see section 3.1). Based on the harvest rate (in m^3 per ha) detailed in the timber harvest plan, the volume that is harvested per species per stratum per hectare is defined ($V_{HRV,sp,i}$).

Following the timber harvest plan, the proponent must quantify the harvested forest carbon stocks per species per stratum (i.e., biomass of the whole tree). This is done for each merchantable tree species and then aggregated using the following formula:

$$C_{HRV,i} = (\sum_{sp=1}^{sp} V_{HRV,sp,i} \times BCEF \times CF_{sp}) \div A_i$$

Where:

$C_{HRV,i}$	Average carbon stock in harvested biomass per hectare in stratum i (tC/ha)
$V_{HRV,sp,i}$	Average volume of harvested biomass per hectare for species sp in stratum i (m^3/ha)
$BCEF$	Biomass conversion and expansion factor (t d.m/m^3)
CF_{sp}	Carbon fraction of biomass for species sp (tC/t d.m)
A_i	Area of stratum i (ha)

To estimate the harvested biomass carbon that is effectively extracted and reaches the market, only the biomass of the bole must be considered thus excluding non-merchantable parts of the tree such as the crown. The following formula is used:

$$C_{EXT,i} = (\sum_{sp=1}^{sp} V_{HRV,sp,i} \times WD_{sp} \times CF_{sp}) \div A_i$$

Where:

$C_{EXT,i}$	Average carbon stock in extracted biomass per hectare I n stratum i (tC/ha)

$V_{HRV,sp,i}$	Average volume of harvested biomass per hectare for species sp in stratum i (m^3/ha)
WD_{sp}	Wood density of species sp (t d.m/m^3)
CF_{sp}	Carbon fraction of biomass for species sp (tC/t d.m)
A_i	Area of stratum i (ha)

This approach is highly similar to the one used in Verra VM0010. Based on our extensive research, currently this is the most simple and standardizable approach available and thus was chosen to be used in this tool.

5.1.2 Deadwood – Logging slash

Carbon in logging slash ($C_{SLA,i}$) is calculated by summing the carbon in tree remainders (non-merchantable proportion of harvested trees that is not extracted) and carbon in damaged forest stocks caused by felling and logging infrastructure development, consisting of coarse and fine woody debris.

Carbon in aboveground tree remainders ($C_{WBR,i}$) is calculated by subtracting the extracted trees carbon stocks ($C_{EXT,i}$) from the harvested trees carbon stock ($C_{HRV,i}$) (see the previous section). Carbon in belowground tree remainders ($C_{BGR,i}$) left to decay (i.e., root systems) is calculated by multiplying the $C_{HRV,i}$ by a root to shoot ratio (R). Below are listed the preferred sources for R in order of priority:

- Local or national literature
- Literature from the same forest type or ecoregion as the project area
- IPCC root to shoot ratios (IPCC 2019, Volume 4, Chapter 4, Table 4.4)

Regarding the quantification of emission from damage to the forest caused by the logging operation ($C_{DMG,i}$), the tool will allow two approaches:

1. **Default data pathway**: the project proponent can use damage factors (expressed as tC of forest damage per m^3 of extracted timber) deduced from local peer-reviewed literature, which relate extracted timber volumes to damage due to logging and infrastructure development, or *Measured data pathway* data of other LtPF projects operating in the same jurisdiction (see the *Measured data pathway* approach below).

In the absence of such literature, the tool will provide an equation to estimate the damage factor which has been developed by fitting the available data from Ellis et al. (2019)[5]. Several models were tested using AIC, RMSE and R^2, with the best fitting one being a simple linear model. The resulting equation predicts damage per hectare (in tC/ha) based on harvest intensity (in m^3/ha). After the damage per hectare is calculated, it must be divided by the harvest intensity to obtain the damage factor (in tC/m^3).

$$C_{DMG,a} = 0.515 \times HI_a + 4.373$$

$$DF_a = C_{DMG,a} \div HI_a$$

Where:

$C_{DMG,a}$	Collateral carbon stock damage resulting from timber harvest and forestry infrastructure establishment in project area a (tC/ha)
HI_a	Expected harvest intensity in project area a (m^3/ha)
DF_a	Logging damage factor for project area a (t C/m^3)

The model equation has a relative uncertainty of 19.68% at 90% confidence interval which should be accounted for in the final uncertainty quantification if this approach is chosen.

2. **Measured data pathway**: the project proponent is asked to define a damage factor by analysing reference areas (i.e., logging concessions in similar contexts) within the country. The damage factor should consider at minimum the damage to forest carbon stocks resulting from felling, skid trail, roads and log landings construction. Such analysis must demonstrate statistical relevance by meeting Plan Vivo requirements for uncertainty as defined in **PU005** (i.e., estimation with sampling approaches should be calculated at 90% confidence interval). The project proponent must submit the data and documentation generated by the analysis at validation. To quantify the damage from logging, two approaches are deemed viable:

   a) **Stock difference approach:** forest carbon stocks are measured in at least 5 logged over concessions or reference areas with similar ecological characteristics and

[5] Ellis, P. W., Gopalakrishna, T., Goodman, R. C., Putz, F. E., Roopsind, A., Umunay, P. M., ... & Griscom, B. W. (2019). Reduced-impact logging for climate change mitigation (RIL-C) can halve selective logging emissions from tropical forests. *Forest Ecology and Management*, *438*, 255-266.

carbon stocks within the jurisdiction. The forest carbon stocks in the logged over areas and in the project area are then compared to determine the logging damage factor. Such analysis requires complete forest inventories (i.e., measuring all trees with DBH $\geq$ 5 cm within sample plots) for both the reference areas and the project area.

b) **Damage factor approach:** separate damage factors are quantified for felling**,** skid trails, roads and log landings. Such quantification must make use of sample plots on the ground possibly in combination with remote sensing. The methods proposed in Ellis et al. (2019) and Pearson et al. (2014)[6] are suggested references. The measurement of logging damage should be done in at least 5 logged over concessions or proxy areas with similar ecological characteristics and carbon stocks within the country.

All the carbon stock in deadwood generated by the logging operations is conservatively expected to decay over 10 years, aligning with the assumptions indicated in the IPCC Good Practice Guidance[7] and substantiated by recent literature[8] [9].

5.1.3 Emissions from harvested wood products

Plan Vivo is currently developing a tool to estimate the carbon stored and emitted in harvested wood product (HWP), which should be released by the end of 2026. The modelling approach in the HWP tool will be based on the conceptual framework detailed in Winjum et al. (1998) and it is expected to align with the LtPF tool. Therefore, the HWP tool will be used to estimate carbon stored and emitted in HWP for LtPF project activities.

5.1.4 Emissions from fossil fuel

[6] Pearson, T. R., Brown, S., & Casarim, F. M. (2014). Carbon emissions from tropical forest degradation caused by logging. *Environmental Research Letters*, *9*(3), 034017.

[7] IPCC (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry. Section 3.3.2.1.

[8] Mills, M. B., Malhi, Y., Ewers, R. M., Kho, L. K., Teh, Y. A., Both, S., ... & Riutta, T. (2023). Tropical forests post-logging are a persistent net carbon source to the atmosphere. *Proceedings of the National Academy of Sciences*, *120*(3), e2214462120.

[9] Wijas, B. J., Flores-Moreno, H., Allison, S. D., Rodriguez, L. C., Cheesman, A. W., Cernusak, L. A., ... & Zanne, A. E. (2024). Drivers of wood decay in tropical ecosystems: Termites versus microbes along spatial, temporal and experimental precipitation gradients. *Functional Ecology*, *38*(3), 546-559.

Estimating emissions from the use of fossil fuel in the baseline scenario is deemed conservative to exclude as these emissions would not occur in the project scenario given logging activities would be prevented.

To estimate emissions from fossil fuel use, module **PU003** (AR-TOOL05 v1.0) must be used.

5.1.5 Regrowth of the forest after logging

Biomass regrowth of the forest ($C_{RGR,i}$) will be estimated using regrowth factors from the best available literature sources. A priority list of sources is defined as below:

- Data from chronosequence field measurements in logged-over reference areas within the same ecoregion and jurisdiction of the project area;
- Literature on regrowth after harvest of the same forest type or ecoregion as the project area;
- IPCC default values for secondary growth of forests older than 20 years (IPCC 2019, Volume 4, Chapter 4, Table 4.9).

5.1.6 Calculation of the Carbon Baseline

In this paragraph explains how to calculate the total baseline scenario emissions due to change in carbon stock as a result of logging operations. Here, the parcel level quantification is introduced for the correct accounting of baseline emissions overtime. Parcels, as introduced in section 3.2, are delineated areas that are meant to be harvested at a specific point in time during the harvesting cycle of the project area.

$$GHG_{BSL,t} = \sum_{i,p} A_{i,p} \times (\Delta C_{SLA,i,p}/10 + \Delta C_{HWP,i,p} - \Delta C_{RGR,i,p}) \times 44/12$$

Where:

$GHG_{BSL,t}$	Net baseline emissions due to logging operations across all parcels and strata at time t (tCO_2)
$A_{i,p}$	Area of stratum i in parcel p that is assumed to be harvested in the baseline scenario (ha)
$\Delta C_{SLA,i,p}$	Carbon stock change from oxidation of deadwood (logging slash) generated during logging operations and left on the forest floor in stratum i in parcel p (tC/ha) – *decaying over a fixed period of 10 years*

$\Delta C_{HWP,i,p}$	Carbon stock change from oxidation of wood products in stratum i in parcel p (tC/ha) – *portions emitted and permanently stored per product type should be indicated in the HWP tool*
$\Delta C_{RGR,i,p}$	Carbon stock change from regrowth of forest biomass after logging activities in stratum i in parcel p (tC/ha)
$44/12$	Ratio of molecular weight of carbon dioxide and carbon (tCO_2e/tC)

This quantification approach does not align with the accounting procedures and parameters indicated in **PM001** where emissions and removals from the baseline are accounted separately. The reason for showcasing the above formula is that it better exemplifies how the emissions in the baseline scenario are modelled. During the development of the tool, we will align all the parameters to their respective acronyms and accounting procedures of **PM001**.

5.2 Project emissions and removals

5.2.1 Forest growth in the project scenario

By preventing logging operations, LtPF project interventions allow the forest in the project area to growth undisturbed in the Project Scenario. To claim Carbon Benefits from the forest growth in the Project Scenario, estimations of forest carbon stocks at the project start date and at each verification are required.

Forest growth in the project scenario will be modelled and estimated following the procedure detailed in module **PU001** (AR-TOOL14 v4.1).

5.2.2 Emissions due to natural disturbances and illegal logging

Actual emissions due to loss of carbon stocks in the Project Scenario caused by natural disturbances or illegal logging will be quantified using the procedure detailed in module **PU002**. If forest loss is caused by fire, module **PU003** (AR-TOOL08 v4.0) should be used to estimate the CH_4 emissions due to biomass burning. Global warming potential and emission factor per specific GHG gas should be determined from the most recent IPCC publication.

Specific monitoring requirements to estimate emissions from natural disturbance and illegal logging will be provided during the tool development phase.

5.3 Leakage emissions

5.3.1 Activity-shifting leakage

As legal commercial logging is the activity in the scope of this tool, the forestland owner and/or project proponent is the primary agent of commercial logging, not the concession operator. Therefore, the proponent must demonstrate that the forestland owner or project proponent does not shift to or intensify its activities to other forestlands outside the project area under their ownership or control. This must be demonstrated at validation by a written testament from the forestland owner and, in the case where the forestland owner already has commercial logging operations outside the project area, records of historical logging operations as well as historical forest management plans of operational logging areas. During verification, the project proponent must provide documented evidence that no logging or logging intensification has taken place in the forest lands under their ownership or control outside the project area during the monitoring period.

If the project proponent has no ownership or access to forestland outside the project area, only market leakage is considered. In the case that forestland owner and/or project proponent is the primary agent of commercial logging, the proponent must demonstrate that the logging agent does not move to or intensify its activities somewhere else.

In the case that the forest owner and/or project proponent is not the primary agent of logging, the LtPF tool assumes that in the context of LtPF activities activity-shifting and market leakage significantly overlap, based on the reason that the logging concession operators, commercial logging agents are fully market driven and not geographically bound to the vicinity of the project area. This means that, even if a single logging company or agent can be identified, this agent will make its decision to shift its operations elsewhere based on the market dynamics as another logging company operating within the same market. Accounting activity shifting and market leakage separately would result in double counting of leakage. Therefore, the project may directly account for market leakage as described below.

The project activities will not result in changes in the level of wood extraction by the community or smallholders for own consumption (which is excluded from accounting as described above) and will thus not lead to activity-shifting leakage. In line with this, activity shifting in fuelwood collection or biomass burning is not considered to be applicable.

5.3.2 Market leakage

Market leakage occurs because price signals induce agents outside a targeted region to change behavior. The market leakage discount factor (LD_M) will be quantified using key factors that determine the extent of displacement of logging. The following formula is used:

$$LD_M = LF_P \times LF_{PD} \times LF_{SUF} \times LF_{SUP} \times LF_T$$

Although market leakage extends beyond the national borders, the scope of this market leakage approach is national. The reason is that international market leakage is difficult to account for due to complex and multi-faceted market dynamics.

Table 5 – explanation of each leakage factor, their quantification method and impact on leakage in percentage.

Leakage factor	Quantification	Leakage impact	References
Proportional productivity (LF_P)	The proportion of average productivity of alternative areas relative to the average productivity of project areas will be quantified. This proportion will be translated in a leakage factor. Evidence will be provided by the project proponent where displacement can be expected.	If the forest in the area of displacement is ≤15% more productive than the forest in the project area: LF_P = 1 If the forest in the area of displacement is >15% more productive than the forest in the project area: LF_P = 0.8 If the forest in the area of displacement is >15% less productive than the forest in the project area: LF_P = 1.2	Based on VM0010 Leakage factor
Proportional harvest decrease (LF_{PHD})	As a proxy for price effects, the proportion of harvest volume decrease as a result from the project activity relative to the national production will be quantified. If the project proponent implements similar projects in the country that also reduce the supply of timber, the harvest volume decrease of all projects implemented need to be aggregated.	If the proportion of harvest volume decrease in the project area / the national production is <1%, then LF_{SC} = 0.2; If the proportion of harvest volume decrease in the project area / the national production is 1-5%, then LF_{SC} = 0.4 If the proportion of harvest volume decrease in the project area / the national production is >5%, then LF_{SC} = 0.8	Inspired by the "Proportion of land enrolled in a carbon project" used in Daigneault *et al*, 2025 (https://www.researchsquare.com/article/rs-3596881/v2).

Substitutability tropical forest (LF_{SUF})	Where (a proportion of) the targeted species for harvest (e.g. specific high-valued species) in the project area is unique and "difficult to substitute"[10] with the same or similar species in other tropical forest in the region, 50% of the volume of these specific species is expected to not leak.	The leakage factor is calculated as follows: LF_{SUF} = 1 – (0.5 x proportion of total harvest volume difficult to substitute)	Murray *et al.* 2004 (https://doi.org/10.2307/3147147);
Substitutability plantation forest (LF_{SUP})	Indicating both demand elasticity and national plantation capacity. If it can be demonstrated that plantation capacity within the country can substitute ≥50% of the target harvest volume, the proponent can assume a reduction in leakage towards other tropical forests. This factor requires two assessments: 1) demonstrate that ≥50% of the target harvest volume can be substituted with plantation species and 2) demonstrate that plantations in the country have the capacity to supply ≥50% of the target harvest volume	If plantations can supply ≥50% of the target harvest volume, then LF_{SPL} = 0.8 In all other cases LF_{SPL} = 1	Jenkins *et al* 2009 and Daigneault et al, 2025 (https://nicholasinstitute.duke.edu/climate/policydesign/offsetseries4 and https://www.researchsquare.com/article/rs-3596881/v2).
National market trend (LF_{MT})	Indicating supply-constrained markets or supply inelasticity as described in Murray et al, 2004. If the project proponent can demonstrate a clear downwards trend in national	If the project demonstrates a downwards supply trend, LF_{MT} = 0.6, In all other cases LF_{MT} = 1	Murray *et al*, 2004 and Jenkins et al, 2009 (https://www.researchgate.net/publication/23697751

[10] Considered criteria are: Endemic or regionally restricted species; ITTO durability classification Class 1 and 2 species; CITES Appendix II or III regulated species; unique properties (i.e. colour, density, working properties)

	timber production (with production data of at least the past 5 years to a maximum of 10 years) and can substantiate that this trend is caused by decreasing availability, not decrease in demand, a partial reduction of supply can be assumed		_Estimating_Leakage_from_Forest_Carbon_Sequestration_Programs; https://nicholasinstitute.duke.edu/climate/policydesign/offsetseries4););

5.4 Uncertainty

Uncertainty for LtPF activities will be quantified and propagated using module **PU005** as referred in methodology **PM001**. Uncertainty must be quantified and aggregated for the following values:

- $V_{MER,i}$ – Forest volume per strata calculated from forest inventory – uncertainty based on sampled values
- $C_{DMG,i}$ – Forest carbon damaged during felling and establishment of infrastructure – uncertainty based on chosen damage factor
- $C_{RGR,i}$ – Forest carbon regrowth after logging activities occurred – uncertainty deduced from reference data or literature
- Any value measured and monitored in the project scenario – uncertainty based on sampled values

6 Development Team

The LtPF tool is being jointly developed by Nakau, TNC and Face the Future. The development team shows relevant expertise and experience in relation to tropical forestry, carbon project development and LtPF project activities. The table below list the members of the development team alongside their role and expertise.

Table 6 – list of members of the development team, their organization, role and expertise.

Person	Organization	Role	Qualification, expertise and experience
Manuel Haas	Nakau	Editor and reviewer	- 5 years' experience in forest carbon projects under Plan Vivo Standard - >10 years' experience in sustainable forestry in tropical forest ecosystems - Expertise in developing technical specifications for IFM-LtPF projects under Plan Vivo in Solomon Islands and Fiji

			- Certificate in Precision Forest Management (Modeflora) released from Embrapa, Brazilian Agricultural Research Corporation - Relevant MSc degree in Natural Resource Management and Forestry
Sophia Bennani-Smires	TNC	Editor and reviewer	- 5 years' experience in forest carbon projects under VCS and CBB as well as other relevant carbon standards. -Expertise in developing and carbon accounting for Blue Carbon, ARR, REDD and IFM forestry carbon projects - Previous member of Plan Vivo ARR Dynamic Baseline Working group - Co-author on two Blue Carbon methodologies for the French Label Bas Carbone - Experience with VCS' VM0010 methodology in the Melanesia Context - Member of The Nature Conservancy's Carbon Project Review Committee - Relevant MSc degree in Natural Resource Management and Forestry
Martijn Snoep	FtF	Reviewer	- > 20 years' experience in forest carbon projects under VCS & CBB as well as other relevant carbon standards. - Participated in developing and updating VM0005 (IFM) methodology. - Experience with commercial logging context in Papua New Guinea and Malaysia - Relevant MSc degree in Forestry
Kars Riemer	FtF	Reviewer	- 12 years' experience in forest carbon projects under VCS & CBB as well as other relevant carbon standards. - Key expert on carbon accounting and biomass modelling - Participated in updating VM0005 (IFM) methodology - Strong experience in application of VM0005 (IFM), leading monitoring and verification in VCS project in Malaysia - Experience with commercial logging context in Papua New Guinea as well as internationally - Up-to-date and hands-on experience in carbon field assessments, forest carbon monitoring design and implementation, data analysis, development of data collection tools and platforms - Relevant MSc degree in Forestry
Wouter van Goor	FtF	Main editor	- 12 years' experience in forest carbon projects under VCS & CBB as well as other relevant carbon standards. - Key expert on biodiversity monitoring - Participated in updating VM0005 (IFM) methodology - Reviewed and provided advice on country specific Module development for the development of a RIL project in Suriname with VM0035. - Experience with commercial logging context in Papua New Guinea and Suriname - Experience with carbon field assessments, forest carbon monitoring design and implementation - Relevant MSc degree in Forestry
Livio Pierro	FtF	Main editor	- 3 years' experience in forest carbon projects under VCS & CBB as well as other relevant carbon standards. - Expertise on carbon accounting and biomass modelling - Experience with commercial logging context in Papua New Guinea - Experience with development of carbon IFM LtPF modelling tool based on VM0010

			- Relevant MSc degree in Forestry