Project Manual for Logging Carbon Emission Calculation

Contents

1. Background

Papua New Guinea (PNG) is well known as the country where one of the largest rain forest areas and its richest biodiversity remained in the world. On the other hand, forestry is one of the most important industries contributing to PNG's economy and rural development. According to PNG's reports submitted to UNFCCC (Forest Reference Level (FRL) and National REDD+ Strategy (NRS)), PNG still keeps forest covering 78% of the country but large percentage of forest area has been degraded by commercial logging and it is actually the largest GHG emission source in PNG.

Although there is no PNG's specific methodology to monitor logging-associated emissions specifically, the Verified Carbon Standard (VCS)'s methodology, namely *"VM0035: Methodology for Improved Forest Management through Reduced Impact Logging"*, is available and could serve to meet this demand. Reduced Impact Logging (RIL), defined as "the intensively planned and carefully controlled implementation of timber harvesting operations to minimize the environmental impact on forest stands and soils (ITTO, 2017)", requires monitoring and assessment of direct impact of logging operation in terms of biomass loss, comparing with conventional logging practices. Since RIL could also contribute to climate change mitigation through reducing avoidable biomass loss by improved and careful logging operations, VM0035 has been ap cleacenceplied for East Kalimantan Jurisdictional Emission Reductions Program in Indonesia funded by the World Bank's Forest Carbon Partnership Facility (FCPF) Carbon Fund, along with its module, titled *"VMD0047 Performance Method for Reduced Impact Logging in East and North Kalimantan"*.

Building based on this internationally certified methodology, the JICA-PNGFA Project has crafted a method to assess logging emissions at the setup level, referring to the context of PNG. This draft method enables the calculation of total biomass loss at the setup level, by the evaluating three key emission activities: Skidding, Felling, and Hauling. Based on the method, this manual has been prepared jointly by project members of PNGFA and JICA experts, in order to ensure the smooth and accurate carbon loss calculation based on collected field data.

2. Overview of Field Carbon Monitoring

As illustrated in the figure 2-1, the main sources of emission caused by commercial logging are not only Felling, but also Skidding and Hauling related activities. The emission caused by logging, therefore, can be calculated based on the biomass loss cased by those activities.

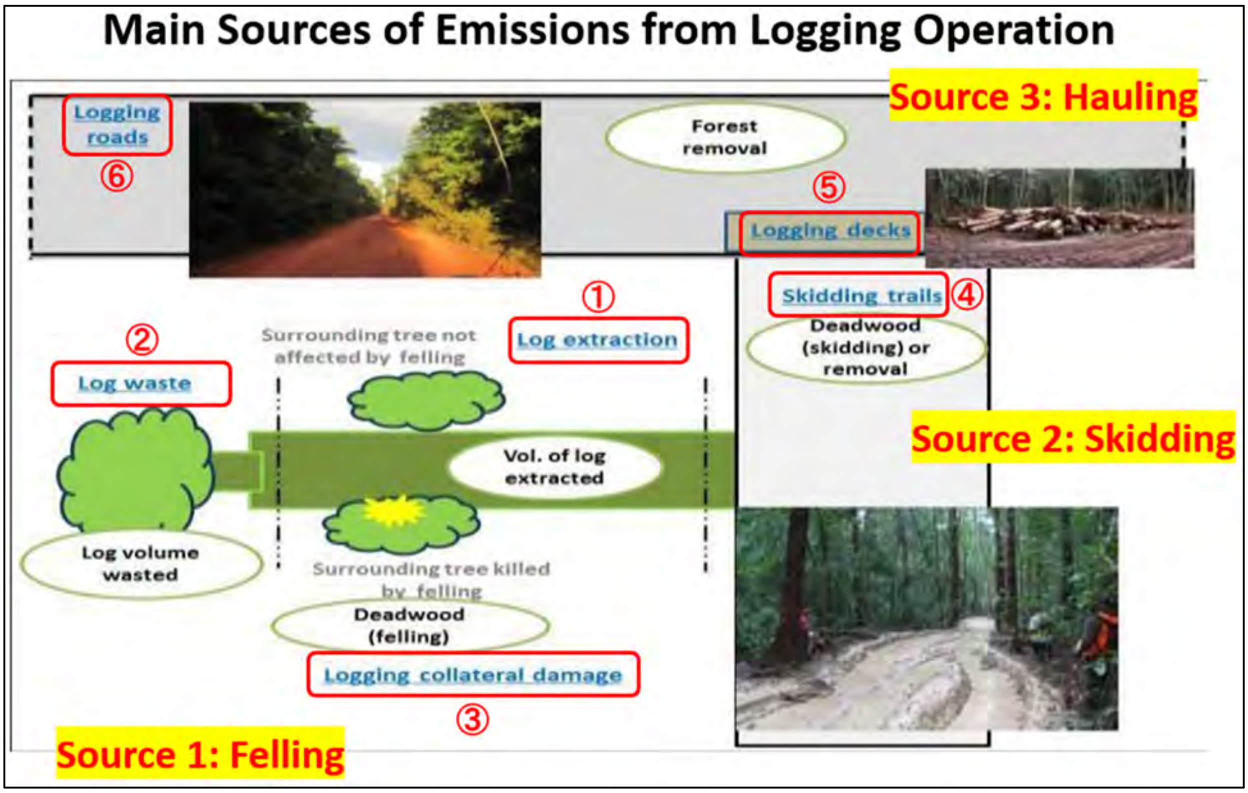

Figure 2-1: Sources of Emission

The following table gives you a clear picture of overview on survey items. In order to assess actual biomass/carbon losses, the listed survey items in the table 2-1 need be covered during the field carbon monitoring survey, by collecting required field measurement data listed in the table 2-2.

Emission Category	***Survey Items***
SKID	**Skid Track Area** at target setup
	(total length of both main and spur roads and average width)
	Skidding-caused Collateral Damage Impact at target setup
	(deadwood density per meter and total length)
	Natural Vegetation Carbon Stock Density
	(average carbon volume of natural vegetation per hectare)
FELL	**Felling-caused Damage Impact Density (Collateral Damage + Waste)** at target setup
	(deadwood and residue density per stump/tree and total number of tree felled)
	Log Extraction Impact of target setup
	(log extraction volume)
HAUL	**Hauling Road Area** at target setup
	(average width and length allocated for target setup)
	Total Log Landing Area at target setup
	(length and width of respective log landings)
	Natural Vegetation Carbon Stock Density
	(average carbon volume of natural vegetation per hectare)

Table 2-1: Survey Item

Sources of emissions					Measurement objects	Measurement values
Forest carbon stock damage from selective logging	Carbon stock damage in logging gaps due to tree felling	Timber-trees	Log volumes	Extracted log volumes	Lying/removed deadwood	Length (L), Diameters of top and bottom of logs (D1-D4)
				Non extracted log volumes: trimmed, abandoned, forgotten	Lying deadwood in logs	Length (L), Diameters of top and bottom of logs (D1-D4)
			Non log volumes	Stumps	Stump	Height (H), Diameters of stump (D1-D2)
				Tops, Head logs	Lying deadwood	Length (L), Diameters of head logs/tops (D1-D2)
		Other trees	Uprooted volumes		Lying deadwood (G)	Length (L), Diameters of uprooted trees (D1-D2)
			Snapped trees	Above the first branch	live tree (mortality<100%)	**Not accounted here**
				Below the first branch	Standing deadwood (S)	Height (H), DBH
	Area Damaged due to log extraction	Skid trails			Standing deadwood (S)	Height (H), DBH
					Lying deadwood (G)	Length (L), Diameters lying deadwood (D1-D2)
					Area removed	Skid trail width, length, area
		Log landings			Area removed	Landing width, length, area
		Haul logging roads			Area removed	Haul road width, length, area
		Others such as camps etc.			Area removed	**Not accounted here**

Table 2-2: Measurement Parameters

Based on measurement data collected from the field, carbon calculation will be carried out by excel spreadsheet. You should follow this manual to complete the task of logging emission calculations in an accurate manner.

3. Theoretical Background: Equations and Calculations

Emissions from forestry sector are calculated by deriving activity data (magnitude of human activity resulting in emissions or removals) and emission factors representing the change in carbon stocks as a result of the activity (IPCC's AFOLU guidelines, 2006).

Net emissions (Em) = Activity Data (AD) x Emission Factor (EF)

In terms of logging emissions, PNG has adopted the methodology of Remote-sensing method for Activity Data (AD) and Stock-change method for Emission Factor (EF) to estimate logging impact on forest carbon. Under this methodology, EF of forest degradation corresponds to the carbon stock change from primary forests to degraded forests, which inevitably includes not only the logging but also other degradations activities such as gardening, fire, fuel wood collection. There is another methodology, which is based on timber extraction rates (Volume Method) for AD, while EF is calculated by Gain-loss Method with focus on biomass loss.

Net emissions	=	Activity Data	x	Emission Factor
Emissions from industrial timber production tCO2e		Extracted volumes m3		Biomass loss associated to timber extraction activities tCO2e/m3

Figure 3-1: Logging Emission Calculation based on IPCC guidelines.

The Gain-Loss Method is designed to provide emission factor for all sources of emission as a function of the unit of timber production (ton of carbon per cubic meter extracted), as follows:

Total Carbon Emission (TCE) = Extracted Log Emission (ELE) + Logging Damage Emission (LDE) + Logging Infrastructure Emission (LIE)

TCE is the total loss of live biomass caused by immediate damage that occurs during operations. ELE (Extracted Log Emission) corresponds to extracted volume of the selected merchantable trees, which can be confirmed from the official record of Log Scaling. LDE (Logging Damage Emission) accounts for a log-related biomass left behind in felling gaps and incidental damage to surrounding trees. LIE (Logging Infrastructure Emission) accounts for removed biomass caused by infrastructures for skidding and hauling operation, including log landings. In order to calculate respective emission volumes, values listed in the table below will be required. Once TCE, or total volume of carbon loss caused by logging operation, is calculated by adding ELE, LDE and LIE, the value of EF can be calculated by dividing TCE with total log volume extracted again.

Emission Factor		Required Values
Logging Infrastructure Emission	Forest Clearance for Hauling Road	Total Hauling Road Area (ha)
		Natural Vegetation Carbon Stock Density (tC/ha)
	Forest Clearance for Log Landing	Total Log Landing Area (ha)
		Natural Vegetation Carbon Stock Density (tC/ha)
	Forest Clearance for Skid Track	Total Skid Track Area (ha)
		Natural Vegetation Carbon Stock Density (tC/ha)
Logging Damage Emission	Skidding-caused Collateral Damage	Total Skid Track Length (m)
		Average Deadwood Carbon Dencity per Skid Track Meter (tC/m)
	Felling-caused Collateral Damage	Recorded Number of Felled Trees (stump)
		Average Deadwood Carbon Density per Felled Trees (tC/stump)
	Log Wastes/Residues	Recorded Number of Felled Trees (stump)
		Average Log Waste Carbon Density per Felled Trees (tC/stump)
Log Extraction Emission	Log Extraction	Recorded Removed Log Carbon Volume (tC) (from Log Scaling Data)

Figure 3-2: Required Values for Emission Calculation

For carbon loss calculation, the methodological concept is adopted from IPCC, which is the equation for the annual carbon loss in biomass from wood removal due to harvesting. For wood density, PNG's NFI default dry wood density factors by genus/species is adopted.

$$L_{\text{wood-removals}} = \text{Removed wood volume (V)} \times \text{Biomass Expansion Factor (BEF)} \times \text{Wood Density (WD)} \times (1+ \text{Ratio of below-ground biomass (R)}) \times \text{Carbon Fraction (CF)}$$

For tree carbon calculation, an allometric equation developed by Chave et al. (2014) is adopted, instead of applying BEF, same as PNG NFI methodology. This equation will be applied mainly for calculation of tree carbon at Natural Vegetation Plot.

$$\text{Tree carbon} = \{0.0000673 \times (DBH^2 \times \text{Tree Height})^{0.976}\} \times WD \times (1+R) \times CF$$

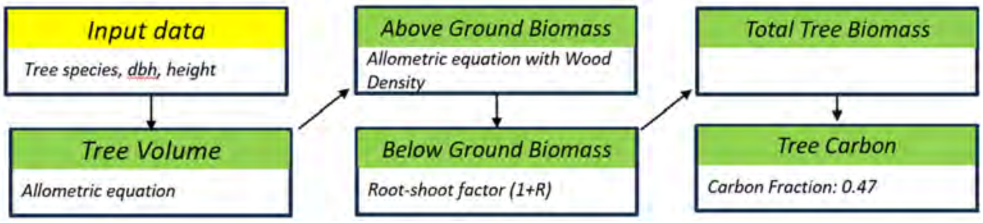

Figure 3-3: Process of Tree Carbon Calculation

In case of carbon volume of logs extracted, since log volume (m^3) is calculated at log scaling process, applying Brereton Formula, its carbon volume (tC) can be calculated through multiplying volume and wood density of species, as well as default value of carbon fraction, as follows.

$$\text{Extracted log carbon} = \{\pi(pi=3.141592)/40000 \times (\text{average of Diameters})^2 \times \text{Log length}\} \times WD \times CF$$

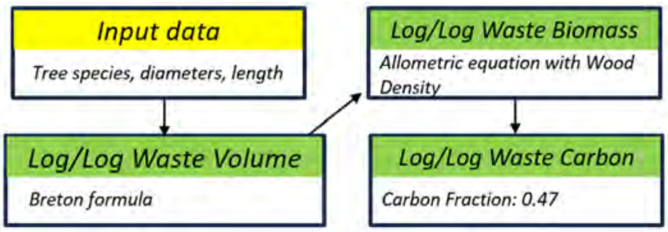

Figure 3-4: Process of Log Carbon Calculation

Additionally, combining equations adopted by PNG NFI methodology, stump carbon can be calculated from top-stump diameter and stump height, while Brereton formula adopted by PNG Log Scaling Guideline is applied for log residues' carbon calculation. Since estimation of removed log volume can be done based on available measurements from stumps and other residues, carbon loss caused by felling is calculated based on volumes (including estimated log volume), wood density, and carbon fraction value, applying following equations.

$$\textbf{Stump carbon} = \{\pi(pi=3.141592)/40000 \times (\text{Stump Top Diameter}^2 + \text{Stump Top Diameter}/0.77510^2) \times \text{Stump height})\} \times WD \times (1+R) \times CF$$

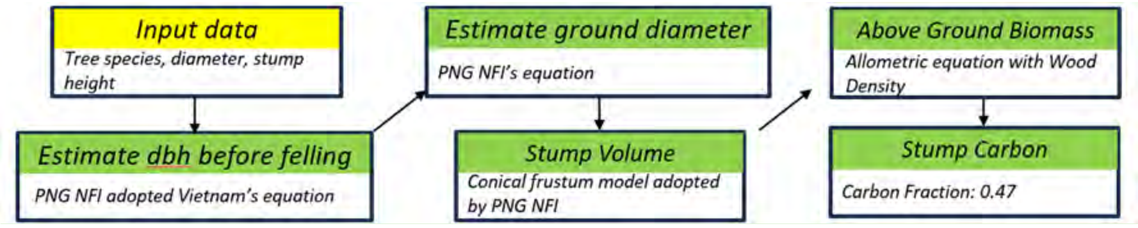

Figure 3-5: Process of Stump Carbon Calculation

$$\textbf{Log residue carbon} = \{\pi(pi=3.141592)/40000 \times (\text{average of Diameters})^2 \times \text{Log length}\} \times WD \times CF$$

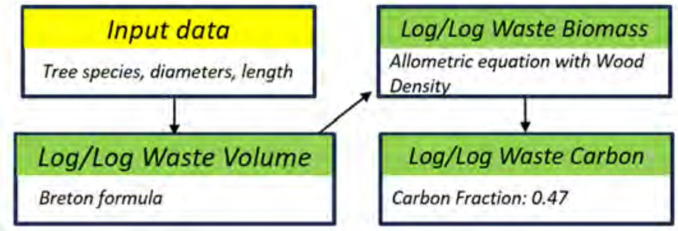

Figure 3-6: Process of Log Waste Carbon Calculation (same as log)

For collaterally damaged deadwood, both lying and standing, which was snapped below the first branch, the same equations will be applied for carbon loss calculations.

4. Preparation for the Carbon Calculation

4.1 Spreadsheet Preparation for Data Processing

Based on completed field record sheets, a spreadsheet for emission calculation needs to be prepared, utilizing the attached template. All the data on the record sheets shall be transferred to the spreadsheet. Data entry itself is not difficult task; however, following data processing or management is required for carbon calculations.

<Tree Species>

If the species name you enter does not match fully with NFI-registered species name, an error will pop up at the carbon calculation sheets as figure below. In such case, you need check the sheet titled “PNG WD List” and identify a proper registerred species name (for the case of Figure 4-1, tree species name should be “Pometia pinnata”, not “Pometia sp”).

Tree Species	Wood Density (t/m3)	DBH(cm)	Height(m)	AGB	AGB+BGB	Tree Carbon (tC)	Carbon Density per hectare
Neuburgia corynocarpa	0.46	22	20.77	0.254152	0.348188	0.163649	0.578789
Pometia sp	#N/A	13.8	20.77	#N/A	#N/A	#N/A	#N/A

Figure 4-1: Error caused by Tree Species Unmatch

No.	Scientific names	Codes	Wood densities
1	Acacia mangium	ACACI/MANGI	0.56
2	Aceratium ledermannii	ACERA2/LEDER	0.477
3	Aceratium pittosporoides	ACERA2/PITTO	0.477
4	Acronychia pedunculata	ACRON/PEDUN	0.477
5	Adinandra forbesii	ADINA/FORBE	0.477
6	Aglaia cucullata	AGLAI/CUCUL	0.735
7	Aglaia sapindina	AGLAI/SAPIN	0.735
8	Ailanthus integrifolia	AILAN/INTEG	0.32
9	Alseodaphne archboldiana	ALSEO/ARCHB	0.49
10	Alstonia scholaris	ALSTO/SCHOL	0.264
11	Alstonia spectabilis	ALSTO/SPECT	0.61
12	Anacolosa papuana	ANACO/PAPUA	0.477
[illegible]	[illegible]	[illegible]	[illegible]

Figure 4-2: List of PNG Tree Species

<Tree Height Estimation>

Tree hight measurement is challenging particularly in undamaged or regenerated natural forests due to many disturbance for lazer finder/Vertex. In case of NFI methodology adopted by PNGFA, the height of every five (5) trees will be measured in addition to all trees above 40 cm diameter at breast height (DBH). Since the field carbon monitoring requires accurate volume of trees, hight measurement at Natural Vegetation Plot needs to be carried out every four (4) trees, in addition to all trees above 40cm DBH. For unmeasured tree height, NFI-adopted Näslund (1937) height model will be adopted to estimate their heights based on measured heights and DBHs, applying following equation.

Näslund (1937) model

$$h = 1.3 + \frac{dbh^2}{(a + b * dbh)^2}$$

where h = estimated top height [m], dbh = breast height diameter [cm], a, b = parameters.

In excel sheet, this equation can be transformed as follows.

*h = (1.3 + a * DBH) / (1 + b * DBH)*

Based on this equation, the parameters *"a"* and *"b"* will be obtained from available tree heights and DBHs, utilizing excel function of "Solver" (analyze function) in the tab of "Data" (Please see the below figure, at the right end, you can find the solver function).

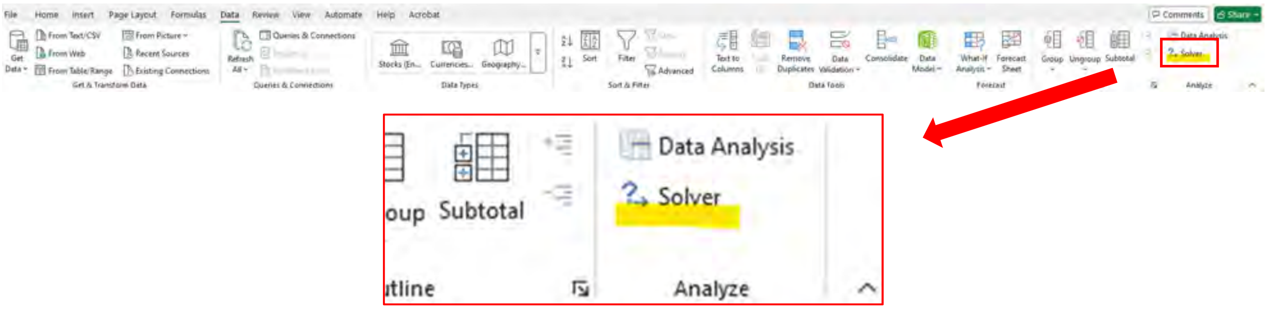

Figure 4-3: Solver function for Näslund (1937) height model estimation

In case that you cannot find "solver" in the Data tab, you can add-in from the option through following steps:

1) After openning Excel, go to the **"File"** tab and Select **"Options"**
2) Open the **"Excel Options dialog box"**, and click on **Add-ins**;
3) At the bottom of the Add-ins section, you'll see a **Manage** box.
4) Make sure **"Excel Add-ins"** is selected and click Go;
5) In the Add-Ins dialog box, <u>check the box next to **Solver Add-in**</u> and click OK.

In the excel sheet, you can extract tree measurement data of both height and DBH for this estimation (for instance you can create a table next to the main record sheet format like below figure).

Setup (SS)	Strip Line (SL#-L/R)	SL Tree ID (SLT#)	Species	DBH (cm)	Height (m) (distance to tree & angle to top)
		SLT1	Cryptocarya (Cryptocaria) sp	22.2	
		SLT2	Tristiropsis sp	21.1	
		SLT3	Pangium edule	40.2	28.50
		SLT4	Canarium indicum	39.7	
		SLT5	Pometia pinnata	60	26.60
		SLT6	Myristica sp	24.1	
		SLT7	Myristica sp	22.9	
		SLT8	Palaquium warburgianum	17.9	12.00
		SLT9	Dysoxylum (Dysoxyllum) sp	20.7	
		SLT10	Terminalia sp	26	
		SLT11	Dendrocnide sp	12.2	
		SLT12	Litsea sp	20	
		SLT13	Cryptocarya (Cryptocaria) sp	13.2	
		SLT14	Canarium oleosum	19.8	16.50
		SLT15	Myristica sp	24.2	
		SLT16	Pimeleodendron amboinicum	51.2	22.30
		SLT17	Terminalia sp	15.4	

	Para A	Para B
	1	0.01
TreeID	DBH	Height
SLT3	40.2	28.5
SLT5	60	26.6
SLT8	17.9	12
SLT14	19.8	16.5
SLT18	31	16.4
SLT22	21.5	18.8
SLT23	47.5	29.2
SLT27	30.3	20.1
SLT28	60	28.7
SLT32	20.3	25.6
SLT34	55.3	26.5
SLT37	19.2	14.3
SLT38	50	20.2
SLT41	24.1	21.9
SLT43	65	30
SLT44	45	26.2

Figure 4-4: Separate Table for Tree Height Estimation

Then, you can insert the Näslund equation to respective trees in the column titled “Calculation”, in order to estimate the heights, while you can also create another column titled “Error” for calculating difference between actual measured heights and Näslund tree height model estimations. For parameters, you can put 1 for “a” and 0.01 for “b” for calculation convenience. In order to explore best value for parameters which make these differences minimized, you can create a column titled “Sum” to calculate the sum of “Errors”. Please see the below figure for further details.

	H	I	J	K	L	M
3		Para A	Para B			
4		1	0.01			
5	TreeID	DBH	Height	Calculation	Error	Sum
6	SLT3	40.2	28.5	=(1.3+$I$4*I6)/(1+$J$4*I6)	=(J6-K6)^2	=SUM(L6:L27)
7	SLT5	60	26.6	=(1.3+$I$4*I7)/(1+$J$4*I7)	=(J7-K7)^2	
8	SLT8	17.9	12	=(1.3+$I$4*I8)/(1+$J$4*I8)	=(J8-K8)^2	
9	SLT14	19.8	16.5	=(1.3+$I$4*I9)/(1+$J$4*I9)	=(J9-K9)^2	
10	SLT18	31	16.4	=(1.3+$I$4*I10)/(1+$J$4*I10)	=(J10-K10)^2	
11	SLT22	21.5	18.8	=(1.3+$I$4*I11)/(1+$J$4*I11)	=(J11-K11)^2	
12	SLT23	47.5	29.2	=(1.3+$I$4*I12)/(1+$J$4*I12)	=(J12-K12)^2	
13	SLT27	30.3	20.1	=(1.3+$I$4*I13)/(1+$J$4*I13)	=(J13-K13)^2	
14	SLT28	60	28.7	=(1.3+$I$4*I14)/(1+$J$4*I14)	=(J14-K14)^2	
15	SLT32	20.3	25.6	=(1.3+$I$4*I15)/(1+$J$4*I15)	=(J15-K15)^2	
16	SLT34	55.3	26.5	=(1.3+$I$4*I16)/(1+$J$4*I16)	=(J16-K16)^2	
17	SLT37	19.2	14.3	=(1.3+$I$4*I17)/(1+$J$4*I17)	=(J17-K17)^2	
18	SLT38	50	20.2	=(1.3+$I$4*I18)/(1+$J$4*I18)	=(J18-K18)^2	
19	SLT41	24.1	21.9	=(1.3+$I$4*I19)/(1+$J$4*I19)	=(J19-K19)^2	
20	SLT43	65	30	=(1.3+$I$4*I20)/(1+$J$4*I20)	=(J20-K20)^2	
21	SLT44	45	26.2	=(1.3+$I$4*I21)/(1+$J$4*I21)	=(J21-K21)^2	
22	SLT49	29.2	17.2	=(1.3+$I$4*I22)/(1+$J$4*I22)	=(J22-K22)^2	
23	SLT52	15.3	10.4	=(1.3+$I$4*I23)/(1+$J$4*I23)	=(J23-K23)^2	
24	SLT56	58.9	27.8	=(1.3+$I$4*I24)/(1+$J$4*I24)	=(J24-K24)^2	
25	SLT61	12.4	13	=(1.3+$I$4*I25)/(1+$J$4*I25)	=(J25-K25)^2	
26	SLT66	54.5	32.8	=(1.3+$I$4*I26)/(1+$J$4*I26)	=(J26-K26)^2	
27	SLT67	51	32.8	=(1.3+$I$4*I27)/(1+$J$4*I27)	=(J27-K27)^2	
28	SLT69	53.9	32	=(1.3+$I$4*I28)/(1+$J$4*I28)	=(J28-K28)^2	

Figure 4-5: Tree Height Model Calculation Table

Once calculation table is ready, you can start estimation utilizing "Solver". Once you click the solver of the Data tab, "Solver Parameters" will pop up. Then, you can make set-ups for estimation as below (please see the figure for details).

1) For "**Set Objective**", select **the cell of "SUM"** on the excel sheet and also "**Min**" for calculating the minimum value of the sum.
2) Select **the cell of Parameter "a" and "b" as "Changing Variable Cells"**.
3) For solving method, **"GRG nonliner method"** should be selected as **"Solving Method"**.
4) Once you complete the setups, click **"Solve"** for start calculation.

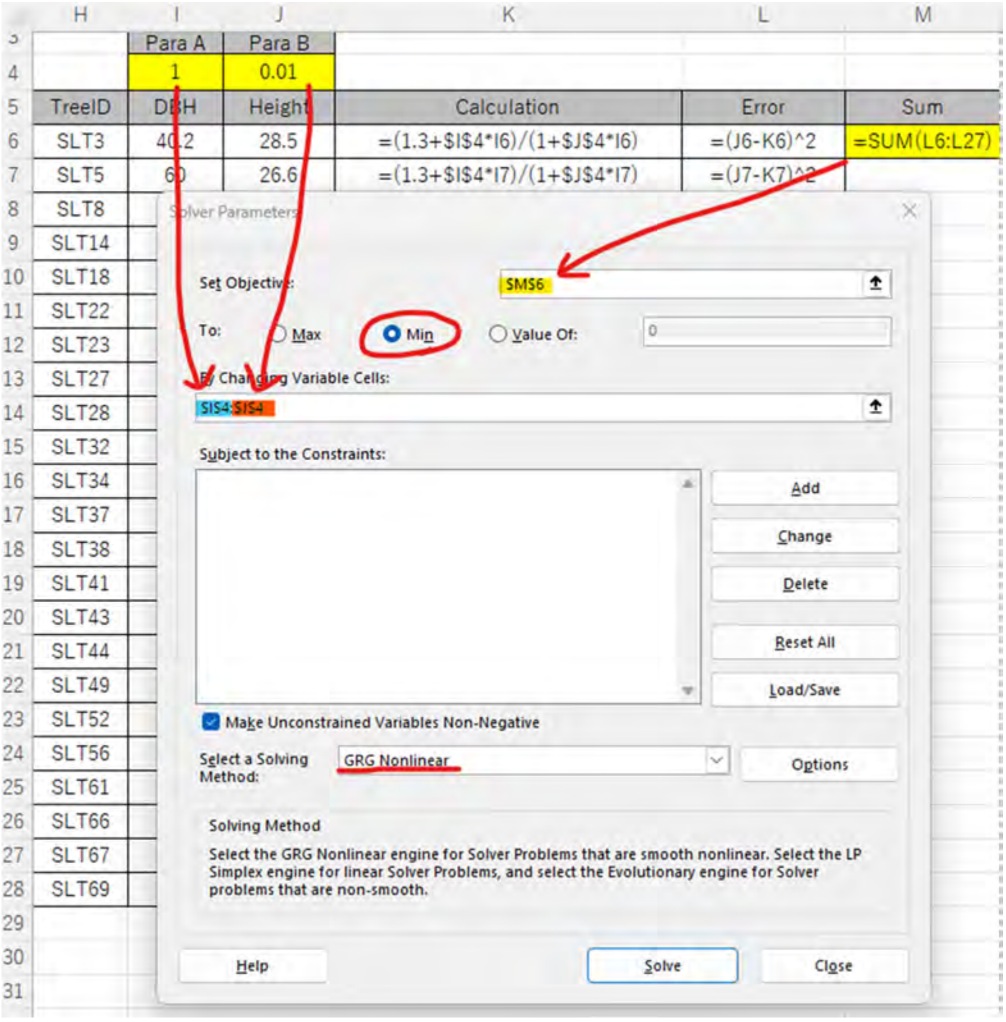

Figure 4-6: Solver Setting

If calculation works well based on the above setting, “Solver Results” window will pop up and a message of successful completion “Solver has converged to the current solution. All contraints are satisfied” will be shown up on the window. In case some errors occur, different messgae will be coming up, thus see the settings of Solver again as described in the Figure 4-7.

Once the best values for Parameter *“a”* and *“b”* are set by the Solver, Näslund equation will be applied for unmeasured tree heights for height estimation as figure below.

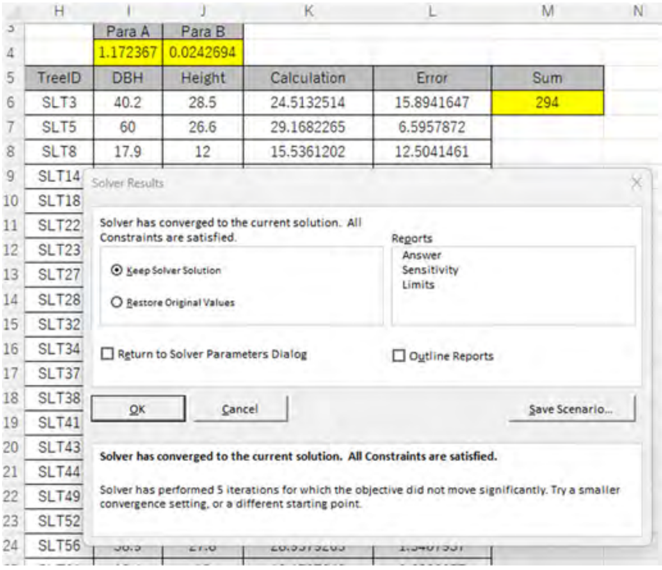

Figure 4-7: Successful Completion of Solver Function

	C	D	E	G	H	I	J
3						Para A	Para B
4	SL Tree ID (SLT#)	Species	DBH (cm)	Height (m) (distance to tree & angle to top)		1	0.01
5	SLT1	Cryptocarya (Cryptocaria) sp	22.2	=(1.3+$I$4*E5)/(1+$J$4*E5)	TreeID	DBH	Height
6	SLT2	Tristiropsis sp	21.1	=(1.3+$I$4*E6)/(1+$J$4*E6)	SLT3	40.2	28.5
7	SLT3	Pangium edule	40.2	28.5	SLT5	60	26.6
8	SLT4	Canarium indicum	39.7	=(1.3+$I$4*E8)/(1+$J$4*E8)	SLT8	17.9	12
9	SLT5	Pometia pinnata	60	26.6	SLT14	19.8	16.5
10	SLT6	Myristica sp	24.1	=(1.3+$I$4*E10)/(1+$J$4*E10)	SLT18	31	16.4
11	SLT7	Myristica sp	22.9	=(1.3+$I$4*E11)/(1+$J$4*E11)	SLT22	21.5	18.8
12	SLT8	Palaquium warburgianum	17.9	12	SLT23	47.5	29.2
13	SLT9	Dysoxylum (Dysoxyllum) sp	20.7	=(1.3+$I$4*E13)/(1+$J$4*E13)	SLT27	30.3	20.1
14	SLT10	Terminalia sp	26	=(1.3+$I$4*E14)/(1+$J$4*E14)	SLT28	60	28.7
15	SLT11	Dendrocnide sp	12.2	=(1.3+$I$4*E15)/(1+$J$4*E15)	SLT32	20.3	25.6
16	SLT12	Litsea sp	20	17.75	SLT34	55.3	26.5
17	SLT13	Cryptocarya (Cryptocaria) sp	13.2	=(1.3+$I$4*E17)/(1+$J$4*E17)	SLT37	19.2	14.3
18	SLT14	Canarium oleosum	19.8	16.5	SLT38	50	20.2
19	SLT15	Myristica sp	24.2	=(1.3+$I$4*E19)/(1+$J$4*E19)	SLT41	24.1	21.9
20	SLT16	Pimeleodendron amboinicum	51.2	22.3	SLT43	65	30
21	SLT17	Terminalia sp	15.4	=(1.3+$I$4*E21)/(1+$J$4*E21)	SLT44	45	26.2
22	SLT18	Ficus sp	31	16.4	SLT49	29.2	17.2
23	SLT19	Ficus sp	10.1	=(1.3+$I$4*E23)/(1+$J$4*E23)	SLT52	15.3	10.4
24	SLT20	Terminalia sp	13.8	=(1.3+$I$4*E24)/(1+$J$4*E24)	SLT56	58.9	27.8

Figure 4-8: Tree Height Estimation

5. Steps for Carbon Emission Calculation

5.1 Steps for calculations

The following is the simplified steps for carbon emission calculation, which comprised of two stages: 1) Infrastructure Scale and Carbon Calculation, and 2) Emission Factor Calculation. These steps will give you a clear view on entire flow of calculations.

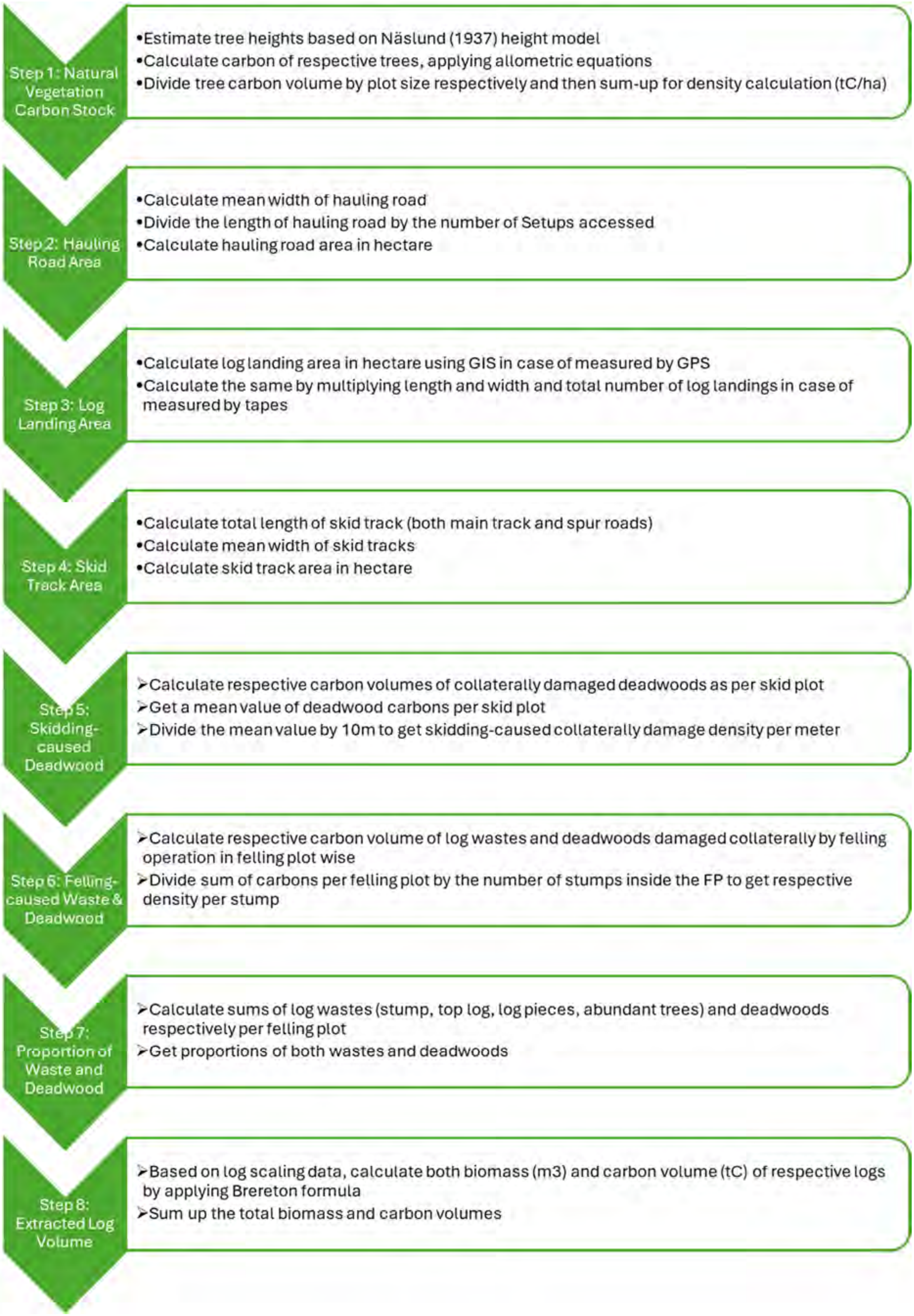

Figure 5-1: Steps for Infrastructure Scale and Carbon Calculation (Stage 1)

Figure 5-2: Steps for Emission Factor Calculation (Stage 2)

6. Step-wise Procedure for Carbon Emission Calculation

<STAGE 1>

6.1 Step 1: Natural Vegetation Carbon Stock Density

Applying the abovementioned allometric equation for tree carbon, tree carbon density will be calculated based on field data collected at the Natural Vegetation Plot. As a trip-line based rectangular survey plots with 1000m^2 (10cm≤DBH<20cm), 2000m^2 (20cm≤DBH<50cm) and 3000m^2 (50cm≤DBH) to be adopted, carbon density per hectare will be calculated through dividing respective tree carbon by each DBH-size class plot size. The actual calculation process requires three actions, as described below:

1) Field measurement data entry

You should enter all the field measurement data collected at Natural Vegetation Plot to the excel spreadsheet of the natural vegetation plot record sheet format, as below. Once you enter all of the data, you should double check if all the respective tree species names will match with NFI-registered names, while tree heights also need to be estimated based on the height model (please refer to above subsection 4.1 for the details).

Setup (SS)	Strip Line (SL#-L/R)	SL Tree ID (SLT#)	Species	DBH (cm)	Height (m) (distance to tree & angle to top)
		SLT1	Cryptocarya (Cryptocaria) sp	22.2	17.76
		SLT2	Tristiropsis sp	21.1	17.22
		SLT3	Pangium edule	40.2	28.50
		SLT4	Canarium indicum	39.7	24.37
		SLT5	Pometia pinnata	60	26.60
		SLT6	Myristica sp	24.1	18.65
		SLT7	Myristica sp	22.9	18.09
		SLT8	Palaquium warburgianum	17.9	12.00
		SLT9	Dysoxylum (Dysoxyllum) sp	20.7	17.02
		SLT10	Terminalia sp	26	19.49
		SLT11	Dendrocnide sp	12.2	12.04
		SLT12	Litsea sp	20	16.66
		SLT13	Cryptocarya (Cryptocaria) sp	13.2	12.71
		SLT14	Canarium oleosum	19.8	16.50

Figure 6-1: Natural Vegatation Plot Data Entry

2) Tree carbon density calculation

Entered field measurement data will be shown up on the Natural Vegetation Carbon Calculation Sheet. As shown in the table of calculation sheet below, the allometric equation developed by Chave et al. (2014) is applied in order to calculate tree biomass in column G. Then, the value of IPCC-defined root ratio (1+0.37=1.37) is applied in column H, in order to calculate total tree biomass including below-ground biomass. The same value of total tree biomass will be converted to tree carbon in column I, by application of the default value for carbon fraction (0.47) provided by IPCC guidelines (2006). In order to calculate tree-wise values of carbon stock density per hectare, the respective tree carbon will be divided by each DBH-size class plot size (1000m^2 for trees of 10cm≤DBH<20cm, 2000m^2 for 20cm≤DBH<50cm, and 3000m^2 for 50cm≤DBH), as indicated in column J.

	A	B	C	D	E	F	G	H	I	J
1								Cell: H2 ↓		Cell: J2 ↓
2		**Natural Vegetation and Carbon Calculation**					Carbon Fraction	0.47	1+Root Ratio	1.37
3		Chave et al 2014 Allometric Equation applied					Conversion Factor	3.67		
4		Tree ID	Tree Species	Wood Density (t/m3)	DBH(cm)	Height(m)	AGB	Tree Biomass (AGB+BGB)	Tree Carbon (tC)	**Carbon Density per hectare**
5		SLT1	Cryptocarya (Cryptocaria) sp	0.465	22.2	17.76	=0.0000673*(D5*E5^2*F5)^0.976	=G5*$J$2	=H5*$H$2	=I5*10000/2000
6		SLT2	Tristiropsis sp	0.56	21.1	17.22	=0.0000673*(D6*E6^2*F6)^0.976	=G6*$J$2	=H6*$H$2	=I6*10000/2000
7		SLT3	Pangium edule	0.552	40.2	28.50	=0.0000673*(D7*E7^2*F7)^0.976	=G7*$J$2	=H7*$H$2	=I7*10000/2000
8		SLT4	Canarium indicum	0.48	39.7	24.37	=0.0000673*(D8*E8^2*F8)^0.976	=G8*$J$2	=H8*$H$2	=I8*10000/2000
9		SLT5	Pometia pinnata	0.593	60	26.60	=0.0000673*(D9*E9^2*F9)^0.976	=G9*$J$2	=H9*$H$2	=I9*10000/3000
10		SLT6	Myristica sp	0.385	24.1	18.65	=0.0000673*(D10*E10^2*F10)^0.976	=G10*$J$2	=H10*$H$2	=I10*10000/2000
11		SLT7	Myristica sp	0.385	22.9	18.09	=0.0000673*(D11*E11^2*F11)^0.976	=G11*$J$2	=H11*$H$2	=I11*10000/2000
12		SLT8	Palaquium warburgianum	0.34	17.9	12.00	=0.0000673*(D12*E12^2*F12)^0.976	=G12*$J$2	=H12*$H$2	=I12*10000/1000
13		SLT9	Dysoxylum (Dysoxyllum) sp	0.62	20.7	17.02	=0.0000673*(D13*E13^2*F13)^0.976	=G13*$J$2	=H13*$H$2	=I13*10000/2000
14		SLT10	Terminalia sp	0.515	26	19.49	=0.0000673*(D14*E14^2*F14)^0.976	=G14*$J$2	=H14*$H$2	=I14*10000/2000
15		SLT11	Dendrocnide sp	0.477	12.2	12.04	=0.0000673*(D15*E15^2*F15)^0.976	=G15*$J$2	=H15*$H$2	=I15*10000/1000
16		SLT12	Litsea sp	0.4	20	16.66	=0.0000673*(D16*E16^2*F16)^0.976	=G16*$J$2	=H16*$H$2	=I16*10000/2000
17		SLT13	Cryptocarya (Cryptocaria) sp	0.465	13.2	12.71	=0.0000673*(D17*E17^2*F17)^0.976	=G17*$J$2	=H17*$H$2	=I17*10000/1000
18		SLT14	Canarium oleosum	0.414	19.8	16.50	=0.0000673*(D18*E18^2*F18)^0.976	=G18*$J$2	=H18*$H$2	=I18*10000/1000
19		SLT15	Myristica sp	0.385	24.2	18.69	=0.0000673*(D19*E19^2*F19)^0.976	=G19*$J$2	=H19*$H$2	=I19*10000/2000
20		SLT16	Pimeleodendron amboinicum	0.57	51.2	22.30	=0.0000673*(D20*E20^2*F20)^0.976	=G20*$J$2	=H20*$H$2	=I20*10000/3000
21		SLT17	Terminalia sp	0.515	15.4	14.09	=0.0000673*(D21*E21^2*F21)^0.976	=G21*$J$2	=H21*$H$2	=I21*10000/1000
22		SLT18	Ficus sp	0.345	31	16.40	=0.0000673*(D22*E22^2*F22)^0.976	=G22*$J$2	=H22*$H$2	=I22*10000/2000
23		SLT19	Ficus sp	0.345	10.1	10.55	=0.0000673*(D23*E23^2*F23)^0.976	=G23*$J$2	=H23*$H$2	=I23*10000/1000
24		SLT20	Terminalia sp	0.515	13.8	13.09	=0.0000673*(D24*E24^2*F24)^0.976	=G24*$J$2	=H24*$H$2	=I24*10000/1000
25		SLT21	Litsea sp	0.4	13.2	12.71	=0.0000673*(D25*E25^2*F25)^0.976	=G25*$J$2	=H25*$H$2	=I25*10000/1000
26		SLT22	Celtis latifolia	0.5	21.5	18.80	=0.0000673*(D26*E26^2*F26)^0.976	=G26*$J$2	=H26*$H$2	=I26*10000/2000
27		SLT23	Palaquium warburgianum	0.34	47.5	29.20	=0.0000673*(D27*E27^2*F27)^0.976	=G27*$J$2	=H27*$H$2	=I27*10000/2000

Figure 6-2: Natural Vegetation Carbon Stock Density Calculation

3) Total carbon stock density calculation

Once carbon density calculation is done, you can sum up the value to get a total carbon stock density. Since the inventory survey at Natural Vegetation Plot focuses only on trees above 10cm DBH, five percent (5%) of total carbon density should be allocated for trees below 10cm DBH. As an output, you can create a summary table of total value of Natural Vegetation Carbon Stock Density, like below.

DBH Class	Number of Trees measured	Natural Vegetation Carbon Stock Density (tC/ha)
DBH<10	N/A	5.72 *(5% of total carbon density was considered)*
10≤DBH<20	26	14.19
20≤DBH<50	36	47.18
50≤DBH	10	53.13
TOTAL	72	**126.23**

Figure 6-3: Summary Table

6.2 Step 2: Hauling Road Area

Next step is a calculation of hauling road area from field measurement data. You can enter the field data of road (widths and lengths, as well as the number of setups where the sample road provides access) to the excel spreadsheet of hauling road, as below, to get values of average road width and length.

Coupe	Setups served by the sampled road	Road Length (RL)	Length (m)	Width (RW)	Width (m)
	6	RL1	3210	RL1-RW1	40
				RL1-RW2	33
				RL1-RW3	31
				RL1-RW4	28

Figure 6-4: Hauling Road Data Entry

Simply by multiplying mean values of road length and width, you can get estimated hauling road area per setup in hectare. As example, you can create a calculation table as below, creating links with data entry sheet.

Nb of serviced setups	Sampled road lengths (m)	Av road Length per setup (m)	Road width 1 (m)	Road width 2 (m)	Road width 3 (m)	Road width 4 (m)	Av road Width (m)	Estimated road area per setup (ha)
6	3210	535	40	33	31	28	33	1.7655
5	3000	600	18	20	12	21	17.75	1.065

Figrue 6-5: Hauling Road Area Calculation

6.3 Step 3: Log Landing Area

For log landings, during the field data collection, the survey team confirms the number of log landings at sampled setups, while also measuring their sizes. You can enter the field data to the spreadsheet for calculations. Then, total log landing area can be calculated.

Coupe (C)	Sampled Setup (SS)	Log Landing ID (LL)	Log Landing Width (m)	Log Landing Length (m)
	2	LL1	34.7	50.2
		LL2	35	23

Figure 6-6 Log Landing Data Entry

Sampled Setups	Areas of Log Landing 1	Areas of Log Landing 2	Total Log Landing areas (ha)
2	0.1742	0.143	0.3172

Figure 6-7: Log Landing Area Calculation

6.4 Step 4: Skid Track Area

Same as hauling road, skid track area can be calculated based on total length and mean width. First, you can enter the data of total length, measured through walking, and widths, measured at respective Skid Plots, on each record sheet.

Setup (SS)	Skid Track Network ID	Main/ Branch	Skid Track (T)	Track length (m)
2	STN1	Main	T1	577
		Branch	T1	671
2	STN3	Main	T3	427
		Branch	T3	237

Setup (SS)	Skid Track (T)	Skid plot (SP)	Skid Track Width (TW)	Short Width btw track edges (m)
2	T3	SP1	TW1	4.1
			TW2	4.1
2	T3	SP2	TW1	4.5
			TW2	4.1
2	T3	SP3	TW1	4.2
			TW2	4.3
2	T3	SP4	TW1	3.8
			TW2	3.9
2	T1	SP1	TW1	4
			TW2	3.4
2	T1	SP2	TW1	3.1
			TW2	3.1
2	T1	SP3	TW1	3.6
			TW2	4.3
2	T1	SP4	TW1	5.5
			TW2	3.9

Figure 6-8: Skid Track Data Entry

In case that the field survey team cannot take measurements of some skid tracks (in above figure case, track 1 and 3 are measured but track 2 is skipped), mean length of both main and branches, calculated based on available measurement data, will be applied as follows, and the total length will be calculated.

	Track ID	Main	Branch	Total
Setup 2	1	577	671	1248
	Average: 2	502	454	956
	3	427	237	664
	Total	1506	1362	2868

Figure 6-9: Estimation of Unmeasured Skid Track Length and Total Length

Meanwhile, you can calculate mean skid track width, and then the total skid track area will be calcuated in hectare, as figures below.

Skid Track	Skid plot	Width 1 (m)	Width 2 (m)	Mean Width (m)
STN1	SP1	3.3	3.2	3.25
STN1	SP2	5.1	4.8	4.95
STN1	SP3	7	8.3	7.65
STN2	SP4	4.8	3.53	4.17
STN2	SP5	6	5.3	5.65
STN2	SP6	5.8	5.9	5.85
			Mean Width (m)	5.25

Figure 6-10: Mean Skid Track Width

ST Length	ST Width	Total Skid Track Area (ha)
1257.5	5.25	0.66

Figure 6-11: Total Skid Track Area

6.5 Step 5: Skidding-caused Collateral Damage (Deadwood)

At Skid Plots, measurements of fresh deadwoods, which were snapped below first branch (standing deadwood) or uprooted (lying deadwood) due to skidding operation, will be taken. Based on measurement data, carbon loss density per meter will be calculated, following the below calculation steps.

1) Collaterally damaged deadwood data entry

You can enter all the field measurement data of deadwoods collected at Skid Plots to a spreadsheet of the skid plot record sheet format, as below. Please double check if all the respective tree species names match with NFI-registered species names.

Skid Track (T)	Skid plot (SP)	Collaterally Damaged Tree ID (SCD#)	Form: Lying (L) / Standing(S)	Species	Length/ Height (m)	DBH (≥20cm) /D1	D2	D 3	D4
T1	SP1	SCD1	Lying	Horsfieldia sp	4.3	22.8			
T1	SP1	SCD2	Lying	Horsfieldia sp	8	30			
T1	SP2	SCD3	Lying	Terminalia sp	3.8	22			
T1	SP3	SCD4	Lying	Endospermum (Endospernum) sp	1.5	26			
T1	SP3	SCD5	Lying	Endospermum (Endospernum) sp	2.1	23.5			
T1	SP3	SCD6	Standing	Pterocarpus indicus	3.5	25.8			
T2	SP4	SCD1	Lying	Cryptocarya (Cryptocaria) sp	4	20.2			

Figure 6-12: Skid Plot Data Entry

2) Collaterally damage carbon loss calculation

Same as Natural Vegetation Plot case, you can create a table linking skid plot record sheet format with carbon calculation spreadsheet, so that the same entered field data will be shown up on it for actual calculation. For respective deadwood carbon calculation, Brereton formula will be applied for volume calculation (column N), then multiplying respective wood density (column O) to get above-ground biomass (AGB). Considering biomass volume in the root system (below-ground biomass: BGB), once the volume is converted to AGB, the value of IPCC-defined root ratio (1.37) is applied to make it total tree biomass (AGB+BGB) in column P. After biomass calculation, biomass can be converted to carbon, applying IPCC's carbon fraction of 0.47 (column Q).

	A	B	C	D	E	F	K	N	O	P	Q
1		Collateral damage impact at skid plot			Pi=	3.14159	Carbon Fraction	0.47	1+Root Ratio	1.37	
2							Conversion Facto	3.67			
3		SP	Form:Lying (L) / Standing(S)	Tree Species	Wood Density	Length/ Height (m)	D-AVG	Volume	AGB	AGB+BGB	Carbon
4		SP1	Lying	Horsfieldia sp	0.36	4.3	22.8	=$F$1/40000*K4^2*F4	=N4*E4	=O4*$P$1	=P4*$N$1
5		SP1	Lying	Horsfieldia sp	0.36	8	30	=$F$1/40000*K5^2*F5	=N5*E5	=O5*$P$1	=P5*$N$1
6		SP2	Lying	Terminalia sp	0.515	3.8	22	=$F$1/40000*K6^2*F6	=N6*E6	=O6*$P$1	=P6*$N$1
7		SP3	Lying	Endospermum (Endospernum) sp	0.385	1.5	26	=$F$1/40000*K7^2*F7	=N7*E7	=O7*$P$1	=P7*$N$1
8		SP3	Lying	Endospermum (Endospernum) sp	0.385	2.1	23.5	=$F$1/40000*K8^2*F8	=N8*E8	=O8*$P$1	=P8*$N$1
9		SP3	Standing	Pterocarpus indicus	0.497	3.5	25.8	=$F$1/40000*K9^2*F9	=N9*E9	=O9*$P$1	=P9*$N$1
10		SP4	Lying	Cryptocarya (Cryptocaria) sp	0.465	4	20.2	=$F$1/40000*K10^2*F10	=N10*E10	=O10*$P$1	=P10*$N$1
11		SP4	Lying	Pometia pinnata	0.593	8.6	25.2	=$F$1/40000*K11^2*F11	=N11*E11	=O11*$P$1	=P11*$N$1
12		SP5	Lying	Cryptocarya (Cryptocaria) sp	0.465	3.9	27	=$F$1/40000*K12^2*F12	=N12*E12	=O12*$P$1	=P12*$N$1
13		SP5	Lying	Pometia pinnata	0.593	7.4	29.8	=$F$1/40000*K13^2*F13	=N13*E13	=O13*$P$1	=P13*$N$1
14		SP5	Lying	Pometia pinnata	0.593	3	22.5	=$F$1/40000*K14^2*F14	=N14*E14	=O14*$P$1	=P14*$N$1

Figure 6-13: Collateral Damage Carbon Loss Calculation

3) Collateral Damage Impact Density

Once the carbon calculation is completed, the carbon volume of respective deadwoods will be summed up as per Skid Plot, to get plot-wise impact. Then, it can be divided by length of Skid Plot (10m), in order to obtain the Skidding-caused Collateral Damage Impact Density per meter.

-	SP1	SP2	SP3	SP4	SP5
Skid Plot wise Carbon loss caused by Collateral Damages	0.172	0.048	0.101	0.202	0.309
Mean Collateral Damage Impact Density per Skid Plot	**0.166**				
Skidding-caused Collateral Damage Impact Density per meter (tC/m)	**0.0166**				

Figure 6-14: Collateral Damage Impact Density

6.6 Step 6: Felling-caused Damage (Log Waste and Deadwood)

Same as Step 5, felling-caused impact will be calculated based on measurement data of log wastes and deadwoods found in Felling Plots.

1) Data entry of log wastes and deadwoods

You can enter all the field measurement data collected at Felling Plots to a spreadsheet of the felling plot record sheet format, as below, while making sure that all the respective tree species names match with NFI-registered species names.

Skid Track (T#)	Fell plot (FP#)	Tree ID (TR#)	Type: 1)Abondoned Tree:AT 2) Removed Log: RL 3) Remaining Top Log: RTP, 4) Stump: STP, 5) Remaining Log Piece: RLP, 5) Coll Damaged Deadwood: CDD)	Form of Deadwood: Lying (L) / Standing(S)	Species	Length/ Height/ Distance+ Angle	DBH/ D1	D2	D3	D4
T1	FP1	TR1	Stump	Standing	Campnosperma sp	1.57	90	70		
T1	FP1	TR1	Removed Log		Campnosperma sp	14.3	92	82	56	56
T1	FP1	TR1	Remaining Log Pieces	Lying	Campnosperma sp	11.3	56	56		
T1	FP1	TR1	Remaining Top Log	Lying	Campnosperma sp	3.9	32	48		
T1	FP1	TR1	Removed Log	Lying	Campnosperma sp	9.6	56	56	32	48
T1	FP1	TR2	Coll. Damaged Deadwood	Lying	Myristica sp	2.4	22.3			
T1	FP1	TR3	Coll. Damaged Deadwood	Lying	Pometia pinnata	7.1	25.5			
T1	FP1	TR1	Remaining Log Pieces	Lying	Campnosperma sp	3.6	27.4			
T1	FP1	TR4	Coll. Damaged Deadwood	Standing	Celtis sp	2.3	58			

Figure 6-15: Log Waste and Deadwood Data Entry

2) Felling-caused Log Waste and Deadwood Carbon Calculation

You can create a table linking felling plot record sheet format with carbon calculation spreadsheet, so that the same entered field data will be shown up on on the spreadsheet for actual calculation. As defined in the section 4. “Theoretical Background: Equations and Calculations”, two different formulas will be applied for volume calculation (column M). Once you get volume values, you can multiply respective wood density (column O) to get above-ground biomass (AGB) in colum N. Only in case of stumps, the value of IPCC-defined root ratio (1.37) is applied to include below-ground biomass (in column O). After biomass calculation, biomass can be converted to carbon, applying IPCC's carbon fraction of 0.47 (column Q).

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**Felling-caused Carbon Loss**				Pi=	3.14159	Carbon Fraction		0.47		1+Root Ratio	1.370000			
2							Conversion Factor		3.67						
3	Felling Plot ID	Types	Form	Species	Wood Density	Length/ Height	DBH/D1	D2	D3	D4	D-AVG	Volume	AGB	AGB+BGB	Carbon
4	FP1	Stump	Standing	Campnosperma sp	0.35	1.57	90	70	0	0	80.00	=$G$1/40000*(L4^2+(L4/0.77510)^2)*G4	=M4*F4	=**N4*SMS1**	=O4*$J$1
6	FP1	Remaining Log Pieces	Lying	Campnosperma sp	0.35	11.3	56	56	0	0	56.00	=$G$1/40000*L6^2*G6	=M6*F6		=N6*$J$1
7	FP1	Remaining Top Log	Lying	Campnosperma sp	0.35	3.9	32	48	0	0	40.00	=$G$1/40000*L7^2*G7	=M7*F7		=N7*$J$1
9	FP1	Coll. Damaged Deadwoo	Lying	Myristica sp	0.385	2.4	22.3	0	0	0	22.30	=$G$1/40000*L9^2*G9	=M9*F9		=N9*$J$1
10	FP1	Coll. Damaged Deadwoo	Lying	Pometia pinnata	0.593	7.1	25.5	0	0	0	25.50	=$G$1/40000*L10^2*G10	=M10*F10		=N10*$J$1
11	FP1	Remaining Log Pieces	Lying	Campnosperma sp	0.35	3.6	27.4	0	0	0	27.40	=$G$1/40000*L11^2*G11	=M11*F11		=N11*$J$1
12	FP1	Coll. Damaged Deadwoo	Standing	Celtis sp	0.64	2.3	58	0	0	0	58.00	=$G$1/40000*L12^2*G12	=M12*F12		=N12*$J$1
13	FP1	Remaining Log Pieces	0	MIS	0.57	6.5	23.5	0	0	0	23.50	=$G$1/40000*L13^2*G13	=M13*F13		=N13*$J$1
14	FP1	Coll. Damaged Deadwoo	Lying	MIS	0.57	5	21	0	0	0	21.00	=$G$1/40000*L14^2*G14	=M14*F14		=N14*$J$1
15	FP2	Stump	Standing	Pometia pinnata	0.593	0.87	70	68	0	0	69.00	=$G$1/40000*(L15^2+(L15/0.77510)^2)*G15	=M15*F15	=**N15*SMS1**	=O15*$J$1
17	FP2	Remaining Top Log	Lying	Pometia pinnata	0.593	1.25	57	0	0	0	57.00	=$G$1/40000*L17^2*G17	=M17*F17		=N17*$J$1
18	FP2	Remaining Log Pieces	Lying	Pometia pinnata	0.593	1.25	62	52	0	0	57.00	=$G$1/40000*L18^2*G18	=M18*F18		=N18*$J$1
19	FP2	Coll. Damaged Deadwoo	Lying	Carallia brachiata	0.66	15.7	23	0	0	0	23.00	=$G$1/40000*L19^2*G19	=M19*F19		=N19*$J$1
20	FP2	Stump	Standing	Pometia pinnata	0.593	0.98	66	60	0	0	63.00	=$G$1/40000*(L20^2+(L20/0.77510)^2)*G20	=M20*F20	=**N20*SMS1**	=O20*$J$1

Figure 6-16: Log Waste and Deadwood Carbon Calculation

3) Felling Impact Density per Stump

After respective carbon calculations, total carbon loss per Felling Plot will be calculated, and then divided by the number of stumps per Felling Plot, in order to estimate felling impact density per stump. Once plot-wise density is estimated, the meaning value of Felling Impact Density per stump can be obtained.

FP ID	Total Carbon Loss per FP (tC)	Number of Stump per FP	Felling Impact Density per stump (tC/stump)	Mean Felling Impact Density (tC/stump)
FP1	1.469993	1	1.46999	
FP2	1.472608	2	0.73630	
FP3	1.566055	3	0.52202	
FP4	0.379025	2	0.18951	
FP5	0.309074	1	0.30907	**0.78486**
FP6	0.996606	2	0.49830	
FP7	3.604391	2	1.80220	
FP8	1.502970	2	0.75148	

Figure 6-17: Plot-wise Density Calculation

6.7 Step 7: Proportion of Log Waste and Deadwood in Felling Impact

Utilizing the same spreadsheet of Step 6, the proportion of log wastes (stump, top log, log pieces, abandoned logs) and deadwoods in overall felling impact will be calculated, utilizing COUNTIF function, in order to see the breakdown of per-stump carbon loss volume as per differentiated sources. You can create a simple table like below to get proportions.

FP ID	Log Waste / Residues	Collateral damage / Deadwoods	Total Carbon Loss per FP (tC)
FP1	1.12279	0.34721	1.46999300
FP2	1.18162	0.29099	1.47260824
FP3	1.40488	0.16118	1.56605478
FP4	0.37902	0.00000	0.37902474
FP5	0.13781	0.17127	0.30907428
FP6	0.57536	0.42125	0.99660551
FP7	3.44319	0.16120	3.60439104
FP8	0.45792	1.04505	1.50296981
SUM	**8.70258**	**2.59814**	**11.30072141**
Proportion	***77%***	***23%***	***100%***

Figure 6-18: Proportion of Felling Impact

6.8 Step 8: Extracted Log Volume

Based on log scaling data obtained from logging company, calculatition both biomass (m3) and carbon volume (tC) of respective logs will be undertaken by applying Brereton formula. You can trasfer log scaling data to carbon calculation spreadsheet. Same as previous carbon calculation, calculated log volume will be converted to biomass by multipying wood density, and then to carbon by default value for carbon fraction. You can create a simple summary table about log volume and carbon.

Log Scaling Data_Log Carbon Volume Carbon Fraction 0.47

Brereton Formula based Carbon Calculation Conversion Fact 3.67 Pi= 3.14159

Log No	Species Acro	Tree Species	Wood Density (t/m3)	DBH(cm)	Length (m)	Volume	AGB	Log Carbon (tC)
0676501	TER	Terminalia sp	0.515	54	9.00	2.06	1.061517	0.498913
0676502	TAU	Pometia pinnata	0.593	64	10.70	3.44	2.041211	0.959369
0676503	TAU	Pometia pinnata	0.593	48	10.50	1.90	1.126720	0.529558
0676504	TRC	Pometia pinnata	0.593	67	10.80	3.81	2.257967	1.061244
0676505	TAU	Pometia pinnata	0.593	53	16.60	3.66	2.171721	1.020709
0676506	TAU	Pometia pinnata	0.593	55	14.60	3.47	2.056944	0.966764
0676507	TAU	Pometia pinnata	0.593	49	15.30	2.89	1.710912	0.804129
0676508	KIS	Pterocarpus indicus	0.497	66	19.20	6.57	3.264638	1.534380
0676509	TAU	Pometia pinnata	0.593	75	10.70	4.73	2.803177	1.317493
0676510	TAU	Pometia pinnata	0.593	69	11.00	4.11	2.439131	1.146391
0676511	TER	Terminalia sp	0.515	47	19.10	3.31	1.706577	0.802091
0676512	TAU	Pometia pinnata	0.593	55	14.40	3.42	2.028767	0.953520
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 6-19: Log Scaling Data and Carbon Calculation

Recorded number of logs tallied	Total Log Volume Estimated (m3)	Total Carbon Extracted at Setup level (tC)
73	246.32	**64.76**

Figure 6-20: Summary Table of Log Extraction

<STAGE 2>

All the required values for emission calculations are organized by the previous step 8. From here onwards, the focus of calculation is source-wise emission calculations, which are 1) Logging Infrastrcture Emission, 2) Logging Damage Emission, and 3) Log Extraction Emission. Please follow the steps below to get the final output of carbon calculation.

6.9 Step 9: Logging Infrastructure Emission (LIE)

As indicated in the table below, LIE is comprised of three emissions from infrastructure development (hauling road, log landings, skid track). You can sum up all carbon losses caused by those three and then convert the tC to tCO2e by multiplying IPCC's default factor 3.67.

Emission Factor		Required Values
Logging Infrastructure Emission	Forest Clearance for Hauling Road	Total Hauling Road Area (ha)
		Natural Vegetation Carbon Stock Density (tC/ha)
	Forest Clearance for Log Landing	Total Log Landing Area (ha)
		Natural Vegetation Carbon Stock Density (tC/ha)
	Forest Clearance for Skid Track	Total Skid Track Area (ha)
		Natural Vegetation Carbon Stock Density (tC/ha)

Figure 6-21: Required Values for LIE's Emission Calculation

1) Forest Clearance for Hauling Road

For hauling road, you can simply multiply Hauling Road Area (ha) and Natural Vegetation Carbon Stock Density (tC/ha).

Sampled setups	Hauling Road Area (ha)	Carbon density	Carbon Loss by Hauling Road
6	1.065	115.26	122.7518662

Figure 6-22: Carbon Loss by Hauling Road

2) Forest Clearance for Log Landings

Same as hauling road, carbon loss by log landing can be calculated by multipying log landing area (ha) and Carbon Stock Density (tC/ha).

Log landing area per setup (ha)	Natural Vegetation Carbon Stock Density (tC/ha)	Carbon Loss caused by Log Landing (tC)
0.20	126.23	**25.33**

Figure 6-23: Carbon Loss by Log Landings

3) Forest Clearance for Skid Track

The carbon loss caused by forest clearance due to skid track construction can be estimated by multipying skid track area (ha) and Carbon Stock Density (tC/ha).

Estimated Skid Track Area (ha)	Natural Vegetation Carbon Stock Density (tC/ha)	Carbon Loss caused by Skid Track Construction (tC)
0.66	126.23	**83.38**

Figure 6-24: Carbon Loss by Skid Track

4) Total Logging Infrastructure Emission

Carbon Loss caused by Hauling Road (tC)		*Carbon Loss caused by Log Landing (tC)*		*Carbon Loss caused by Skid Track (tC)*		*Total Logging Infra caused Carbon Loss (tC)*		*Logging Infra Emission (tCO2e)*
122.75	+	**25.33**	+	**83.38**	=	**231.46**	→	**849.46**

Figure 6-25: Logging Infrastructure Emission Calculation

6.10 Step 10: Logging Damage Emission (LDE)

Same as LIE, Logging Damage Emission is the sum of Skidding-caused Collateral Damage, Felling-caused Collateral Damage, and Log Wastes/Residues. For the sake of convenience, you can calculate a combined value for Felling-caused Collateral Damage, and Log Wastes/Residues, as indicated in the Step 6. Based on required values obtained by the previous calculations, you can calculate total carbon loss (tC) related to LDE and then covert it to emission volume (tCO2e).

Emission Factor		Required Values
Logging Damage Emission	Skidding-caused Collateral Damage	Total Skid Track Length (m)
		Average Deadwood Carbon Dencity per Skid Track Meter (tC/m)
	Felling-caused Collateral Damage	Recorded Number of Felled Trees (stump)
		Average Deadwood Carbon Density per Felled Trees (tC/stump)
	Log Wastes/Residues	Recorded Number of Felled Trees (stump)
		Average Log Waste Carbon Density per Felled Trees (tC/stump)

Figrue 6-26: Required Values for LDE's Emission Calculation

1) Skidding-caused Collateral Damage

For Skidding-caused Collateral Damage, you can simply multiply total skid track length (m) and skidding-caused collateral damage impact density (tC/m).

Total Skid Track Length (m)	Skidding-caused Collateral Damage Impact Density (tC/m)	Carbon Loss Caused by Log Skidding (tC)
1257.5	0.0166	**20.93**

Figure 6-27: Carbon Loss by Skidding-caused Collateral Damage

2) Felling-caused Carbon Loss (Log Wastes and Deadwoods)

Carbon loss by felling-caused collateral damage can be calculated by multipying the Recorded Number of Felled Trees (stump) and Felling Impact Density per Stump (tC/stump).

Felling Impact Density per stump (tC/stump)	Recorded Number of Felled Trees	Total Felling-caused Carbon Loss (tC)
0.78486	50	**39.24**

Figure 6-28: Felling-caused Collateral Damagez

The felled tree number can be obtained from logging company or official document. In case of "no record" about felled tree number (not the number of logs tallied), you can estimate the number of stumps from total length of skid track (m) and mean value of stump density (stump/m), through dividing the length of main skid tracks by the number of stumps counted during the field measurement, and get a mean value, as below.

Track ID	Stumps at Right side	Stumps at Left side	Total number of Stump	Length of main skid tracks	Felling density per meter
ST1	12	8	20	559.2	3.577
ST2	11	9	20	698.3	2.864
Mean felling density					**3.220**
Estimated number of tree felling at Set-up scale					**40.496**

Figure 6-29: Stump Estimation

3) Total Logging Damage Emission

Carbon Loss Caused by Log Skidding (tC)	Total Felling-caused Carbon Loss (tC)	*Total LD caused Carbon Loss (tC)*	*Logging Damage Emission (tCO2e)*
20.93 +	**39.24** =	**60.17** ➡	**<u>220.83</u>**

Figure 6-30: Logging Damage Emission Calculation

6.11 Step 11: Log Extraction Emission (LEE)

In terms of Log Extraction Emission, since you have already calculated total removed log carbon volume based on log scaling data, you can simply convert the value of carbon to emission with IPCC's default value.

Emission Factor		Required Values
Log Extraction Emission	Log Extraction	Recorded Removed Log Carbon Volume (tC) (from Log Scaling Data)

Figrue 6-31: Required Values for LEE's Emission Calculation

Recorded number of logs tallied	Total Extracted Log Carbon at Setup level (tC)	*Total Log Extraction Emission (tCO2e)*
73	**64.76** →	**237.67**

Figure 6-32: Log Extraction Emission Calculation

6.12 Step 12: Emission Factor

The final calculation is Emission Factor per cubic meter of harvested log volume. As "Total Carbon Emission" is a sum of Total Log Extraction Emission, Log Infrastructure Factor, and Log Damage Factor, you can sum up the emission volumes and then divide the value with total extracted log volume, which is previously calculated based on Log Scaling Data.

Total Log Extraction Emission (tCO2e)	*Logging Infrastructure Emission (tCO2e)*	*Logging Damage Emission (tCO2e)*	*Total Carbon Emission (tCO2e)*
237.67 +	849.46 +	220.83 =	**1,307.96**

Total Carbon Emission (tCO2e)	Total Log Volume Estimated (m^3)	**Emission Factor ($tCO2e/m^3$)**
1,307.96 /	246.32 =	**5.31**

Figure 6-33: Emission Factor Calculation

6.13 Summary Organization

In order to make it easy to grasp a overview of calculation results of the respective carbon losses, a summary format is prepared as below. You can put respective calculation results in this format through linking with each calculation spreadsheet.

Summary of Carbon Loss caused by Selective Logging Operation at Open Bay		
Sources of Carbon Loss	***Target Setup***	***Proportion***
Hauling-caused Carbon Loss (tC)	**25.33**	**10%**
Hauling Road Construction		
Carbon loss by hauling road (tC)	**0.00**	
Log landing Establishment		
Nb of log landing in the setup	1.0	n/a
Total Log landing area (ha)	0.20	n/a
Natural Vegetation Carbon Stock Density (tC/ha)	126.23	n/a
Carbon loss by log landing (tC)	**25.33**	**100%**
Skidding-caused Carbon Loss (tC)	**104.31**	**45%**
Skid Track Construction		
Total skid track length (m)	1257.50	n/a
Mean skid track width (m)	5.3	n/a
Mean skid track area (ha)	0.66	n/a
Natural Vegetation Carbon Stock Density	126.23	n/a
Carbon loss by skid tracks (tC)	**83.38**	**79.9%**
Skidding Operation		
Total skid track length (m)	1257.50	n/a
Collateral Damage Impact Density (tC/m)	0.01	n/a
Carbon loss by log skidding (tC)	**20.93**	**20.1%**
Felling-caused Carbon Loss (tC)	**104.00**	**45%**
Felling-caused Damage		
Number of trees harvested	50	n/a
Felling Impact Density per stump (tC/stump)	0.78	n/a
Total Felling-caused Carbon Loss (tC)	**39.24**	**38%**
[Proportion of Log Waste/Residue]	*[30.22]*	*[77%]*
[Proportion of Deadwood]	*[9.02]*	*[23%]*
Extracted Log		
Number of Tallied Logs	73	n/a
Scaled Log Volume (m^3)	246.32	n/a
Total Carbon of Logs Extracted (tC)	**64.76**	**62%**
All Sources of Carbon Loss (tC)	**233.64**	**100%**

Figure 6-34: Summary Format for Calculation Result

<After Calculation…>

This is the end of this manual. Once you complete all the calculations, you should prepare a presentation to your superiors and colleagues to share the results and get their feedback.

[END]

Attachment: Data Entry and Carbon Calculation Spreadsheet

Attachment: Data Entry and Carbon Calculation Spreadsheet

Logging Carbon Monitoring Survey

Record Sheet Set No. ________

FORM 1: General Information

Date:	/ /
Day No.	1 2 3 4 5 6 7

(circle by day only)

1. Generic Information

Name of Field Recorder

Organization (Directorate, Division, Office, Section)

Position Title

Contact Number and Email

Mobile:	Email:

DATA ENTRY

Data Entry Date:

Name of Data Entry Officer:

Organization

Contact Number and Email

Mobile:	Email:

2. General Information

Location of Concession

Province:	
LLG:	
Site/Village:	

Target Setup for Field Carbon Monitoring

Coupe No.		Setup No:	
Size of Target Setup:			

When harvesting was conducted: / /

Number of trees felled

Number of logs produced

Volume of log produced m3

Completion of Log Scaling: YES / NO

Map: Concession ☐ Coupe ☐ Setup ☐

List of Targeted Merchantable Tree Species ☐

Annual Harvesting Volume Records (5-10years) ☐

Estimated timber density m3/ha

GPS Data

GPS Device Type

GPS Device Keeper

Starting Position (use 6 digits in decimal degrees)

GPS Y (longitude) S

GPS X (Longitude) E

Concessioner/Logging Company

Concession No.

Permit Holder's Name

Concession Type

Contact Details:

Contact Person 1

Mobile:	Email:

Contact Person 2

Mobile:	Email:

Survey Team Member

Team Leader

Team members

Field Assistants

PAPUA NEW GUINEA

JICA

Measurement tools and devices: Checklist

No	Measurement tools and devices	Measurement type / activity	Check Box
INFRASTRUCTURE			
1	GPS devices (one for respective surve teams)	Width and length of instrastructures	☐
2	Flagging tape		☐
3	Measurement tape		☐
4	Clinometers / Laser range finder / Vertex	Slope Correction	☐
5	Digital camera / video	Photo documentation if any	☐
PLOTS			
6	GPS devices (one for respective surve teams)	Plot establishment	☐
7	Flagging tape		☐
8	Measurement tape		☐
9	Clinometers / Laser range finder / Vertex	Slope Correction	☐
10	Digital camera / video	Photo documentation if any	☐
11	Densiometer	Canopy closure	☐
LIVING TREES			
12	Tree species determination keys (book, photo, etc.)	Species name	☐
13	Diameter tape	Tree diameter	☐
14	1.3 m pole if available		☐
15	Portable retractable ladder (3 to 5 m) if available		☐
16	Laser range finder / Vertex	Tree height	☐
17	Clinometer (in case laser range finder does not work)		☐
18	Measurement tape (in case laser range finder does not work)		☐
STANDING DEADWOOD (SNAPPED BELOW FIRST BRANCH)			
19	Diameter tape	Standing deadwood diameter	☐
20	Laser range finder / Vertex	Standing deadwood height	☐
21	Clinometer (in case laser range finder does not work)		☐
22	Measurement tape (in case laser range finder does not work)		☐
STUMPS			
23	Diameter tape	Stump diameter and height	☐
UPROOTED LYING DEADWOOD / LOG WASTES (RESIDUES)			
24	Diameter tape	Deadwood diameters	☐
25	Measurement tape	Deadwood length	☐
RECORDING			
26	Field record sheet	Recording measurement data	☐
27	Clip board		☐
28	Waterproof document case		☐
29	Pencil		☐
30	Erazer		☐
31	Pen		☐
32	Crayon	Writing measurement data on cross section of trees/logs	☐
33	Carrying bag / backpack	Carring tools and devices	☐

MEMO:

Logging Carbon Monitoring Survey

FORM 2: Skidding Infrastructure

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		Track Length						Track Width			
Setup ID	***Skid Track No.***	***Main Track (m)***		***Track Branch / Spur Road (m)***		***Stump No. alongside of main track***		***Skid Plot No.***	***Track Width (m)***		***Remarks***
	ST___	1)		1)		**Left**		**SP1**	TW1		
				2)		**Right**			TW2		
				3)				**SP2**	TW1		
				4)					TW2		
				5)				**SP3**	TW1		
				6)					TW2		
				7)				**SP4**	TW1		
				8)					TW2		
				9)				**SP5**	TW1		
				10)					TW2		
	ST___	__)		__)		**Left**		**SP___**	TW1		
				__)		**Right**			TW2		
				__)				**SP___**	TW1		
				__)					TW2		
				__)				**SP___**	TW1		
				__)					TW2		
				__)				**SP___**	TW1		
				__)					TW2		
				__)				**SP___**	TW1		
				__)					TW2		
	ST___	__)		__)		**Left**		**SP___**	TW1		
				__)		**Right**			TW2		
				__)				**SP___**	TW1		
				__)					TW2		
				__)				**SP___**	TW1		
				__)					TW2		
				__)				**SP___**	TW1		
				__)					TW2		
				__)				**SP___**	TW1		
				__)					TW2		
	ST___	__)		__)		**Left**		**SP___**	TW1		
				__)		**Right**			TW2		
				__)				**SP___**	TW1		
				__)					TW2		
				__)				**SP___**	TW1		
				__)					TW2		
				__)				**SP___**	TW1		
				__)					TW2		
				__)				**SP___**	TW1		
				__)					TW2		

Logging Carbon Monitoring Survey | **FORM 3: Skidding Damage** | Page 1 / _______

Setup ID	*Skid Track No.*	*Skid Plot No.*	*Deadwood No.*	*Form* LB=Lying/Broken LF=Lying/Full S=Standing	*Tree Species*	*Height / Length (m)*	*Root Collar Diameter (cm)*	*Trunk Top Diameter (cm)*	*Remarks*
	ST1		S-CD1						
	ST___		S-CD2						
	ST___		S-CD3						
	ST___		S-CD4						
	ST___		S-CD5						
	ST___		S-CD6						
	ST___		S-CD7						
	ST___		S-CD8						
	ST___		S-CD9						
	ST___		S-CD10						
	ST___		S-CD11						
	ST___		S-CD12						
	ST___		S-CD13						
	ST___		S-CD14						
	ST___		S-CD15						
	ST___		S-CD16						
	ST___		S-CD17						
	ST___		S-CD18						
	ST___		S-CD19						
	ST___		S-CD20						
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	ST___		S-CD27						
	ST___		S-CD28						
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	ST___		S-CD30						
	ST___		S-CD31						
	ST___		S-CD32						
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	ST___		S-CD40						
	ST___		S-CD41						
	ST___		S-CD42						
	ST___		S-CD43						
	ST___		S-CD44						
	ST___		S-CD45						
	ST___		S-CD46						
	ST___		S-CD47						
	ST___		S-CD48						

Logging Carbon Monitoring Survey

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Setup ID	Skid Track No.	Felling Plot No.	Tree ID	Object Type + Form	Tree Species	Height / Length (m)	Root Collar Diameter D1 (cm)	Trunk Top Diameter D2 (cm)	Only in case that diameter cannot be measured with D3 (cm)	D4 (cm)	Remarks
	ST1		F-TR1								
	ST___		F-TR ___								
	ST___		F-TR ___								
	ST___		F-TR ___								
	ST___		F-TR ___								
	ST___		F-TR ___								
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	ST___		F-TR ___								
	ST___		F-TR ___								

Logging Carbon Monitoring Survey

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FORM 5: Hauling Infrastructure

In case of measuring with tape measure

Setup ID	Log Landing No	Length (m)	Width (m)	GPS Measurement Result (ha)	Remarks
	LL 1				LL location: ST1
	LL 2				LL location: ST__
	LL 3				LL location: ST__
	LL 4				LL location: ST__
	LL 5				LL location: ST__
	LL 6				LL location: ST__
	LL 7				LL location: ST__
	LL 8				LL location: ST__

Setup ID	Hauling Road ID	Road Length (m)	Rord Width No.	Road Width (m)	No. of steups the road provides access to
	HR 1		Width 1		
			Width 2		
			Width 3		
			Width 4		
			Width 5		
			Width 6		
			Width 7		
			Width 8		
			Width 9		
			Width 10		

Memo:

Logging Carbon Monitoring Survey

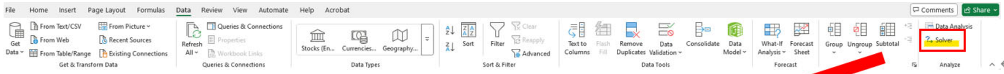
FORM 6: Natural Vegetation

Location (Left/Right side of Strip line)	**Tree ID**	**Tree Species**	**Height (m)**	**DBH (cm)**	**Remarks** (in case laser range finder does not work, please write angle and distance here)
	NV-TR1				
	NV-TR2				
	NV-TR3				
	NV-TR4				
	NV-TR5				
	NV-TR6				
	NV-TR7				
	NV-TR8				
	NV-TR9				
	NV-TR10				
	NV-TR11				
	NV-TR12				
	NV-TR13				
	NV-TR14				
	NV-TR15				
	NV-TR16				
	NV-TR17				
	NV-TR18				
	NV-TR19				
	NV-TR20				
	NV-TR21				
	NV-TR22				
	NV-TR23				
	NV-TR24				
	NV-TR25				
	NV-TR26				
	NV-TR27				
	NV-TR28				
	NV-TR29				
	NV-TR30				
	NV-TR31				
	NV-TR32				
	NV-TR33				
	NV-TR34				
	NV-TR35				
	NV-TR36				
	NV-TR37				
	NV-TR38				
	NV-TR39				
	NV-TR40				

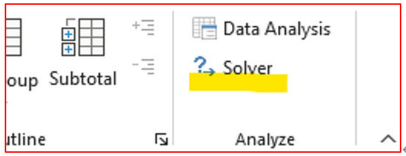
Location *(Left/Right side of Strip line)*	**Tree ID**	**Tree Species**	**Height (m)**	**DBH (cm)**	**Remarks** *(in case laser range finder does not work, please write angle and distance here)*
	NV-TR41				
	NV-TR42				
	NV-TR43				
	NV-TR44				
	NV-TR45				
	NV-TR46				
	NV-TR47				
	NV-TR48				
	NV-TR49				
	NV-TR50				
	NV-TR51				
	NV-TR52				
	NV-TR53				
	NV-TR54				
	NV-TR55				
	NV-TR56				
	NV-TR57				
	NV-TR58				
	NV-TR59				
	NV-TR60				
	NV-TR61				
	NV-TR62				
	NV-TR63				
	NV-TR64				
	NV-TR65				
	NV-TR66				
	NV-TR67				
	NV-TR68				
	NV-TR69				
	NV-TR70				
	NV-TR71				
	NV-TR72				
	NV-TR73				
	NV-TR74				
	NV-TR75				
	NV-TR76				
	NV-TR77				
	NV-TR78				
	NV-TR79				
	NV-TR80				

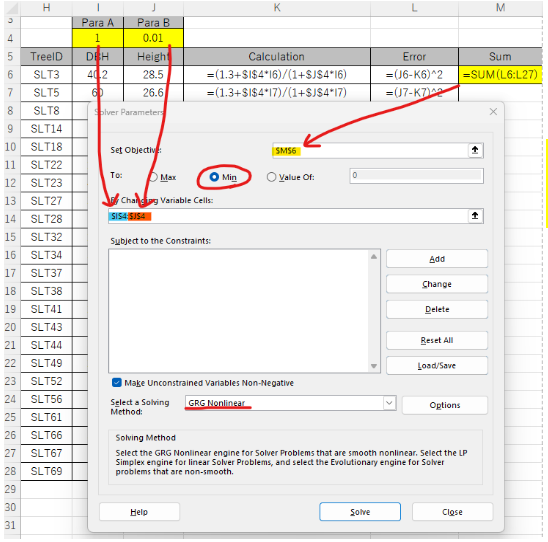
Parameter a	1.00
Parameter b	0.01

Height	DBH	Calculation	Error	Sum
		1.3	1.69	50.7
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	
		1.3	1.69	



1) Please execute SOLVER to automatically calculate the best values for parameter a & b.





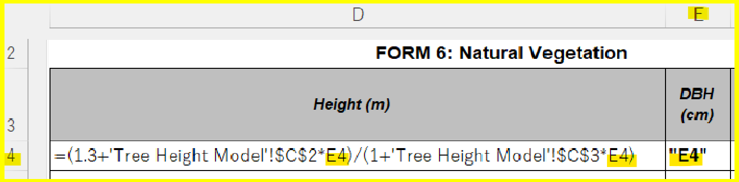
2) Please make sure the setting for SOLVER is correct.

3) In order to estimate its height based on this tree height model, once SOLVER works, please do the following:

①Please copy the following equation and paste it to the blank "height" cell of the sheet titled "Step 6_Natural Vegetation".
*=(1.3+'Tree Height Model'!$C$2*__)/(1+'Tree Height Model'!$C$3*__)*

Please do not click Enter, as you need to make some editting as explained in ②.

②Then, please delete both underlines "___" and select DBH value in "E" column instead. Please see the following for your reference.



Tree Height Model

No.	Scientific names	Codes	Wood densities
1	Acacia mangium	ACACI/MANGI	0.56
2	Aceratium ledermannii	ACERA2/LEDER	0.477
3	Aceratium pittosporoides	ACERA2/PITTO	0.477
4	Acronychia pedunculata	ACRON/PEDUN	0.477
5	Adinandra forbesii	ADINA/FORBE	0.477
6	Aglaia cucullata	AGLAI/CUCUL	0.735
7	Aglaia sapindina	AGLAI/SAPIN	0.735
8	Ailanthus integrifolia	AILAN/INTEG	0.32
9	Alseodaphne archboldiana	ALSEO/ARCHB	0.49
10	Alstonia scholaris	ALSTO/SCHOL	0.264
11	Alstonia spectabilis	ALSTO/SPECT	0.61
12	Anacolosa papuana	ANACO/PAPUA	0.477
13	Anisoptera thurifera	ANISO/THURI	0.612
14	Anthocephalus chinensis	ANTHO5/CHINE	0.373
15	Antiaris toxicaria	ANTIA/TOXIC	0.345
16	Araucaria cunninghamii	ARAUC/CUNNI	0.443
17	Araucaria hunsteinii	ARAUC/HUNST	0.422
18	Artocarpus altilis	ARTOC/ALTIL	0.35
19	Artocarpus fretissii	ARTOC/FRETI	0.35
20	Astronidium montanum	ASTRO2/MONTA	0.477
21	Baccaurea papuana	BACCA/PAPUA	0.477
22	Barringtonia apiculata	BARRI/APICU	0.48
23	Barringtonia papuana	BARRI/PAPUA	0.48
24	Bhesa archboldiana	BHESA/ARCHB	0.477
25	Bischofia javanica	BISCH/JAVAN	0.545
26	Bombax ceiba	BOMBA/CEIBA	0.22
27	Brackenridgea forbesii	BRACK/FORBE	0.477
28	Bridelia macrocarpa	BRIDE/MACRO	0.47
29	Buchanania macrocarpa	BUCHA2/MACRO	0.295
30	Calophyllum inophyllum	CALOP/INOPH	0.495
31	Calophyllum microcarpum	CALOP/MICRO	0.495
32	Cananga odorata	CANAN/ODORA	0.275
33	Canarium indicum	CANAR/INDIC	0.48
34	Canarium oleosum	CANAR/OLEOS	0.414
35	Carallia brachiata	CARAL/BRACH	0.66
36	Castanopsis acuminatissima	CASTA/ACUMI	0.52
37	Castanospermum australe	CASTA2/AUSTR	0.707
38	Celtis latifolia	CELTI/LATIF	0.5
39	Celtis philippinensis	CELTI/PHILI	0.64

No.	Scientific names	Codes	Wood densities
40	Cerbera floribunda	CERBE/FLORI	0.395
41	Chionanthus ramiflorus	CHION2/RAMIF	0.477
42	Chrysophyllum roxburghii	CHRYS2/ROXBU	0.4
43	Citronella suaveolens	CITRO/SUAVE	0.477
44	Cnesmocarpon dasyantha	CNESM/DASYA	0.477
45	Codiaeum variegatum	CODIA/VARIE	0.477
46	Commersonia bartramia	COMME2/BARTR	0.477
47	Cordia dichotoma	CORDI/DICHO	0.42
48	Cryptocarya depressa	CRYPT2/DEPRE	0.465
49	Cryptocarya multinervis	CRYPT2/MULTI	0.465
50	Cryptocarya multipaniculata	CRYPT2/MULTI2	0.465
51	Cyathocalyx obtusifolius	CYATH2/OBTUS	0.477
52	Cyathocalyx petiolatus	CYATH2/PETIO	0.477
53	Dacrycarpus imbricatus	DACRY/IMBRI	0.46
54	Dendrocnide longifolia	DENDR4/LONGI	0.477
55	Dictyoneura obtusa	DICTY2/OBTUS	0.477
56	Dillenia papuana	DILLE/PAPUA	0.48
57	Diospyros papuana	DIOSP/PAPUA	0.58
58	Dolichandrone spathacea	DOLIC/SPATH	0.477
59	Dracontomelon dao	DRACO/DAO	0.47
60	Dryadodaphne novoguineensis	DRYAD/NOVOG	0.43
61	Duabanga moluccana	DUABA/MOLUC	0.32
62	Dysoxylum acutangulum	DYSOX/ACUTA	0.62
63	Dysoxylum gaudichaudianum	DYSOX/GAUDI	0.62
64	Dysoxylum parasiticum	DYSOX/PARAS	0.62
65	Elaeocarpus culminicola	ELAEO/CULMI	0.375
66	Endiandra brassii	ENDIA/BRASS	0.55
67	Endospermum medullosum	ENDOS/MEDUL	0.318
68	Eriandra fragrans	ERIAN/FRAGR	0.477
69	Erythrospermum candidum	ERYTH4/CANDI	0.477
70	Erythroxylum ecarinatum	ERYTH5/ECARI	0.477
71	Eucalyptopsis papuana	EUCAL/PAPUA	0.477
72	Eucalyptus deglupta	EUCAL2/DEGLU	0.502
73	Euroschinus papuanus	EUROS/PAPUA	0.477
74	Fagraea racemosa	FAGRA/RACEM	0.73
75	Ficus benjamina	FICUS/BENJA	0.345
76	Ficus mollior	FICUS/MOLLI	0.345
77	Ficus polyantha	FICUS/POLYA	0.345
78	Ficus pungens	FICUS/PUNGE	0.345

No.	Scientific names	Codes	Wood densities
79	Ficus variegata	FICUS/VARIE	0.345
80	Finschia chloroxantha	FINSC/CHLOR	0.477
81	Firmiana papuana	FIRMI/PAPUA	0.477
82	Flindersia ifflaiana	FLIND/IFFLA	0.83
83	Flindersia pimenteliana	FLIND/PIMEN	0.395
84	Galbulimima belgraveana	GALBU/BELGR	0.38
85	Galearia celebica	GALEA/CELEB	0.477
86	Ganophyllum falcatum	GANOP/FALCA	0.625
87	Garcinia dulcis	GARCI/DULCI	0.645
88	Garcinia hollrungii	GARCI/HOLLR	0.645
89	Garcinia hunsteinii	GARCI/HUNST	0.645
90	Garcinia latissima	GARCI/LATIS	0.645
91	Garuga floribunda	GARUG/FLORI	0.555
92	Geijera salicifolia	GEIJE/SALIC	0.91
93	Glochidion philippicum	GLOCH/PHILI	0.4645
94	Gluta papuana	GLUTA/PAPUA	0.45
95	Gmelina moluccana	GMELI/MOLUC	0.4
96	Gnetum gnemon	GNETU/GNEMO	0.477
97	Gomphandra montana	GOMPH/MONTA	0.477
98	Gonocaryum litorale	GONOC2/LITOR	0.64
99	Gonystylus macrophyllus	GONYS/MACRO	0.57
100	Grevillea papuana	GREVI/PAPUA	0.59
101	Gymnacranthera paniculata	GYMNA/PANIC	0.477
102	Gynotroches axillaris	GYNOT/AXILL	0.477
103	Gyrinops ledermannii	GYRIN/LEDER	0.477
104	Halfordia papuana	HALFO/PAPUA	0.77
105	Helicia forbesiana	HELIC2/FORBE	0.477
106	Helicia latifolia	HELIC2/LATIF	0.477
107	Heritiera littoralis	HERIT/LITTO	0.66
108	Hernandia ovigera	HERNA/OVIGE	0.245
109	Hibiscus papuodendron	HIBIS/PAPUO	0.34
110	Homalium foetidum	HOMAL2/FOETI	0.714
111	Hopea iriana	HOPEA/IRIAN	0.832
112	Hopea papuana	HOPEA/PAPUA	0.595
113	Horsfieldia irya	HORSF/IRYA	0.36
114	Horsfieldia spicata	HORSF/SPICA	0.36
115	Ilex cymosa	ILEX/CYMOS	0.477
116	Inocarpus papuanus	INOCA/PAPUA	0.477
117	Intsia bijuga	INTSI/BIJUG	0.677

No.	Scientific names	Codes	Wood densities
118	Intsia palembanica	INTSI/PALEM	0.645
119	Jagera javanica	JAGER/JAVAN	0.477
120	Kibara papuana	KIBAR/PAPUA	0.477
121	Kleinhovia hospita	KLEIN/HOSPI	0.36
122	Koompassia grandiflora	KOOMP/GRAND	0.58
123	Lithocarpus celebicus	LITHO/CELEB	0.58
124	Litsea collina	LITSE/COLLI	0.4
125	Litsea firma	LITSE/FIRMA	0.4
126	Litsea globosa	LITSE/GLOBO	0.4
127	Litsea guppyi	LITSE/GUPPY	0.4
128	Litsea timoriana	LITSE/TIMOR	0.4
129	Macaranga aleuritoides	MACAR/ALEUR	0.3
130	Macaranga tanarius	MACAR/TANAR	0.3
131	Madhuca leucodermis	MADHU/LEUCO	0.53
132	Magnolia tsiampacca	MAGNO/TSIAM	0.303
133	Mallotus paniculatus	MALLO/PANIC	0.64
134	Mammea cordata	MAMME/CORDA	0.62
135	Mangifera minor	MANGI/MINOR	0.495
136	Manilkara kanosiensis	MANIL/KANOS	0.76
137	Mastixia kaniensis	MASTI/KANIE	0.47
138	Mastixiodendron pachyclados	MASTI2/PACHY	0.477
139	Medusanthera laxiflora	MEDUS/LAXIF	0.477
140	Mischocarpus paradoxus	MISCH3/PARAD	0.477
141	Myristica chrysophylla	MYRIS/CHRYS	0.385
142	Myristica cornutiflora	MYRIS/CORNU	0.385
143	Myristica kajewskii	MYRIS/KAJEW	0.385
144	Myristica subalulata	MYRIS/SUBAL	0.385
145	Myristica umbrosa	MYRIS/UMBRO	0.385
146	Neoscortechinia forbesii	NEOSC/FORBE	0.61
147	Neuburgia corynocarpa	NEUBU/CORYN	0.46
148	Nothofagus grandis	NOTHO2/GRAND	0.64
149	Ochrosia ficifolia	OCHRO2/FICIF	0.477
150	Octamyrtus pleiopetala	OCTAM/PLEIO	0.477
151	Octomeles sumatrana	OCTOM/SUMAT	0.246
152	Olea paniculata	OLEA/PANIC	0.477
153	Oreocallis wickhamii	OREOC/WICKH	0.47
154	Palaquium warburgianum	PALAQ/WARBU	0.34
155	Pangium edule	PANGI/EDULE	0.552
156	Parartocarpus venenosus	PARAR2/VENEN2	0.477

No.	Scientific names	Codes	Wood densities
157	Parastemon versteeghii	PARAS4/VERST	0.477
158	Falcataria moluccana	PARAS5/FALCA	0.287
159	Parinari nonda	PARIN/NONDA	0.68
160	Pericopsis mooniana	PERIC2/MOONI	0.7
161	Picrasma javanica	PICRA/JAVAN	0.477
162	Pisonia umbellifera	PISON/UMBEL	0.21
163	Pittosporum ferrugineum	PITTO/FERRU	0.477
164	Planchonella chartacea	PLANC/CHART	0.46
165	Planchonella firma	PLANC/FIRMA	0.46
166	Planchonia papuana	PLANC2/PAPUA	0.595
167	Platea excelsa	PLATE/EXCEL	0.477
168	Podocarpus neriifolius	PODOC/NERII	0.51
169	Polyalthia oblongifolia	POLYA/OBLON	0.48
170	Pometia pinnata	POMET/PINNA	0.593
171	Pongamia pinnata	PONGA/PINNA	0.477
172	Pouteria luzoniensis	POUTE/LUZON	0.66
173	Pouteria maclayana	POUTE/MACLA	0.66
174	Prunus grisea	PRUNU/GRISE	0.477
175	Pseudobotrys cauliflora	PSEUD5/CAULI	0.477
176	Pterocarpus indicus	PTERO/INDIC	0.497
177	Pterocymbium beccarii	PTERO3/BECCA	0.36
178	Pterygota horsfieldii	PTERY/HORSF	0.595
179	Rhodamnia latifolia	RHODA/LATIF	0.477
180	Rhus taitensis	RHUS/TAITE	0.477
181	Rinorea bengalensis	RINOR/BENGA	0.477
182	Rinorea horneri	RINOR/HORNE	0.477
183	Ryparosa javanica	RYPAR/JAVAN	0.477
184	Schizomeria serrata	SCHIZ6/SERRA	0.495
185	Sloanea forbesii	SLOAN/FORBE	0.485
186	Sloanea sogerensis	SLOAN/SOGER	0.485
187	Spondias cytherea	SPOND/CYTHE	0.32
188	Spondias dulcis	SPOND/DULCI	0.32
189	Steganthera hirsuta	STEGA/HIRSU	0.477
190	Sterculia ampla	STERC/AMPLA	0.28
191	Sterculia schumanniana	STERC/SCHUM	0.28
192	Symplocos cochinchinensis	SYMPL/COCHI	0.477
193	Syzygium buettnerianum	SYZYG/BUETT	0.61
194	Syzygium furfuraceum	SYZYG/FURFU	0.61
195	Syzygium subcorymbosum	SYZYG/SUBCO	0.61

No.	Scientific names	Codes	Wood densities
196	Syzygium thornei	SYZYG/THORN	0.61
197	Terminalia brassii	TERMI/BRASS	0.387
198	Terminalia complanata	TERMI/COMPL	0.4
199	Terminalia kaernbachii	TERMI/KAERN	0.45
200	Ternstroemia cherryi	TERNS/CHERR	0.53
201	Ternstroemia merrilliana	TERNS/MERRI	0.53
202	Tetrameles nudiflora	TETRA4/NUDIF	0.27
203	Timonius kaniensis	TIMON/KANIE	0.477
204	Timonius pulposus	TIMON/PULPO	0.477
205	Timonius timon	TIMON/TIMON	0.477
206	Toona sureni	TOONA/SUREN	0.315
207	Trema orientalis	TREMA/ORIEN	0.477
208	Trichadenia philippinensis	TRICH/PHILI	0.477
209	Trichospermum burretii	TRICH7/BURRE	0.477
210	Trichospermum pleiostigma	TRICH7/PLEIO	0.477
211	Vatica papuana	VATIC/PAPUA	0.485
212	Vatica rassak	VATIC/RASSA	0.485
213	Vavaea amicorum	VAVAE/AMICO	0.477
214	Vitex cofassus	VITEX/COFAS	0.528
215	Vitex quinata	VITEX/QUINA	0.61
216	Xanthophyllum papuanum	XANTH3/PAPUA	0.641
217	Xanthostemon brassii	XANTH5/BRASS	0.85
218	Xylocarpus granatum	XYLOC/GRANA	0.55
219	Xylopia papuana	XYLOP/PAPUA	0.64
220	Ziziphus angustifolius	ZIZIP/ANGUS2	0.477
221	Acacia sp	ACACI	0.56
222	Aceratium sp	ACERA2	0.477
223	Acronychia sp	ACRON	0.477
224	Actinodaphne sp	ACTIN	0.477
225	Adenanthera sp	ADENA	0.477
226	Adinandra sp	ADINA	0.477
227	Agathis sp	AGATH	0.41
228	Aglaia sp	AGLAI	0.735
229	Ailanthus sp	AILAN	0.32
230	Alangium sp	ALANG	0.65
231	Aleurites sp	ALEUR	0.37
232	Alphitonia sp	ALPHI	0.5
233	Alseodaphne sp	ALSEO	0.49
234	Alstonia sp	ALSTO	0.61

No.	Scientific names	Codes	Wood densities
235	Anacolosa sp	ANACO	0.477
236	Anisoptera sp	ANISO	0.52
237	Annesijoa sp	ANNES	0.477
238	Anthocephalus sp	ANTHO5	0.365
239	Antiaris sp	ANTIA	0.345
240	Antidesma sp	ANTID	0.59
241	Aphanamixis sp	APHAN	0.52
242	Aralia sp	ARALI	0.477
243	Araucaria sp	ARAUC	0.415
244	Archidendron sp	ARCHI	0.477
245	Ardisia sp	ARDIS	0.62
246	Artocarpus sp	ARTOC	0.35
247	Astronia sp	ASTRO	0.477
248	Astronidium sp	ASTRO2	0.477
249	Barringtonia sp	BARRI	0.48
250	Bauhinia sp	BAUHI	0.67
251	Beilschmiedia sp	BEILS	0.7
252	Blumeodendron sp	BLUME2	0.477
253	Brackenridgea sp	BRACK	0.477
254	Bridelia sp	BRIDE	0.47
255	Brownlowia sp	BROWN2	0.477
256	Burckella sp	BURCK	0.59
257	Caldcluvia sp	CALDC	0.477
258	Callicarpa sp	CALLI2	0.477
259	Calophyllum sp	CALOP	0.495
260	Campnosperma sp	CAMPN	0.35
261	Cananga sp	CANAN	0.275
262	Canarium sp	CANAR	0.48
263	Canthium sp	CANTH	0.42
264	Carpodetus sp	CARPO	0.477
265	Celtis sp	CELTI	0.64
266	Ceratopetalum sp	CERAT2	0.51
267	Cerbera sp	CERBE	0.395
268	Chionanthus sp	CHION2	0.477
269	Chisocheton sp	CHISO	0.45
270	Chrysophyllum sp	CHRYS2	0.4
271	Cinnamomum sp	CINNA2	0.325
272	Citronella sp	CITRO	0.477
273	Claoxylon sp	CLAOX	0.477

No.	Scientific names	Codes	Wood densities
274	Cleistanthus sp	CLEIS2	0.88
275	Colubrina sp	COLUB	0.477
276	Conandrium sp	CONAN	0.477
277	Cordia sp	CORDI	0.42
278	Corynocarpus sp	CORYN2	0.477
279	Croton sp	CROTO	0.57
280	Cryptocarya (Cryptocaria) sp	CRYPT2	0.465
281	Cupaniopsis sp	CUPAN2	0.477
282	Cynometra sp	CYNOM	0.74
283	Dacrycarpus sp	DACRY	0.45
284	Dacrydium sp	DACRY2	0.45
285	Decaspermum sp	DECAS	0.477
286	Dendrocnide sp	DENDR4	0.477
287	Dictyoneura sp	DICTY2	0.477
288	Dillenia sp	DILLE	0.48
289	Diospyros sp	DIOSP	0.98
290	Dracontomelon sp	DRACO	0.47
291	Dryadodaphne sp	DRYAD	0.43
292	Drypetes sp	DRYPE	0.67
293	Dysoxylum (Dysoxyllum) sp	DYSOX	0.62
294	Elaeocarpus sp	ELAEO	0.375
295	Elattostachys sp	ELATT	0.477
296	Endiandra sp	ENDIA	0.55
297	Endospermum (Endospernum) sp	ENDOS	0.385
298	Eriandra sp	ERIAN	0.477
299	Erythrina sp	ERYTH	0.23
300	Erythrospermum sp	ERYTH4	0.477
301	Erythroxylum sp	ERYTH5	0.477
302	Eucalyptopsis sp	EUCAL	0.477
303	Eucalyptus sp	EUCAL2	0.64
304	Eugenia sp	EUGEN	0.65
305	Euphorbia sp	EUPHO	0.477
306	Eurya sp	EURYA	0.477
307	Fagraea sp	FAGRA	0.73
308	Ficus sp	FICUS	0.345
309	Finschia sp	FINSC	0.477
310	Flacourtia sp	FLACO	0.477
311	Flindersia sp	FLIND	0.83
312	Garcinia sp	GARCI	0.645

No.	Scientific names	Codes	Wood densities
313	Gardenia sp	GARDE	0.64
314	Geniostoma sp	GENIO	0.477
315	Gironniera sp	GIRON	0.477
316	Glochidion sp	GLOCH	0.4645
317	Gmelina sp	GMELI	0.4
318	Gomphandra sp	GOMPH	0.477
319	Goniothalamus sp	GONIO3	0.477
320	Gonocaryum sp	GONOC2	0.64
321	Grevillea sp	GREVI	0.59
322	Guioa sp	GUIOA	0.477
323	Gynotroches sp	GYNOT	0.477
324	Haplolobus sp	HAPLO	0.477
325	Harpullia sp	HARPU	0.62
326	Helicia sp	HELIC2	0.477
327	Heritiera sp	HERIT	0.66
328	Hernandia sp	HERNA	0.245
329	Hibiscus sp	HIBIS	0.34
330	Homalanthus sp	HOMAL	0.38
331	Homalium sp	HOMAL2	0.68
332	Hopea sp	HOPEA	0.785
333	Horsfieldia sp	HORSF	0.36
334	Ilex sp	ILEX	0.477
335	Intsia sp	INTSI	0.645
336	Itoa sp	ITOA	0.477
337	Ixonanthes sp	IXONA	0.477
338	Kibara sp	KIBAR	0.477
339	Kingiodendron sp	KINGI	0.48
340	Kleinhovia sp	KLEIN	0.36
341	Koompassia sp	KOOMP	0.58
342	Lagerstroemia sp	LAGER	0.55
343	Laportea sp	LAPOR	0.477
344	Leea sp	LEEA	0.477
345	Lepidopetalum sp	LEPID5	0.477
346	Lindsayomyrtus sp	LINDS3	0.477
347	Lithocarpus sp	LITHO	0.58
348	Litsea sp	LITSE	0.4
349	Lophopetalum sp	LOPHO	0.345
350	Macaranga sp	MACAR	0.3
351	Magodendron sp	MAGOD	0.477

No.	Scientific names	Codes	Wood densities
352	Mallotus sp	MALLO	0.64
353	Mammea sp	MAMME	0.62
354	Mangifera sp	MANGI	0.495
355	Maniltoa sp	MANIL2	0.62
356	Maranthes sp	MARAN2	0.655
357	Mastixiodendron sp	MASTI2	0.615
358	Medusanthera sp	MEDUS	0.477
359	Melaleuca sp	MELAL	0.66
360	Melanolepis sp	MELAN	0.477
361	Melicope sp	MELIC2	0.37
362	Memecylon sp	MEMEC	0.477
363	Merrilliodendron sp	MERRI	0.477
364	Metrosideros sp	METRO	0.73
365	Microcos sp	MICRO2	0.42
366	Micromelum sp	MICRO6	0.64
367	Mischocarpus sp	MISCH3	0.477
368	Myristica sp	MYRIS	0.385
369	Nauclea sp	NAUCL	0.63
370	Neolitsea sp	NEOLI	0.477
371	Neonauclea sp	NEONA	0.58
372	Neuburgia sp	NEUBU	0.46
373	Nothofagus sp	NOTHO2	0.64
374	Ochrosia sp	OCHRO2	0.477
375	Oreocallis sp	OREOC	0.47
376	Palaquium sp	PALAQ	0.525
377	Parinari sp	PARIN	0.68
378	Pentaphalangium sp	PENTA3	0.477
379	Pichonia sp	PICHO	0.477
380	Pipturus sp	PIPTU	0.477
381	Pithecellobium sp	PITHE	0.477
382	Pittosporum sp	PITTO	0.477
383	Platea sp	PLATE	0.477
384	Plectronia sp	PLECT2	0.477
385	Podocarpus sp	PODOC	0.51
386	Polyalthia sp	POLYA	0.48
387	Polyosma sp	POLYO	0.477
388	Polyscias sp	POLYS	0.38
389	Pouteria sp	POUTE	0.66
390	Premna sp	PREMN	0.63

No.	Scientific names	Codes	Wood densities
391	Protium sp	PROTI	0.54
392	Prunus sp	PRUNU	0.477
393	Psychotria sp	PSYCH	0.477
394	Randia sp	RANDI	0.78
395	Rhizophora sp	RHIZO	0.78
396	Rhodamnia sp	RHODA	0.477
397	Rinorea sp	RINOR	0.477
398	Santalum sp	SANTA2	0.477
399	Saurauia sp	SAURA	0.477
400	Schizomeria sp	SCHIZ6	0.495
401	Schuurmansia sp	SCHUU	0.477
402	Semecarpus sp	SEMEC	0.477
403	Serianthes sp	SERIA	0.48
404	Sericolea sp	SERIC	0.477
405	Siphonodon sp	SIPHO2	0.477
406	Sloanea sp	SLOAN	0.485
407	Sonneratia sp	SONNE	0.575
408	Sphenostemon sp	SPHEN3	0.477
409	Steganthera sp	STEGA	0.477
410	Stemonurus sp	STEMO2	0.37
411	Sterculia sp	STERC	0.28
412	Streblus sp	STREB	0.477
413	Symplocos sp	SYMPL	0.477
414	Syzygium (Syzigium) sp	SYZYG	0.442
415	Tarenna sp	TAREN	0.477
416	Teijsmanniodendron sp	TEIJS	0.37
417	Terminalia sp	TERMI	0.515
418	Ternstroemia sp	TERNS	0.53
419	Timonius sp	TIMON	0.477
420	Trema sp	TREMA	0.31
421	Trichospermum sp	TRICH7	0.477
422	Tristiropsis sp	TRIST3	0.56
423	Turpinia sp	TURPI	0.36
424	Uromyrtus sp	UROMY	0.477
425	Vavaea sp	VAVAE	0.477
426	Weinmannia sp	WEINM	0.477
427	Vitex sp	VITEX	0.61
428	Wrightia sp	WRIGH	0.75
429	Xanthomyrtus sp	XANTH2	0.477

No.	Scientific names	Codes	Wood densities
430	Xanthophyllum sp	XANTH3	0.62
431	Xanthostemon sp	XANTH5	0.85
432	Xylopia sp	XYLOP	0.64
433	Zanthoxylum sp	ZANTH	0.33
434	Ziziphus sp	ZIZIP	0.477
435	Zygogynum sp	ZYGOG	0.477
436	Albizia sp	ALBZ	0.57
437	Alstonia Brassii	ALST/BRSS	0.61
438	Buchanania sp	BUCHA	0.295
439	Falcourtia sp	FALCO	0.57
440	Hernandia papuana	HRNND/PPN	0.245
441	Maranthes corymbosa	MRNTH/CRYM	0.655
442	MIS	MIS	0.57
443	Palaquium amboinense	PLQM/AMBN	0.525
444	Paratocarpus sp	PRTCRP	0.57
445	Pimeleodendron amboinicum	PMLDN/AMBNC	0.57
446	Schefflera actinophylla	SCHFF	0.57

Marshall Lagoon

STEP 1

Natural Vegetation Carbon Stock Density Calculation

Chave et al 2014 Allometric Equation applied

Carbon Fraction	0.47	1+Root Ratio	1.37
Conversion Factor	3.67		

Tree ID	Tree Species	Wood Density (t/m3)	Height(m)	DBH(cm)	Biomass (ABG)	Tree Biomass (AGB+BGB)	Tree Carbon (tC)	Plot size based on DBH class (threshold)	Carbon Density per hectare
NV-TR1	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR2	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR3	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR4	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR5	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR6	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR7	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR8	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR9	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR10	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR11	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR12	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR13	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR14	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR15	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR16	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR17	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR18	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR19	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR20	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR21	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR22	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR23	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR24	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR25	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR26	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR27	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR28	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR29	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR30	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR31	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR32	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR33	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR34	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR35	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR36	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR37	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR38	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR39	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR40	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR41	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR42	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR43	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR44	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR45	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR46	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR47	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A

DBH Threshold	No. of Trees	Carbon Density	
dbh<10	N/A	0.00	←5% of total carbon of 10<DBH
10≤dbh<20	0	0.00	
20≤dbh<50	0	0.00	
50≤dbh	0	0.00	
Carbon Stock Density	0.00	0.00	

NV-TR48	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR49	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR50	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR51	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR52	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR53	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR54	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR55	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR56	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR57	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR58	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR59	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR60	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR61	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR62	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR63	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR64	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR65	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR66	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR67	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR68	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR69	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR70	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR71	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR72	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR73	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR74	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR75	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR76	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR77	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR78	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR79	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A
NV-TR80	0	#N/A	0.00	0	#N/A	#N/A	#N/A	FALSE	#N/A

STEP 2

Hauling Road Area Calculation

Hauling Road ID	Road Length (m)	No. of steups the road provides access to	Road Length allocated for Target Setup (m)	Average Road Width (m)	Hauling Road Area (ha)
HR 1	0	0	#DIV/0!	#DIV/0!	#DIV/0!

STEP 3

Log Landing Area Calculation

Log Landing ID	LL Area by Tape Measure (ha)	LL Area by GPS (ha)
LL 1	0	0
LL 2	0	0
LL 3	0	0
LL 4	0	0
LL 5	0	0
LL 6	0	0
LL 7	0	0
LL 8	0	0
Total LL Area	0	0

STEP 4

Skid Track Area Calculation

No. of Skid Track	Total Skid Track Length (m)	Mean Skid Track Width (m)	Skid Track Area (ha)
0	0	#DIV/0!	#DIV/0!

↑Number of main skid track

In case that the field survey team cannot take measurements of some skid tracks (in below case, track 1 and 3 are measured but track 2 is skipped), mean legth of
both main and branches, calculated based on available measurement data, will be applied, as follows, and total length will be calculated.

	Track ID	Main	Branch	Total
Setup 2	1	577	671	1248
	Average: 2	502	454	956
	3	427	237	664
	Total	1506	1362	2868

STEP 5

Skidding-caused Collateral Damage (Deadwood) Calculation

Pi= 3.14159　Carbon Fraction= 0.47

Brereton Formula or Chave's allometric equation will be applied

1+Root Ratio= 1.37　Conversion Factor= 3.67

Deadwood No.	*Skid Plot No.*	*Form LB=Lying/Broken LF=Lying/Full S=Standing*	Tree Species	Wood Density (t/m3)	*Height / Length (m)*	*Average Diameter (cm)*	Deadwood Biomass (ABG)	Total Biomass (AGB+BGB)	Carbon	Carbon per meter
S-CD1	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD2	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD3	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD4	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD5	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD6	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD7	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD8	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD9	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD10	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD11	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD12	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD13	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD14	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD15	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD16	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD17	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD18	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD19	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD20	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD21	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD22	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD23	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD24	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD25	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD26	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD27	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD28	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD29	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD30	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD31	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD32	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD33	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD34	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD35	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD36	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD37	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD38	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD39	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD40	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD41	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD42	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD43	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD44	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD45	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD46	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD47	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!
S-CD48	0	0	0	#N/A	0	#DIV/0!		#VALUE!	#VALUE!	#VALUE!

Biomass DBH>20	Plot-wise Carbon per meter	Mean Skidding-caused Collateral Damage Impact Density
SP1	0	#DIV/0!
SP2	0	
SP3	0	
SP4	0	
SP5	0	
SP6	0	
SP7	0	
SP8	0	
SP9	0	
SP10	0	
SP11	0	
SP12	0	

Pulldown	
SP1	Lying(broken)
SP2	Lying(full)
SP3	Standing
SP4	
SP5	
SP6	
SP7	
SP8	
SP9	
SP10	
SP11	
SP12	

STEP 6 + 7

Felling-caused Collateral Damage (Deadwood) and Log Waste Calculation

Pi= 3.14159　　Carbon Fraction= 0.47

Brereton Formula or Chave's allometric equation will be applied　　1+Root Ratio= 1.37　　Conversion Factor= 3.67

Felling Plot No.	Tree ID	Object Type & Form	Tree Species	Wood Density (t/m3)	Height / Length (m)	Average Diameter (cm)	Biomass (ABG)	Total Biomass (AGB+BGB)	Carbon Volume (tC)
0	F-TR1	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?

FP ID	Log Waste Carbon	Deadwood Carbon	Total Felling Damage	Number of Stump	Felling Damage Impact per stump
FP 1	0	0	0	0	#DIV/0!
FP 2	0	0	0	0	#DIV/0!
FP 3	0	0	0	0	#DIV/0!
FP 4	0	0	0	0	#DIV/0!
FP 5	0	0	0	0	#DIV/0!
FP 6	0	0	0	0	#DIV/0!
FP 7	0	0	0	0	#DIV/0!
FP 8	0	0	0	0	#DIV/0!
FP 9	0	0	0	0	#DIV/0!
FP 10	0	0	0	0	#DIV/0!
FP 11	0	0	0	0	#DIV/0!
FP 12	0	0	0	0	#DIV/0!
FP 13	0	0	0	0	#DIV/0!
FP 14	0	0	0	0	#DIV/0!
FP 15	0	0	0	0	#DIV/0!
FP 16	0	0	0	0	#DIV/0!
FP 17	0	0	0	0	#DIV/0!
FP 18	0	0	0	0	#DIV/0!
FP 19	0	0	0	0	#DIV/0!
FP 20	0	0	0	0	#DIV/0!
FP 21	0	0	0	0	#DIV/0!
FP 22	0	0	0	0	#DIV/0!
FP 23	0	0	0	0	#DIV/0!
FP 24	0	0	0	0	#DIV/0!
SUM	0	0	0	SUM	#DIV/0!
%	#DIV/0!	#DIV/0!			

↑ STEP 7: Proportion of Log Waste &

↑ STEP 6: Mean Felling Damage

Cal④ Felling Damage

0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?
0	F-TR ___	0	0	#N/A	0	#DIV/0!	#NAME?	#NAME?	#NAME?

Pull-down	Pull-down
FP 1	Stump
FP 2	Log Piece
FP 3	Top Log
FP 4	Abandoned Log
FP 5	Deadwood(lying/broken)
FP 6	Deadwood(lying/full)
FP 7	Deadwood(standing)
FP 8	
FP 9	
FP 10	
FP 11	
FP 12	
FP 13	
FP 14	
FP 15	
FP 16	
FP 17	
FP 18	
FP 19	
FP 20	
FP 21	
FP 22	
FP 23	
FP 24	

Cal⑤ Log Scaling Data Entry

STEP 8

Pi= 3.14159 Carbon Fraction= 0.47

Log Scaling Data Entry + Log Extraction Carbon

Log ID	Tree Species	Wood Density (t/m3)	Length (m)	D1 (cm)	D2 (cm)	Average Diameter (cm)	Volume (m3)	Biomass (ABG)	Carbon Volume (tC)
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Total Log Extracted Volume (m3)	Total Log Extraction Carbon (tC)
0.000000000	0.000000000

Total Number of Tallied Log
0

		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
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		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		#N/A				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Cal⑥Emission Factor

STEP 9

Conversion Factor= 3.67

Logging Infrastructure Emission (LIE)

Hauling Road Area (ha)	Natural Vegetation Carbon Stock Density (tC/ha)	Carbon loss caused by Hauling Road (tC)
#DIV/0!	0.00	#DIV/0!

Total Log Landing Area (ha)	Natural Vegetation Carbon Stock Density (tC/ha)	Carbon loss caused by Log Landings (tC)
0	0.00	0

Total Skid Track Area (ha)	Natural Vegetation Carbon Stock Density (tC/ha)	Carbon loss caused by Skidding Track (tC)
#DIV/0!	0.00	#DIV/0!

Carbon loss caused by Hauling Road (tC)	Carbon loss caused by Log Landings (tC)	Carbon loss caused by Skidding Track (tC)	Total Carbon Loss caused by Logging Infrastructure (tC)	Logging Infrastructure Emission (tCO2e)
#DIV/0!	0	#DIV/0!	#DIV/0!	#DIV/0!

STEP 10

Logging Damage Emission (LDE)

Total Skid Track Length (m)	Skidding-caused Damage Density (tC/m)	Skidding-caused Damage Carbon Loss (tC)
0	#DIV/0!	#DIV/0!

Recorded Number of Felled Trees	Felling Impact Density per stump (tC/stump)	Felling-caused Damage Carbon Loss (tC)
0	#DIV/0!	#DIV/0!

Skidding-caused Damage Carbon Loss (tC)	Felling-caused Damage Carbon Loss (tC)	Total Carbon Loss caused by Logging Damage (tC)	Logging Damage Emission (tCO2e)
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

<In case the number of felled trees is unknown>

Track ID	Number of Stump	Length of Main Skid Track	Felling Density per meter	Mean Density	Total Skid Track Length	Estimated number of tree felling at setup-scale
ST___	0	0	#DIV/0!	#DIV/0!	0	#DIV/0!
ST___	0	0	#DIV/0!			

STEP 11

Log Extraction Emission (LEE)

Total Extracted Log Carbon at Setup level (tC)	Log Extraction Emission (tCO2e)
0	0

STEP 12

Emission Factor

Logging Infrastructure Emission (tCO2e)	Logging Damage Emission (tCO2e)	Log Extraction Emission (tCO2e)	Total Carbon Emission (tCO2e)	Log Extracted Volume (m3)	Emission Factor per volume (tCO2e/m2)	Total Setup Area (ha)	Emission Factor per hectare (tCO2e/ha)
#DIV/0!	#DIV/0!	0	#DIV/0!	0	#DIV/0!	0	#DIV/0!

Logging Infrastructure Emission (tCO2e)	Log Extracted Volume (m3)	Emission Factor of Logging Infrastructure per volume (tCO2e/m3)
#DIV/0!	0	#DIV/0!

Logging Damage Emission (tCO2e)	Log Extracted Volume (m3)	Emission Factor of Logging Damage per volume (tCO2e/m3)
#DIV/0!	0	#DIV/0!

Logging Infrastructure Emission (tCO2e)	Total Setup Area (ha)	Emission Factor of Logging Infra per hectare (tCO2e/ha)
#DIV/0!	0	#DIV/0!

Logging Damage Emission (tCO2e)	Total Setup Area (ha)	Emission Factor of Logging Infra per hectare (tCO2e/ha)
#DIV/0!	0	#DIV/0!

FINAL STEP

Summary Organization

General Information

1) Location of Concession

Province:	0
LLG:	0
Site/Village:	0

2) Concessioner/Logging Company

Permit Holder's Name

0

3) Target Setup for Field Carbon Monitoring

Coupe No:	0
Setup No:	0

Summary of Carbon Loss Caused by Selective Logging Operation

Source of Carbon Loss		*Target Setup*	*Proportion*
TOTAL CARBON LOSS		***#DIV/0!***	***#DIV/0!***
1) Hauling-caused Carbon Loss (HAUL)		#DIV/0!	#DIV/0!
Hauling Road Construction			
	Hauling Road Area (ha)	#DIV/0!	N/A
	Natural Vegetation Carbon Stock Density (tC/ha)	0.00	N/A
	Carbon loss caused by Hauling Road (tC)	#DIV/0!	#DIV/0!
Log Landing Establishment			
	Total Log Landing Area (ha)	0	N/A
	Natural Vegetation Carbon Stock Density (tC/ha)	0.00	N/A
	Carbon loss caused by Log Landings (tC)	0	#DIV/0!
2) Skidding-caused Carbon Loss (SKID)		#DIV/0!	#DIV/0!
Skid Track Construction			
	Total Skid Track Area (ha)	#DIV/0!	N/A
	Natural Vegetation Carbon Stock Density (tC/ha)	0.00	N/A
	Carbon loss caused by Skidding Track (tC)	#DIV/0!	#DIV/0!
Skidding Operation Damage			
	Total Skid Track Length (m)	0	N/A
	Skidding-caused Damage Density (tC/m)	#DIV/0!	N/A
	Skidding-caused Damage Carbon Loss (tC)	#DIV/0!	#DIV/0!
3) Felling-caused Carbon Loss (FELL)		#DIV/0!	#DIV/0!
Felling Operation Damage			
	Recorded Number of Felled Trees	0	N/A
	Felling Impact Density per stump (tC/stump)	#DIV/0!	N/A
	Felling-caused Damage Carbon Loss (tC)	#DIV/0!	#DIV/0!
Log Extraction			
	Total Number of Tallied Log	0	N/A
	Total Log Extracted Volume (m3)	0	N/A
	Total Extracted Log Carbon at Setup level (tC)	0	#DIV/0!