Annex 22. Methodology for GHG accounting for the Reduced Emissions through Climate Smart Agroforestry (RECAF)

The Ex-Ante Carbon-Balance Tool (EX-ACT) has been developed by the Food and Agriculture Organization of the United Nations (FAO) to evaluate impacts of the interventions in the Agriculture, Forestry and Other Land Use (AFOLU) sector on greenhouse gas (GHG) emissions. EX-ACT provides estimates of the mitigation potential of public or private investment projects, policies and national level programs. It helps the decision makers to understand whether the planned agricultural interventions contribute to meeting climate change mitigation objectives. The EX-ACT appraisals, initially designed for ex-ante analysis, can be also conducted during the project implementation as well as ex-post for comprehensive monitoring and evaluation, both at a project and at a country level. EX-ACT calculations are based on land use data.

The current version of EX-ACT is primarily based on *the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC, 2006) and *the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands* (IPCC 2014), complemented by other scientific research. GHG emissions for farm operations, inputs, transport and irrigation systems implementation are based on Lal (2004). Emissions factors for the fishery sector are derived from Parker & Tyedmers (2014), Sciortino (2010), Winther et al. (2009) and Irribaren et al. (2010 & 2011). Soil carbon stock in mangroves is complemented by the review from Atwood et al. (2017). These references provide EX-ACT with recognized default values for emission factors and carbon values, the so-called Tier 1 level of precision.

The tool consists of seven topic modules that allow to analyze a range of agricultural and forestry activities including crop production, land rehabilitation, forest management, livestock, and grassland production systems among others. The tool calculates changes in carbon stocks and GHG emissions including carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), which once converted to CO2 equivalent are used to derive the carbon balance that indicates the impact of the project: positive carbon balance indicates that the project leads to greater emissions, while negative carbon balance indicates that project contributes to emissions reduction.

The evaluation assesses how the impacts of an intervention compared to the business as usual (BAU) scenario. The calculator requires data for 3 specific points in time: initial situation, with project scenario, without project or BAU. In preparing this data a lot of work is required up front to determine the adequate modeling of activities/interventions in the tool. This takes into consideration technical specificities, conversations with national staff to determine current and future projections, literature reviews to assess availability of tier 2 or 3 coefficients to improve the accuracy of the assessment. Once all this information is gathered, a plan based on technical expertise is generated on how to best model the intervention in the tool along with the assumptions made. This is a crucial step as this is what really determines the measurement of the impact. All these aspects are discussed below to ensure a clear and transparent understanding of the assessment done for this project.

Project boundaries and data sources

The Project development objective is: “Forest dependent communities improve their livelihoods and adapt to climate change while reducing GHG emissions and enhancing carbon stock.”

The project is expected to support 420,000 beneficiaries

The project is structured in 3 components:

- Component 1: Enabling environment for the planning and implementation of measures to reduce emissions and adapt to climate change:
- Component 2: Transition to deforestation-free and climate resilient rural economic development
- Component 3: Project management

Detailed information on activities from each component were used to inform the GHG analysis, providing some basic data needed to shape the EX-ACT analysis. The assumptions and data used are presented in the consecutive sections

Table 1: Project activities considered under EX-ACT analysis.

Activity description	Ex-ACT Module
Output 2.1 Deforestation-free value chains developed by 4Ps and increased access to finance: - Activity 2.1.1: Develop deforestation-free commodity supply chains through 4P platforms (131,650 ha): Investments for enriched agroforestry systems (51,950 ha) and improved bamboo management plans (79,700 ha).	LUC / Cropland / Forest management
Output 2.2 Deforestation-free value chains and forest restoration infrastructure upgraded and established. - Activity 2.2.1 Develop infrastructure for deforestation-free value chains. Investments in small-scale and micro irrigation systems to improve resilience against droughts (12,000 ha supplied with irrigation) and upgrading of feeder roads important for selected VCs to make them CC-proof (174 km)	Inputs / LUC
Output 2.3 Collaborative forest management capacity enhanced through performance-based incentives - Activity 2.3.1 Develop a results-based payments for ecosystem services (PES) mechanism for collaborative forest management (40,000 ha) Innovative PES mechanisms that provide performance-based payments for carbon sequestration and retention services. - Activity 2.3.2 Support multi-stakeholder commune-level collaborative forest management (MCCFM) (18,000ha) Support fully developed MCCFM by allocating land to local communities or adjusting FLA (15,000 ha)* and planting and management of agroforestry systems on bare or degraded land (3,000 ha).	Forest management / LUC / cropland

*The 15,000 ha of activity 2.3.2 overlap with the 40,000 ha of Activity 2.3.1.

The estimation of emissions for this project considers the sequestration, reduction and or avoidance that result from the implementation of the activities summarized in Table 1. EX-ACT differentiates between two time periods: project implementation phase and capitalization phase. The implementation phase is the period during which the project activities are carried out. Yet, the period covered by the analysis does not necessarily end with the termination of the active project intervention. Further changes may occur as the result of the interventions (project activities) such as changes soil carbon content or biomass. This period defines the capitalization phase. In this analysis, following the set target in the Funding proposal MRA4. "Reduced emissions from forestry and land use", we consider an overall 12 years. In the current analysis the physical implementation of the project consists of 6 years, the benefits generated by the project will continue to capitalize for 6 more years to reach the 12-year period.

Results of the EX-ACT analysis:

Overall, results show a total carbon balance due to the implementation of the project's activities of -6,684,338 tCO2-eq over 12 years for a total area of 144,805 hectares. This would amount to a carbon balance of -3.8 tCO2-eq per hectare and per year.

Project Name	*Reduced Emissions through C*	Climate	*Tropical (Wet)*					Duration of the Project (Years)		*12*
Continent	*Asia (Continental)*	Dominant Regional Soil Type	*LAC Soils*					Total area (ha)		*144805*
Components of the project	**Gross fluxes**			**Share per GHG of the Balance**				**Result per year**		
	Without	**With**	**Balance**	**All GHG in tCO2eq**				**Without**	**With**	**Balance**
	All GHG in tCO2eq			CO_2			N_2O / CH_4			
	Positive = source / negative = sink			**Biomass**	**Soil**	**Other**				
Land use changes										
Deforestation	0	0	0	0	0		0 / 0	0	0	0
Afforestation	-1,344,097	-1,637,217	-293,120	-275,662	-17,458		0 / 0	-112,008	-136,435	-24,427
Other LUC	87,471	75,359	-12,112	-6,457	-5,632		-23 / 0	7,289	6,280	-1,009
Agriculture										
Annual	0	0	0	0	0		0 / 0	0	0	0
Perennial	-3,613,985	-6,023,093	-2,409,108	-2,406,683	-2,426		0 / 0	-301,165	-501,924	-200,759
Rice	0	0	0	0	0		0 / 0	0	0	0
Grassland & Livestocks										
Grassland	0	0	0	0	0		0 / 0	0	0	0
Livestocks	0	0	0				0 / 0	0	0	0
Degradation & Management										
Forest degradation	0	-4,002,980	-4,002,980	-3,521,126	-481,854		0 / 0	0	-333,582	-333,582
Peat extraction	0	0	0		0		0 / 0	0	0	0
Drainage organic soil	0	0	0		0		0 / 0	0	0	0
Rewetting organic soil	0	0	0		0		0 / 0	0	0	0
Fire organic soil	0	0	0	0			0	0	0	0
Coastal wetlands	0	0	0	0	0		0 / 0	0	0	0
Inputs & Investments	0	32,982	32,982			32,982	0 / 0	0	2,749	2,749
Fishery & Aquaculture	0	0	0			0	0 / 0	0	0	0
Total	-4,870,611	-11,554,949	-6,684,338	-6,209,928	-507,369	32,982	-23 / 0	-405,884	-962,912	-557,028
Per hectare	-33.6	-79.8	-46.2	-42.7	-3.5	0.2	0.0 / 0.0			
Per hectare per year	-2.8	-6.6	-3.8	-3.6	-0.3	0.0	0.0 / 0.0	-2.8	-6.6	-3.8

The carbon balance disaggregated by outputs are:

- The output 2.1 is reflected in the Land use change, cropland, and Forest degradation modules. Given the computation of data (detailed in Computation of data in EX-ACT), the total carbon balance over 12 years of this output is equal to -5,134,337 tCO2-eq. The conversion of existing agroforestry systems and the restoration activities in bamboo and timber-bamboo forests are the main contributors on increasing carbon sequestration.
- The output 2.2 is reflected in the input and land use change modules. Given the computation of data (detailed in Computation of data in EX-ACT), the total carbon balance over 12 years of this output is equal to 35,948 tCO2-eq. The construction of irrigation systems and roads to support production and market access will contribute with emissions, but they do not overweight the land-based benefits from output 2.1 and 2.3.
- The output 2.3 is reflected in the land use change modules, cropland and forest degradation. Given the computation of data (detailed in Computation of data in EX-ACT), the total carbon balance over 12 years of this output is equal to -1,585,952 tCO2-eq. The restoration activities on forest are the main contributors to increase sequestration under this output.

Computation of data in EX-ACT:

The following section presents the rationale of how activities were considered in the analysis and data used. Furthermore, it includes the activities that have been excluded from the analysis and the rationale for such exclusion and recommendations for the refinement of the analysis.

General:

According to the project area defined, the value for Soil Organic Carbon (SOC) content was retrieved from the Global Soil Organic Carbon (GSOC) map via Earthmap. The reference value of SOC used was the average at the provincial level (table 2):

Table 2: Reference SOC levels at the district level

District	Dah Lak	Dak Nong	Lam Dong	Gia Lai	Ninh Thuan
SOC (tC/ha)	32.62	33.4	37.55	32.56	34.45

According to the project area defined, the value for average precipitation and average temperature for the last 20 years was retrieved from the CHIRPS v2.0 and ECMFW- ERA 5 via Earthmap. (table 3)

Table 3: Reference climate data used to set the climate on the project under analysis.

Precipitation (mm)	Temperature (°C)
2,120.73	24.4

The data was inserted in the EX-ACT climate helper and accordingly, the climate in the project area was considered tropical wet.

The analysis only accounts for the direct areas of intervention.

Activities:

Output 2.1 Deforestation-free value chains developed by 4Ps and increased access to finance:

- Activity 2.1.1: Develop deforestation-free commodity supply chains through 4P platforms (131,650 ha):

- Investments for enriched agroforestry systems (51,950 ha)

The project will intervene on Acacia monocrop plantations (11,200 ha) which currently follow a 5-year rotation. Following the assumptions of the EFA only 70% of the hectares impacted will successfully finalize the conversion (7,840 ha). The project will convert the plantations to mixed plantations and increase the rotation period to 9-years[1]. The analysis had into account that a longer period of rotation

[1] The rotation lengths were assumed according to Arvola et al., 2020 which states that smallholders in central Vietnam manage short-rotation Acacia (4-6 years) for pulpwood. However, increasing demand for logwood will

will suppose a higher average total area under plantation for 12 years period under analysis. Therefore, according to that assumption, in the without project scenario (no change from the current situation) an estimated 4,492 ha would be planted. In the with project scenario an estimated of 5,472 ha would be planted.
The conversion from monocrop to mixed systems is expected to result in a change on biomass growth on the plantations. However, at the time of the analysis, the mix of species to be implemented was not set. Therefore, no changes on the biomass growth level were considered from the without to the with project scenario. In both scenarios the Above Ground Biomass growth was assumed to be 7.58 tC/ha/yr and the Below Ground Biomass growth was considered to be 1.44 tC/ha/yr.[2] Litter was considered to be 0.6 tC/ha/yr[3].

The carbon balance for the sub activity is -293,120 tCO2-eq.

The project will convert and establish agroforestry systems (40,750 ha). The project will implement new management practices in existing perennial systems (39,765 ha). In addition, the project will avoid the conversion of existing perennial crops into annual cropping systems and convert existing annual croplands into perennial croplands (985 ha). Without the project it was assumed that no changes in the management of existing perennial systems would happen (table 4).

Table 4: Summary of allocated hectares per system under the three relevant scenarios.

Agroforestry system	Start (ha)	Without (ha)	With (ha)
Monocrop coffee (full sun)	23,500	23,500	
Coffee (10% shade)	2,600	2,600	
Coffee (30% shade)			26,100
Pepper monocrop (wood or brick poles)	3,175	3,175	
Pepper on cassia	3,175	3,175	
Shaded perennial crop system			6,350
Cashew monocrop	7,700	7,315	
Annual cropland	500*	735	
Cashew intercropped with lemongrass			7,700
Fruit trees			500*
TOTAL	40,750	40,750	40,750

*Following the assumptions of the EFA only 70% of the hectares impacted will successfully finalize the conversion (350 ha).

The changes in management of perennial systems are expected to increase the biomass density per ha, due to the inclusion of more and diverse trees. Therefore, the biomass growth levels of the existing agroforestry systems are expected to increase. To account for the introduction of different agroforestry systems the following tier 2 values were considered. All values correspond to studies conducted in Vietnam (table 5).

Table 5: Biomass carbon stocks growth (Tier 2) per type of perennial system

require longer rotations with financially optimal rotation length of 9-10 years. https://info.frim.gov.my/infocenter_applications/jtfsonline/jtfs/v33n2/137-148.pdf

[2] Data on Above Ground Biomass Growth corresponds to the mean of the results obtained by Arvola et al, 2020 and Cuong et al., 2020. Below Ground Biomass growth were obtained by applying the root:shoot ration of 0.19 from Cuong et al, 2020. https://dialnet.unirioja.es/descarga/articulo/7682647.pdf

[3] Litter levels according to Cuong et al., 2020.

Agroforestry System	Above Ground Biomass (tC/ha/yr)	Below Ground Biomass (tC/ha/yr)	Observations	Sources
Monocrop coffee (full sun)	0.75	0.165	0.22 root: shoot. Robusta coffee	Mulia et al., 2020[4]
Coffee (10% shade)	0.56 (coffee)+ (1.24 (shade) = 1.8		The study provides overall carbon stocks for intensive shaded systems (85 shade trees/ha)	Nguyen-Duy et al., 2018[5]
Coffee (30% shade)	2.63	0.58	0.22 root: shoot. Robusta coffee (85-150 shade trees/ha)	Mulia et al., 2020[6]
Pepper monocrop (wood or brick poles)	0.308		Only AGB considered. Calculated following allometric equation and linear growth during project implementation and 2000 plants/ha	USAID 2020[7] Mulia & Nguyen, 2021[8]
Pepper on cassia	2.17	0.52	Default IPCC values (average).	EX-ACT
Shaded perennial crop system	2.63	0.58	Assumed coffee (30% shade)	Mulia et al., 2020
Cashew monocrop	4.2	0.7	100-200 cashew trees/ha	Mulia et al., 2020
Cashew intercropped with lemongrass	4.2	0.7	100-200 cashew trees/ha. No impact from lemon grass on biomass levels considered.	Mulia et al., 2020

The carbon balance for the sub activity is -2,250,824 tCO2-eq.

- Improved bamboo management plans (79,700 ha).

The targeted areas correspond to two types of bamboo forests according to the national classification used in the hotspot analysis. The project will target 12,000 ha of Bamboo forests and 67,700 ha of mixed bamboo forests. Following the assumptions of the EFA only 70% of the hectares impacted will successfully implement new management practices. Therefore, the project will impact 8,400 ha of Bamboo forests and 47,390 ha of mixed bamboo forests. The project is expected to improve the biomass levels of the hectares under intervention due to a better management. To estimate the increment brought by the project it was assumed that project activities will allow forests to grow according to the average annual wood increment rates in Vietnam (Ministry of Agriculture and Rural development Vietnam, 2016)[9] presented in table 6.

Table 6: Average annual wood increment rates in Vietnam per type of bamboo forest

Forest type	Annual increment (%)
Bamboos	5.0
Mixed timber-bamboo	3.0

[4] https://www.mdpi.com/2073-445X/9/12/528/htm
[5] https://cgspace.cgiar.org/bitstream/handle/10568/107927/Robusta%20Coffee%20Carbon%20Assessment%20Dak%20Lak.pdf
[6] https://www.mdpi.com/2073-445X/9/12/528/htm
[7] https://www.idhsustainabletrade.com/uploaded/2021/03/Scaling-up-Sustainable-Robusta-Coffee-Production-in-Vietnam-full-tech-report_March-102021.pdf
[8] https://worldagroforestry.org/publication/diversity-agroforestry-practices-viet-nam
[9] https://redd.unfccc.int/files/2016_submission_frel_viet_nam.pdf

According to table 6, Bamboo forests are expected to recover 30% of their biomass while mixed-timber bamboo forests 18% of their biomass during the project implementation. To be conservative, no further degradation without the project was assumed. The data was entered considering the with project biomass level to be achieved as non-degraded (0% biomass loss) and the initial state and without project corresponding to the % loss expected to be restored by the project.

The analysis of the activity was refined using tier 2 values (table 7). The values were calculated as the weighted average of the carbon stock values from the technical annex on the REDD+, according to the decision 14/CP.19 (Ministry of Agriculture and Rural Development, 2020)[10] for the year 2019, per type of forest, together with the proportion of forest per district aggregated at the province level.

Table 7: Biomass carbon stock per type of forest per province and weighted project area average.

Type of forest	Central highlands		South central coast		Final TIER 2 value
	Biomass carbon stock (tC/ha)	Proportion	Biomass carbon stock (tC/ha)	Proportion	Biomass carbon stock (tC/ha)
Bamboo forest	14.86	0.96	17.16	0.04	14.77
Mixed timber-bamboo forest	63.37	0.9	61.85	0.1	63.2

*Carbon stock corresponds to Above Ground Biomass and Below Ground Biomass.

To refine the Soil Organic Carbon content, SOC reference values at the district level (table 1) were weighted according to the proportion of forest available on each district (table 12). The TIER 2 values introduced in the analysis of SOC for bamboo forests correspond to 35.8 tC/ha and for mixed timer-bamboo forests to 36.1 tC/ha.

The carbon balance for the sub activity is -2,590,393 tCO2-eq.

Output 2.2 Deforestation-free value chains and forest restoration infrastructure upgraded and established.

- Activity 2.2.1 Develop infrastructure for deforestation free value chains.

The project will support investments in small-scale and micro irrigation systems to improve resilience against droughts (12,000 ha supplied with irrigation). The analysis assumed that surface irrigation systems without an irrigation runoff return system will be implemented.

The project will support the construction and upgrading of feeder roads important for selected VCs to make them Climate Change proof (174 km). The analysis assumed asphalt roads for medium traffic 2.5 m wide. Besides the emissions from the road construction, the analysis assumes a land use change. The areas for road construction will be selected from set-aside lands and due to earth works will become degraded (43.5 ha)

[10] https://unfccc.int/sites/default/files/resource/Viet%20Nam_Technical%20Annex%20on%20REDD%20.pdf

The carbon balance for the activity is 35,948 tCO2-eq.

Output 2.3 Collaborative forest management capacity enhanced through performance-based incentives.

- Activity 2.3.1 Develop a results-based payments for ecosystem services (PES) mechanism for collaborative forest management (40,000 ha).

Innovative PES mechanisms that provide performance-based payments for carbon sequestration and retention services (25,000 ha). The remaining 15,000 ha will overlap with activity 2.3.2 and are explained below.

The targeted areas correspond to six types of forests according to the national classification used in the hotspot analysis. The analysis assumed that the project would implement activities on different forests according to their current proportion in the project area[11] represented in table 8.

Table 8: Hectares per forest type to be managed under the project intervention.

Forest type	Proportion Central Highlands	Proportion Southcentral coast	Ha
Rich Evergreen broadleaved forest	0.14	0.00	3,478
Medium Evergreen broadleaved forest	0.18	0.01	4,704.2
Poor Evergreen broadleaved forest	0.21[a]	0.05[a]	6,445.3
Deciduous Forest	0.25	0.04	7,203.1
Coniferous	0.10	0.01	2,704.0
Mixed broadleaved-coniferous forest	0.01	0.01	465.3
TOTAL	0.89	0.12	25,000

(a) the proportion of Rehabilitated forests were added to poor evergreen forest following the assumption that the project will target the most degraded forests.

The project is expected to improve the biomass levels of the hectares under intervention due to a better management. To estimate the increment brought by the project it was assumed that project activities will allow forests to grow according to the average annual wood increment rates in Vietnam (Ministry of Agriculture and Rural development Vietnam, 2016) (table 9)

Table 9: Average annual wood increment rates in Vietnam per type of forest

Forest type	Annual increment (%)	Increment during the implementation phase (%)

[11] Rehabilitation forests were not considered for these activities as it was assumed that they are already under rehabilitation measures; Bamboo and mixed timber-bamboo forests were excluded as they are contemplated under another activity; Mangrove forests, forest on rocky mountain and plantations were excluded as areas of intervention during project design. In addition, the proportion of forests did not consider the conservation management status.

Rich Evergreen broadleaved forest	1.5	9.0
Medium Evergreen broadleaved forest	2.3	13.8
Poor Evergreen broadleaved forest	3.0	18.0
Deciduous Forest	1.5	9.0
Coniferous	2.8	16.8
Mixed broadleaved-coniferous forest	3.7	22.2

To be conservative, no further degradation without the project was assumed. The data was entered considering the with project biomass level to be achieved as non-degraded (0% biomass loss) and the initial state and without project corresponding to the % loss expected to be restored by the project.
The analysis of the activity was refined using tier 2 values (table 10). The values were calculated as the weighted average of the carbon stock values from the technical annex on the REDD+, according to the decision 14/CP.19 (Ministry of Agriculture and Rural Development, 2020) for the year 2019 per type of forest together with the proportion per type of forest per district aggregated at the province level.

Table 10: Biomass carbon stock per type of forest per province and weighted project area average.

Type of forest	Central highlands		South central coast		Final TIER 2 value
	Biomass carbon stock (tC/ha)	Proportion	Biomass carbon stock (tC/ha)	Proportion	Biomass carbon stock (tC/ha)
Rich Evergreen broadleaved forest	153.24	0.997	141.72	0.003	153.20
Medium Evergreen broadleaved forest	78.41	0.955	72.67	0.045	78.15
Poor Evergreen broadleaved forest	38.03	0.857	34.11	0.143	37.47
Deciduous Forest	38.97	0.865	36.76	0.135	38.67
Coniferous	111.70	0.946	111.70	0.054	111.70
Mixed broadleaved-coniferous forest	92.73	0.538	91.45	0.462	92.14

*Carbon stock corresponds to Above Ground Biomass and Below Ground Biomass.

To refine the Soil Organic Carbon content, SOC reference values at the district level (table 1) were weighted according to the proportion of forest available on each district (table 12). The TIER 2 values introduced in the analysis of SOC are represented in table 11.

Table 11: Soil Organic Carbon stock per type of forest as the project area average.

Type of forest	Rich Evergreen broadleaved forest	Medium Evergreen broadleaved forest	Poor Evergreen broadleaved forest	Deciduous Forest	Coniferous	Mixed broadleaved-coniferous forest
Soil Organic Carbon (tC/ha)	33.51	33.80	33.28	32.92	36.83	36.06

- Activity 2.3.2 Support multi-stakeholder commune-level collaborative forest management (MCCFM)

Support fully developed MCCFM by allocating land to local communities or adjusting FLA (15,000 ha) and planting and management of agroforestry systems on bare or degraded land (3,000 ha).

The 15,000 ha of CFM targeted areas correspond to four types of forests according to the national classification used in the hotspot analysis. The analysis assumed that the project would implement activities on the most degraded areas. Therefore, for this activity rich and medium evergreen forests were not considered. The allocation of hectares per different types of forests was done according to their current proportion in the project area[12] represented in table 12.

Table 12: Hectares per forest type to be managed under the project intervention.

Forest type	Proportion Central Highlands	Proportion Southcentral coast	Ha
Poor Evergreen broadleaved forest	0.53[a]	0.06[a]	8,776.55
Deciduous Forest	0.25	0.04	4,321.85
Coniferous	0.10	0.01	1,622.44
Mixed broadleaved-coniferous forest	0.01	0.01	279.15
TOTAL	0.89	0.12	15,000

(a) the proportion of Rich and medium evergreen forests and rehabilitated forests were added to poor evergreen forest following the assumption that the project will target the most degraded forests.

[12] Rehabilitation forests were not considered for these activities as it was assumed that they are already under rehabilitation measures; Bamboo and mixed timber-bamboo forests were excluded as they are contemplated under another activity; Mangrove forests, forest on rocky mountain and plantations were excluded as areas of intervention during project design. In addition, the proportion of forests did not consider the conservation management status.

The project is expected to improve the biomass levels of the hectares under intervention due to a better management. To estimate the increment brought by the project it was assumed that project activities will allow forests to grow according to the average annual wood increment rates in Vietnam (Ministry of Agriculture and Rural development Vietnam, 2016) presented in table 9.

To be conservative, no further degradation without the project was assumed. The data was entered considering the with project biomass level to be achieved as non-degraded (0% biomass loss) and the initial state and without project corresponding to the % loss expected to be restored by the project.

The analysis of the activity was refined using tier 2 calculated following the same approach as in activity 2.3.1 (table 10).

The activities 2.3.1 and 2.3.2 regarding forest management activities were inserted together in the EX-ACT tool. The carbon balance from forest management for activities 2.3.1 and 2.3.2 is -1,412,588 tCO2-eq.

In addition, the project will establish agroforestry systems (3,000 ha) in degraded or bare lands. To be conservative, the analysis assumes the conversion of grasslands (higher levels of SOC and biomass than degraded and bare lands). The final land use was assumed to be shaded perennial systems with a 30% shade.

The carbon balance of the sub activity is -173,364 tCO2-eq.

Activities not taken into account:

The project documentation refers to activities that could be accounted for in EX-ACT but could not be included in this analysis due to insufficient data information in available project documentation.

The implementation of deforestation free activities is expected to avoid commodity driven deforestation caused by the expansion of perennial systems (i.e. coffee). However, the data available during the development of the analysis was not enough to attribute a reliable potential reduction of deforestation due to the activities implemented by the project. Therefore, to be conservative avoided deforestation was not considered.

Refinement of the analysis:

Given the scale of the activities converting existing agroforestry systems towards a more diversified systems, a more in-depth analysis of potential change in input use should be conducted. Currently, chemical fertilizer accounts for a great number of emissions in coffee cultivation in Vietnam. Therefore, management techniques reducing application rates could provide reduction in emissions from coffee cultivation.

In addition to the consideration of changes in input use, once the agroforestry systems to be implemented are clear, tier 2 values should be revisited to represent the agroforestry systems to be implemented (mix of species). The same applies for the mixed acacia plantations.

A key activity accounting for around one third of the mitigation potential of the project is the management of bamboo and timber-bamboo forests. Therefore, when management plans are in place, stating felling volumes, the increase of biomass levels could be revisited.

Extra information:

Table 12: Proportion of forest type per district.

	DAK LAK	DAK NONG	LAM DONG	GIA LAI	NINH THUAN
1 - RICH EVERGREEN BROADLEAVED FOREST	0.51	0.07	0.17	0.24	0.00
2 - MEDIUM EVERGREEN BROADLEAVED FOREST	0.17	0.11	0.22	0.48	0.02
3 - POOR EVERGREEN BROADLEAVED FOREST	0.32	0.25	0.06	0.26	0.11
4 - REHABILITATION EVERGREEN BROADLEAVED FOREST	0.15	0.07	0.20	0.46	0.12
5- DECIDUOUS FOREST	0.45	0.07	0.02	0.37	0.08
6- BAMBOO	0.17	0.19	0.60	0.01	0.03
7-MIXED WOOD-BAMBOO	0.10	0.18	0.66	0.00	0.06
8-CONIFEROUS	0.10	0.02	0.83	0.00	0.05
9-MIXED BRADALEAVED-CONIFEROUS FOREST	0.01	0.01	0.53	0.00	0.46
10-MANGROVE FOREST	0.00	0.00	0.00	0.00	1.00
11-FOREST ON ROCKY MOUNTAIN	0.00	0.00	0.00	0.00	1.00
12-PLANTATION	0.19	0.16	0.31	0.30	0.04