PLAN VIVO PROJECT DESIGN DOCUMENT

zeroCARBON Program
→ Petén, Guatemala

Version 3.1 - 4 July 2024

RIFORESTAZIONE AD ALTO IMPATTO SOCIALE

zeroCARBON Program

Petén, Guatemala

PLAN VIVO PDD

Version 3.1
July 4, 2024

Developed by:

zeroCO2 Srl Società Benefit

Authors: Guido Cencini; Cecilia Monari; Andrea Pesce, Ignacio Auger, Francisco Chi, Virgilio Galicia.

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Overview

Project Title:	zeroCARBON Program
Location:	Guatemala, Petén Department, 9 municipalities
Version:	V 3.1
Project Coordinator:	zeroCO2 SRL SB & Vivero Mundo Verde cecilia.monari@zeroco2.eco virgilio.galicia@zeroco2.eco
Validator:	Lead validator: Flavio Murillo Machado Guiera Control Union Certifications Germany GmbH Bornitzstraße 73-75 - 10365 - Berlin https://controlunion-germany.com/de Local expert / Validator in Training: Gema Echegoyen Control Union Certifications Germany GmbH
Validation Date:	17/09/2024
Project Intervention(s):	**Improved land management through forest plantations and agroforestry** The objective of zeroCARBON program is to restore, through tree planting, Assisted Natural Regeneration and sustainable forest management, the ecological function of degraded land, enabling the restoration of the ecosystem, landscape and providing a sustainable livelihood for local communities. The main planting systems are: - Forest plantations - Agroforestry system with intercropping
Project Participants:	zeroCARBON involves a group of 46 local farming communities spread across 9 municipalities in the Peten region. The ZeroCARBON program reaches 209 participants, considering both cooperatives participating as a group and individuals). The program will expand year by year in the region, involving new families/groups that meet zeroCARBON's eligibility requirements.

Project Area:	134 hectares in 2022, +303,5 hectares in 2023, + ~ 300 hectares from 2024 onward.
Project Period:	2020-2050
Methodology:	Agriculture and Forestry Carbon Benefit Assessment Methodology developed by TLLG & Plan Vivo TAC
Expected Carbon Benefit:	Describe the expected carbon benefit of the project (in tCO2e). 80,283,95 tCO2e (net of the 20% buffer)
Expected Ecosystem Benefit:	• Reducing soil erosion • improving soil fertility • Carbon sequestration • Biodiversity conservation and regeneration • Tree cover regeneration
Expected Livelihood Benefit:	• Food and agricultural production improvement • Community capacity building • Income and economic growth • Diversified and resilient production against the effects of the climate change

1 General Information

1.1 Project Interventions

One of the greatest environmental challenges faced by tropical countries is the design of development models that can reduce rural poverty while preserving natural resources[1]. In Guatemala, the LULUCF (Land Use, Land-Use Change and Forestry) sector represents 27 % of the country's total annual emissions. Moreover, between 1950 and 2010, 53,4 % of the total forest area in the country was lost.

zeroCARBON interventions will serve to discourage deforestation by providing communities with a sustainable livelihood that, simultaneously, will enable the regeneration of the ecosystems in which the projects are implemented.

The objective of zeroCARBON program is to restore, through tree planting, Assisted Natural Regeneration and sustainable forest management, the ecological function of degraded land, enabling the restoration of the ecosystem, landscape and providing a sustainable livelihood for local communities. This will be achieved by shifting land use from extensive livestock farming, cropland, and unproductive fallow to the creation of forestry and agroforestry systems. The project interventions will be implemented following an approach that will not affect the local dynamics of income and subsistence production or the surrounding ecosystems.

The main **project intervention** is **improved land management through forest plantations and agroforestry.** Technical specifications are collected in annex 7.

The two types of activities involve different planting schemes but in fact can be considered in the same project intervention considering the uniformity of the species and the management practices applied.

The main planting systems are listed below:

1. **Forest plantations**

This system will be implemented in fallow areas exploited by years of monoculture, through planting tree species to produce wood and other products. Mainly native species such as Cedar (Cedrela odorata), Mahogany (Swietenia macrophylla) and other forest species of economic and cultural value will be incorporated. Due to their high commercial value, both species have suffered from years of overexploitation in Guatemala. Overexploitation together with their difficulty to recover through natural regeneration, makes both Cedar and Mahogany Vulnerable species according to the IUCN Red List and are both listed in Appendix II of CITES. Hence the importance of recovering these species.
After the first 5 years of planting, communities will be encouraged to allow natural regeneration to restore the ecological functioning of the landscape. From this point, the forest will continue as a production forest while incorporating natural regeneration into the interrows

[1] Scherr, S. J.; White, A.; and Kaimowitz, D. (2004). A new agenda for forest conservation and poverty reduction: making markets work for low-income producers. Forest Trends/CIFOR/UICN: Washington, D.C.

and gaps, which will become available by the gradual thinning of the timber species. More information about the evolution of the project interventions can be found in “long-term management”(pag 13)
Many of the communities, from the early years, establish agroforestry systems mainly with maize, yucca and other annual species.
The density of the forest plantations will be 1,111 plants per hectare. This type of intervention is expected to increase the amount of carbon storage due to the density of trees per hectare, which will grow every year increasing the carbon storage capacity of the plot. In the meantime, livelihoods and ecosystems will be improved through the recovery of forest cover and the gradual integration of other species of flora and fauna. Participants will improve their quality of life by benefiting from the ecosystem services provided by forests and the added value that the land will acquire due to the high commercial value of the cedar and mahogany species used.

2. **Agroforestry system with intercropping.**

Agroforestry system that combines tree plants with annual and permanent crops. These crops and fruit trees will be able to provide additional income in the early years, while the trees will benefit from the cultivation care given to crops. These agroforestry systems will follow the same technical management plan as forest plantations. Therefore, the species that will be used are Cedar and Caoba. The main difference lies that they will be incorporated in plots where fruit trees are already present and, therefore, lower densities per hectare are adopted. Fruit trees associated with forest trees at this stage are not included in the project to generate carbon benefits.

At this stage, there are no participants or plots who have been eligible to implement this type of planting system, thus no plots have been included in the project design or the carbon benefits. However, this planting system is still described in detail and technical specifications have been provided as it is expected that participants adopting agroforestry will be incorporated into the project in the coming years. Therefore, **the current number of participants and hectares for the agroforestry system is 0.**

This type of intervention with perennial fruit species will be limited to specifically defined areas (agroforestry system). In the remaining project area zeroCO2 will provide agroforestry systems together with forest tree crops (Cedar and Caoba) but only with annual herbaceous species (e.g. maize).

In addition to this zeroCO2 will continue to donate fruit plants to families for inclusion in family and community gardens. These plants, however, have a CSR purpose and will not be counted within the project for carbon benefit purposes.

More details on project interventions in Annex 7.

The planting density will be 100 to 400 plants per hectare. This type of planting system will increase carbon storage by including forest species in areas that are solely used for

agricultural crops or livestock. Participants will benefit from the improved agricultural practices and from the economic value that the cedar and mahogany forest species will add to their land.

zeroCO2 trains communities in land use practices that include as many species as possible, increasing the complexity of the system and, therefore, its resilience. This is a long-term process that begins at the first year and will continue during the entire lifetime of the project, sensitising communities to allow the gradual natural revegetation of parts of the project sites.

Figure 1: Agroforestry system managed by communities and zeroCO2 operational team. Same species and management with respect to forest plantation systems.This system is also used with perennial fruit species. Source: zeroCO2

Project sites and species selection

In a number of cases, there will only be one species introduced in a certain plot and adopted by a beneficiary. The number of species to be used in a plot will depend firstly, on the preferences of each participant and, secondly, on the requirements of each species to certain environmental conditions, such as soil type and topography. In the cases where only one species is being introduced, this is mostly due to the limiting physical conditions of that plot, being suitable only for that particular species. Cedar and Mahogany have different requirements and optimal conditions for their establishment and growth. In particular, the most limiting factors for the development of each species and the ones used to determine species selection are topography, soil and drainage.

Species	Topography	Soil	Drainage
Cedar (Cedrela odorata)	The species grows in slopes >20%	Adaptable to eroded or degraded soils	High drainage required, intolerant to waterlogged soils

Caoba (Swietenia macrophylla)	The species can only grow in flat terrain or slopes up to 20%	Intolerant to eroded or degraded soils	Low drainage, tolerant to waterlogged soils

Table 1.1: Limiting factors for growth and development of Cedar and Caoba.

During the initial stage of participant onboarding, the operational team conducts a preliminary analysis of the plot where the person interested in joining the project wishes to introduce a forestry or agroforestry system. Several factors are assessed here, such as topography, soil type, drainage and the current and historical land use of the area. Areas that are forested or that have advanced natural regeneration as current land use will not be accepted in the project, as well as areas in which the characteristics are not appropriate to introduce the species used in this project.
Based on these characteristics, the most suitable type of intervention and the most appropriate species for each participant are recommended. Besides, it is crucial for our project that the choice of species and planting system is made together with each beneficiary, based on their needs and preferences, to avoid imposing a fixed project intervention. Below, three examples of the three different cases of species selection for this project are illustrated through images.

1. Mahogany Forest Plantation

Figure 2: Forest plantation with Caoba established in 2022 in Nuevo Horizonte, Santa Ana, Petén. Conditions: Flat terrain, low drainage soils, only suitable for Caoba. Source: zeroCO2

2. Cedar Forest Plantation

Figure 3: Forest plantation with Cedar established in 2022 in Caserío Setul, Sayaxche, Petén. Conditions: Slope >20% and high drainage soils, only suitable for Cedar. Source: zeroCO2

3. Mixed Forest Plantation

Figure 4: Forest plantation with Caoba and Cedar established in 2020 in Monte Carmelo, La Libertad, Petén. Conditions: No limiting factors for any species. Topography, drainage and soil suitable for both species. Source: zeroCO2

Long term management

With regard to the long-term management of their reforestation plots, communities will be trained and incentivised to promote natural and assisted regeneration of their plots from year 4. The main reason for selecting this timeframe is that both Cedar and Caoba are shade intolerant species in their initial life stages. This makes both species highly sensitive to

competition for light, requiring the elimination of understory vegetation during the first five years to guarantee their establishment and growth.

From this point onwards, participants will be encouraged to allow gradual natural regeneration in their plots. The interrows and gaps will provide suitable conditions for the establishment of a wide range of native herbaceous, shrubs and tree species, consecutively. In the medium term, considering the fast recovery of vegetation in tropical forests, which has already been observed in the project area, there will be a wide range of species present at the project sites, which in later stages will resemble a secondary mixed forest. Considering the variability in locations and environmental conditions, natural regeneration will develop differently in each project site, hence the difficulty to determine at this stage which plant species will be established. Thus, natural regeneration will be actively monitored and documented following the approach described in section 4.8. A list of the species that can appear through natural regeneration in forests in Peten can be found in Annex 17, data was collected from a forest inventory carried out by zeroCO2 operational team.

The increased vegetation brought by natural regeneration will gradually provide habitat for a wide range of wildlife species and connect forest patches, which will facilitate the movement of wildlife across the landscape. The project sites are located in a landscape that includes fragmented primary and secondary forests, thus a wide range of fauna species that inhabit these ecosystems can benefit from an increase in tree cover and utilise the project sites for shade, shelter or pollination opportunities. Considering the biodiversity richness of the project area, a list of vulnerable species that inhabit the forests of Petén and this project aims to benefit is provided in Annex 10. The presence of specific fauna species that are benefitting from the project will be monitored and documented as described in 4.8. More information about the current ecosystem and expected ecosystem changes can be found in section 3.4.

Besides, other ecosystem services which have been lost in the area due to common land uses will be recovered by the presence of trees. The planted trees and revegetation will reduce soil erosion, by increasing the capacity of soil to absorb water and by retaining soil through their root systems. Besides, soil fertility in the project sites, which has been drastically reduced over the years, will also gradually increase as forestry and agroforestry systems develop, as trees access nutrients located in the deeper soil layers, provide organic matter and facilitate nutrient exchange with other plants.

Although one of the main goals of this project is the production of timber and products derived from agroforestry to support local livelihoods, both project interventions also aim to enhance ecosystem restoration and biodiversity by improving the ecological conditions from the baseline scenario. The dominant land uses in the area, particularly agriculture and extensive livestock farming, have resulted in a degradation of forest cover, decrease in soil fertility and scarce vegetation, conditions which are found at every project site. These environmental conditions result in reduced ecosystem services and do not provide a suitable habitat for biodiversity. Through the project interventions, which entail tree planting and are both

compatible with natural regeneration, there will be an increase in various ecosystem services that will benefit both the participants and the natural environment. After the project interventions, the project sites will arrive at a scenario that resembles a secondary mixed forest as opposed to a pasture, guamil or an agricultural plot, resulting in a large improvement from the baseline ecological conditions.

In year 20, the goal is to reach a mixed forest with the remaining mature individuals of cedar and caoba and a variety of species in the understory brought by natural regeneration in the previous years. From this point onwards, the objective is to enable a transition to a sustainable forest management system. This means that commercial trees will be left standing and gradually extracted while enabling the development of the other species. However, each participant will specifically decide whether to only maintain the forest species, Cedar and Mahogany, or enrich the plantation with other species to arrive in the desired scenario at year 20, in which there will be a gradual shift from forest plantation to sustainable forest management. At this initial project stage, as there are not sufficient elements to determine the different long-term management systems that the participants will adopt, a rotation forestry plantation with a 20-year rotation, referring to Cedar and Mahogany, will be considered. During annual monitoring, the different management approaches followed by the participants will then be determined and documented.

Figure 5: Forest plantation managed by communities and zeroCO2 operational team with Cedar and Mahogany with active natural revegetation with wild species. Source: zeroCO2

Assisted Natural Regeneration: implementation and CO2 estimation

The aim of integrating ANR is to increase the biodiversity benefits of a conventional forest plantation by allowing a certain level and form of natural regeneration that biologically enriches the forest while increasing its CO_2 fixing capacity, as well as being able to replace trees that are harvested for timber. Two forest rotations will be carried out, one based on planting and the other based on secondary vegetation management after year 20.
Integrating natural regeneration within the forestry plantations will be a gradual process, which will depend on thoughtful management, ensuring a suitable species selection and abundance of regeneration plants. To date, there are no measures defined by Guatemalan forestry institutions regarding the integration of natural regeneration inside forestry plantations, nor reference to other projects in Guatemala that have adopted this model. Therefore, zeroCARBON will be a pioneer project in implementing this approach in Guatemala. This will require an iterative learning process to find the balance between the successful development of the project interventions, participants' needs, and requirements of Guatemalan forestry institutions. An initial proposal of management plan and implementation actions can be found in the ANR proposal in Annex 18. A detailed management plan that will guide the specific actions to implement ANR is in the development phase, to be approved by INAB.

In order to begin understanding the development, species diversity and CO_2 capture potential of ANR in the project area, three inventories were conducted in Petén in three different plots outside of zeroCARBON. The data collected from the inventories shows a great number of species and structural diversity, which can be reached through natural regeneration in a short period of 5 to 10 years. The total number of species identified was a total of 68 species, which is an average of 33 species per sampled plot, considering the 3 inventories. Several species were recorded in all 3 inventories, which indicates that they are recurrent species in the project area, thus they have a solid chance of establishing in the zeroCARBON plantations through natural regeneration. A detailed explanation of the results from the inventories can be found in Annex 18 in the ANR proposal.

Using dendrometric data collected from these inventories, and based on the initial management plan, a CO_2 model was developed to provide an initial estimation of potential carbon benefits derived from ANR. Three different CO_2 scenarios were modelled, using an average of CO_2 absorption per tree that was calculated from the inventory species that had available data. The medium scenario would bring a cumulative value of 27.8 t CO_2/ha in 20 years, which would amount to approximately 12% of total carbon benefits from the zeroCARBON program. A detailed explanation of the ANR carbon assessment can be found in Annex 18.

Over the course of the project, the carbon model will be improved using monitoring data from zeroCARBON plots.
Overall, integrating ANR within project interventions and in the participant agreements will bring significant added value to the program. Besides the biodiversity benefits and valuable

species, ANR carbon benefits will provide medium and long term economic incentives for participants to promote ANR within their forestry plantations, which will add to the project's permanence and continuity.

1.2 Management Rights

1.2.1 Project Boundaries

Geography

The department of Petén is in the extreme north of Guatemala (north latitude 15° 90' - 17° 81' and west longitude 89° 22'-91° 43'), bordering Mexico to the north and west, Belize to the east, and the departments of Izabal and Alta Verapaz to the south.

Petén has a territorial extension of 35,854 km^2, which represents almost a third of the national territory, making it the largest department in Guatemala, as well as the largest subnational entity in Central America.

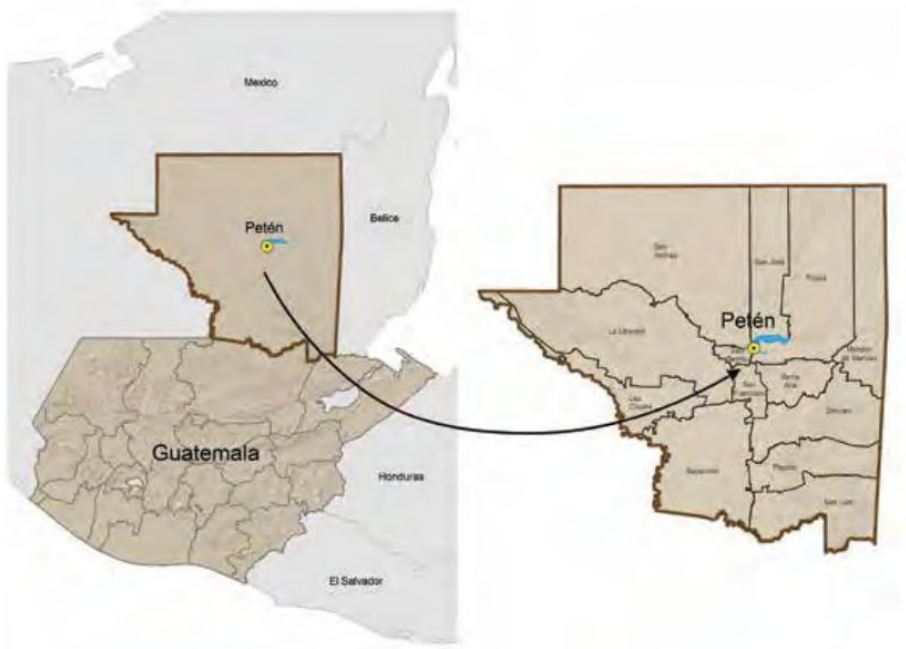

Figure 6: Geographical location of Petén department. Source: Secretaría de Planificación y Programación de la Presidencia –Segeplan (2013)– Diagnóstico Territorial de Petén.

Project Area

The project is being developed in the department of Petén in Guatemala, in 9 of the department's 14 municipalities - Santa Ana, La Libertad, Sayaxche, Las Cruces, Flores, San Andrés, El Chal, Poptun, San Francisco. The map in **figure 6** shows the locations of all communities involved. Communities are spread all over the region.

Specifications on the list of participants, extent of land, baseline land use, and location polygons can be found in **Annex 3**.

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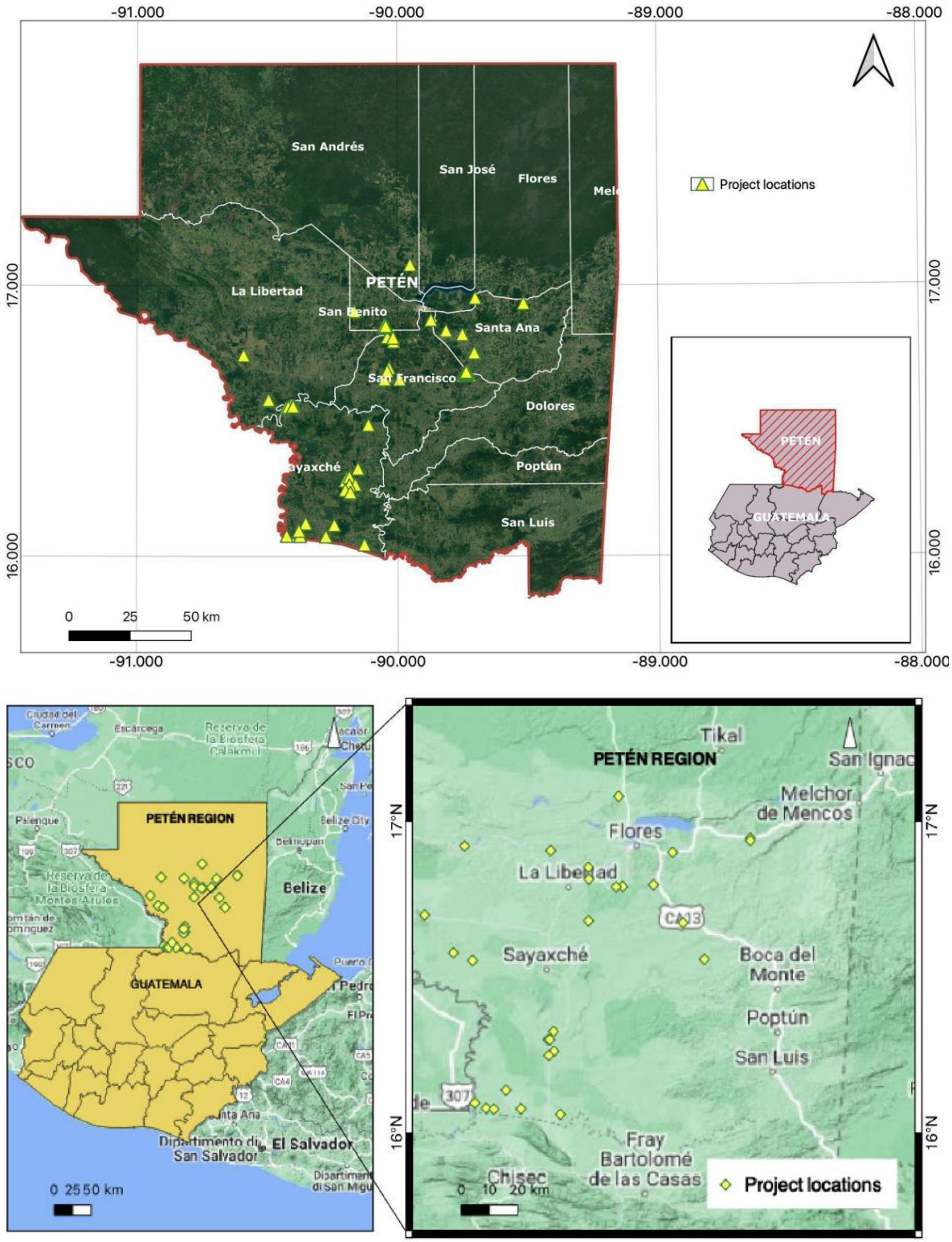


Figure 7: Project locations. The individual georeferenced plots of the project areas are collected in kml format in Annex 17 - Project areas. Source: elaboration of zeroCO2 based on Google satellite imagery

The department of Petén is in the extreme north of the country, sharing borders with Mexico (north and west), Belize (east), and the departments of Izabal and Alta Verapaz (south).

Petén has a territorial extension of 35,854 km2, representing almost a third of the national territory, which makes it, with its 14 municipalities, the largest department in Guatemala and the largest subnational entity in Central America.
Petén is the most extensive wooded tropical ecoregion in Mesoamerica and functions as the natural northern boundary for tropical vegetation. There are two protected areas in the Petén region that represent 74% of the territory (25,071 km2): the Maya Biosphere Reserve, the largest block forest area in Mesoamerica, and the Protected Areas of southern Petén. The protected areas are composed of 3 zones: Buffer Zone (in some of which the project is developed), Multiple Use Zone, and Core Zone.
The most significant impacts on this ecoregion are evident in the extensive areas of forests that have disappeared, mainly due to agriculture and livestock raising activities.

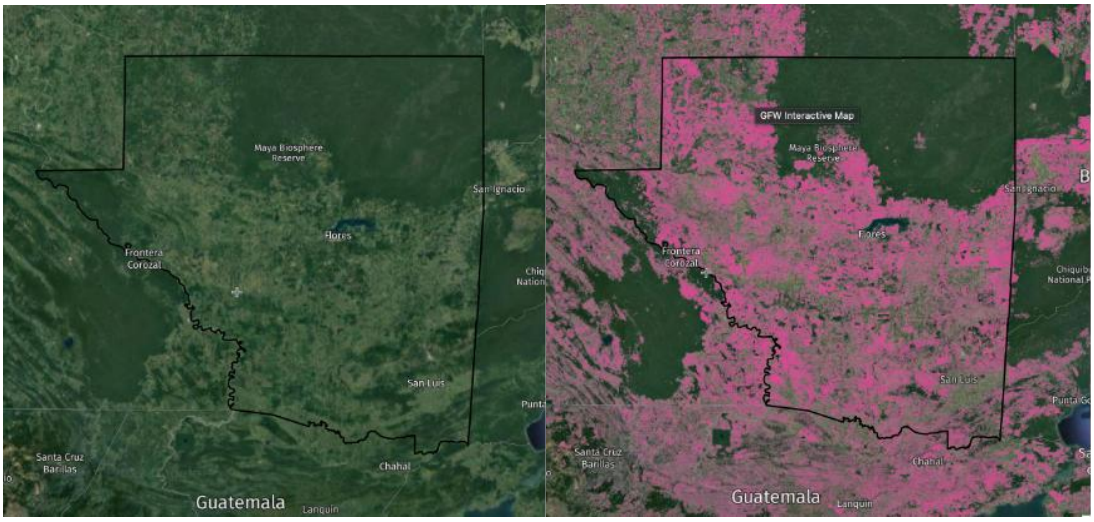


Figure 8: The areas in pink are the result of an algorithm developed by Global Forest Watch that represents the loss of tree cover and primary forest in the Peten region over the period 2001-2021. Source: Global Forest Watch

Drivers of land use change, deforestation, and degradation

Over the past 30 years, Guatemala has lost about 23% percent of its humid primary forest cover.
According to CEMEC-CONAP 2011, forest cover in 1993 was 22,646 km2 equivalent to 73% of the department and decreased to 64% by 2001. By 2006, the department had approximately 50% of the national forest cover, and the dynamics of forest cover show that by 2010 it was at approximately 48.42%. A discouraging fact for the department is that 85.3% of the total loss of forest cover at the national level occurs in Petén. According to the 2006-2010 forest cover map, the relative loss of forest cover in the municipalities of Petén that present the highest numbers, even at the national level are: San Andrés, La Libertad, Sayaxché and Poptún, reporting more than 25,000 ha hectares lost each. According to the Global Forest Watch data, from 2010 to 2021, Guatemala lost 311kha of primary wet forest (more than 61% of which was in Petén), accounting for 43% of the total loss of tree cover over the same period. The total area of primary rainforest in Petén decreased by 12% during

this time. Reforestation and agroforestry initiatives are crucial to reverse this alarming rate of forest loss in the Petén department.

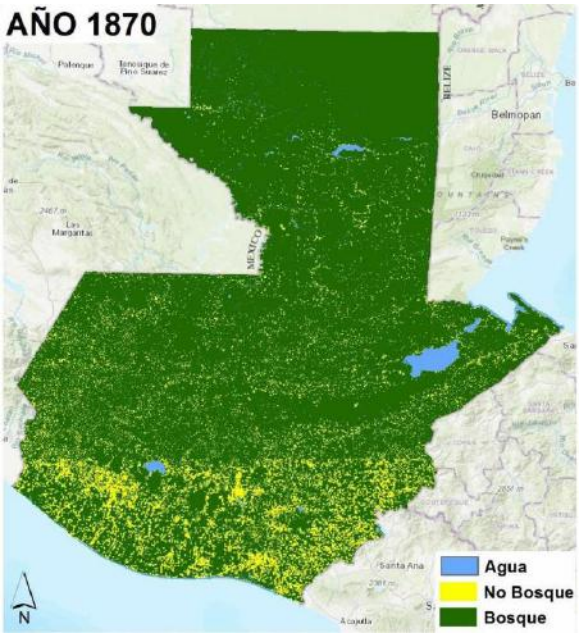


Figure 9: Land use of Guatemala, 1870. Source: Guatemala Emission Reductions Program: Overview of ER-PD. Government of Guatemala, July 2019

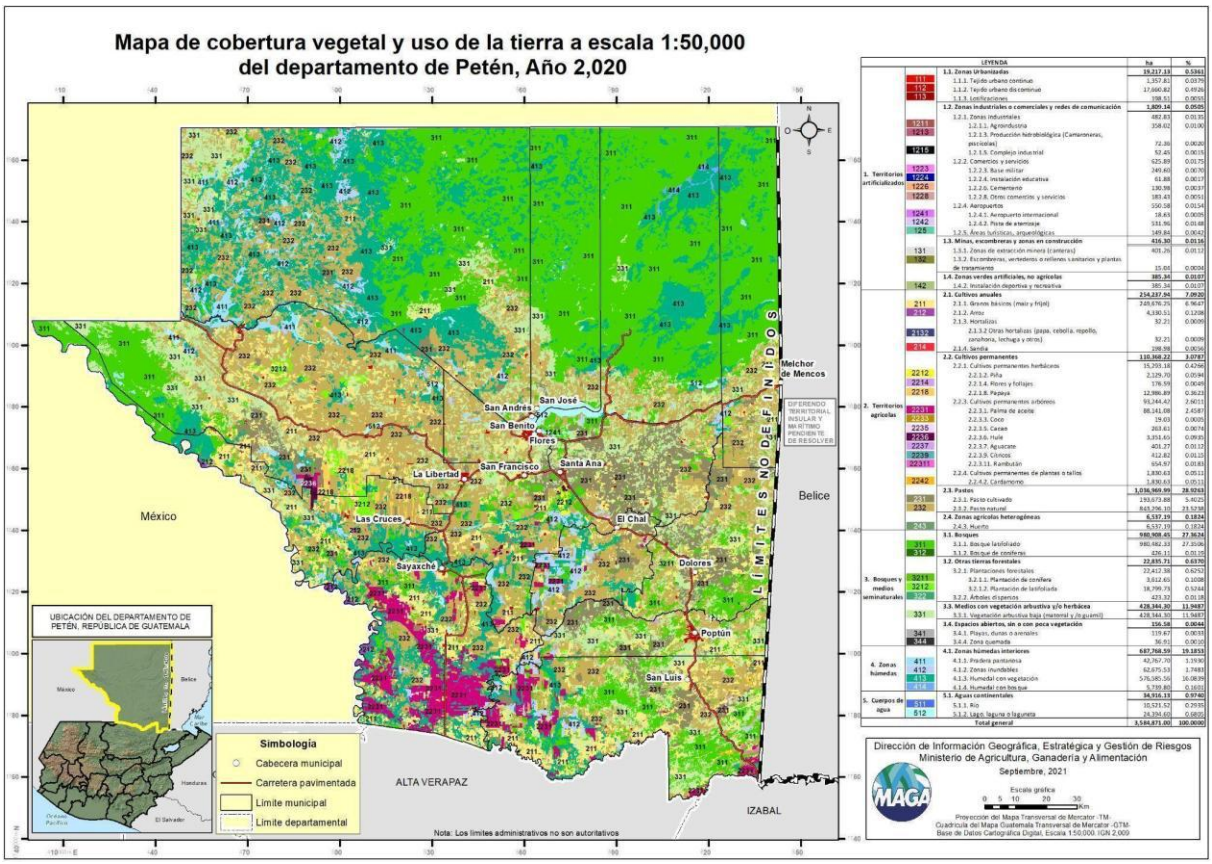


Figure 10: Land use of Guatemala, 2020. Source: Ministerio de Agricultura Ganaderia y Alimentacion de Guatemala (2021)

The main causes of deforestation have been agricultural colonisation and the establishment of intensive cattle ranches and plantations by large, often absentee, landowners.
80% of the forest loss in Petén is mainly caused by the habilitation of land for agriculture and livestock, which is evident considering that in the period from 2006 to 2010, 1.246,11 km2 of forest was lost for crops or pastures. These are subsequently abandoned and converted into “charral” or “guamil”, subsistence land management systems that in the short-term lead to high land degradation.

Guamil is a slash and burn system where periods of subsistence farming alternate with periods of fallow land.
In modern 'guamil' or 'milpa', the small size of the land often causes the resting phase (secondary regeneration of the soil) to be skipped or reduced to a minimum, causing a decrease in soil fertility in the long run, ultimately reducing diversity to maize production alone. This is without taking into account the cyclical burning processes destroy secondary regeneration in the resting phase causing large amounts of emissions as well as a risk of loss of fire control.
Over-cultivation, overgrazing and monoculture lead to a loss of fertility and a severe degradation of the area's soil characteristics. In this context, the increasing variability and intensity of rainfall due to climate change has increased the number of extreme weather events such as hurricanes, floods, droughts with consequent problems to the crops.

In fact, this advance of the agricultural frontier increases soil deterioration, as the forest cover is being eliminated and replaced by a less protective soil cover, making the resilience of the soil in Petén hard to achieve.
This situation is massively extended throughout the region, including in the project development areas, to date composed mainly of agriculture, livestock, and land with degraded forest.
The project is developed in some of the buffer zones inhabited by communities or individuals with land titles, which is why the project can also be implemented in the buffer zone of the Mayan Biosphere Reserve, which is considered as category II of protected areas by the IUCN. The reason is that land titles were awarded prior to the creation of the protected area.

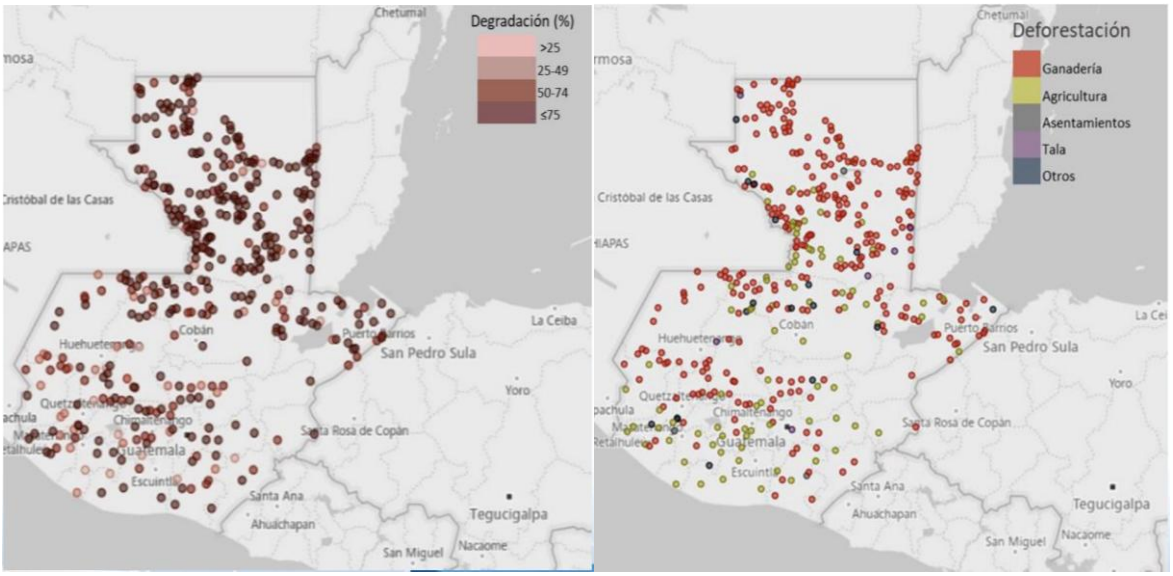


Figure 11: (sx) Spatial distribution of land degradation; (dx) Spatial distribution of main causes of deforestation in Guatemala. Source: Guatemala Emission Reductions Program: Overview of ER-PD. Government of Guatemala, July 2019

In the meantime, palm oil plantations expanded their cultivated area by over 800% between 2005 and 2011. In many cases, people sold their land to plantation companies immediately after receiving it through land distribution programmes sponsored by the country's Fondo de Tierras[2] (Land Fund) or after legalising their existing plots. Hurtado (2008, pp. 14-15)[3] reports that the Fondo de Tierras has distributed land in the Sayaxché area (southwest of Petén) to 2,113 beneficiary families. The author estimates that of total plots assigned to beneficiaries between 2001 and June 2008, 60 per cent were acquired by palm oil plantation companies.

1.2.2 Land and Carbon Rights

Table 1.2.2 Land and Carbon Rights

Project Area	Ownership and user rights status	Carbon rights	Evidence

[2] https://www.acnur.org/fileadmin/Documentos/BDL/2008/6732.pdf

[3] Hurtado, L., 2008. Plantations for Agrofuels and Loss of Lands for the Production of Food in Guatemala. Report prepared for Actionaid, Guatemala, August 2008.

Individuals .	**Individual property** A) Propietarios (Owners): These individuals have a registered title to the land. B) Poseedores legales (Legal Possessors): In this case, the holder has a title, but it is not registered in the Land Registry. In both cases, zeroCO2 signs an agreement with each person/family. 85 participants out of the total participate with individual ownership titles.	The resulting by-products, including carbon-related rights and timber & no-timber products, become, according to the project agreement defined between the parties, the property of the project participant. Ley Marco del Cambio Climático (LMCC) Article 22 regulates Carbon market projects and is the main article dealing with the nature of carbon rights in Guatemala. As stated in Article 22, carbon rights apply to the two types of land tenure (property and possession) covered by the project: "Activities and projects that generate emissions reduction or removal certificates may access voluntary and regulated carbon markets and other bilateral or multilateral compensation mechanisms and payment for ecosystem services. Rights, ownership and negotiation of emissions reductions units of carbon or other greenhouse gases will belong to the owners [dueños titulares] of the generating project referred to in the preceding paragraph, for which purposes they [the projects] must be entered in the register created by the	Title of property or possession right, which provide absolute rights in decision-making on land use. With respect to the title of property, this is registered in the general Property Registry of Guatemala. With respect to the possession rights, these are issued by the Fondo de Tierra law (FONTERRA decree 24-99) or by Municipalities due to the fact that the possessor is still taking the corresponding steps to register the land in the general Property Registry of Guatemala as his property. According to Article 20 of FONTERRA decree 24-99, its beneficiaries are Guatemalan campesinos peasants, individually considered or organised in groups for access to land and agricultural products, livestock, forestry and hydrobiological production.

		Ministry of Environment and Natural Resources (MARN). Individuals, legal persons or the State that are the Owners or Legal Possessors (A, B, C) of the land or goods in which the project is realized may be the registered owners of projects.	
Cooperatives and associations	**Group ownership title** C) Tierra comunal (Communal Land): Group ownership titles are obtained through different legal figures like Cooperatives, Peasant Business Associations (Empresas Campesinas Asociativas), and Collective Agrarian Patrimony (Patrimonio Agrario Colectivo). These titles provide land Ownership to the members of each legal figure. Ownership is by the organised group that	Both the trees donated by zeroCO2 to the communities and the resulting by-products, including carbon-related rights, become, according to the agreements defined between the parties, the property of the project participant. Ley Marco del Cambio Climático (LMCC) Article 22 regulates Carbon market projects and is the main article dealing with the nature of carbon rights in Guatemala. As stated in Article 22, carbon rights apply to the two types of land tenure (property and possession)	The Group ownership title is duly registered in the general Property Registry of Guatemala.

	plants the trees in the community plots. Group ownership titles are obtained through the creation of cooperatives or corporations with legal personality. The titles are in the name of the cooperative or society, which is represented by a board of directors. Land titles provide absolute rights in decision-making on land use. In the case of collective land titles, zeroCO2 signs an agreement with each cooperative or society. It is important to mention that in the case where the property title is communal, not all the villagers participate in the project, so the benefits are individual for each participant.	covered by the project: "Activities and projects that generate emissions reduction or removal certificates may access voluntary and regulated carbon markets and other bilateral or multilateral compensation mechanisms and payment for ecosystem services. Rights, ownership and negotiation of emissions reductions units of carbon or other greenhouse gases will belong to the owners [dueños titulares] of the generating project referred to in the preceding paragraph, for which purposes they [the projects] must be entered in the register created by the Ministry of Environment and Natural Resources (MARN). Individuals, legal persons or the State that are the Owners or Legal Possessors (A, B, C) of the land or goods in which the project is realized may be the registered owners of projects.[4]	

[4] https://www.minambiente.gob.gt/wp-content/uploads/2017/07/Ley-Marco-del-Cambio-Climatico-y-Estrategia-Nacional-de-Cambio-Climatico-y-Manejo-de-Recursos-Naturales-2016-2021.pdf

2 Stakeholder Engagement

2.1 Stakeholder Analysis

2.1.1 Stakeholder Identification

Table 2.1.1 Stakeholder Analysis

Stakeholder Group	Stakeholder Type	Impact	Influence	Engagement
Vulnerable and marginalised communities zeroCO2 works with smallholders, (landowners), either individually or communally. Project participants live in rural areas with little access to basic services, facing conditions of social, economic and climatic vulnerability. The project involves smallholders, (landowners) with land or individual property titles. Project participants live in rural areas with low economic resources with little access to basic services, facing conditions of social, economic and climatic vulnerability, due to the absence or difficulty of access to basic services,	Local	<u>Social</u> • Increased knowledge and skills of farming communities (*high*) • increase in local people's capacity to manage the land and to produce (*high*) <u>Economic</u> • Diversification of production (*high*) • Diversification of income sources (carbon and plantation by-products) (*high*) • Improvement in crop productivity (*high*) <u>Environmental</u> • Regeneration of soils at risk of degradation through the improvement of above ground biomass, below ground biomass and soil litter (*high)*	<u>Social</u> • Access to educational and environmental programs (*high*) • Strengthening of community social relations (*Moderate*) • Emergence of new community projects (*Low*) <u>Economic</u> • Initiation of micro-entrepreneurship pathways (*moderate*) <u>Environmental</u> • Reducing the risk of diseases and fires (*high)* • Increasing environmental awareness within communities (*Moderate*)	<u>Communities' engagement</u> 1. zeroCO2 starts the engagement process, by organising periodic meetings with participating communities to present the project objectives, the PVCs functioning, and operations (both technical and economic), gathering feedback and interest. 2. Subscription of the agreement with each community/participant. 3. Subsequent meetings to organise commissions by community, in the case of individuals, to directly discuss the commitments. 4. Training on the short, medium and long term implementation of the projects and social empowerment.

quality education, and health. Participants' land sizes average 2-4 hectares and up, on which diversified use and absence of conflict with food production is guaranteed. Land use varies from one area to another (usually each person owns more than one area that they devote to different activities). In general, the main land use is traditional farming and low-scale livestock.		• Restoration of forest ecosystems and biodiversity (*high)* • Land fertility improvement (*high)*		5. Technical assistance in the management of their plantations. 6. Follow-up on the above aspects for the duration of the project.
Non participants farming communities/ individuals	Local	<u>Social</u> • Increased knowledge and skills of farming communities (*low*) • increase in local people's capacity to manage the land and to produce (*low*)	<u>Social</u> • Strengthening of community social relations (*Low*) • Emergence of new community projects (*Low*) <u>Environmental</u> • Reducing the risk of diseases and fires (*medium)* • Increasing environmental awareness within communities (*Low*)	All members of the target communities will be involved and sensitised in the initial stages of engagement (up to the creation of the participant groups), ensuring widespread and shared awareness of the program's objectives, benefits and obligations.

INAB (Forest National Institute) - government agency responsible for forestry and environmental legislation.	Secondary	Environmental • Improvement of forest cover and institutional objectives. (High)	Institutional • Good coordination to respect the laws and regulations of the Republic of Guatemala (Moderate)	Institutional bodies are not directly involved in decision-making within the project, but rather as governing and regulatory bodies of the state. The project will mainly collaborate with INAB, which has been informed about the program. The definition of a structured collaboration is currently being developed.

2.1.2 Indigenous Peoples and Local Communities

Table 2.1.2: Indigenous Peoples and Local Communities

Indigenous Peoples or local communities.	**Rights to land or resources in the project area(s)**	**Governance structure**	**Involvement of women and marginalised groups**	**Engagement**
Local and indigenous (mayan) communities	They have absolute rights to make decisions about their land, as they have a title deed or contract that accredits them as	Participating communities have different forms of organizational structures, depending on the goals for which they were founded. In general terms, each community may be organized as a cooperative or an agricultural enterprise,	Access to the Board of Directors is open to all democratically elected members of the community, regardless of their gender or ethnic group. The communities are built on a strong basis of cultural and historical	The project will directly involve the communities as it targets rural and marginalised areas that are not prioritised by the state for basic services. Indigenous and local communities are the main beneficiaries of this project, which

	land owners.	with different representative bodies. In most cases, the highest authority within the community is the General Assembly, which elects the Board of Directors, the body composed of a certain number of members (5 to 9) elected by the community members, in which decisions are made and which will represent the community during the period of its establishment and be responsible for it. In some communities, the Board of Directors is replaced instead by the Community Development Council (COCODE), a body with legal representation before state institutions. COCODE's highest institution is the community assembly, made up of all community members and acting as the coordinating body at the municipal level. Parallel to the Board of Directors/COCODE, each community is organized into a number of specific committees, such as education, health, women, reforestation, and any other relevant issues within the community.	continuity. Therefore, the composition of the Boards varies according to the composition of the community. Although in Mayan culture it is mostly men who are in charge of field work, within the cooperatives women maintain a prominent role in decision-making on community land-use projects. zeroCARBON promotes equal access to decision-making bodies related to the program in order to give equal hearing and voice to all members of the participating group. Thus, in community committees, representation is expected to be proportional to the composition of the community, both in terms of women and indigenous representation.	ensures their engagement in every stage of the project.

		The type of committee and the success of its work varies depending on the community and its priorities. The zeroCARBON program is centrally managed by the Board of Directors/COCODE in the early stages of engagement, being the first entity with which it interacts. As the program develops, the creation of additional specific committees/bodies at the community level is planned for the representation of participants and the operational management of the program. These bodies are responsible for verifying compliance with all agreements established in reforestation projects and for signing agreements with communities, as well as for coordinating and organising all activities to be carried out during the process, from area selection and preparation to tree planting, pest control, or monitoring and supervision against forest fires. They also play an active role in collecting grievances and in daily communication with the		

		Project Developer. Further information is described in Section 5.1.		

2.1.3 Disputed Land or Resources

The project does not involve disputed land or resources, as it is limited to participants who have title deeds or contracts for the right of possession of the land.

These are covered by the national law that regulates access to land is the Land Fund - FONTIERRA - decree 24-99. According to Article 20 of this law, its beneficiaries are Guatemalan campesinos/peasants, individually considered or organised for access to land and agricultural, livestock, forestry and hydrobiological production, and those who are registered in the Property Registry, a state entity that governs the movable and immovable property of Guatemalan and foreign citizens. This entity oversees providing deeds to land rights, as long as there is no conflict with the laws of the country.

A proactive approach ensures that ZeroCARBON operations are conducted in areas where land rights are secure, minimising the risk of involvement in potential property rights issues such as drug trafficking and cases of corruption. For instance, regions affected by armed conflicts and unstable land ownership are avoided, with focus directed towards areas where participants have established property rights and resolved any outstanding debts. Additionally, locations known for drug trafficking activities are also avoided.

2.2 Project Coordination and Management

Table 2.2 Responsibility for Project Coordination and Management Functions

Project Coordination and Management Function	**Responsible Party/Parties**
Stakeholder engagement during project development and implementation	zeroCO2/Vivero Mundo Verde
Ensuring conformance with the Plan Vivo Standard and compliance with applicable policies, laws and regulations	zeroCO2
Developing technical specifications, land management plans and project agreements with project participants	zeroCO2/Vivero Mundo Verde
Ensuring that the PDD is updated with any changes to the project	zeroCO2
Registration and recording of management plans, project agreements, monitoring results, and sales agreements	zeroCO2

Managing project finances and dispersal of income to project participants as described by the benefit sharing mechanism	zeroCO2
Managing Plan Vivo Certificates in the Plan Vivo Registry	zeroCO2
Preparing annual reports and coordinating validation and verification events	zeroCO2
Securing certificate sales and other means of funding the project	zeroCO2
Assisting Project Participants to secure any legal or regulatory permissions required to carry out the project	zeroCO2/Vivero Mundo Verde
Providing technical assistance and capacity building required for project participants to implement project interventions	zeroCO2/Vivero Mundo Verde
Monitoring progress indicators, livelihood indicators and ecosystem indicators and providing ongoing support to project participants	zeroCO2/Vivero Mundo Verde

The management of the zeroCARBON program is based on a strong collaboration between the two teams, the Italian team (zeroCO2) and the Guatemalan team (Vivero Mundo Verde).

In Italy, a team of 3 people is in charge of the management and development of all activities necessary to ensure compliance with the Plan Vivo Standard and compliance with applicable policies, laws and regulations; it also takes care of updating the PDD with any changes in the project and of the annual reporting and validation and verification events, and of the issuance in the PV registry of the PVCs. Finally, it deals with the financial management of the project and the commercialization of the PVCs in the market and sales agreements, ensuring the sale of certificates and other means of financing the program.

The Vivero Mundo Verde team will be responsible for following the operational development of the project with the participants, providing technical assistance and capacity building necessary for each project participant to implement project interventions and following the monitoring of Progress Indicators, Means of Living Indicators and Ecological Indicators and providing ongoing support to project participants.

It is important to emphasise the importance of the role of the local partner in building relationships with the communities, by virtue of its extreme link with the territory and its deep knowledge of the local context.

All program activities are based on a common strategy and planning, defined together by the both partners, according to the normative and technical needs and to the different phases of the program. Therefore, each team is fundamental and functional for the achievement of the project's quality objectives.

zeroCO2 S.r.l. Società Benefit

zeroCO2 S.r.l. Società Benefit is a Bcorp company based in Italy with most of its operations in Guatemala that focuses on sustainability through reforestation projects with high social impact in various parts of the world.

Through reforestation, afforestation, agroforestry, and planting projects in rural, urban and sub-urban areas in different regions of the world, zeroCO2 contributes to economic and food security of farming communities while it enables individuals or companies to adopt/gift different species of trees and create their own forest with high social impact.

In order to guarantee full transparency and traceability of its projects, zeroCO2 has developed Chloe, an innovative tracking system applied to reforestation programs prior to zeroCARBON that allows the users to monitor tree growth, receiving a series of photographic updates of the plant over time.

zeroCO2 was founded in 2019 between Italy and Guatemala, where, thanks to the direct management of the value chain, it launched one of the largest reforestation projects in the country, planting more than 1 million trees in 4 years in the Petén region. These trees have been used for CSR and communication projects and will not be used to generate Plan Vivo Certificates.

The project involves the direct participation of local farming communities (now more than 70), to which zeroCO2 donates native fruit and forest trees to support the economy of individual families and their food security. In addition, each community receives training on organic agriculture and sustainable tree management over time, delivered through the involvement of a team of local experts and institutions.

Currently, zeroCO2 is also working in Peruvian Amazon, Tanzania, Patagonia Argentina, and Europe, where it applies the same project model, aimed at generating strong positive social and environmental impacts. To date, zeroCO2 has planted more than 1.2 M trees in forest and agroforestry systems through an approach based on three distinctive elements: transparency and traceability, social impact and value chain management.

Main activities:

- Reforestation/afforestation and agroforestry project management and coordination in different countries (Latin America, Africa and Europe).
- Life Cycle Assessment (LCA) and Carbon Footprint (CFP) analysis
- Communication and sustainability strategy advisory·
- Over 350 B2B partners in Europe
- Over 7,000 B2C partners in Europe
- Community engagement activities through awareness campaigns, events, training.

Vivero Mundo Verde

Vivero Mundo Verde is a Guatemalan nursery company based in Santa Ana Petén and dedicated to the ecological production of native forest and fruit plants for the zeroCO2 project

(+200,000 plants/year). The plants produced in the nursery are properly managed from seed selection, seedlings, transplanting and plant growth management.
Vivero Mundo Verde consists of a team of 12 people, including the Program Director and Local Representative of zeroCO2 (Virgilio Galicia), the Technical Director (Francisco Chi), the nursery team (6 people), and the operations team (4 people). Each team member has been hired by Vivero Mundo Verde in compliance with national contracting and rights under the Guatemalan Labor Code.

As partner of zeroCO2, Vivero Mundo Verde provides technical advice and operational support in forest design and plantation monitoring.
During the distribution and monitoring phases, part of the nursery team works to support the operations team, thus doubling the resources in the field. As the project expands, a proportional increase in team resources is expected.

2.3 Project Participants

Table 2.3: Project Participants (grouped by village, area or region)

Project Participant Communities	Participant Type*	Location of Residence Municipalities	Typical Land Holding Hectares	Land and Natural Resource Use	Participants per community
Agua Chiquita	Type 1	Sayaxche	4	Agriculture	4
Canahan	Type 1	Sayaxche	4	Agriculture	5
Caserio La Isla	Type 1	Sayaxche	30	Livestock	1
Cooperativa La Palma	Type 1	Las Cruces	4	Livestock	1
Cruce Semuy	Type 1	Sayaxche	4	Agriculture	1
El Buen retiro	Type 1	Santa Ana	4	Livestock	2
El Caoba	Type 1	Flores	4	Agriculture & Livestock	2
El Eden	Type 1	Sayaxche	4	Agriculture	3
El Juleque	Type 1	Santa Ana	4	Agriculture	1
El Polol	Type 1	La Libertad	4	Livestock	1
El Rosalito	Type 1	Sayaxche	4	Agriculture	3
Entre Rios	Type 1	Sayaxche	4	Agriculture	1
Km 40	Type 1	Santa Ana	4	Livestock	2
La Laguna Perdida	Type 1	San Andrés	4	Livestock	1

La Pita	Type 1	Santa Ana	4	Agriculture	1
Las Camelias	Type 1	Sayaxche	4	Agriculture	4
Las Mojaras	Type 1	El chal	4	Agriculture	1
Las Pozas	Type 1	Sayaxche	4	Agriculture	1
Los Angeles	Type 1	Santa Ana	4	Livestock	1
Monte Carmelo	Type 1	La Libertad	4	Agriculture & Livestock	30
Nueva Colorada	Type 1	Flores	4	Livestock	1
Nueva Esperanza	Type 1	Sayaxche	4	Agriculture	3
Nueva Libertad	Type 1	Sayaxche	4	Agriculture & Livestock	2
Nuevo Amanecer	Type 1	La Libertad	4	Agriculture	8
Nuevo Coban	Type 1	Sayaxche	4	Agriculture	1
Nuevo Horizonte	Type 1	Santa Ana	4	Livestock	96
Parcelamiento Acte	Type 1	San Andrés	4	Agriculture	1
Parcelamiento El Sinte	Type 1	La Libertad	4	Agriculture	1
Paso del Norte	Type 1	Flores	4	Agriculture	1
Poptun	Type 1	Poptun	10	Livestock	2
Purucila	Type 1	Santa Ana	4	Agriculture	1
Purushila	Type 1	Santa Ana	4	area agricola en descanso	1
San Antonio Seinup	Type 1	La Libertad	10	Livestock	1
San Francisco	Type 1	San Francisco	4	Livestock	1
San Juan de Dios	Type 1	La Libertad	4	Livestock	1
San Juaquin	Type 1	Sayaxche	4	area agricola en descanso	1
Santa Ana	Type 1	Santa Ana	4	Agriculture & Livestock	4
Santa Melia	Type 1	El chal	4	Agriculture & Livestock	7

Santa Rita	Type 1	La Libertad	4	Agriculture	1
Santo Domingo	Type 1	Sayaxche	4	Agriculture	1
Saragoza	Type 1	Sayaxche	4	Livestock	1
Setul	Type 1	Sayaxche	4	Agriculture	1
Tezulutlan I	Type 1	Sayaxche	4	Agriculture & Livestock	5
Tezulutlan II	Type 1	Sayaxche	4	Agriculture	1
Tierra Blanca	Type 1	Sayaxche	4	Agriculture	4
Unión Maya Itza	Type 1	Las Cruces	4	Agriculture	1
Vista Hermosa Los Chorros	Type 1	Las Cruces	4	Agriculture	1

* Type I = Project participants that do not meet the Type II definition; Type II = Project participants that are not resident within the project area, do not manage land or natural resources within the project area for small-scale production, or are structurally dependent on year-round hired labour for their land or natural resource management activities.

zeroCARBON involves a group of 46 local farming communities spread across 9 municipalities in the Peten region. The 2022 program reaches 119 participants, considering both cooperatives participating as a group and individual farmers. The program in 2023 reaches 209 participants, Of which over 55 are participants who have also been involved since 2022 and have decided to plant new trees as part of zeroCARBON.

In Annex 6 Carbon Calculation spreadsheet we also include the baseline scenario for each participant with the different strata selected.
The ground truth of the land use evidence was realised on the basis of the operational team's visits and the collection of individual participants' georeferenced polygons mapped in Appendix 1 and shared separately with Plan Vivo. A complete list of participants can be found in Annex 3.

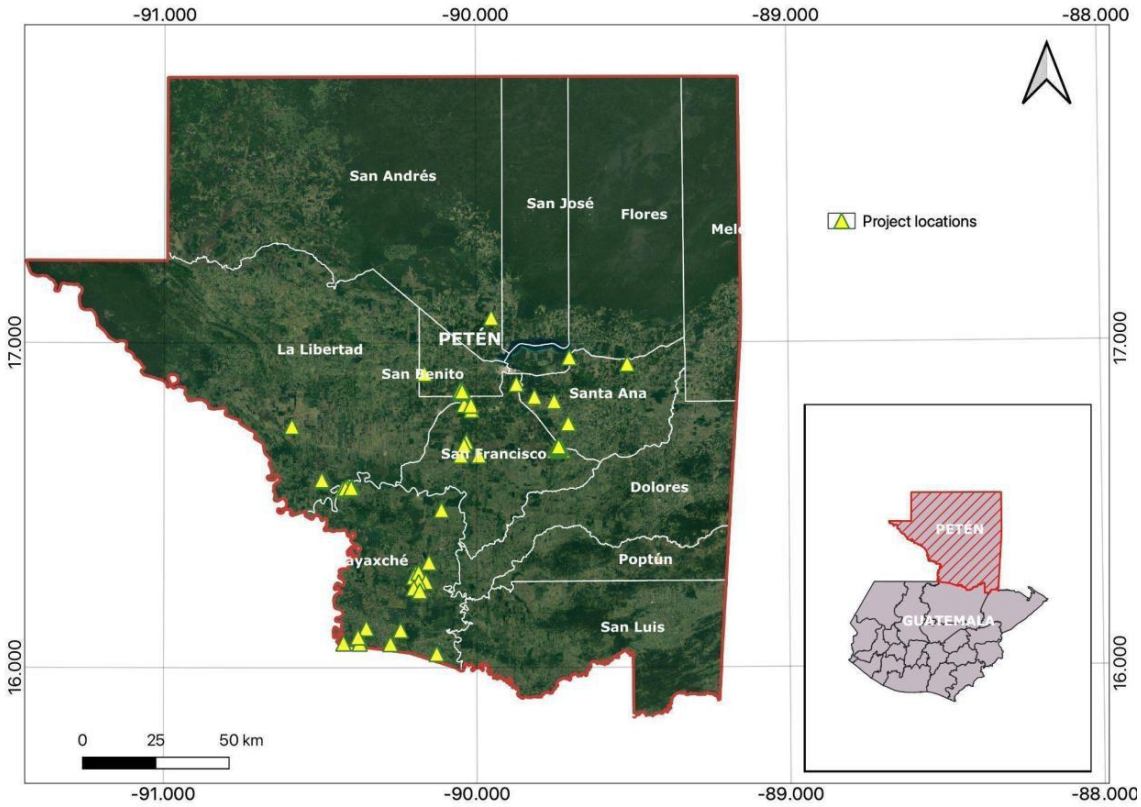


Figure 12: Project locations involved in zeroCARBON project in 2022. Source: elaboration of zeroCO2 based on Google satellite imagery

Target communities description The general characteristics of the project participants are diverse, mainly poor families, with an average size of 4.5 people. The project includes participants from different ethnic groups, mainly Maya and Ladino, Petén being a region with increasing migration of people from the Q'eqchi' group. Petén has over 32 percent indigenous population, with 90 percent represented by the Q'eqchi' ethnic group, which reaches over 50 percent of the population in the south of the region, especially in municipalities such as San Luis (60 percent) and Sayaxche (63 percent), both of which are involved in the zeroCARBON project. In the group of 2023 participants, over 25% are Mayan Q'eqchi' population (of which about 22 percent are women).

In the region, the percentage of the population living below the poverty line reaches 70 percent (including 16 percent in extreme poverty) with a GDP per capita (World Bank 2020 data) of $4,603. This situation is also reflected in the participant groups where more than 50% of them live below the poverty line.

Many of the participating communities lack basic services such as electricity, potable water, secondary education, and primary health care.

The economic dynamics of most Petén municipalities are based mainly on agricultural, livestock and agroforestry activities, which occupy 68 percent of the region's GDP.

The totality of participants in the zeroCARBON program obtain their economic and food resources from agriculture, in which the family participates in all agricultural activities, making income diversification crucial for their long-term well-being. The agriculture practised in the

communities is traditional with hand tools for the production of crops used in the local diet, such as maize, beans, cassava, chili, sweet potato, macal among others. There are different agricultural species in a small area, the type of farming is similar throughout the region where the project is implemented. It is important to note that the areas where the program interventions are carried out, are additional to the areas where the above agricultural activity is carried out, which are normally located around the house instead. Carbon and timber benefits generated in project sites will provide a significant additional revenue for participants along the project period, which will be complementary to their agricultural activities. At the same time, income diversification will reduce their dependence on the agricultural income stream, increasing their economic resilience.

At the social and demographic level, although the population of the department is relatively young, social and gender inequality is very high. According to INE 2018 data, women make up 50 percent of Petén's population. Guatemalan society is strongly marked by gender inequality, to the detriment of women. The patriarchal system has established a system of social relations in which women are relegated to positions characterised by exclusion, oppression, and discrimination. According to the World Economic Forum's Global Gender Inequality Report 2021, Guatemala ranks 122nd in terms of gender equity, out of a total of 156 countries analysed. According to this ranking, Guatemala is the country with the lowest gender equity in the Americas.

The project aims to improve gender equality by providing equal access and opportunities for men and women. At the same time, it is important to acknowledge the gender cultural context of the project area, which is reflected when property titles are occasionally not held in women's names. However, there are communities where most of the beneficiaries are women.

zeroCARBON promotes social equality and non-discrimination in its projects to ensure that everyone can have access to the activities and benefits that are promoted by this institution, regardless of their gender. In the current list of participants, about a quarter of the group are women. In some communities such as Nuevo Horizonte, where zeroCO2 has been working the longest, the female presence exceeds 32 %. The program's goal is to expand this number over time through widespread outreach and engagement activities.

Among them, to strengthen the project´s reach in this issue, zeroCO2 will hold periodic workshops about gender-based violence. The frequency and content of these workshops is still under development.

zeroCO2, as an organisation, has a strict policy in gender equality matters which will be followed by project staff throughout the lifetime of the project. Vivero Mundo Verde is part of zeroCO2 on the operational level, which means that their staff will follow the same policy and principles in this matter.

2.4 Participatory Design

The project begins with the definition of the areas and communities to be intervened. These include mainly areas that were used for livestock farming and agriculture. As for the participants, the project focuses on those living in populations with high poverty levels or with

social exclusion which leads to social, economic or climatic vulnerability, and indigenous communities.

Once the areas and potential communities are identified, the project follows the following participatory process:

1. The first contacts are made with the communities that have previously expressed their interest in the project, and a programme of visits and training is carried out to provide more details about the objectives, scope, and proposed activities of zeroCARBON. The trainings aim to raise awareness on topics of relevance to the communities participating in the carbon project (climate change, design and implementation of living plans, establishment of plantations and agroforestry systems, prevention of forest fires, prevention and management of pests and diseases, maintenance, and fertilisation, etc.). In this process, Plan Vivo plays a vital role as a framework that ensures that the free, prior, and informed consent of individual or community participants is fulfilled.
2. Through meetings and workshops, the commitments, responsibilities, and rights that both parties (zeroCO2 and community members) acquire as part of this initiative are made known to the potential participants.
3. zeroCO2 and Vivero Mundo Verde technical assistance staff then make frequent visits to the individuals and communities to initiate the process with each person, community or interested group, to describe and evaluate the social and environmental conditions of the sites. The communities select what type of project and intervention to make on their land through the initial engagement process. This process allows for verification of the information provided by the local participants, to assess whether the forest species proposed by the farmers are suitable.
4. Once the availability, forestry, environmental and social conditions of the site have been assessed, the groups in charge are formed. These groups are organised as democratically defined Boards of Directors, and form their administrative council. In addition to the Board of Directors, it is planned to create an additional Body, The Community Program representative Body, composed of a group of 3-5 representatives democratically elected by the participants, which becomes the direct contact with the community for the development of the programmed activities, the establishment of the plantations, the follow-up, the verification, and the payment of the carbon benefits according to the acquired commitments. These bodies coordinate with zeroCO2 and Vivero Mundo Verde technicians who provide direct support in any situation that may arise. In case of individual participants, there can be two cases: direct contact between the zeroCARBON team and the participant or the presence of farming cooperatives that act as representatives of peasants from the same municipality but from different communities. In 2023, zeroCO2 initiated the establishment of representative groups at the community level to effectively address the diverse demands of individual participants. The Community Program Representative Bodies were elected for the three primary participating communities, Nuevo Horizonte, Monte Carmelo, and Nueva Colorada, while the remaining communities relied on individual participant representation. Beginning in 2024, the Community Program Representative Bodies for the 2023 participant group will be established.

5. Technical training is carried out through theoretical and practical workshops and field visits, in which an exhaustive description of the Plan Vivo programme is given, as well as the minimum social and environmental conditions for the development of the programme. Among the environmental requirements for instance, it includes factors such as relief, soil type, drainage and the current land use of that area. The areas that have forest as current use will not be accepted in the project, as well as areas where the characteristics are not appropriate to introduce the species to be used, whether forest or fruit trees. With respect to social & legal requirements, they refer to availability of land for the implementation of the project (no conflict with food production), ownership title or right of possession of the land, no land conflicts or not being in regions or territories influenced by drug trafficking.

In the workshops, the establishment of plantations and agroforestry systems most suitable for the community is discussed with the local participants, considering the following aspects:

- Explanation of the Plan Vivo programme
- Land use and availability
- Previous experiences in forestry or agroforestry systems established in the community.
- Determination of timber species with potential benefits for the community.
- Form of participation: individual, community or organised groups.
- Number of families involved in the project.
- Community coordination capacity.

More in particular, the technical training is carried out over a series of 7 capacity building sessions, in which beneficiaries acquire the necessary capacities to participate in the project and to manage their plantations in a way that can fulfil the goals of the project. The technical skills transferred are related to the fundamental aspects of silviculture and are included in the sessions as described below:

- Session 1. Informative meeting with the community to introduce zeroCO2 objectives and approach and present the basic requirements to participate in zeroCARBON.
- Session 2. Information about the basic requirements to participate in zeroCARBON and explanation about the project interventions, in which interested persons are registered.
- Session 3. Site visit to the plots proposed for the project, to evaluate the physical characteristics of the area and , if planting is suitable, determine the most suitable species and type of intervention.
- Session 4. Technical training to beneficiaries for the adequate planting of trees, including hole digging and distance between planting (3m x 3m)
- Session 5. Technical training to beneficiaries on management of the systems, including pruning, cleaning and tree health monitoring.
- Session 6. Training on pest and disease management, in which beneficiaries learn how to identify the most common pests and diseases that can affect the trees and how to manage them accordingly, to guarantee the health of the plantation.
- Session 7. Training on prevention and control of wildfires, through the establishment of fire cutting bands, vigilance activities, fuel management and response in the case of fire.

After these sessions and during the entire implementation of the project, the operational team conducts regular visits to beneficiaries in an organised manner following a visit calendar and responding to requests that arise, to support participants continuously in applying this knowledge.
During the initial meetings, the local communities determine whether they want to continue with the next stage and prepare their Plan Vivo participation. Otherwise, each party separates without generating any commitment.

Through this approach, zeroCO2 ensures the voluntary and consensual participation and freedom of choice of every participant.

To ensure that participants adopt and promote natural regeneration within their forestry plantations, this will require a participatory approach with continued support from the zeroCO2 local team and an integration into the economic benefits of the program. Engaging zeroCARBON beneficiaries in this process will be carried out in three ways:

1. Natural regeneration will be linked to payments and integrated into the benefit sharing mechanism of zeroCARBON. This will begin once monitoring data is recorded to better understand the functioning of ANR in plantations and incorporated into the carbon accounting, which will begin from year 5 onwards. Besides, ANR will be included into the participant agreements as one of the requirements to participate in zeroCARBON, becoming an integral part of the project interventions.
2. A training activity on natural regeneration will be incorporated into the existing capacity building activities. This will include species selection and identification, and training on the management practices needed to successfully integrate natural regeneration within a forestry plantation. Participants will be encouraged to promote the species list found in Annex 17, but participants will also be free to promote other native species of their interest.
3. Consideration will be given to the registration of beneficiaries in the PROBOSQUE programme according to the applicable characteristics and requirements for the “Forest Restoration” project type. This can be done only for participants that have not previously participated in PROBOSQUE. In this way, beneficiaries would be able to access additional incentives to maintain natural regeneration within the plantations.

As mentioned in point 2, capacity building will train beneficiaries in implementing actions described in the ANR management plan, which is still under development and on approval for INAB. These actions will include:

- Locate species in Annex 17 and with commercial and ecological value for participants, and mark them with forestry tape to allow better monitoring and thus encourage the growth of these species. A list of favoured species can be found in Annex 17 and will be shared with participants, including pictures and a description of these species.
- Eliminate species to maintain the desired abundance and diversity of regeneration species, according to the management plan. Besides, remove species with minimal

value and which compete with the promoted species. The management of natural regeneration is mainly done through the elimination of competition for favoured species according to their importance.

- Fire control to allow for natural regeneration.
- If seed trees are identified, mark them with tape and allow them to be present in the plantation.
- The growth of cedar and mahogany will be encouraged by removing plants that exceed the height of the seed trees or show signs of suppressing their development.

2.5 Stakeholder Consultation

2.5.1 Design Phase Consultations

The pertinent consultations were carried out with the project participants as follows:

- Information about the functioning of the project was provided to the participants upon receiving notification of interest in participating. The information was provided through meetings with the community members in the places where they live, i.e., each of the communities was visited and the relevant informative meetings were held.
- Each community proposed their own way of participating according to what best suited their possibilities, planting, agroforestry systems, silvopastoral systems or others, including annual crops for as long as the planted trees would allow.
- The feedback from the communities was crucial for the project design since they provided information on what type of system is best suited to their land, pest typology or vulnerable areas in terms of floods, fires or others.
- Another important contribution is in terms of the organizational structure, to be organized by commissions to ensure the active involvement of all participants. Efforts are being made to create in each community, where there is no involvement and/or proper representation of all instances on the Board of Directors, a committee to represent the participants, as specified both in item 4 of Table 2.4 and in 5.1, in addition to the Community Board of Directors.

2.5.2 Stakeholder Engagement Plan

The stakeholder engagement plan in the zeroCARBON project is based on the following steps:

1. Meetings with individuals, cooperatives or organized groups that are interested in participating in the project, in which the commitments of Plan Vivo are explained and it is determined if they meet the minimum requirements established. If they are interested in participating and meet the requirements, they continue with the next stage.
2. Each beneficiary community will be organized, according to the plan established by the project coordinator (zeroCO2), by a Board of Directors. This board is made up of members of the community elected through a general assembly held with all the members of the organization, be it a cooperative or an association, and will specifically be responsible for the development of the project. With the accompaniment of the project

coordinator; this board will be in charge of convening periodic meetings to evaluate the progress of the project, analyse the problems and define the solutions. It is a requirement that women form part of the Board of Directors.

3. The project coordinator (zeroCO2), together with the project developer (Vivero Mundo verde) and Board of Directors of each community, design the training plan for forest management and control of the project, considering some aspects related to pest control, firebreaks, cleaning of reforested areas, or others, in which all the beneficiaries can participate.
4. When designing the training plan, proceed as follows:
    a. Climate change and explanation of the project agreement, rights and obligations.
    b. Establishment of plantations and agroforestry systems.
    c. Prevention of forest fires.
    d. Prevention and management of pests and diseases,
    e. Maintenance, fertilization and other practices that participants are interested in.
5. The rest of the participants, through the Boards of Directors, will be permanently involved during the operational phases of the project. In fact, the participants, being the ones who operationally implement the project on the ground, can make significant contributions to key decisions and provide valuable observations, which will improve their understanding of the feasibility and complexity of the project.

2.6 Free, Prior and Informed Consent (FPIC)

2.6.1 FPIC Legislation

Table 2.6.1: National Legislation and International Standards on FPIC

Legislation/Standard	Relevance to Project	Compliance Measures
UNDRIP	Indigenous peoples are entitled, as peoples or as individuals, to the full enjoyment of all human rights and fundamental freedoms recognised in the Charter of the United Nations, the Universal Declaration of Human Rights and international human rights law. The project respects all human rights and	Part of the measures is that organizations and individuals voluntarily request to participate in the project, not the contrary. The project is built upon the right of indigenous peoples to strengthen their own cultures, ways of life and institutions and their right to participate effectively in decisions that affect them.

	environmental laws and regulations.	The project respects all human rights and environmental laws and regulations.
ILO 169	The right of indigenous peoples to strengthen their own cultures, ways of life and institutions and their right to participate effectively in decisions that affect them.	The project respects all human rights and environmental laws and regulations. The implementation of this project is based on the participants' own decisions about their land and how they wish to implement the proposed activities. The prioritized participants of the project are the most vulnerable groups (social, socio-economic, environmental vulnerability or other). By providing complete information on how the project works, it is the people who decide voluntarily whether to participate or not. Otherwise, it is only implemented with those who wish to participate.

2.6.2 FPIC Process

1. **Stakeholder assessment**

Identification of stakeholder groups that can potentially be involved in the project. The assessment is based on socio-economic criteria, environmental analysis of land and land use change, and full ownership and land rights criteria (see paragraph 2.4). The local team carries out the analysis on site and initiates dialogues and group discussions with community representatives.

2. **Consultation**

Once groups are identified and initial interest in participating collectively is received, preliminary community meetings are held in which the activities, benefits, rights and obligations of each stakeholder in participating in the carbon programme are explained in detail. During the consultation phase, informational material summarizing the basics of

collaboration, the benefit sharing mechanism and the carbon market is shared ("zeroCARBON infographic" attached).

Following this meeting, groups have an understanding of the project, which then meet within their organisation to determine those who wish to participate voluntarily and communicate this to zeroCO2. Once the group is identified, key eligibility requirements for the program (land tenure, leakage, etc) are verified. Upon confirmation, an initial preliminary approval document (hoja de aprobacion) is signed, including personal information and the hectares involved in the program to establish a soft commitment between the two parties.

3. **Organisation of the groups**

Once the participants have been identified and according to type, the different responsibilities are set up:

a. Board of Directors (Junta Directiva) with legal representation (in the case of organisations with a defined number of members, these persons are democratically elected by the general assembly. The general assembly is the highest authority where any kind of decisions are taken for the common benefit.
b. The Community Development Council (Consejo Comunitario de Desarrollo - COCODE), also represented by a Board of Directors with legal representation, the difference is that all members of the community, men and women over 18 years of age, can participate; the community assembly is the highest authority.

   In both cases, men and women participate equally.

In addition a Community Program Representiative Body is created.

4. **Negotiation**

ZeroCO2, together with the Board of Directors of each community and the community members, designs the different project steps, including the training plan for the management and control of the project's forests, considering certain aspects related to pest control, firebreaks, cleaning of reforested areas and others, in which all beneficiaries can participate. The entire timetable is planned jointly by zeroCO2 and the communities according to the working time for the project. During negotiations, carbon payment schemes and concrete obligations and rights are discussed, and grievances and conflicts are resolved.

5. **Agreements**

Consensus is signed with each participant in the Project Agreement.

6. **Implementation of the project**

Development and implementation of the activities according to the project design plan.

2.6.3 Initial FPIC

After a comprehensive stakeholder assessment and a collection of interests from the communities approached, the local team of zeroCO2 and Vivero Mundo Verde conducted specific meetings, where rights and obligations of joining the zeroCARBON program were

defined (see point 2 of paragraph 2.6.2) . Participants who confirmed their interest in participating in the program were included in the working group.

All parties were equally involved, ensuring the inclusion and nondiscrimination of those considered most vulnerable due to issues of gender, ethnicity, or age. In the presence of ethnic indigenous people, zeroCO2 involved a local bilingual interpreter to ensure a full understanding of the program and to address their concerns.

Once they had ensured full understanding of the program, and resolved any further concerns, the members of the community-designated Board of Directors collected the memberships and made them official to the Project Coordinator.

3 Project Design

3.1 Baseline Scenario

Identification of baseline scenario

Following the CDM methodology AR-ACM0003, and the specific tool AR-TOOL02 v1.0.: "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities" is used to demonstrate the additionality of the proposed project.

This tool was suggested from Plan Vivo's Carbon Benefit Assessment Methodologies for Agriculture and Forestry (PM001).

Table 3.1.1 Selected baseline scenario: historic use of the land, stratification.

Baseline scenario	*Stratum*	*Area (ha)*
Pastureland	I	297.03
*Cropland**	II	140,97
Total		**438**

*Long term cultivation and cultivation with fallow period 'guamil'

The land within the project boundary prior to the start of the project was degraded grassland occupied by extensive pastures, as is the case for the department and municipalities where the project areas are located.

The other most common land use is subsistence farming. In both cases, baseline management involves slash burn and over-exploitation of soil.

Below are the steps that were followed to identify the baseline and assess the additionality of the project:

- Step 0. preliminary screening based on the starting date of the A/R project activity
- Step 1. Identification of alternative scenarios
- Step 4. Analysis of common practice

Step 0. preliminary screening based on the starting date of the A/R project activity

The incentive from the planned use of 'carbon credits' was seriously considered in early 2021 between zeroCO2 and Vivero mundo Verde.

After two years of developing reforestation projects dedicated to CSR (corporate social responsibility), zeroCO2 decided to develop a new carbon credit project from scratch with the support of its local team and involving the local communities that will manage the project sites.

In September 2022, the project started the certification process and about 173,000 plants were planted (of which around 127,000 remained in the zeroCARBON program). The project also included in the program a small number of plants from 2021 and 2020, the actual year of project start (corresponding to about 4.5 percent of the project area).

Step 1. identification of alternative scenarios

The following section shows an estimation of the main land uses where the project activity will be established. The main activity that preserves in the project area is cultivated pasture. This could be evidenced through the validation visit and using photos taken on-site.

Sub-step 1a. Identify credible alternative land use scenarios to the proposed project activity.

1. Continuation of pre-project land use

- Land use scenario A. **Cropland**: Subsistence farming: maize, beans, and other crops. However, the degraded soil conditions, low access to irrigation, effects of climate change and low investment opportunities allow for insufficient yields.
  Based on information gathered from project participants two sub-strata can be described according to land management: **long-term cultivation and cultivation with fallow periods**. The latter is a very common method in Guatemala, called 'guamil'.
- Land use scenario B. **Extensive livestock** with no pasture improvement.
- Land use scenario C. **Forestation Continuation** in the project area without any incentive from the Plan Vivo Certificates.

Analysis of alternative scenarios

The land uses explained previously follow all legal and regulatory requirements.

The analysis conducted by the Centro de Monitoreo y Evaluación de CONAP (CEMEC) in 2011[5] concluded that only 40% of the entire department remains forested and that the annual net loss of forest over the previous eight years averaged 316 km2, or about 1% per year.

Agriculture (including livestock) remains the most important economic activity in Petén. Over 67% of the economically active population (aged seven and over) is employed in the primary sector. The main crop in the region has long been white corn, grown on more than 11,000 farms in 2008 [6]. The black bean has also been important for both domestic consumption and the market. Indeed, in 2003 (if not earlier), Petén was producing more maize and beans than

[5] SEGEPLAN, 2011. Petén: Proceso de Actualización del Plan de Desarollo Integral.Diagnostico Teritorial, Tomo I. Guatemala City, Guatemala: Secretaria Generalde Planificación y Programación de la Presidencia, April 2011.

[6] INE, 2008. Encuesta Nacional de Agricultura (National Agricultural Survey), 2008. Instituto Nacional de Estadística.

any other department, accounting for 15% and 27% respectively of the total national production of these crops.[7]

In the specific case of project areas, among the agricultural uses of land in the reference scenario, two different uses can be distinguished: **long-term cultivation and cultivation with fallow periods.** The latter is a very common method in Guatemala, called 'guamil'.

Guamil involves periods of land rest alternating with periods of resumption of agricultural activity preceded by slash and burn activities.

The soils of 'Guamil y/o Matorral' in the rest period have shrubby woody plants that do not reach 5m in height in association with weeds of less than 0.5m[8] . After a few years, these plant associations are converted back into arable land by humans.

The production of cattle has exploded in the last decade. Livestock production has a long history in Petén.

In 2003 there were 315,819 heads in the department, more than 19% of all cattle in the country; in 2008 there were more than 1.362 million heads, over 31% of the national total. Shiriar, A. J. (2014) reports that in 2014 local officials revealed that there may be 1.5-2 million heads of cattle in the department.

Local authorities commonly argue that the huge increase in the region's cattle population is partly since investments in livestock and agricultural land offer an affordable way to ''wash''/ launder the money earned through drug trafficking or other illegal activities.

As evidenced by the ESA (European Space Agency) WorldCover map (see Fig 6), grasslands and croplands are the most widespread land use. The map does not differentiate grasslands and croplands from livestock farming uses.

[7] Shriar, A. J. (2014). Theory and context in analyzing livelihoods, land use, and land cover: Lessons from Petén, Guatemala. Geoforum, 55, 152-163.

[8] Instituto Nacional de Bosques y Consejo Nacional de Áreas Protegidas. 2020. Manual de campo para el Inventario Forestal Nacional 2020, Grupo Interinstitucional de Monitoreo de Bosques y Uso de la Tierra. Guatemala. 88p.

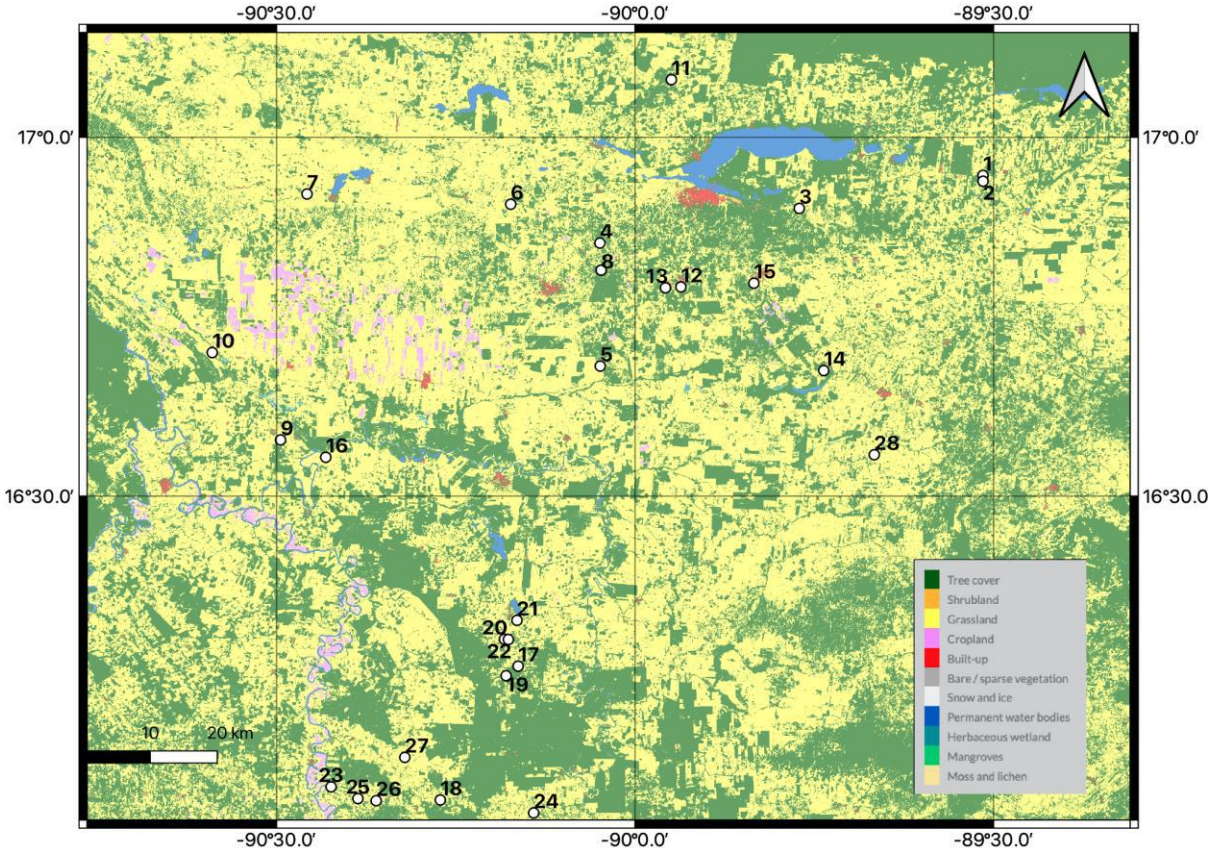


Figure 13: Land use satellite map, Guatemala - Petén region. White points represent the project's locations. Source: ESA; World cover project 2021[9] (available at https://esa-worldcover.org/en)

The ESA WorldCover product (2021) with a resolution of 10 metres is a useful tool for analysing land use over large areas. However, in many cases it fails to distinguish cultivated land from grasslands depending on the period of satellite acquisition and resolution. Especially in the case of Guatemala where the low/medium resolution of Sentinel images fails to highlight small plots dedicated to subsistence farming. For this reason, the map shows few areas dedicated to cropland in the whole of Guatemala.
However, the ground truth of the land use evidence was realised on the basis of the operational team's visits and the collection of individual participants' georeferenced polygons mapped in Appendix 1 and shared separately with Plan Vivo.

Furthermore, pastures may also contain uncultivated cropland areas (no cropland/ bare land) at the time of satellite imagery acquisition. Therefore, land, even if dedicated to crops, is visualised as grassland. However, stratification based on project-specific boundaries and,

[9] Zanaga, D., Van De Kerchove, R., Daems, D., De Keersmaecker, W., Brockmann, C., Kirches, G., Wevers, J., Cartus, O., Santoro, M., Fritz, S., Lesiv, M., Herold, M., Tsendbazar, N.E., Xu, P., Ramoino, F., Arino, O., 2022. ESA WorldCover 10 m 2021 v200. https://doi.org/10.5281/zenodo.7254221
PRODUCT USER MANUAL link:https://viewer.esa-worldcover.org/worldcover/?language=en&bbox=-91.77972195611981,16.082677424698858,-89.06887495224153,17.43592064259937&overlay=false&bgLayer=MapBox_Satellite&date=2022-11-21&layer=WORLDCOVER_2021_MAP

thus, the analysis of higher resolution images, will allow more specific land use maps to be constructed.

- **Land use scenario C. Forestation Continuation** in the project area without any incentive from the Plan Vivo Certificates.

Without Plan Vivo, communities can still benefit from INAB subsidies related to the PRO BOSQUE programme.

Nevertheless, programme grants are not sufficient to cover the start-up costs of such a project, especially with the involvement of many communities dislocated throughout the region.

Reforestation projects require significant upfront investments that are often seen as unattractive to communities living on low economic standards. In addition, timber prices are very low in the region due to the high inflation rate generated by illegal logging and deforestation. It is estimated that illegal logging represents 30% to 50% of the annual harvested timber in Guatemala[10] (PROFOR, 2017). This illegal timber is offered at a lower price than legal timber, making the legal timber less competitive in the market.

Over the last 15 years, deforestation and forest disturbance have, in fact, affected all forested areas in Guatemala, even protected areas, with deforestation rates of around 846,000 ha in the period 2000 - 2015 as reported by the FAO.[11] (MacDicken et al. 2016)

Communities are therefore much more likely to adopt subsistence land management systems that allow for steady income but, at the same time, lead to the inevitable degradation of soil fertility.

In conclusion, the most likely baseline scenario is degraded agricultural land and pastureland. Based on the information gathered by the zeroCO2 operations team and the experience gained from direct contact with the Petén communities, two reference strata were identified within the project: cultivated land and pastureland. In the first case, two sub-strata can be described according to land management: long-term cultivation and cultivation with fallow periods 'guamil'.

Sub-step 1b. Consistency of credible alternative land use scenarios with enforced mandatory applicable laws and regulations

All land-use alternatives identified above comply with all mandatory regulations in the country.

No alternative has been eliminated under this criterion.

Step 2. barrier analysis

Sub-step 2a. Identification of barriers that would prevent the implementation of at least one alternative land use scenario.

Below is a list of possible barriers for the land-use alternatives identified above:

10 PROFOR 2017

11 MacDicken, O. Jonsson, L. Pi~na, S. Maulo, V. Contessa, Y.Adikari, et al. 2016. Evaluacion de los recursos forestales mundiales 2015: como estan cambiando los bosques del mundo?

- Barriers due to local ecological conditions, including:
    - Degraded soils (overgrazing, desertification, prolonged summer drought, flooding).
    - High erosion risk.

The soils of the Petén can be classified into two main groups. The first group consists of well-drained, mainly sloping soils that are not suitable for modern agriculture and, in most cases, not even to ploughing due to their stone content. The soils, although fertile, are located on steep slopes, which makes them highly vulnerable to erosion.

The other types of soils are found in flood plains and valleys, which, although fertile, are difficult to use for agriculture as they require high investments in drainage methods. The plasticity of these soils also limits their mechanisation.

According to the soil classification of the Guatemalan Ministry of the Environment, more than two thirds of the Petén area is not suitable for agricultural practices. The remaining portion can be used but with the limitations already presented (stagnation, slope, erosion).

Consequently, the most common type of land use is subsistence farming and grazing [12].

- Investment barriers
    - Insufficient money to develop the project completely. Current forms of subsidies are not enough.
    - Long-term return on investment.

The project will be co-financed by the PROBOSQUE programme. PROBOSQUE, created through the Legislative Decree No. 2-2015, is a national forestry policy instrument that came into force in 2017 and is designed to last for 30 years. PROBOSQUE promotes reforestation, forest creation and sustainable forest management. The programme is administered by INAB, Guatemalan National Forest Institute, which is the state body created to manage the PROBOSQUE programme.

The incentive is granted once a management plan is approved by INAB. For a given landowner, the grant application must be made through an official form prior to planting operations. This includes an analysis of the land suitability and a commitment to a sustainable management plan for the area to be reforested.

If successful, INAB approves the application in the same calendar year. Thereafter, the landowner has one year to carry out the reforestation plans. Once the reforestation is completed, the INAB evaluates the execution of the project with a field visit and initiates annual payments to the landowner.

However, this incentive has not proved sufficient to ensure the creation of large-scale community-based, robust and long-term projects. Using solely this form of financing would result in major cash flow problems to implement projects effectively. An ARR project, such as the one proposed in this document, requires major upfront investments that cannot be covered by national subsidies alone.

[12] Secretaría de Planificación y Programación de la Presidencia –Segeplan (2013)– Diagnóstico Territorial de Petén.

The project is made possible due to direct investments by zeroCO2, which it will be able to cover through the sale of fPVCs and, thus, vPVCs. In addition, the project in the initial stages will only be initiated through zeroCO2's own funds.

The possibility of relying on PVCs incentives will also be crucial to make the project attractive to communities that often see these projects as uneconomical and with excessively long rates of return on investment.

PVCs will also enable monitoring, training and general management of such a large and constantly expanding project that aims to involve hundreds of households with the constant operational support of a specialised team on site.

- Technological barriers
    - Lack of access to necessary materials, such as planting materials.
    - Lack of infrastructure for technology implementation.
    - Lack of expertise in plant management.
    - Local communities usually do not have access to sources of quality seeds or seedlings and lack the skills needed to produce them and successfully execute tree planting, especially in drought climatic conditions. They also lack the knowledge and experience to prevent fires and pest and disease attacks.

Sub-step 2b. Elimination of land use scenarios that are prevented by the identified barriers

Alternative scenario	**Type of barrier**
1. Agriculture, Livestock	- Status Quo. However, there are barriers due to local ecological conditions: erosion, low soil fertility that requires a high initial investment - It is not prevented by any barrier. It is the current land use, with a long tradition and low production costs (for both inputs and labour)
2. Forestation Continuation of the project activity without any incentive from the Plan Vivo certificates.	-Forest planting is not a common practice in the project area. In fact, this production system in terms of local tradition is not widely known and practised. -This type of land use for the extremely poor communities in the region would provide for payback periods of 10 years or more that are viewed as unsustainable, considering the common custom of receiving an annual income from agricultural production.

	-In addition, the starting limited knowledge of the communities would entail difficulties in plantation management. -This alternative is also prevented by the fact that many communities are located in distant and difficult to access locations, making timber harvesting and marketing complex.

Scenario 2 faces all the aforementioned barriers and would not be implemented unless it is undertaken as a PVCs project.

The actual net GHG removals by sinks will be increased above those that would have occurred in the absence of the project, because Scenario 1 is the most plausible scenario and it is different from the project activity.

Sub-step 2c. Determination of the baseline scenario (if allowed by the barrier analysis).

Applying the decision tree of sub-step 2c (considering the result of sub-step 2b) leads to the following conclusions:

- Continuation of the pre-project activity was identified as the most plausible scenario in the absence of the proposed project activity.

Step 3. investment analysis (not conducted);

According to the methodology, this step is not necessary if the barrier analysis has been performed.

Step 4. Common practice analysis.

There are no ARR activities similar to this project implemented or realised in the region. Its specific characteristics make this project the first of its kind:

- Number of communities involved: ownership of the project area is not concentrated and is distributed across several communities and individual farmers.
- Scale of the project and size of the planted plots: This project was conceived as a clustered project with a planted area of 200 hectares that will be expanded over time. The average area of the planted plots is between 2 and 4 hectares.
- Planting systems: Planting systems consider mixed species and with the inclusion of agroforestry systems.

The combination of these characteristics makes this project unique in the region and highly complex.

In fact, as explained in Phase 2, ARR project activities at similar scales of this project, face two main barriers: investment barriers, other than economic-financial barriers, technological barriers, barriers due to social conditions and organisational barriers.

To develop an activity with the specific characteristics of this project, it is necessary to be able to overcome all these barriers. ARR projects with different characteristics (e.g. on a smaller scale) do not have to deal with the barriers mentioned (no specific technological knowledge is needed and no major funding is required).

Based on the above, the project activity is not a common practice and therefore does not represent the baseline.

3.2 Carbon Baseline

The most likely land use scenario in the absence of project interventions and the additionality of project interventions were determined using AR-TOOL02 v1.0 with the relevant specifications taken from the Plan Vivo Agriculture and Forestry Carbon Benefit Assessment, methodologies PM001, PU001 and PU002.

The reference scenario and additionality will be re-evaluated at least every 10 years.

Calculation of baseline removals by carbon pools

Baseline removals developed following Equation 1 according to Plan vivo Methodology “Agriculture and Forestry Carbon Benefit Assessment Methodology” Version 0.1 and specific methodologies procedures for estimating parameters in Equation 1 provided in modules PU001 and PU002 respectively of the same methodology.

As confirmed in section 3.1 of this document, the most likely reference scenario is considered to be the land use prior to the implementation of the project activity (pastureland and cropland). Based on information gathered from project participants, two reference strata were identified: cultivated land and pastureland. In the first case, two sub-strata can be described according to land management: long-term cultivation and cultivation with fallow periods. The latter is a very common method in Guatemala, called 'guamil'.

In some cases, the biomass stock in the project area is different from zero, due to the presence of scattered trees or fallow areas.

In the specific case of the 'guamil' base layer, during the fallow phase, carbon stocks and their variation may be significant. However, in the long term, the carbon stocks in this layer will be in a steady state, with some areas losing biomass and others gaining in the same year.

This is all the more so considering that, once the fallow period is over, all trees are harvested and slash and burn practices are adopted with high emission levels

In conclusion, in line with the above and following the Methodological Tool A/R "Estimation of carbon stocks and carbon stock variation of trees and shrubs in CDM A/R project activities" (Version 04.2.), the ex-ante and ex-post variation of carbon stocks of trees and shrubs in the baseline can be considered as zero (for the three base layers considered).

In particular for zero baseline claim, AR-TOOL14 v4.2 Section 5 was followed.

Through the following tool It has been assumed that there is no variation in the carbon stocks of woody biomass.

To arrive at this statement it has been verified that conditions present in AR-TOOL14 v4.2 Section 5 (point 11 and 12) were satisfied.

In particular:

Point 11

(a) The pre-project trees are neither harvested, nor cleared, nor removed throughout the crediting period of the project activity;

(b) The pre-project trees do not suffer mortality because of competition from trees planted in the project, or damage because of implementation of the project activity, at any time during the crediting period of the project activity;

(c) The pre-project trees are not inventoried along with the project trees in monitoring of carbon stocks but their continued existence, consistent with the baseline scenario, is monitored throughout the crediting period of the project activity.

Furthermore, the AR-Tool 14 mentions at point 12 for zero baseline estimations of carbon stock changes the following criteria:

"12. Changes in carbon stocks in trees and shrubs in the baseline may be accounted as zero for those lands for which the project participants can demonstrate, through documentary evidence or through participatory rural appraisal (PRA), that one or more of the following indicators apply:

(a) Observed reduction in topsoil depth (e.g. as shown by root exposure, presence of pedestals, exposed sub-soil horizons);
(b) Presence of gully, sheet or rill erosion; or landslides, or other forms of mass movement erosion
(c) Presence of plant species locally known to be indicators of infertile land;
(d) Land comprises of bare sand dunes, or other bare lands;
(e) Land contains contaminated soils, mine spoils, or highly alkaline or saline soils;
(f) Land is subjected to periodic cycles (e.g. slash-and-burn, or clearing-regrowing cycles) so that the biomass oscillates between a minimum and a maximum value in the baseline;
(g) Conditions (a), (b) and (c) under paragraph 11 apply. "

The project satisfies both points (11 and 12) of AR- tool 14.

Regarding point 11, the project is not harvesting the remaining large trees in the project area, the large trees will not be affected by planting, and the project will not count the carbon of the large trees. However, the survival of the remaining trees will be monitored. Regarding item 12, the project is likely to fulfil most of these sub-items, but the clearest is 12F. Felling and burning for basic land management are commonly used in the baseline scenario. The same applies to grazing, the other main type of baseline scenario.

Due to the dynamics of this practice, fallow periods are short and insufficient for forest regeneration or establishment of local flora. The alternative land use is generally fallow or the

absence of agricultural crops. Therefore, the change in baseline emissions due to changes in tree carbon stocks was assumed to be zero.

Also carbon pools of dead wood, litter and SOC are assumed to be zero in the baseline scenario due to the fact that the baseline scenario was degraded pasture and cropland with common use of slash and burn practices. Therefore, it is prudent to assume that the sum of changes in deadwood, litter and SOC carbon stocks is zero for the reference scenario.

Baseline monitoring data will be collected and updated whenever changes are highlighted during the project activity. This monitoring will be shared with the Plan Vivo Secretariat as soon as possible through the annual reporting process, at the latest by the second annual report.

This baseline stratification carried out in the field by the operations team was then confirmed by the GIS analysis of the individual georeferenced plots for each participant.

Specific details can be found in technical specifications (Annex 7).

Table 3.2 Total net-greenhouse gas emissions under the baseline scenario

Year	Baseline emissions (t CO_2e)
1	0
2	0
3	0
4	0
5	0
6	0
7	0

8	0
9	0
10	0

3.3 Livelihood Baseline

3.3.1 Initial Livelihood Status

For each of the local stakeholder groups identified in Section 2.1.1, provide descriptions of livelihood status immediately prior to the start of the project, disaggregated by gender where appropriate. Include details of access to and main uses of land and natural resources, typical assets, income levels and sources, livelihood activities, and other factors important in the context of the project region. Include data sources.

Population

Guatemala population: ~ 14.901.286

Peten population: ~ 545.600 people, of which more than 60% live in rural areas (INE 2018).

The size of each community involved in the project is particularly variable (from 100 to 500 households), with an average of about 150/200 households per community.

zeroCARBON involves a group of 46 local farming communities spread across 9 municipalities in the Peten region. The 2022 program reaches 209 participants, considering both cooperatives participating as a group and individual farmers.

Cultural/ethnic/social groups

The target communities contain a mix of different indigenous groups, accounting for 32 percent of Petén's population. The main indigenous groups present in the Peten are Q'eqchi' (90%) followed by Itza', Mopan and Kaqchikel. In the south of the department, more than 50% of the population is indigenous (mainly composed of Q'eqchi' ethnic groups), especially in municipalities such as San Luis (60%) and Sayaxche (63%) - both participating in the zeroCARBON project. In the group of 2022 participants, more than 25% are Mayan Q'eqchi' population (of which about 14 percent are women).

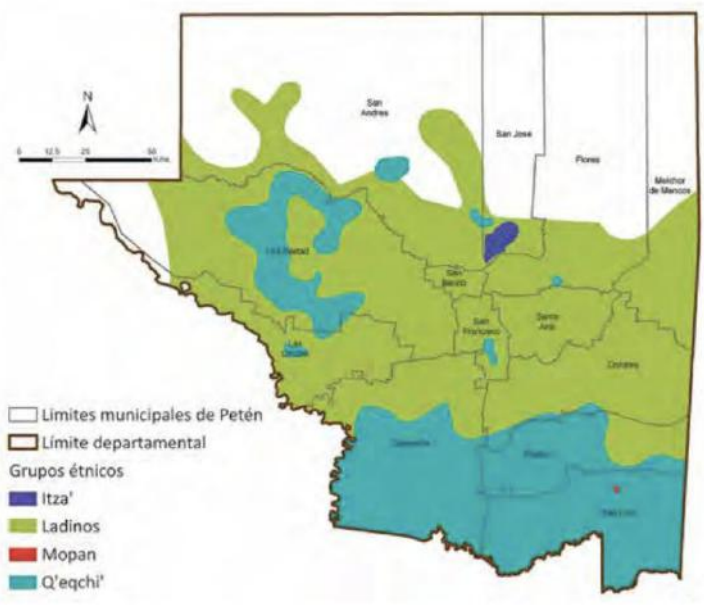


Figure 14: Indigenous territories in Petén. Source: PDI Petén 2032 Diagnóstico

Gender equality

According to the INE 2018 figures, women represent 50% of the population in Petén.
Guatemalan society is strongly marked by gender inequality, to the detriment of women. The patriarchal system has established a system of social relations in which women are relegated to positions characterized by exclusion, oppression and discrimination. According to the World Economic Forum's 2021 Global Report on Gender Inequality, Guatemala ranks 122nd in terms of gender equity, out of a total of 156 countries analyzed. According to this list, Guatemala is the country with the least gender equity in the Americas.
zeroCARBON promotes social equality and non-discrimination in its projects to ensure that everyone can have access to the activities and benefits that are promoted by this institution, regardless of their gender. In the current list of participants, about a quarter of the group are women. In some communities such as Nuevo Horizonte, where zeroCO2 has been working the longest, the female presence exceeds 32 %. The program's goal is to expand this number over time through widespread outreach and engagement activities.

Age equity

Guatemala has a relatively young population: in 2020, more than 33% of Guatemala's total population were aged 0 to 14 years, with only 5%of the population over 64 years old (Source: World Bank data 2020). According to 2020 Global Youth Development Report, Guatemala ranks 147th out of 170 countries in the Youth Development Index, that measures the conditions of young people around the world based on 6 macro parameters, such as education employment and opportunity, political and civic participation, equality and Inclusion; peace and security, health and wellbeing.

Income sources

At the socioeconomic level, Guatemala has one of the highest poverty rates in Latin America. According to the 2014 World Bank report for Guatemala, about 49% of the population are poor, or live below the upper-middle income poverty line (defined as US$5.5 per day in 2011). In the Petén area, where most of the indigenous population is concentrated, the percentage of the population living below the poverty line reaches 70% (of which 16% in extreme poverty) with a GDP pro capita (World Bank 2020 data) of 4,603 $.

The economic dynamics of most of the municipalities of Petén are predominantly based on agricultural, livestock and agroforestry activities, occupying 68% of the GDP of the region. The main source of income, as well as for the participating communities, is agricultural production.
The agriculture practiced in the communities involved in zeroCARBON program is traditional with hand tools for the production of crops used in the local diet, such as maize, beans, cassava, chili, sweet potato, macal among others. There are different agricultural species in a small area, the type of farming is similar throughout the region where the project is implemented.

At present, the livelihoods of the communities involved in the project depend on subsistence agriculture and livestock farming. Over time, the land becomes less productive, which forces people to look for alternative livelihoods, often leading to negative outcomes, as they can choose to sell their land to large cattle ranchers or multinational companies working in the palm oil sector, or migrate to the USA, because they are left without a livelihood for their families.

In many cases they must deforest patches of primary forest to get a piece of land, which will be later converted to agriculture or cattle ranching.

3.3.2 Expected Livelihood Change

For each of the local stakeholder groups identified in Section 2.1.1, provide a description supported by evidence of how livelihood status is expected to change under the baseline scenario.

The incorporation of an agroforestry system will provide a diversified source of food and income. The income from carbon payments will be crucial for communities because it will provide them with additional income, which is critical for their livelihoods. Besides, they will earn more income in the long term from the sale of timber, while increasing soil fertility and productivity in an environmentally sustainable way. This contributes to families becoming more empowered and resilient to external and extreme events.

The expected change in livelihoods is based on the project participants having a secure annual income for a medium term through the sale of carbon credits and, in the long term, an income from the sale of timber obtained from the plantation through sustainable management. These two aspects can ensure an improved quality of life, something that agriculture cannot guarantee due to the region's soil infertility and the effects of climate change.

Under the baseline scenario, generally for people who do not participate in the project, the medium-term result is the progressive loss of soil fertility regardless of use (whether agricultural or livestock). This would, in turn, lead to increased use of chemical fertilizers that would damage the soil as residual or organic amendments, increasing the cost of agricultural production. In the case of livestock, climate change is affecting livestock production in the Petén, which indicates the need to diversify the management and production of plots (production projects and forest-environmental projects).

Economic valuation of timber

In order to estimate the potential benefits from timber generated by the project, the team conducted an initial evaluation of timber market prices for Cedar and Caoba in Guatemala and assessed the functioning of the regional supply chain. Complex supply chain, various actors with depending, there community forestry enterprises have emerged in Petén, mostly linked to the community forestry concessions at the Reserva Biosfera Maya. While Cedar and Caoba are amongst the most valuable tropical species, there is a great fluctuation of prices depending on timber quality, the stage of timber processing, intermediaries, and the local and international market. In this initial economic evaluation, standing timber was considered, which means timber inside the plantation before processing. As for the supply chain, timber will be sold to local forestry enterprises and sawmills, which have already been identified.

One of the main factors that will influence the price of timber is its quality, which will depend on the growth and development of each forestry plantation. This variability will depend on the management practices implemented by participants and the ecological conditions, which can vary significantly between each project site. Three different scenarios for cedar and caoba were identified based on three potential timber prices (minimum, medium, maximum) expressed in $/m3. Each price is associated with three possible levels of development of a plantation (minimum, medium, maximum). Timber prices were estimated based on data found in literature, reports by INAB and international organisations, and information shared by the local team. Commercial volume is an approximate value calculated by using the allometric equation used to estimate carbon in Harvested Wood Products, which refers to the equation 27 in Annex 7. A document explaining the process to estimate timber value from the project can be found in Annex 19.

Project year (t)	Silvicultural activity	Commercial volume (m3/ha)	Timber sale value ($/ha)		
			Scenario 1 (minimum)	Scenario 2 (medium)	Scenario 3 (maximum)
5	Thinning 1	0	0	0	0
8-12	Thinning 2	10,5	1556	2558	3415
15-18	Thinning 3	17	3782	6215	8300
20	Final	20,6	6094	10014	13373

	harvest				
			11432	18787	25088

Table 3.3.2.1. Economic productivity of cedar plantation in zeroCARBON

Project year (t)	Silvicultural activity	Commercial volume (m3/ha)	Timber sale value ($/ha)		
			Scenario 1 (minimum)	Scenario 2 (medium)	Scenario 3 (maximum)
5	Thinning 1	0	0	0	0
8-12	Thinning 2	8,4	1818	2450	3181
15-18	Thinning 3	12,1	3928	5400	6874
20	Final harvest	13,6	5894	8105	10316
			11640	15955	20371

Table 3.3.2.2: Economic productivity of caoba plantation in zeroCARBON

Overall, the initial assessment shows the economic potential of forestry, as the three scenarios would provide a significant income stream in the medium and long term, for the duration of the project period. Besides, timber extracted from thinning activities will provide significant revenue in the medium term, which will add to the other benefits of the program and support their continued participation in the program and the permanence of the project interventions. ZeroCO2 will assist participants in accessing the market and ensure that fair prices are obtained from timber sales.

3.4 Ecosystem Baseline

3.4.1 Initial Ecological Conditions

The mean annual temperature in the Project areas located in the North (Peten) is 25°C.

Tab 3.4.1.1: Climate parameters of Petén

Climate parameter	Average
Annual rainfall*	1787 mm
Rainfall days per year	160 to 180 days
humidity	80 to 85 %
Annual average temperature	30.0° C

Wind intensity	25 to 100 km/h

*Data retrieved from WorldClim (https://www.worldclim.org/data/worldclim21.html) data for monthly Precipitation specific for the area of Petén are elaborated in R. Values are the average annual rainfall from 1970 to 2000. Source: Wordclim and Segeplan (2013) [13]

a. **Life Zones and Ecoregion**

Petén has a native forest ecosystem characterised by a warm subtropical rainforest with annual precipitation ranging from 1160 to 1700 mm in the least humid part in the north and 1587 to 2000 mm in the most humid part in the south-east.

The characteristic terrestrial ecoregion is the Petén-Veracruz humid forest, which is the only transnational Mexico-Guatemala-Belize ecoregion.

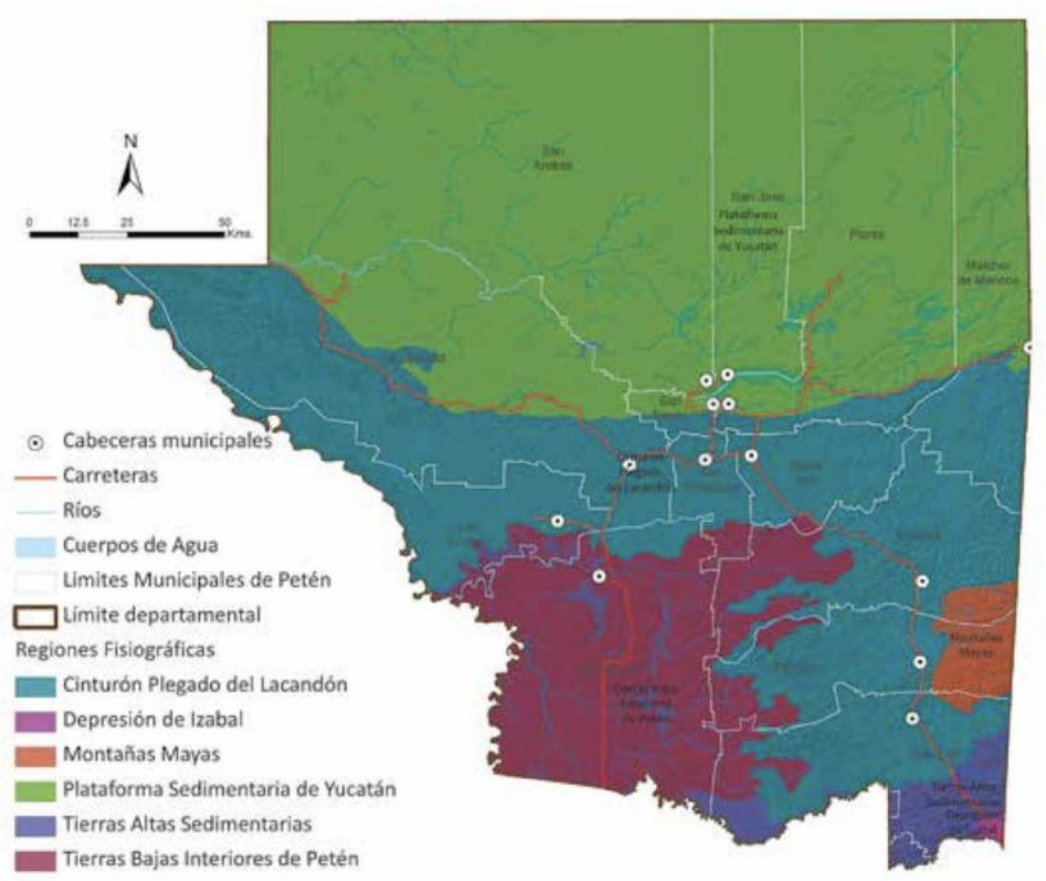


Figure 15: Ecoregion Peten. Source: Segeplan 2013.

The project is specifically implemented in communities in the lowland areas of the "Despresión de Izabal" and the lowland areas alternating with small elevations of the "Cinturón Plegado de Lacandón".

[13] Secretaría de Planificación y Programación de la Presidencia –Segeplan (2013)– Diagnóstico Territorial de Petén.

b. Soil

The soil is characterised by widespread degradation due to extreme weather events such as hurricanes, torrential rains and dry periods in addition to high over-exploitation due to agriculture and livestock.

The soils of the Petén are shallow karstic soils in most areas with a predominance of marine limestone.

The results of the classification of the productive potential of soils, by municipality, carried out for El Plan de Desarrollo Integral de Petén de 1992 (Segeplan, 1992), confirm the findings that are currently available on the soils of Petén (Segeplan 2012):

- There are no soils in the Petén that could respond to Class I, which would be the most suitable for agricultural exploitation.
- If Class II and III soils are considered as usable soils, under certain management conditions, only 31.8 % of the total area of the department could be usable for agricultural activities, with the necessary management conditions and significant limitations.
- According to the aforementioned classification, more than two thirds of the Petén area are not suitable for agricultural practices, with 20% (classes IV and V), and another 47.7% (classes VI, VII and VIII) having severe limitations, i.e. soils that should not be used for agriculture but intended for protection.

c. Land use

Agriculture (including livestock) remains the most important economic activity in the project locations.

The main land use practice in all municipalities is 'milpa'. The milpa is a traditional cultivation system of maize, beans and squash, based on ancient Mayan agricultural methods. In modern milpas, the small size of the land means that smallholders cannot practice regeneration of soil fertility through rest periods, causing a decrease in soil fertility and crop yields, and reducing diversity, focusing mainly on maize production alternating in some cases with extensive livestock.

Over the past 30 years Guatemala has lost about 23% percent of its humid primary forest cover. A discouraging fact for the department is that 85.3% of the total loss of forest cover at the national level occurs in Petén. According to the 2006- 2010 forest cover map, the relative loss of forest cover in the municipalities of Petén that present the highest rates, even at the national level, are: San Andrés, La Libertad, Sayaxché and Poptún, reporting more than 25,000 hectares lost in each municipality.

The main causes of deforestation have been agricultural colonization and in particular the establishment of intensive cattle ranches and plantations by large, often absentee, landowners. 80% of the forest reduction in Peten is mainly due to the habilitation of land for agriculture and livestock, which is evidenced by the 1,246.11 km2 of forest that has been cleared for crops or pastures in the period from 2006 to 2010. These areas are subsequently abandoned and converted into *charral* or *guamil*. The advance of the agricultural frontier

increases soil deterioration, as the forest cover is being eliminated and replaced by a less protective soil cover, making the resilience of the soil in Peten difficult to achieve.

The land where the projects are implemented is, in most cases, uncultivated or heavily impoverished land devoted to extensive grazing or subsistence farming.

At present, during the initial stage of participant onboarding, the operational team conducts a preliminary analysis of the plot where the person interested in joining the project wishes to introduce a forestry or agroforestry system. Several factors are assessed here, such as topography, soil type, drainage and the current and historical land use of the area. Areas that are forested or that have advanced natural regeneration as current land use will not be accepted in the project, as well as areas in which the characteristics are not appropriate to introduce the species used in this project, whether forest or fruit trees.
Based on these characteristics, the most suitable type of intervention and the most appropriate species for each participant are recommended.

3.4.2 Expected Ecosystem Change

As previously described, the project is located within an ecoregion known as the Peten-Veracruz humid forest, which is a biodiversity hotspot and contains one of the last major fragments of humid forest in Central America. Using the Maya Biosphere Reserve as a reference of the ecological conditions of the primary forest in Peten, the reserve has registered 2800 plant species, 513 bird species, 62 amphibian species, 122 mammal species and 95 reptile species[14] which is an indicator of the biodiversity richness of the primary forests in the project region. Several of these species have been listed in Annex 10 as vulnerable species according to the IUCN Red List, which are found in the project region. Although data is insufficient to assess with certainty the extent of species loss occurring in the project region, as of 2021, 230 plant and 635 vertebrate species have been identified as vulnerable or threatened with extinction in Guatemala[15]. This is an indication of the alarming rate of biodiversity loss that the country is experiencing.

According to Global Forest Watch, the Petén Veracruz ecoregion is in critically endangered state and, as previously described, Peten is the region in Guatemala with the highest deforestation rates in the country. This has resulted in a reduction of the quantity, quality and connectivity of natural habitat, which is the first cause of biodiversity and forest loss in Peten[16]. The main driver behind this is the conversion of forests to cropland and pastures. Shifting agriculture, a common practice in the region, is a process that causes temporary deforestation in small land patches. The short-term impacts of shifting agriculture include fragmentation of undisturbed forest patches, local species extirpation, and a change in species composition and abundances. The land is cultivated for a few years until low productivity and yields leads farmers to abandon these land parcels in favour of other primary forest stands. In addition, considering the low fertility and unsuitability of the soils in Peten for agriculture, an increasing number of individuals are resorting to cattle ranching, which

14 CONAP 2015

15 CONAP 2021

16 USAID 2003

requires a long-term total conversion of forests into pastures. Overall, demand for land in the project region keeps increasing, together with the threat to the ecosystems.

Under the baseline scenario, the continuation of cropland and pastures, the project region will continue experiencing a conversion from forests into these land uses. This expectation is based on the historical and current trends in land use practices and forest loss in the region, which have been widely documented and experienced by zeroCO2 operational team. As previously described, both land uses require the conversion of forests, with its consequent loss in ecosystems services and biodiversity. The continuation of forest loss will have associated impacts in the project region including a decrease in soil fertility, loss in habitat availability and connectivity, less water availability and an increase in temperature.

In the absence of alternative land uses that are economically viable and do not rely on deforestation, such as the interventions proposed in this project, the trends in ecosystem degradation and deforestation will continue to take place, together with the population loss of fauna and flora species that populate the Peten-Veracruz humid forests. This project aims to address the main drivers of forest loss by bringing forward forestry and agroforestry as alternative land uses that respond to the socioeconomic needs of the population and are beneficial for the ecological conditions of the project region.

The interventions proposed in this project will provide an economically viable alternative to the dominant land uses that are causing deforestation and ecosystem degradation in the project region. Besides, the gradual regeneration of agro ecosystems will result in increased biodiversity, greater resilience to extreme weather events (droughts, floods) and increased carbon storage per unit area, in addition to increased soil fertility and stability. The project will also allow for the rapid sequestration of carbon in the woody material, enabling a concrete form of mitigation to the climate crisis.

Theory of Change

3.5 Project Logic

Table 3.5.1: Project Logic

Aim

zeroCARBON promotes the restoration of natural ecosystems, the improvement of land degradation, and the economic and social empowerment of local farming communities through the implementation of mixed plantations and agroforestry interventions.

In particular, the project aims at:

- Ecosystem restoration and assisted regeneration of areas with degraded forest cover through the improvement of above-ground biomass, below-ground biomass, and soil litter and management of forestry and agroforestry systems to restore ecological function.
- Improved land management practices to increase carbon stocks and/or reduce greenhouse gas emissions through education programs about sustainable management of resources.

- Sustainable livelihoods and capacity building for marginalized farming communities, struggling with high levels of chronic poverty and lacking technical knowledge and experience.
- Generation of additional income through carbon payments and sale of timber and non-timber products.
- Biodiversity conservation and regeneration through native tree species and recovery of local knowledge of the natural environment.

	Description	**Assumptions/Risks**
Outcomes		
Carbon Benefit	zeroCARBON implementation leads to the generation of carbon benefits redistributed to participating communities, with important environmental and social benefits. Due to the presence of new forest cover, it increases the absorption capacity of the area, providing a new carbon sink as a mitigation measure to the effects of global warming. The quantity of carbon benefits per hectare is calculated based on the technical specifications as described in the next chapter. The distribution of carbon benefits, linked to plantation management plans, triggers virtuous project management mechanisms over time, while ensuring effectiveness, durability and environmental and social sustainability.	Involvement in the zeroCARBON project reduces the risk of participating communities being pushed into monoculture land cultivation (oil palm, soya). The expansion of extensive cattle ranching, which is one of the main drivers of deforestation in the project area, will be reduced. Forestry and agroforestry land uses will become economically attractive options that will support environmental and socio-economic improvement in the project area. The additional income generated by the carbon benefits will become an incentive for participants to maintain forestry and agroforestry land uses. As the project grows in scale, this incentive will attract more participants and promote the gradual conversion of unproductive agriculture areas and extensive cattle ranching to forestry and agroforestry systems. Carbon benefits will improve the economic value associated with the land of communities and individuals, which will reduce their need to sell their

		land or convert it to land uses harmful to the environment. Fire occurrence will be minimised by the application of fire cutting bands that will be applied in every project site, to ensure the success of the project interventions and their associated carbon sequestration. The application of fire cutting bands is an integral part of the management plan and the capacity building that every participant will receive. Leakage will be minimised, as the project will only be implemented in unproductive areas and grasslands, while every participant already uses more suitable areas for agricultural practices that will be maintained. Therefore, the project will not compromise the economic and productive needs of participants. Carbon benefits resulting from this project will reduce the need for agricultural expansion and its associated emissions. Participants will acquire the necessary capacities and knowledge to follow the management plan and implement the project interventions successfully, with the technical support of the operational team, ensuring the continuity of carbon sequestration. Carbon benefits plus the commercialization of timber and non-timber forest products will be sufficient to satisfy the participants' expectations and maintain their participation and interest in the project. Carbon sequestration will increase in the project area during the project period in comparison with the

		baseline scenario. The project interventions incorporate woody species that store carbon, in comparison to the baseline scenario, which is cattle ranching and agriculture. Both cases involve slash and burn and they don't include the introduction of woody species or a vegetation increase and its associated increment in carbon sequestration.
Livelihood Benefit	The project will generate several livelihoods benefits: - Food and agricultural production improvement: soil and biodiversity regeneration guarantee more efficient habitats for sustainable agricultural production and environmental services (e.g pollinating insects, medicinal plants etc.) - Community capacity building: increasing the technical and managerial skills of participating communities enables better management of production and promotes the development of individual and community micro-entrepreneurial activities. For instance, through the commercialization of agricultural products in local markets derived from the agroforestry systems. In the long-term, the benefits generated by the project will support communities in	The participating communities do not currently have the economic, organisational and technical resources to operate independently and see zeroCARBON as an important opportunity for social empowerment. Building strong and trusting relationships with the participating communities is a prerequisite for the success and effectiveness of the project over time, something zeroCO2 has been engaged in for years and will continue to strengthen over time. Participants will be able to access markets and successfully commercialise the timber and non-timber forest products resulting from this project. Cedar and caoba will remain in high demand in national and international markets. Participants will have access to a functional supply chain to ensure that they receive a fair price for timber from their participation in the project. Tree species introduced by the project will achieve the optimal

	investing into other economic activities . - Income and economic growth: selling wood and non-wood forest products, new sources of income can be created for households, to be added to the carbon benefits - Diversified and resilient production against the effects of climate change: reduction and prevention of soil erosion and floods, improved soil fertility through carbon uptake in the soil, improved balance of water supplies.	conditions of growth and shape that are suitable for timber production. Participants will apply the best practices included in the management plan and recommended by the operational team to reach these conditions.
Ecosystem Benefit	The project will generate several ecosystem benefits: - Reducing soil erosion - improving soil fertility - Carbon sequestration - Biodiversity conservation and regeneration - Tree cover regeneration	Participating communities see trees as a key form of livelihood for their subsistence economy. They therefore take great care to ensure the survival of trees with all the associated benefits that come with it. The project interventions will facilitate the gradual natural regeneration of the project sites, which is compatible with forestry and agroforestry systems, once these are established. Natural regeneration will bring native herbaceous, bushes and tree species to the subtropical forests of Peten. In the medium-long term, the increased vegetation will provide habitat for wildlife and connect forest patches, which will facilitate the movement of wildlife across the landscape. The planted trees and revegetation will reduce soil erosion, by increasing the capacity of soil to absorb water and by retaining soil through their

		root systems. Soil fertility in the project sites will also gradually increase as forestry and agroforestry systems develop, as trees access nutrients located in the deeper soil layers, provide organic matter and facilitate nutrient exchange with other plants. This project is needed to reverse the current land use trends and practices that are causing deforestation. As the project advances and increases in scale, the expansion of cattle ranching and agriculture will be reduced as a result of the adoption of forestry and agroforestry systems by more communities and individuals, which will lead to a decrease in deforestation. Consequently, more extension of remaining primary and secondary forests will be preserved, together with the ecosystem services that these forests provide.
Outputs and activities		
Output 1	Carbon sequestration	The project promotes the creation of stable carbon sinks, and ensures their permanence through project management over the years and payment schemes to communities. Permanence of the project interventions will be strengthened through a constant engagement with participants and a distribution of economic benefits across the lifetime of the project. On the short-term, payments from the sale of fPVCs (Base Fund), on the medium-term timber from thinning, ANR and other additional carbon benefits (Additional Fund), and on the long-term timber

		sales from the end of the forestry rotation.
Activity 1.1	Forest plantation and agroforestry systems development <u>*Sub - Activities*</u> *1.1.1. Trees production* *1.1.2 Project technical design* *1.1.3 Land preparation and plantation* *1.1.4 Carbon modelling*	Communities lose interest in the project and new land use alternatives emerge (e.g., palm oil): zeroCARBON provides the trees and supports participating communities through the planning and planting stages, ensuring that participants receive opportunities for new sources of income in the long run and maintain their interest in the project. Participants don't implement the management practices established in the management plan, leading to an unsuccessful development of the project interventions and their associated benefits. To minimise this risk, zeroCO2 operational team will provide constant support and guidance to ensure that the participants understand and apply the best practices and to respond to any arising concerns. The conditions stated in the project agreement will also be used to reinforce the participants's responsibilities towards the project. Unpredictable weather patterns caused by climate change, such as a delay in the rainy season, negatively affect the schedule for tree production and distribution and, consequently, the next steps of the project. To minimise this risk, the distribution and planting will be adjusted to the most suitable weather conditions for each phase.

Activity 1.2	Land use analysis and monitoring <u>*Sub - Activities*</u> *1.2.1 Preliminary land use analysis (both on site and using GIS and remote sensing tools)* *1.2.2 Progress and carbon KPIs monitoring and measurement*	Lack of organisation in defining roles and responsibilities in the project: in the first phase of participant involvement, a clear organisational structure is defined and responsibilities are distributed and obligations arising from the project are shared. There is also constant support from the zeroCO2 team in the prevention and monitoring phases.
Output 2	Increased social and economic impact	Increasing participants' technical, organisational and managerial skills promotes increased awareness and opportunities for social development of the entire community. Diversification of forest production and possible sources of income (sale of forest and agricultural products and carbon benefits) promotes improved economic conditions for participants and improved resilience in the face of climate change effects.
Activity 2.1	Communities' inclusion and engagement process <u>*Sub - Activities*</u> *2.1.1 Stakeholder identification and assessment* *2.1.2 Participants selection and consultation* *2.1.3 Organization of the groups and engagement activities*	Exclusion of some vulnerable groups: participant selection starts with preliminary community analysis that is based on socioeconomic variables, ensuring the inclusion of vulnerable and isolated groups and communities.
Activity 2.2	Training for technical and project management improvement <u>*Sub - Activities*</u> *2.2.1 Training program preparation and meeting plan organization*	Low capacity of communities to implement project activities: the project provides training for participants and continuous on-site support by the zeroCO2 technical team. In fact, the relationship with the community is maintained and consolidated over time; training and operational activities in the field follow a schedule defined during the

	2.2.2 Selection and education of community technical project leaders *2.2.3 Implementation of the technical training program* *2.2.4 Accompaniment in project management* *2.2.5 Livelihood KPIs monitoring and measurement*	design of the forest/agroforestry systems. With the training, the families will improve their technical-scientific skills in the management of forest plantations and agroforestry systems.
Activity 2.3	Market access and employment *<u>Sub - Activities</u>* *2.3.1 PVCs market analysis and sales activities* *2.3.2 Support in accessing domestic and non-domestic markets for the sale of by-products (e.g., high-quality wood products) from the project*	No market access: timber products, given the quality of the product (cedar and caoba) have an important market both nationally and internationally. zeroCO2 aims to facilitate market access especially for the most marginalised communities. With the resources obtained from the sale of ecosystem services, the communities will improve their socioeconomic situation and their children will be able to have access to secondary and diversified education, which is very difficult for rural communities.
Output 3	Ecosystem and biodiversity restoration	The development of forest and agroforestry systems will improve soil conditions, enhance soil fertility and productivity. The project is implemented in areas where the baseline scenario involves extensive livestock farming and subsistence agriculture on heavily degraded land. These land uses have negative effects on the local biodiversity, as no natural regeneration is permitted, they lead to slash and burn practices and large areas of land are needed for cattle ranching, which is one of the main drivers of deforestation in the project area. Gradually, the tree cover will be reconstituted and natural revegetation will be encouraged in

		the project sites after 4 years, which is the time that cedar and caoba need to develop effectively without competition for nutrients and light. Natural regeneration will be included as one of the conditions in the project agreements, to strengthen the participants's commitment to allow for regeneration. In the medium term, considering the fast recovery of vegetation in tropical forests, there will be a wide range of species present at the project sites, which will resemble a mixed forest. The gradual increment of natural regeneration will bring a succession of native plant species, first herbaceous, then shrubs and finally trees. This will provide suitable conditions for the appearance of a wide range of wildlife species that will benefit from the vegetation increment in the form of habitat, pollination opportunities and corridors to facilitate their movement across forest patches. After the year 20, the objective of the project is to promote a transition from forestry plantations to forest management systems, in which the focus will shift from timber production to a balanced use between timber production and conservation, which will ensure the permanence of the tree cover. Soil fertility in the project sites will be significantly improved by the nutrient exchange facilitated by the planted trees, the organic matter provided, and the improved capacity for water absorption as a result of their root systems, which will also reduce soil erosion.

Activity 3.1	Forest management plan implementation and monitoring *<u>Sub - Activities</u>* *3.1.1 Land management plan (LMP) definition* *3.1.2. LMP implementation* *3.1.3 Ecosystem KPIs monitoring and measurement*	Disease spread, fire and extreme weather events prevent ecosystem restoration: the activation of specific management and prevention measures, reduce the risks associated with these events.
Output 4	Improved land management	The implementation of forestry and agroforestry systems will allow participants to benefit from their land while achieving a sustainable management of resources.
Activity 4.1	Empowerment in the management of sustainability tools, supporting local communities in sustainable agricultural practices *<u>Sub - Activities</u>* *4.1.1 Dissemination of good land management practices for improved resilience and adaptation to the effects of climate change*	Community members will improve their ability to take advantage of the resources available to them, while empowering them to use their land appropriately.

Among other benefits, communities will gain valuable timber from the plantations, which is essential for the long-term sustainability of the project interventions.

The plots will be managed according to the specifications in Annex 7, which is based on the most conservative scenario.

Regarding long-term management of the plots and reforestation practices, communities will be trained and incentivized to promote natural and assisted regeneration of the area. However, each participant will specifically decide whether to keep only the forest species, Cedar and Mahogany, or enrich the plantation with other species to arrive at the desired scenario at year 20.

At present, species selection is based on the environmental characteristics of the project site and the preferences of each participant, which means that the starting point will be Cedar and Caoba. The intention is to make the project design as inclusive as possible, instead of imposing a fixed project intervention on the participants. This is the reason why planting additional species will remain as a decision of each participant. Even so, zeroCO2 will promote the planting of other species to their plots, once Cedar and Caoba have been

established and after analysing the most suitable species. Besides, the objective is to promote natural regeneration in the project sites from year 4, which will be included in the project agreements.

At year 20, at the end of the first rotation, a conservative scenario was selected at this stage for the purpose of carbon benefit calculation in which a cut of the commercial species takes place while leaving an amount of trees (seed trees). zeroCO2 will strive for there to be assisted natural regeneration of the area with other tree and herbaceous species starting in year 4.

At this early stage of the project, because there is insufficient evidence to determine the different long-term management systems that participants will adopt, a 20-year rotational forest planting will be considered, with reference to Cedar and Mahogany.

During annual monitoring, the different management approaches followed by the participants will then be determined and documented.

Technical Specification

3.6 Project Activities

Table 3.6.1: Project Activity Summary

Project Intervention	Project Activities	Inputs
Improved land management through forest plantations and agroforestry	Manage wasteland exploited by years of monoculture and extensive grazing by planting tree species to produce wood and other products. In this project design phase, the use of native species such as cedar (Cedrela odorata) and mahogany (Swietenia macrophylla) is planned. In almost all cases, after the start of forest cultivation, agroforestry systems with annual crops, first and foremost maize, will be established for the first few years. The planting density will be 1,111 plants per hectare. The long-term management goal is to reach year 20 through natural regeneration assisted by a complex, biodiverse system, with a gradual transition from plantation forestry to sustainable forest management. zeroCO2 will guide communities in long-term plantation planning. By	• Trees • Technical tools • Carbon benefit distribution (for management)

	training project participants in organic management and promoting complexity. When, together with Cedar and Caoba, perennial fruit tree species are planted, planting densities will be reduced to 100 to 400 forestry plants per hectare. This second planting system is considered as an agroforestry system (SAF). The species used and management are the same.	

3.7 Additionality

The extended description of the identification of the baseline scenario and additionality has been included in chapter 3.1 Baseline scenario, as well as in Annex 7 using the AR-ACM0003 methodology "Afforestation and reforestation of lands except wetlands, version 02.0" and its subset qualifying methodology "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities". as suggested by Plan Vivo in the PM001 Agriculture and Forestry Carbon Benefit Assessment Methodology developed by PlanVivo and TLLG.

Table 3.7.1: Additionality Assessment Summary

Project Intervention	**Main Barriers**	**Activities to Overcome Barriers**
Improved land management through forest plantations and agroforestry	**Financial & social barriers** The project targets communities struggling with high levels of chronic poverty without the financial means to invest in planting and restoration activities. Significant initial liquidity problems (high initial costs and medium- to long-term return on investment) discourage the start-up of projects in favour of "business as usual" land management practices.	The project will provide communities with the primary resource (trees) and the tools for proper and effective management of the resource over time.

	Technical barriers - High training deficit in forestry and other fields necessary for sustainable management. - Few projects with similar characteristics have been attempted in the Peten region.	- This programme utilizes the experience of forestry experts and brings that experience to the community.The zeroCARBON project will be able to ensure continuous cycles of training thanks to the specialized operational team on site and the institutions (local universities) with which zeroCO2 works. As the project grows, the number of experts and stakeholders involved could increase and provide knowledge of good practices in sustainable forest management and agroforestry.
	Institutional barriers - The systems prevalent in the region hardly ever involve trees, although the Mayan tradition was quite the opposite. The current widespread management involves a continuous subsistence farming cycle through the typical 'milpa'. There is no set-aside or crop rotation due to the limited availability of land. This leads to a rapid impoverishment of the land. - Lack of support from state and private	- Through the project, it will be possible to gradually rediscover traditional agroforestry management methods of the Mayan culture. - Through the project, communities will be empowered with the technical tools and knowledge to adopt a more sustainable approach to land management. - The project will provide training on social organization and management of local institutions.

	institutions to the communities involved. The access to state programs that provide incentives for reforestation (PROBOSQUE) is highly challenging for smallholders with limited resources and knowledge about forestry. In order to register in PROBOSQUE, there are a series of procedures and technical requirements that need to be fulfilled, which are complicated to achieve without external support from non-governmental organisations. In particular, the expertise and resources needed to define, describe and implement silvicultural practices, which need to be registered in the management plan.	ZeroCO2 supports participants along the entire process for registering their plots in PROBOSQUE, to facilitate their access to additional financial benefits, in a complementary way to zeroCARBON. Mainly through the development of the management plan, mapping and forestry design, which allows them to access the program. The management plans for zeroCARBON are designed in a way that is compatible with the PROBOSQUE program so that participants can receive the incentives during the first 5 years while successfully participating in zeroCARBON. zeroCO2 also provides the seedlings, capacity building, and constant technical support to implement the silvicultural practices needed to benefit from PROBOSQUE.
	Ecological barriers Natural events such as floods, unpredictable climatic conditions, land-pressures such as intensive grazing and monoculture plantation. Particularly, one of the main ecological barriers is the disrupted weather patterns during the rainy season, which is leading to many smallholders having limited access to water and therefore limited opportunities to start forestry practices that can	The project produces seedlings in the nursery for those individuals who want to participate in the project but who lack access to water to produce seedlings during the dry season. Seedlings are delivered to project participants when the rainy season begins so they can plant them when water is available. The project considered water availability as a key ecological barrier in selecting species and developing the project

	make their land productive and profitable. The production of seedlings that make the establishment of forestry plantations possible, have limited growth periods that mostly coincide with the dry season when they heavily depend on water. This represents a barrier for smallholders to access forestry land uses.	intervention. The planting systems take into consideration the specific precipitation conditions of the project area.

The additionality of the present project was performed using the combined tool to identify the baseline scenario and demonstrate additionality in A/R VCS project activities (Version 01). See section 3.1 for more details.

3.8 Carbon Benefits

Table 3.8a: Expected Carbon Benefits Summary

Project Intervention	**Baseline Emissions (t CO_2e/ha)**	**Project Emissions (t CO_2e/ha)**	**Leakage Emissions (t CO_2e/ha)**	**Carbon Benefit (t CO_2e/ha)**
Improved land management through forest plantations and agroforestry	- 229.12	- 100,354.44*	0	100,354.44**

*gross value with buffer included
**with long term average applied

Table 3.8b: Plan Vivo Certificate Potential

Project Intervention	**Carbon Benefit (t CO_2e/ha)**	**Project Area (ha)**	**Total Carbon Benefit (t CO_2e)**	**Risk Buffer (t CO_2e/ha)**	**Potential PVCs (t CO_2e)**

Improved land management through forest plantations and agroforestry	229.12	438	100,354	20 %	**80,283**

Risk Management

3.9 Environmental and Social Safeguards

3.9.1 Exclusion List

The project does not include any activities listed in the Plan Vivo Exclusion List (as reported in Annex 8). The only aspect on which a degree of uncertainty remains is in relation to pesticides.

Weed management will mainly be done manually.

Pesticides are almost always too expensive for communities. However, at this stage we cannot exclude a priori that no participants will use them.

zeroCO2 will monitor this and continue to train communities to adopt nature-based solutions and eliminate the use of synthetic products (both pesticides and fertilisers) where use occurs.

zeroCO2 will also provide and develop alternatives with communities such as mulching, green manure, composting, bio-fertilisation and climate-smart fertilisation (biochar).

3.9.2 Environmental and Social Screening

Table 3.9.2.1: Environmental and Social Risks

Risk Area	**Likelihood (1-5)**	**Magnitude (1-5)**	**Significance (low, moderate, severe, high)**
Vulnerable Groups	1	1	Low
Gender Equality	2	2	Low
Human Rights	1	1	Low
Community, Health, Safety & Security	1	1	Low
Labour and Working Conditions	1	1	Low

Risk Area	Likelihood (1-5)	Magnitude (1-5)	Significance (low, moderate, severe, high)
Vulnerable Groups	1	1	Low
Resource Efficiency, Pollution, Wastes, Chemicals and GHG emissions	2	2	Low
Access Restrictions and Livelihoods	1	1	Low
Cultural Heritage	1	1	Low
Indigenous Peoples	2	2	Low
Biodiversity and Sustainable Use of Natural Resources	3	3	Moderate
Land Tenure Conflicts	2	3	Moderate
Risk of Not Accounting for Climate Change	2	4	Moderate
Other – e.g., Cumulative Impacts	1	1	Low

3.9.3 Environmental and Social Assessment

As described in the screening process summarized in 3.9.3, zeroCARBON was classified as a low-risk project. This being considered, and following the recommendations of Plan Vivo, a full environmental and social risk assessment was not required. However, every potential risk that was identified, including low and moderate risks, have been accounted for and considered in the design of this project. The corresponding mitigation measures that will be applied for every identified risk are described in 3.9.4.

During the initial risk assessment, there were several identified themes that could pose a significant risk in our project, particularly in regard to climate change risks, use of pesticides and biodiversity. In this case, our team expanded the scope of the assessment to gain a better understanding of the potential impacts that these issues could generate in our project. The extended assessment of the three themes is provided in Annex 10, including an explanation of the analysis that was performed to evaluate the significance of each risk, and a description of the measures developed to minimize their potential impacts.

3.9.4 Environmental and Social Management Plan

Table 3.9.4.1: Environmental and Social Risk and Impact Mitigation Measures

Risk/Impact	Mitigation Measures	Project Activity
Pest and illness	1. Preventive management 2. Trap placement 3. Plague and illness management	3.1 Forest management plan implementation and monitoring
Wildfires	1. Fire-cutting bands, which are land stripes of 3 metres of width surrounding the plots, in which vegetation is removed to avoid the spread of fires. 2. Removal of fuel wood from program areas 3. Identification of critical areas	3.1 Forest management plan implementation and monitoring
Droughts and extreme weather events	1. Mulching with plant residues against evaporation (mitigation for droughts) 2. Living fence against extreme weather events 3. Replanting 4. For flooding risks, tree species distribution in the project sites will be adjusted to their resilience to flooding and based on the locations identified as at risk by project participants, who are highly knowledgeable about the areas which are most vulnerable to flooding.	1.2 Land use analysis 2.2 Training for technical and project management improvement 3.1 Forest management plan implementation and monitoring
Biodiversity and sustainable use of natural resources	1. Pesticides have been identified as a risk in this matter and specific mitigation measures have been developed (see Pesticides). Except for pesticides, the project activities will not create additional disturbances on the local ecosystem. All project interventions will be carried out in ecologically degraded plots with low levels of biodiversity.	1.1 Forest plantation and agroforestry systems development 2.2 Training for technical and project management improvement 3.1 Forest management plan implementation and monitoring

	2. For the sites assigned for forest plantation, combining Assisted Natural Regeneration with tree planting has proven to be an effective combination to provide habitat for wildlife and facilitate the establishment of native vegetation. 3. The Participant Agreements together with Land Management Plans will serve as a clear framework to support the sustainable use of natural resources, which participants will be responsible to follow. Legal sanctions can be pursued for participants that carry out harmful activities to the environment. 4. The only areas eligible for this project are areas with degraded forest cover and scarce vegetation, these being either pasture or low-productivity agricultural land. These areas currently do not provide favourable habitat for most wildlife species. Besides, the degradation of forest cover has resulted in the loss of other ecosystem services. The team follows strict requirements regarding the areas eligible to be included in this project, to ensure that the project interventions are not implemented in areas of ecological value and to avoid negatively affecting local fauna and flora. Before including any participant in the project, a site visit is carried out to ensure that the area proposed for planting has no forest cover or developed secondary vegetation. Besides, the area is	

	evaluated to ensure that adopting a forestry or agroforestry system is beneficial for the natural environment.	
Land tenure conflicts	1. Every plot included in the project is owned by an individual with title deeds that provide evidence of clear ownership and rights to use the land, which minimizes the appearance of land tenure conflicts between smallholders. 2. zeroCO2's approach of selling fPVCs during the initial stages of the project is aimed at providing early benefits to participants and increasing their willingness to maintain their land. Once participants start receiving products and additional income from carbon benefits which add economic value to their land, it is expected to discourage them from selling their property to third parties interested in acquiring land for other unsustainable land uses. 3. If conflicts between participants occur, the project will make use of the Grievance Mechanism and local institutions to craft solutions adjusted to each scenario.	1.2 Land use analysis and monitoring 2.1 Communities inclusion and engagement process
Pesticide Use	1. Pesticide application will only be needed for the first 2/3 years of the plantation to maximize tree establishment. 2. Pesticide quantities needed for this project are minimal, and their application will be strictly controlled by project staff. The	2.2 Training for technical and project management improvement

	precise quantities that will be implemented together with the maximum levels is provided in the Management Plan, to demonstrate that the applied quantities will always remain well below harmful concentrations. 3. The project acknowledges that there is limited access to alternative methods to pesticides. Capacity building workshops for participants on alternative methods will be implemented to encourage a transition in the project area.	
Indigenous peoples	1. The language barrier has been identified as a main factor of Indigenous people´s vulnerability in relation to this project. zeroCO2 uses a translator to communicate with indigenous communities to eliminate language barriers, reduce their vulnerability and facilitate their engagement in the project. Besides, a bilingual person will be employed to assist in the project with indigenous peoples´ engagement. 2. Every project intervention will follow a FPIC process, based on existing indigenous institutions and cultural values.	2.1 Communities inclusion and engagement process 2.2 Training for technical and project management improvement
Vulnerable groups	1. Project engagement will be personalized to the most vulnerable individuals of the community to prevent their exclusion from their participation in the project. An individual's vulnerability will be assessed based on their age, gender, participation in	2.1 Communities inclusion and engagement process 2.2 Training for technical and project management improvement 4.1 Empowerment in the management of sustainability tools, supporting local

	community assemblies or the existence of a family support system, to ensure they are given specific support. 2. The project will increase project participants' capacity to produce their own food and add value to their land, reducing their vulnerability. Every participant, including the most vulnerable farmers, will be provided with all the tools and capacity needed to implement the land management plan and benefit from products and PVC sales.	communities in sustainable agricultural practices
Gender equality	1. To ensure women participation in community-level decision-making and prevent their exclusion, women will be required to be part of the Board of Directors that will be established in each community.	2.1 Communities inclusion and engagement process 2.2 Training for technical and project management improvement

3.9.5 Native Species

Complete Table 3.9.5 to identify any non-native tree species that will planted or other non-native plant or animal species that will be introduced to project. For each non-native species, describe the livelihood or ecosystem benefits that justify their inclusion in the project in lieu of alternative native species, and provide an assessment and evidence that they pose no environmental risk or threat.

Table 3.9.5.1: Non-Native Species Overview

Project Intervention	**Non-Native Species Planted/ Introduced**	**Justification**	**Risk Assessment and Management**
Non-native species will not be used			

3.10 Achievement of Carbon Benefits

Selectable PVCs: 90% (total saleable PVCs after future 20% risk buffer reduction.) Of this amount, we plan to sell 100% as fPVCs in 2023.

The remaining 10% not issued, will be kept in a Conservation Reserve that can be cancelled if the project fails to convert part of the fPVCs or PVCRs to PVCVs.

Achievements table of carbon credits per participant are contained in **Annex 6_carbon calculation spreadsheet**

3.11 Reversal of Carbon Benefits

Table 3.11 was completed to describe the impact and probability of the risks to the long-term maintenance of the project's carbon benefits.

In the Score column, we multiplied the Impact and Probability scores to obtain a total score between 0 and 9.

Table 3.11.1: Risk of Reversals

Risk Factor	Impact	Likelihood	Mitigation Measures*	Score
Social				
Land tenure and/or rights to climate benefits are disputed	2 Disputes caused by conflict of program aims/activities with local communities/organisation	1	2.1. Communities' inclusion and engagement process An accompaniment and informed consent, as well as a participatory planning and continued stakeholder consultation over program lifespan, reduce the likelihood of disputes and conflicts. In general, there are minimum criteria in the participant selection process regarding the rights that participants must have over land, the main risk factor associated with the program.	2

Political or social instability	3	1	zeroCO2 is linked to Guatemalan forestry institutions and policy makers and is updated as regulations change so that it can respond to potential changes.	3
Community support for the project is not maintained	2 Lack of interest in continuing with the program.	2	2.1. Communities' inclusion and engagement process An accompanying and informed consent, as well as participatory planning and ongoing stakeholder consultation throughout the life of the program, reduce the likelihood of a loss of interest and thus a lack of support for the program. Receiving benefits from fPVCs and other products will increase their interest and motivation to participate. In the worst case scenario, new participants would be considered.	4
Economic				
Insufficient finance secured to support project activities	3 Lack of financial resources and low sales of fPVCs results in the inability to initiate and follow up the program	1	2.3 Market access and employment zeroCO2 provides sufficient funds and resources for project start-up in terms of development (tree provision), management, and	3

			monitoring (local team). This is complemented by the commercial and strategic activity of selling fPVCs already initiated by zeroCO2, based on the growing interest in PVCs also following ICROA's endorsement of the standard. This activity will be strengthened over time, including in terms of integrating new resources into the sales team engaged in these products.	
Alternative land uses become more attractive to the local community	2 The offer of these activities could result more interesting for smallholders.	2	2.2 Training programs 2.3 Market access and employment Accompaniment, awareness, and informed consent; training complementary to forestry programs; production diversification (timber and non- timber) and market access support.	4
External parties carry out activities that reverse climate benefits	2	1	3.1. Forest management plan implementation and monitoring	2
Environmental				
Fire	1	1	3.1. Forest management plan implementation and monitoring	1

			- Removal of fuel wood from program areas - Fire-cutting bands - Identification of critic areas - Surveillance	
Pest and disease attacks	2	2	3.1. Forest management plan implementation and monitoring - Strong pest management control (see technical specifications) - Tree species diversification (living fence)	4
Extreme weather or geological events	2	1	1.1 Designing and planting activities - Replanting of trees as required - Selecting drought resistant species - Planting operations in the right season - These types of risks are limited to the first years of the project.	2
Administrative				
Capacity of the project coordinator to support the project is not maintained	2	1	2.2 Training Adequate training of project managers and staff in zeroCO2. The administrative process is in continuous improvement.	2

Technical capacity to implement project activities is not maintained	3	1	2.2 Training Constant and focused training for technical capacity building and monitoring programs.	3

* Cross reference activities from Section 3.5 (e.g. Activity 1.1.1)

3.12 Leakage

The project interventions will only take place on low productive land and in every case the participants already have an area of their land dedicated to their agricultural activities, as its conditions are more suitable for agriculture. This means that none of the participants' agricultural production will be compromised, as the forestry or agroforestry use will be complementary to the agricultural use that was already present before the start of the project.

Since families have a more suitable land for subsistence agricultural production, all participants will retain the current scale and production of their agricultural plots. Therefore, there will not be a need to claim other forested land for agriculture use, minimising the risk of leakage. On the contrary, one of the objectives of the project is to encourage the local population to adopt forestry land uses instead of continuing with cattle ranching or extensive agriculture, and thus, reduce deforestation in the project's area of influence.

Leakage risk (outside the project areas), leakage estimation and monitoring, and leakage mitigation measures for each project intervention have been described in Annex 7 based on an approved methodology.

Within the applicability of methodology **AR-ACM0003**, the main source of leakage emissions considered in the selected methodology is leakage due to displacement of agricultural and pastureland activities.
Should leakage occur, it will be calculated using the A/R CDM methodology using AR-TOOL15 : "*Estimation of the increase in GHG emissions attributable to the displacement of pre-project agricultural activities*". in A/R CDM project activities. Version 0.2.0.

However, during the initial activity in the project area, no displacement of pre-project agricultural activities is expected to occur and, if they do occur, they will be on land with equal or lower Soil Organic Carbon (SOC) and biomass stocks than the original agriculture.
During the project duration land cover analysis through remote sensing and on field survey will be performed to avoid this possibility.
Therefore, in the first instance, leakage losses will be considered zero (LK,t =0).

The summary of leakage risks and mitigation measures are shown in the following table 3.12

Risk of leakage in-depth analysis

The participants or beneficiaries of the zeroCARBON project allocated the areas of the farms according to their use and the potential of the area while ensuring the economic viability of their properties.

A basic requirement is that the individual participants have title or ownership rights to the land.

In all cases, communities are divided into agricultural areas, livestock areas and forest areas (unmanaged or managed forests).

As a measure to mitigate the risk of leakage from the zeroCARBON project, the entry of participants with very small areas of land of less than one hectare is restricted, while entry is considered possible for people with two hectares or more of land, depending on the current use and productive capacity of the land.

The land use scenarios in the communities in the baseline scenario are as follows:

1. 100% agricultural

2. 100% livestock

3. Agricultural 50% livestock 50%

4. Agriculture, livestock and forest (unmanaged or poorly managed forest)

a. For the owners of two hectares, 50% of the land is part of the zeroCarbon project and 50% is left to its previous use.

This allows the person to continue the productive activity they were engaged in before the project.

b. For entities with areas greater than two hectares, the four criteria described above shall be considered, taking into account the percentage occupied by each land use on the farm or property, with the aim of enabling the beneficiaries to continue to carry out the production activities they were engaged in prior to the zeroCarbon project.

In other words, they choose which percentage of the area of the farm occupied by agriculture or livestock farming will be part of the project ensuring that there is no alteration of the economic and/or family subsistence of their property

c. In the event that the beneficiary's land is not agriculturally productive, it can be included in the zeroCarbon project. If the area is agriculturally productive, it will be determined what percentage of the area to allocate to the project based on the history of the area and the beneficiary's observations on the condition of the area (relief, stoniness, drainage, etc.) made during the visit by the Zeroco2 technical team.

Geographically, leakage is very hard to conceptualise, especially for smaller projects.
In our case, we work with communities that have land ownership. We'll monitor in the field that deforestation does not occur in non-owned areas through recurring satellite analysis and constant training and updates in the field.

In the chapter 4.1 Progress indicator, we have incorporated a parameter for monitoring deforestation in the area based on remote sensing data and data truth based on field visits.
A numerical ratio between annual deforestation rates before and after the project start date in the project surroundings and the specific drivers may be the only method to have a reference on potential geographical losses (however, this figure is subject to a rate of uncertainty).

Table 3.12.1: Leakage Risk Mitigation

Project Intervention	Leakage Risk	Mitigation Measures*
Improved land management through forest plantations and agroforestry	Displacement of agricultural and pastureland activity to other areas, leading to deforestation and its associated emissions.	- **2.2. Training** and support of local communities in sustainable agricultural practices (agroforestry) - **1.2. Monitoring** land use changes within the project area, and supporting analysis with GIS and remote sensing tools. A numerical relationship between annual deforestation rates before and after the project start date in the project surroundings and specific factors will be made to try to have a reference on potential geographical leakage. Planning of the project areas according to the areas owned by the individual participants and their use to ensure that the participants can still continue their activities prior to the zeroCarbon project.

* Cross reference activities from Section 3.5 (e.g. Activity 1.1.1)

3.13 Double Counting

Table 3.13.1: GHG Emission Reduction and Removal Projects and Programmes in the Project Region

Project, Programme or Initiative	Scope	Carbon Credit Generation	Risk Mitigation
REDD+ (Guatecarbon project)	In Peten, the project region, the REDD+ national programme is being implemented through a project known as Guatecarbon. The project covers 717,000 hectares of the Mayan Biosphere Reserve in northern Peten. Even though Guatecarbon is being	Generating Verified Carbon Units (VCUs) listed on the Verra registry. Following VCS and CCB standards.	-There is no overlap between Guatecarbon's intervention area and the project sites. Carbon accounting for Guatecarbon is strictly limited to the Multiple Use Zone, which is based on an official designation of land use with clearly

	developed in the same region, there is no overlap with the project sites included in zeroCARBON or with the carbon that will be accounted for. Guatecarbon is being developed within the Multiple Use Zone of the Mayan Biosphere Reserve, while the nearest zeroCARBON sites are located in the Buffer Zone.		defined geographical boundaries. -Although CONAP (National Council for Protected Areas) is the national entity that manages the reserve, project participants still maintain land ownership on project sites, including carbon rights. This ensures that participants have complete decision-making over their land and that no other entities can claim carbon sequestration taking place in these plots. -Contracts with project participants (see Annex 12) clearly specify that carbon rights and their associated benefits cannot be sold via other programmes, which avoids double counting. -zerocarbon will maintain a thorough monitoring and tracking of every PVC generated and their sales.

ZeroCarbon has no intention to generate any other form of GHG-related environmental credit for GHG emission removals claimed under the Plan vivo program. zeroCO2 will use the Plan Vivo database to track, archive and manage carbon sales.

ZeroCO2 will also maintain an internal database modelled on that of Plan Vivo to track monitoring data, carbon sales and the amount paid to producers so that all carbon sales can be further tracked and linked to monitoring indicators.

Agreements

3.14 Land Management Plans

The land management plan is the technical tool to establish the forest management to be given to the plantation, including activities such as planting, clearing, pruning, thinning or selective felling, protection against pests and diseases, forest fire prevention and control, and final felling.

The definition of the land management plans to be followed to achieve the benefits of the zeroCARBON program is carried out in collaboration with the participating communities, starting from the forest planning phase of each plot.

The main activities included in the management plan are:

- Planting: It is the activity that allows the establishment of the plantation after preparing the area where the plantation will be carried out.
- Cleaning: Includes the elimination of weeds within the planted area to prevent plants from competing with weeds and allow the plantation to develop properly.
- Pruning; Consists of the removal of branches from a tree; it can be training pruning to support a positive development of the trees or sanitation pruning to eliminate damage caused by pests or disease.
- Thinning or selective felling; the objective of long-term plantations is to produce timber for harvesting or marketing; therefore, thinning or selective felling consists of cutting or eliminating trees that have not developed, are malformed or have been affected by pests or diseases. This activity is planned at a minimum percentage and can be carried out every four years depending on the need for space and nutrient competition for the development of the plantation.
- Protection against pests and diseases; these are activities planned to prevent the attack of pests or the development of diseases that may affect the growth and health of the plantation.
- Forest fire prevention and control; these are activities planned to prevent or combat any forest fire that may affect the plantation.
- Final cutting: the final cutting of the plantation is when all the trees are cut with the purpose of commercializing all the products they can provide, after a period of 15 years or more, however, the forestry law establishes that after the final cutting the area occupied by the plantation must be replanted.

All activities contemplated in the Management Plan are in accordance with the Forestry Law, decree 101-96, the Law to promote the establishment, recovery, restoration, management, production and protection of forests in Guatemala -PROBOSQUE-, decree 2-2015, and their respective regulations and Volume I of the Probosque Manual.

In this first year of starting the zeroCARBON program, as almost all plantations are mahogany and cedar based forest systems, we have a one standard management plan template.

zeroCO2 refers to the attached document in annex 11, which serves as a guide for the development of a standard management plan that will be discussed with the community and adapted to each project situation.

Management plans are built upon the technical knowledge of zeroCO2 operational team and following the guidelines of INAB, (Instituto Nacional de Bosques). Considering the technical expertise and resources needed to define and describe silvicultural practices, participants commonly request zeroCO2 for the management plans, as these are also needed to access the incentives from the PROBOSQUE program. Participants decide which type of intervention suits best their interests and the environmental conditions of their plot, and based on that, the type of intervention is recommended together with the according management plan. The plan is discussed in detail with each participant to ensure their understanding, and through the capacity building sessions described in section 2.6, participants acquire the knowledge to implement the activities listed on the management plan. Thus, the management plans are currently designed in a standard way that is compatible with the PROBOSQUE program so that participants can receive the incentives during the first 5 years while successfully participating in zeroCARBON. This is the reason why, at this initial stage of the project, there is one standard management plan which will be updated and customised to each participant, including carbon calculations, and the hectares and location of each area, once the project achieves validation.

The design and development of management plans is done through a participatory process with communities based on a number of key elements:

- Disclosure and understanding of the process and monitoring of the carbon project, to inform in an appropriate way about the benefits participants will receive from the carbon project, and the technical processes involved.
- Acceptance of rights and obligations due to the program adhesion: when the benefits of the carbon project are understood and agreed upon by the participants, the process that the project entails are followed.
- Benefit analysis and livelihood enhancement. The project and its benefits have the potential to improve the livelihoods and life quality of the participants, due to the additional economic income that will be generated by each family or participant.
- Balance between food security of production and participation in the project. The project does not put at risk the food security and/or income of the participants considering that the lands incorporated into the project are lands that were used for low productivity agricultural production or livestock.
- Definition of location and extent of area. The definition of the area to be utilized by the carbon project is defined by the landowner according to their plantation management capabilities. Each area is geographically located by taking coordinates at its vertices.
- Definition of activities to be carried out during the project. The activity plan, timeline and target participants are defined based on the specific capabilities and characteristics of the community and included in the Management Plan.

The development of a management plan will be a fundamental tool to ensure the success of the project and the active participation of the community, considering that it is developed jointly with the participants from the initial stages of the project. This activity is complemented

by the training program offered to the participants, which follows the various steps of the management process. Continuous technical accompaniment will ensure an adequate support to achieve the objectives and a strong reduction of the environmental risks associated with the project.

3.15 Crediting Period

State the initial crediting period and any plans for extension.

The initial crediting period is from 1 January 2020 to 1 January 2040, which may be extended when necessary and/or for project areas that are added to the project after 2020.

The zeroCARBON program in Guatemala commenced in 2020, initially reforesting areas from that year as well as a small portion (about 9% of the total area involved in the program) from 2020 and 2021. The program has scaled up since 2023, with over 300 hectares, and plans further scaling up from 2024 to involve annual quantities of around 300 hectares.

The total carbon quantification period, known as the Crediting Period, is estimated to be 20 years, representing the duration during which the wood trees in the system can be harvested.

The value of tree and non-tree products from plantations, in addition to the carbon benefits from the sale of PVC, encourages project participants to continue to protect and maintain trees over time, as they can rely on both a short and medium-term source of income (such as carbon benefits) and a long-term source of income (such as timber and non-timber products). In the case of agroforestry, this is complemented by significant agricultural production for both subsistence and sale.

3.16 Benefit Sharing Mechanism

The benefit sharing mechanism of the zeroCARBON program is based on compliance with the requirements listed on 3.16 of Plan Vivo Standard v5.0.

All proceeds from the sale of Plan Vivo Certificates will be distributed according to the benefit sharing mechanism described below, developed in collaboration with project participants.

To ensure that most of the economic benefits reach registered participants in zeroCARBON, it is planned that 60 percent of the proceeds from the sales of PVCs (both fPVC-rPVCs and vPVC formats) will directly benefit Project Participants and other local stakeholders, either in the form of direct payments to participants or in other in-kind benefits (such as nursery and tree supply, mapping and land management technical design) that are intrinsically linked to the project. Additionally, beneficiaries will benefit from the sale and use of products (such as wood, non-timber forest products, and crops) generated directly from their plots as a result of this program. In addition to direct benefits, program participation contributes to generating additional indirect co-benefits, such as improved productive activities and increased knowledge in resource utilization, facilitating and promoting local development and the creation of new additional projects.

The remaining 40% will be allocated to zeroCO2 to cover program implementation and coordination costs.

The framework of collaboration, obligations, and rights associated with the program are defined within the Project Agreement, based on the principles of Free, Prior, and Informed Consent (FPIC).

Consistent with the principles of the Standard Plan Vivo and the zeroCARBON program, direct economic benefits from carbon sales are accredited to participants who have demonstrated compliance with their management plan, as stipulated in project agreements.

Depending on the type of intervention, beneficiaries are required to implement an activity plan (land management plan) and achieve certain objectives, upon which the payment system is configured. Among these objectives are included plant survival, prevention and care of the plantation from diseases and fires, as well as the adoption of ANR practices to promote biodiversity enrichment.

The project agreement, organized into two phases, sets up two funds: the Base Fund for the initial 7 years and the Additional Fund for subsequent years.

- Base Fund: It ensures that beneficiaries receive 80% of the potential carbon benefits (sold as ex-ante or fPVCs) generated during the 20-year accreditation period in the plot. This is based on predefined technical targets regulated by the land management plan and a fixed conservative price.
- Additional Fund: This fund covers revenue from selling the remaining 20% of credits, the margin between the sale and agreed price, and additional credits (e.g., over-performance, ANR). It becomes operational from year 8 onwards, upon agreement renewal, and will be based on specific activity targets regulated by the land management plan.

Further details are described in chapter 5.4 of the document.

The amount of carbon accredited in each phase (year) is proportional to the percentage of activities and targets achieved.

Through the annual monitoring plan, the local zeroCARBON team verifies the effective achievement of management targets for each individual plot. Each participant receives an average of three annual visits from the zeroCARBON team during the first three years, which reduce to two until the seventh year, once the plantation has established and the risks associated with project permanence have decreased. From the eighth year onwards, an annual monitoring visit is scheduled. During these visits, specific field data is collected, including the implementation of fire protection activities, disease prevention, pruning as outlined in the management plan, survival rate, and disease attack rate on each plot. Additional site visits to designated permanent plots are conducted for data collection purposes for carbon and biodiversity monitoring. Further details on the monitoring plan are available in Chapter 4.

If in any of the monitored years the farmer does not meet the activities initially planned, the duration of the overall process (and therefore payments) will be extended.

In the monitoring corresponding to year 7, the farmer must meet all agreed targets to complete that stage, otherwise he keeps his zeroCARBON commitment active.

At each stage of the carbon credit, monitoring data is recorded by zeroCO2 in the project database, which contains all the relevant information about the carbon credits, commitments and transactions made.

In the event a farmer does not meet their annual commitments, their payment is withheld until the respective targets are met. In case the yield has been affected by external factors beyond the farmer's control, such as pests, zeroCO2 supports the participant in monitoring and treating the problem so that in the next monitoring period they can meet their commitments.

If the target is not met for two consecutive years, the project participant is removed from the program and a new ground is included as a replacement.

3.17 Grievance Mechanism

Figure 11 below illustrates the organization that was given to the project participants to have efficient management and open and free discussion among the participants through cooperative grievance management.

The aim of the grievance mechanism is to enable participants to give their feedback and raise any issues related to the project, which can then be resolved.

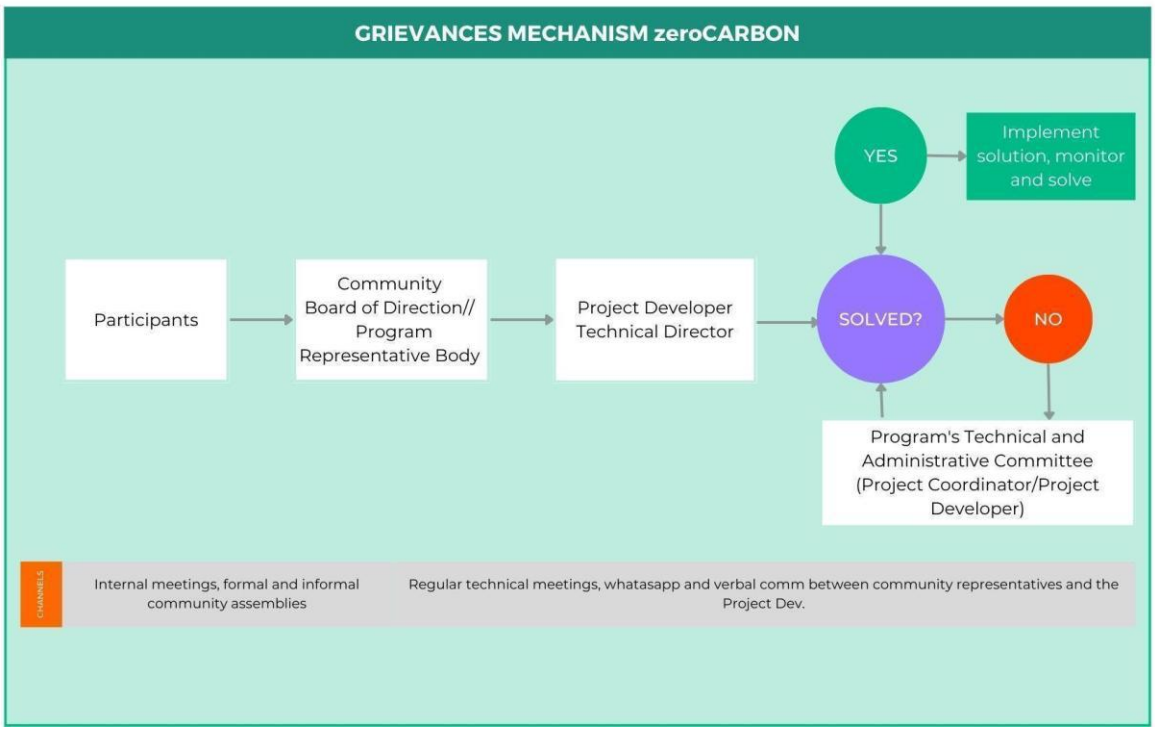


Figure 16: Grievance mechanism for participants of the zeroCARBON program.

Monitoring will be developed at the local level through the project representative (Board of Directors and the Program Representative Committee) of each community who will report to the Project Developer Technical Director.

During the periodic technical meetings organized by the Project Developer, complaints pending resolution will be addressed and possible solutions will be provided, describing each related issue in the minutes of the meeting.

The collection of feedback and issues may also take place outside of official project meetings, and it will be the responsibility of the Program Representative Body of each community to collect and report them through other communication channels (mainly telephone) to the Project Developer's Technical Director, with whom they are in constant contact.

If the complaint can be resolved and the technical coordination of the program can provide a solution, it will be provided. Otherwise, depending on its complexity, the complaint will be referred to the Program's Technical and Administrative Committee (composed of zeroCO2 technical and administrative staff).

The response to the complaint should not exceed 60 working days and is provided in writing. Complaints are filed in the participants folders, along with a description of the attention mechanism. Complaints will be addressed as long as they are within the program's area of influence or occur within the program's implementation period.

3.18 Project Agreements

The sharing process of carbon benefits will take place as defined within the Project Agreement, the legal document that bonds zeroCO2 and the participants in an official collaboration.

The agreements are built to make the participant fully aware of the obligations and rights integrated in the program membership, in accordance with the principles of Free, Prior and Informed Consent (FPIC).

The agreement aims to establish a framework in which the participant provides environmental services and zeroCO2 represents him or her in the transaction of these services, while clarifying that zeroCO2 does not own these environmental services or the land in which they are generated.

Participants interested in joining the program must meet the following minimum criteria:

- Demonstrate ownership of the land through relevant documentation.
- Demonstrate that the property is free from litigation or conflict.
- Demonstrate Guatemalan nationality.
- Possess sufficient land to participate in the program without jeopardising their food security.
- Have a commitment to maintain and preserve the plot(s) for the period stipulated in the agreements.
- Be willing to carry out program activities, as well as participate in training and exchange of experiences.

Each agreement contains details about the obligations and commitments of both parties and key information such as:

- The duration of the agreement and opportunities for renewal.

- The minimum value of support that will be received by the Project Participant if all monitoring targets are met.
- The nature of support (i.e. cash payments, in kind support, training, etc.).
- The estimated total sellable carbon benefits (in t CO2e) in the specific area over the entire crediting period and zeroCO2 sales assumption.
- The timing when support will be provided.
- The expected schedule of management and monitoring activities and the functioning of related payments.
- The description of the payment plans that zeroCO2 commits to pay to the participant (based on the PVCs sale assumption, management schedule and monitoring activities).
- The functioning of any subsequent payments additional to those in the agreement.
- The means of accessing the grievance systems and resolving arising conflicts and problems.

Each agreement is based on the system (forestry or agroforestry) chosen and the remuneration figures provided in the project's financial plan (considering sales assumptions), which will be part of the annexes to the following agreement.

The agreement stipulates that benefits from the provision of the environmental service will be granted to those who demonstrate ownership of the land, depending on the results of the monitoring and on the compliance with the activities listed in the management plan, which are also specified in the annexes to the contract.

Given its legal nature, the agreement obligates the signatory parties to abide by it, including the specific conflict resolution mechanisms described in the document.

4 Monitoring and Reporting

Indicators

4.1 Progress Indicators

Table 4.1.1: Progress Indicators

Output/Activity	**Indicator**	**Means of Verification**
Output 1 **Carbon sequestration**	-Amount of carbon sequestration (tC/ha)	- Field measurements
Activity 1.1 Forest plantation and agroforestry systems development	Number trees planted per year	- Internal database/monitoring
Activity 1.2 Land use analysis and monitoring	Survival Rate per year (%)	- Field measurements

Leakage and deforestation monitoring	Numerical ratio between annual deforestation rates before and after the project start date in the project surroundings and accounting for the specific drivers of deforestation	-Global Forest Watch data, remote sensing analysis, ground truthing
Output 2 **Increased social and economic impact**	-Skills enhancement and income gains for participating farming communities compared to minimum wage of the Region (Peten)	- Survey - Annual interviews with participants
Activity 2.1 Communities inclusion and engagement process	-Number of participants split by gender	- Internal database/annual monitoring
Activity 2.2 Training for technical and project management improvement	Training delivered split by gender	- Internal database/annual monitoring
Activity 2.3 Market access and employment	Job created (splitted by gender) Amount paid to project participants Number of tree products brought to market (in the first 5 years)	- Market analysis - Survey with participants - Annual interviews
Output 3 **Ecosystem and biodiversity restoration**	Number of native species (trees, shrubs, herbaceous) Presence of birds, mammals and soil macrofauna in project sites	- FIeld analysis and measurement

Activity 3.1 Forest management plan implementation and monitoring	-Number of hectares of rehabilitated tree cover	- FIeld analysis
Output 4 **Food and sustainable development.**	- Soil fertility improvement	- Field analysis
Activity 4.1 Empowerment in the management of sustainability tools, supporting local communities in sustainable agricultural practices	- Number and type of good practices implemented in land management (ha agroforestry system developed with annual crops and perennial trees)	- FIeld analysis -Survey and interview with participants

4.2 Carbon Indicators

Below in Table 4.2 is a summary of the carbon indicators that will be monitored for each project intervention. Full details with the monitoring plan for each carbon indicator can be found in Annex 7.

Table 4.2.1: Carbon Indicators

Project Intervention	**Carbon Indicator**	**Means of Verification**
Improved land management through forest plantations and agroforestry	Tree Planting: n planted	Internal documentation
	Area of project	Internal documentation
	Survival: Survival rate	Field measurement
	Pruning: % Pruned	According to forest management plan/ field measurement
	Thinning: % of trees harvested	Management plan/ field measurement
	Inventory: Above and below ground biomass per hectare of different species	Field measurement /internal calculations
	Tree growth: Change in diameter at breast height (DBH) and height	Field measurement

	Plot location GPS coordinates	Field measurement
	Disturbed area	Field measurement

Every year, zeroCO2 technicians on site will visit communities to assess the parameters listed in the table above. Based on established minimum management or growth requirements, participating producers will receive payments for ecosystem services.

The results of monitoring are used for adaptive management on an ongoing basis to ensure that carbon sequestration targets are met. This adaptive forest management system is achieved by leaving room for natural regeneration and early or delayed harvesting of fuel species depending on the growth of the stand.

4.3 Livelihood Indicators

Table 4.3.1: Livelihood Indicators

Contribution to the SDGs	Livelihood Indicator	Means of Verification
SDG 1. No poverty	Number of participant households (divided by gender/indigenous group)	Project/administrative documentation
SDG 1. No poverty	Quantity of carbon payments distributed to participants	Annual monitoring
SDG 1. No poverty	Products (timber and non-timber) generated by the project	Monitoring every 2-3 years
SDG 2. Zero hunger	Number of agroforestry systems	Annual monitoring
SDG 4. Quality education	Total number of trainings delivered (divided by gender/indigenous group)	Project/administrative documentation
SDG 5. Gender equality	Number of active women in training sessions and in the implementation of project activities	Project/administrative documentation
SDG 5. Gender equality	Number of working groups with women, indigenous, young and elderly people	Project/administrative documentation
SDG 8. Decent work and economic growth	Creation of direct employments	Annual monitoring

SDG 17. Partnerships for the goals	Number of partnerships with national and international institutions	Annual monitoring
SDG 17. Partnerships for the goals	Number of productive practices implemented for mitigation and adaptation to climate change	Annual monitoring

4.4 Ecosystem Indicators

Table 4.4.1: Ecosystem Indicators

Contribution to SDGs	Ecosystem Indicator	Means of Verification*
SDG 15. Life on land	Number of living trees established	Annual monitoring with field measurement
SDG 15. Life on land	Number of ha reforested	Annual monitoring with field measurement
SDG 15. Life on land	Number (diversity) of plant species promoted by the project activities	Annual monitoring with field measurement
SDG 15. Life on land	Number (diversity), distribution and quality of regenerative land use systems	Annual monitoring with field measurement
SDG 15. Life on land	Relative abundance of birds	Annual monitoring with direct observation
SDG 15. Life on land	Presence of mammals	Annual monitoring with direct observation
SDG 15. Life on land	Soil macrofauna	Annual monitoring with soil sampling

*Specifications about monitoring are included in the technical specifications guidelines (Annex 7) and Monitoring Plan (Annex 13)

4.5 Monitoring Plan

Following the selected methodology (AR-ACM0003-Version 02.0) requirements, the monitoring plan provides the necessary guidelines for the collection of all relevant data necessary for verifying that the applicability conditions of the methodology and of the applied tools have been demonstrated ex-ante, while others will be verified during the monitoring of the project and forest establishment.

During the monitoring, which will be conducted twice a year indicatively in March and August, it will be demonstrated that:

a) The land subject to the project activity does not fall in wetland category;
b) Soil disturbance attributable to the ARR project activity does not cover more than 10 % of area

Below are the main parameters to be monitored (in depth analysis is provided on Annex 13):

- Amount of carbon sequestration (above and belowground), based on Plan Vivo carbon sequestration calculation (annex 6)
- Quantity of trees donated to farming communities
- Number of hectares of rehabilitated forest (annex 13-15, showing progress and final results per farmer).
- Number of project-employed household members, split by gender (annex 13).
- Income gains for participating farming households (annex 3 - 16). Following the selected methodology (AR-ACM0003-Version 02.0) requirements, the monitoring plan provides the necessary guidelines for the collection of all relevant data necessary for verification that the applicability conditions of the methodology have been met:

Some applicability conditions of the methodology and of the applied tools have been demonstrated ex-ante and some others will be verified in the monitoring of the project boundary and of forest establishment.

During the monitoring it will be demonstrated that:

a) The land subject to the project activity does not fall in wetland category;
b) Soil disturbance attributable to the ARR project activity does not cover more than 10 % of area

Here are the main parameters monitored (in depth analysis on annex 13):

- Amount of carbon sequestration (above and belowground), based on Plan Vivo carbon credits (annex 6)
- Quantity of (tree) of trees donated to farming communities
- Number of hectares of rehabilitated forest (annex 13).
- Number of project-employed household members, split by gender (annex 13).
- Income gains for participating farming households (annex 13).

As for Life on Land, the monitoring approach will be carried out as follows. As previously described, it is necessary that both cedar and caoba are favoured through the elimination of vegetation for the first five years. From the fifth year onwards, the presence and permanence of natural regeneration will be promoted, especially of species of cultural and ecological interest. The gradual increase of vegetation will, in turn, start to provide favourable conditions for the appearance of mammals and birds. Soil macrofauna will also be favoured by the increase in soil organic matter.

Thus, an appropriate timeline to begin the monitoring of natural regeneration and biodiversity will be from year 5 onwards. The monitoring approach will be built upon and updated

according to the findings in the field. Below, an overview of the current monitoring plan regarding the indicators defined for Life on Land:

- Natural regeneration will be monitored annually in the month of September from year 4-5 onwards. The sampling size defined at this stage will be 7% of the total plots included in the project in that specific year. Monitoring will be carried out by zeroCO2 operational team by walking through the plot and identifying appearing plant species, with a particular emphasis on identifying species of ecological or economic importance. The number of species identified will be documented and associated with that particular plot.
- Presence of mammals will be monitored annually in the month of September from year 5 onwards. The sampling size defined at this stage will be 7% of the total plots included in the project in that specific year. Monitoring will be carried out by zeroCO2 operational team in a point located at the centre of each plot, by documenting tracks or excrements found in a 100 m2 sampling area. This data will be complemented with sightings by the participants.
- Presence of birds will be monitored annually in the month of September from year 5 onwards. The sampling size defined at this stage will be 7% of the total plots included in the project in that specific year. Monitoring will be carried out by zeroCO2 operational team in a point located at the centre of each plot, by establishing a 10 m radius and documenting the birds viewed or heard in that radius during 15 minutes. This data will be complemented with sightings by the participants.
- Soil macrofauna will be monitored annually in the month of September from year 5 onwards. The sampling size defined at this stage will be 7% of the total plots included in the project in that specific year. Monitoring will be carried out by zeroCO2 operational team in a point located at the centre of each plot. A soil sample will be collected and analysed using a Berlese funnel.

The sampling percentage and frequency will be revised and adjusted according to the needs of the project and results of the monitoring. All data regarding natural regeneration and biodiversity will be recorded by the zeroCO2 operational team using a standard form, which can be consulted in the shared folder.

4.6 Progress Monitoring

Carbon sequestration and ecosystem restoration

- To plant around 170 hectares within the first year. Double the area in 2023 and for the next 4 years;
- Achieve a 80 percent survival rate in the first two years after planting.

Increased social impact

- Train 100 percent of participants in organic farming practices and tree management.

Economic growth for local communities

- Promote diversified sources of income over the long term.
- Strengthen timber supply to furniture industries to enable long-term carbon immobilisation.

Ecosystem and biodiversity restoration

- At least 50 % of the participants adopt sustainable soil management practices and enrich their land with additional fruit and wild forest species in addition to the original species (Cedar and Caoba).
- At least 50 % of participants in year 20 switch to a sustainable forest management system once a regeneration process has been initiated during the first crediting period.
- Natural regeneration. At the end of year 5, identify an average of 5 plant species of all the plots monitored.
- Biodiversity. At the end of year 5, identify an average of 3 mammal species, 5 bird species and 20 soil macrofauna species of all the plots monitored.

4.7 Carbon Monitoring

- A yearly inventory on the field will be conducted by the zeroCO2 operational team.
- A project verification will be carried out every 3 years by a third party certification body.
- All carbon indicators described in Annex 7 will be monitored throughout the accreditation period.

The following monitoring scheme is considered to be followed:

- An annual field inventory conducted by the zeroCO2 operational team .

- A field verification audit will be conducted every 3 years, before which no vPVCs will be issued. This allows the carbon sequestration estimate to be verified and the carbon model to be calibrated to match the measured sequestration rates based on field measurements.

- Carbon indicators are listed in Table 4.2 (Section 4.2 Carbon Indicators) and will be monitored through the accreditation period following the specifications contained in the extended monitoring plan included in **Annex 7 - Monitoring and Annex 13 - Monitoring Plan.**

- The results and benefits in terms of carbon emissions achieved will be presented as required by PlanVivo with the Annual Report prior to Verification as specified in Section 4.9.

4.8 Livelihood and Ecosystem Monitoring

4.8.1 Livelihood Monitoring

- Number of participants: reach +200 farming families in the first 5 years;
- Training programs: cover 100% of the participants with the training program
- Number of women participants: increase by 10% annually the number of women actively involved in the program
- Number of working groups: activate in each community at least one productive project/working group run by women and/or indigenous people connected to the program
- Employment: generate new skills and job opportunities within the communities and the program

- Additional income: duplicate income sources from the plot within 5 years of planting

4.8.2 Ecosystem Monitoring

- Number of ha reforested: we expect to reach between 1,000-1,500 hectares of reforested area in the next five years.
- After the first 5 years, once rooting and establishment is guaranteed, the natural regeneration of the land will be accompanied by letting wild species grow. The milestone defined at this stage is to achieve an average of 5 plant species after 10 years from the beginning of the project.
- Number of agroforestry systems: agroforestry systems will gradually be created in many communities by integrating herbaceous species (maize, beans, chilli pepper, yucca) and native shrubs (coffee, mother cacao, plane tree).
- Number of tree species: in terms of forest plants, the main plants will be Caoba and Cedar and in some projects Ramon but during the project period new native species will be integrated by analysing adaptation characteristics and productive performance (food, wood, medicinal uses, etc.) using the approach of natural revegetation.
- The project areas will be continuously monitored and updated through GIS tools. An updated map with the project areas will be produced annually.
- In the first five years, different management systems will be found in the communities.
- Throughout the period, the zeroCO2 operations team will ensure a presence among the communities to raise awareness of organic land management practices. We will provide the communities with 120 hours of training per year, 1 day per month.
- The communities and individual participants will still maintain management independence while having to comply with a management plan that does not allow trees to be harvested before 20 years of age.

- Presence of birds. In the first monitoring year (year 5) the milestone is to detect the presence of an average of 5 bird species.
- Presence of mammals. The milestone is to assess the presence of an average of 3 mammal species per year, from year 5.
- Soil macrofauna. The milestone is to assess the presence of an average of 20 species per year, from year 5.

4.8.3 Sharing Monitoring Results

Annual sharing of monitoring results with communities and all stakeholders will be conducted. Feedback and possible improvement actions on the current trends identified will be collected.

Reporting

4.9 Annual Report

The annual report will be provided by Q1 of each year and the responsibility for its production will be under zeroCO2 with the support of the local VMV team.

The annual report will include all new areas and participants included in the program and all updated information regarding carbon, livelihood and biodiversity benefits collected through monitoring activities. The report will also include the financial aspects related to costs and

revenues generated, as well as the amounts of PVCs issued and retired, with corresponding benefit sharing with participants.
The report will also focus on the results of the monitoring of environmental and social KPIs, as well as the results of the grievance mechanism activated.

4.10 Record Keeping

All information related to the zeroCARBON program has been collected within an initial simplified database, which includes basic information on:

- Participants
- Plots involved
- Interventions
- Carbon benefits provided and that will be included in the project agreement.

The database will be supplemented over time with new detailed variables (such as GPS locations of single plots/project areas, land management plan, monitoring results) and information on the different phases of the program.

5 Governance and Administration

5.1 Governance Structure

The organizational structure of the zeroCARBON program is composed by two main entities:

- The project coordinator (zeroCO2 srl SB), who oversees the overall coordination of the project, financial and commercial planning and management, development of technical specifications and annual documentation for certification, and the relationship with the Plan Vivo Foundation.
- The project developer (Vivero Mundo Verde), which, given its widespread presence in the area, oversees the operational and technical development of the project, contributing to the design, production and definition of management plans and monitoring. Besides, it is responsible for community involvement, implementation of training programs and technical accompaniment over the life of the project.

The two entities are strongly interconnected at all stages of the program, from technical and training design to the resolution of any issues and grievances within individuals belonging to participating communities.

In terms of governance, respective technical and program directors have been designated within each organization to compose a common governance body, the Program Technical-Administrative Committee, which meets periodically (based on periods ranging from once a week to a minimum of once a month) to monitor project progress.

At the community level, the organizational structure within communities is based on the democratic election of the representative body of the Board of Directors or COCODE, as described in the paragraph 1.2.2. of the document. Depending on the type of participation in the zeroCARBON, whether communal or individual, the Board of Directors will have a different role and responsibilities within the program.

In the case of community participation (e.g., Monte Carmelo or Nuevo Horizonte), the Board of Directors will be involved in the initial stages of the participatory process, up to the definition of the participating group. In the case of individual participation, each participant, based on its individual property right, has full rights and decisions over his or her own land. In this case, although there is a Community Board of Directors, this body does not intervene in the program, but zeroCARBON team communicates directly with the individual participant without interference or - in other cases - works with representative organizations (Cooperatives or associations) in which the participants are grouped (e.g. Sayaxche).

In order to improve and consolidate the participation process and ensure a diverse and effective grievance resolution and management system, an additional election and representation mechanism is integrated at a community level.

In the case of community participation, an additional representative body (called the Program Representative Body) in each involved community, consisting of a group of 3 to 5 people, democratically elected by the participants, is to be integrated from 2023. The body is intended to facilitate the communication flows with the zeroCARBON team and the management of project activities within the community. It will also play an essential role in collecting and handling grienvances related to the program and in identifying-along with zeroCO2 and VMV- possible solutions.
Finally, the body will also need to fairly, inclusively and proportionately represent all diversity and minorities in the target community and participant group, with special attention to women's participation.

To date, the 3 main communities participating as a group have elected their representatives, while new Representative Bodies will be established in other communities pertaining to the 2023 group during 2024.

In the case of individual participants, on the other hand, the creation of these community representative bodies is more complex because of the great fragmentation and a very limited average number of participants per community.
To date, individual participants are self-represented and have direct contact with zeroCO2/VMV, which directly manages the relationship and the grievance system. The growth of the project and the number of participants per community will undoubtedly make it necessary to establish these communitarian bodies to facilitate the successful running of the program.

In addition to the community body and based on the needs that may arise during the course of the program, we plan to create gradually two additional representative bodies:

- Municipal body: representative group of collective and individual participants at the municipal level, meaning that all participants within a municipality's jurisdiction will form a representative body in front of zeroCO2 and other secondary stakeholders. This entity, composed of 3 people elected from among representatives of community groups and individual participants, will be responsible for submitting participants' grievances (collective or individual) related to municipality issues to zeroCO2. The municipal body also democratically elects a person who will represent it on the regional body. The municipality body meetings are expected to be organized every 4-6 months

and, if necessary, may request other extraordinary meeting with the Project Coordinator.

- Regional body: in relation to the development of the zeroCARBON program and the possible needs that emerge for participants (collective and individual), a representative body will be established at the regional level, i.e., at the Petén level, which will be in charge of presenting to zercoCO2 the complaints that emerge at the regional level and that affect participants from the different municipalities. This body will be composed of a representative of participants from each municipality (and must have at least one female representative). The representative body from each municipality must democratically elect the person who will represent it on the regional body. It will meet once/twice a year to address issues of concern and, when necessary, may request extraordinary meetings at zeroCO2. In addition, this body will represent zeroCARBON participants together with zeroCO2 before authorities and other bodies at the regional (Petén) and national levels.

The effective creation of these additional bodies, will be determined according to the needs that arise during the implementation of the program.

In Figure below, a graphic representation of the governance and organizational structure of the zeroCARBON program, with the different stakeholders involved.

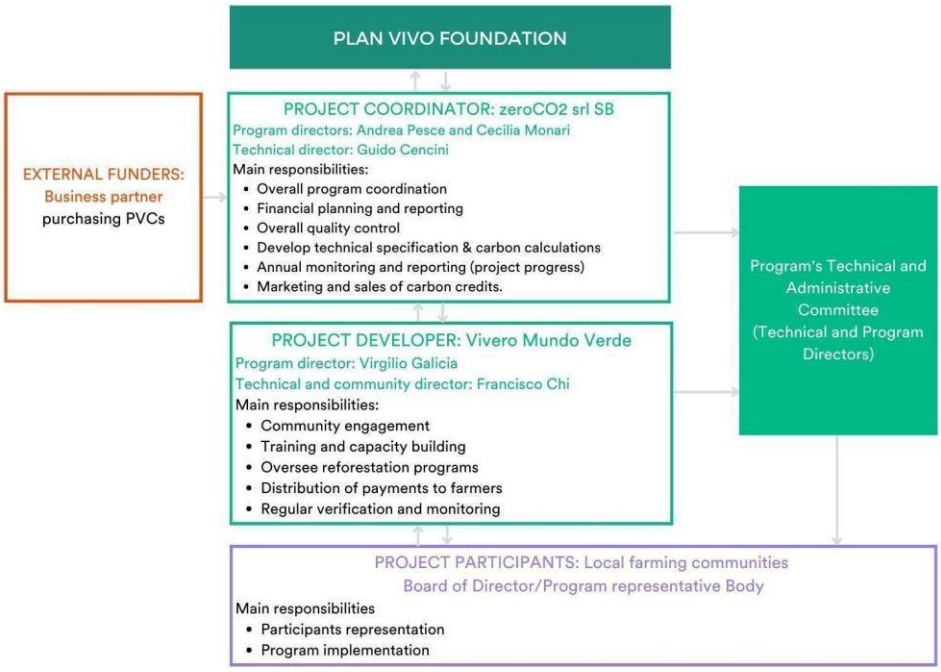


Figure 17: zeroCARBON organizational and governance structure

5.2 Equal Opportunities

zeroCARBON is a program promoted by zeroCO2 and Vivero Mundo Verde in the local farming communities of Peten according to the principles of equity, inclusion, and non-discrimination.

The process of engaging communities and its inhabitants interested in joining the project is carried out in full compliance with the aforementioned principles, with the aim of including people of any age, gender, sexual orientation and ethnic group who are in a situation of economic and social fragility. This is pursued to give them concrete tools for an improvement of their livelihood and land management practices, as well as to activate a process of regeneration of natural ecosystems.

From an internal point of view, both organizations operate by following the same principles of inclusion and non-discrimination, starting with the selection process of employees and collaborators (with more than 50 percent of the workforce composed of women and an average age of less than 30).

For zeroCO2, ongoing training of human resources is a fundamental factor for the company's growth; an approach that is strongly emphasized within the zeroCARBON program.

5.3 Legal and Regulatory Compliance

zeroCO2 and its zeroCARBON program are privately funded and implemented in partnership with individual smallholder farming families and local cooperatives/associations, with the aim of collaborating and responding to the needs of the community and various stakeholders.

Program initiation does not require official approval from government authorities, while all harvesting and sustainable forest resource management work requires approval from the local office of the National Forestry Institute (INAB). Therefore, after the plants are established, all reforestation programs and management plans will be registered with the local INAB representative, who is regularly involved in the program. This process legally pre-approves the use of forest plantations.

zeroCARBON represents an option for the rural people of Peten, as through the donation of trees and an economic incentive, the program allows them to restore their plots that have been under cultivation for several years, leading to the transformation of many of these lands into forests and agroforestry systems.

The program is aligned with national legislation, in areas such as agrarian laws, environmental and climate change regulations, forest management, sustainable development, working conditions, and land tenure. Moreover, the program is in accordance with international treaties signed by the Guatemalan government.

In terms of international laws, zeroCARBON program promotes greenhouse gas mitigation actions in accordance with policies and measures established by the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC).

In Guatemalan legislation it is established in the following:

- Forestry Law decree 101-96 of the Congress of the Republic of Guatemala
- Protected Areas Law, decree 4- 89 of the Congress of the Republic of Guatemala.
- Law to promote the establishment, recovery, restoration, management, production and protection of forests in Guatemala -PROBOSQUE- decree 2-2015 of the Congress of the Republic of Guatemala,

- Law on Forestry Incentives for Holders of Small Tracts of Forest or Agroforestry Land -PINPEP- Decree 51-2010 of the Congress of the Republic of Guatemala,
- Law for the Protection and Improvement of the Environment, Decree 68-86 of the Congress of the Republic of Guatemala and its respective regulations.

Table 5.3.1: Legal and Regulatory Compliance

Policy, Law or Regulation	Relevance	Compliance Measures
Forestry Law decree 101-96 of the Congress of the Republic of Guatemala	ARTICLE 1.- Purpose of the law. This law declares the reforestation and conservation of forests to be of national urgency and social interest, for which purpose forestry development and sustainable management shall be promoted.	Elaboration of a forest management plan, which describes all the activities that guarantee the development of the plantations.
Protected Areas Law, decree 4- 89 of the Congress of the Republic of Guatemala.	ARTICLE 1. *National Interest. Biological diversity is an integral part of the natural patrimony of Guatemalans and therefore, its conservation through duly declared and administered protected areas is declared of national interest.	Implementation of forest plantations in areas that previously had forest cover, promoting the return of biodiversity.
Law to promote the establishment, recovery, restoration, management, production and protection of forests in Guatemala - PROBOSQUE- decree 2-2015 of the Congress of the Republic of Guatemala,	According to the Art. 2, the objectives of the law PROBOSQUE decree 2-2015 are: a. This Law shall contribute to the rural development of the country in harmony with the environment, through the promotion of public and private investments aimed at the fulfillment of the following specific objectives: a. Increase forest cover, through the establishment, recovery, restoration, management, production and protection of forests that ensure the production of goods and the generation of ecosystem and	Compliance with the PROBOSQUE law in the development of forest management plans for the plantations established with the project.

	environmental services and the protection of watersheds. b. Revitalize rural economies through public investments in the forestry sector, aimed at generating employment in direct activities and services that require the establishment, recovery, restoration, management, production and protection of forests and agroforestry. c. Increase forest productivity through the establishment of forest plantations for industrial and energy purposes and the productive management of natural forests, reducing pressure on natural forests and other associated resources. d. Promote forest diversification in agricultural and livestock lands and the restoration of degraded forest lands, through agroforestry systems, forest plantations and other modalities that contribute to the provision of firewood and timber in rural areas and to the recovery of the productive and protective base in degraded forest lands. e. Contribute to guarantee livelihoods, food security, energy security, and the mitigation and reduction of risks to natural disasters associated with the effects of climate variability and change and the protection of the rural infrastructure of the Guatemalan population, through the promotion of activities for the establishment, recovery, restoration,	

	management, production and protection of forests.	
Law on Forestry Incentives for Holders of Small Tracts of Forest or Agroforestry Land - PINPEP- decree 51-2010 of the Congress of the Republic of Guatemala	ARTICLE 2. Objectives. The present Law shall contribute to the sustainable forest management of the forests, through the fulfillment of the following objectives: a) To give participation to the owners of those extensions of land with forest or agroforestry vocation, in the benefits of the economic incentives in forestry matters. b) To incorporate the modality of establishment and maintenance of agroforestry systems to the beneficiaries of the present Law. c) Promote gender equity, prioritizing the participation of women's groups in the management of natural forests, establishment and maintenance of forest plantations and agroforestry systems.	Incorporation of small landholders in an inclusive manner in all stages of the project, as the main beneficiaries.
Environmental Protection and Improvement Law, Decree 68-86 of the Congress of the Republic of Guatemala and its respective regulations.	ARTICLE 1. The State, the municipalities and the inhabitants of the national territory shall promote the social, economic, scientific and technological development that prevents the contamination of the environment and maintains the ecological balance. Therefore, the use and exploitation of the fauna, flora, soil, subsoil and water shall be carried out rationally.	Through the implementation of the project, people will benefit from economic development, and the ecological balance will be restored.

5.4 Financial Plan

Project costs and revenues management

zeroCO2 has been active in CSR and sustainability since 2019, and the related revenues have been used to date to fund projects in Guatemala and other reforestation projects around the world.

Until 2023 zeroCO2 used internal funds obtained from other active business lines (i.e. CSR and sustainability) to cover operating and management costs related to the plantations of the zeroCARBON program.

Starting in 2024, zeroCO2 expects to be able to finance zeroCARBON through revenues from fPVCs sales.

Regarding the commercialization of fPVCs, since the last half of 2022, zeroCO2 has been talking to potential buyers and resellers interested in Plan Vivo certificates, focusing on the future PVC type, and finding increasing interest from the market.

Considering this preliminary analysis, we expect to market 80 percent of credits (net of risk buffer and achievement reserve) produced as fPCVs (2022-2023 cohorts) and sell 100 percent of them by 2024.

In agreement with the Project Participants, the workflow and Benefit Sharing Mechanism was defined. The rationale with which it was jointly constructed was the participants' interests and the economic sustainability of the project.

Initially, the strategic local partner, Vivero Mundo Verde (VMV), a Guatemalan legal entity founded simultaneously with zeroCO2 in 2019 and specializing in nursery production and the management of reforestation projects in Guatemala, was involved. Subsequently, the decision was made to entrust Vivero Mundo Verde with the supply of trees required for the project, as well as all operational development activities of the program, relying on its expertise and deep territorial and contextual knowledge.

This financial collaboration will support Vivero Mundo Verde, which, in addition to initiating the transition to non-profit foundation status in 2023, is entirely composed of community members, many of whom have also chosen to participate as zeroCARBON beneficiaries. This will allow Vivero Mundo Verde to expand its commitment to social projects, also generating local employment and economic benefits.

The initiation of tree supply has sparked strong interest in partner communities, considering the challenges in starting community nurseries on a large scale and the lack of skills in forestry production and management. In the future, once the program is consolidated and participants have acquired forestry management skills, it is expected to initiate pilot projects of community nurseries to ensure greater autonomy for participants in the long term.

Additionally, some project participants have expressed the need for support from Vivero Mundo Verde in developing a Territory Management Plan, including mapping and forest management studies necessary to access incentives from the national PROBOSQUE program. Participation in the national program is voluntary and is only possible if certain fundamental requirements are met. Vivero Mundo Verde, as part of zeroCARBON, provides additional support to those who decide to participate, facilitating access to this additional tool

and amplifying economic opportunities for beneficiaries. The choice to request the preparation of the Land Management Plan is voluntary, so costs related to the same will be deducted only from participants who decide to request this service.

In summary, these operational aspects of the project are considered as in-kind benefits that the project participants are receiving as part of the 60% benefit sharing distribution. Program beneficiaries value these goods and services as direct benefits of the project, together with the direct payments related to carbon benefits.

Finally, it was agreed that from the total revenue generated from the sale of Plan Vivo certificates, taxes paid locally in Guatemala that allow the money to be sent legally should be deducted, as per art. 3.16.2 of the standard. From this total amount of money, 60% will be allocated to cover the costs incurred for the production of trees through the Local Partner. The remaining amount will be distributed as direct payments to the Project Participants, as agreed with them.
All the details are included and described within the financial plan (attachment 16).

In addition, the information attached to the financial plan is based on initial future forecasts. Therefore, if the total revenues were to be higher due to higher price per credit or additional vPVCs that emerged from the verification process (i.e. 20% vPVCs not included in the projections, Achievement Reserve, or additional PVCs derived from over performance), the delta of the additional revenues will be recognized 60% (without deducting any cost) to the Project Participants as Additional Fund and 40% to the Project Coordinator to offset the economic loss generated by the project.

In the table below, the 40-60 breakdown for carbon payments on a hectare basis divided by expenditure type is shown.

Tab 5.4.1: 40-60 breakdown for carbon payments

Stakeholders	Breakdown of revenue per ha by expenditure type	Activities
Project coordinator	**40%**	Staff costs, marketing, commercial activities, overhead, biodiversity and carbon assessments, impact measurements.
Project Participants	**60%** *Broken down as follows (calculated on projected revenue for the 2022 and 2023 projects)*	Direct payments + other in-kind benefits

- *Direct payments (Base fund)*	*Direct carbon payments to farmers in 7-year contracts.*
- *Local partner*	*Plant supply, raw materials, salaries and management activities.*

Functioning of payments to participants

The first financial agreement (Base Fund) will last for 7 years, during which time each participant will receive direct payments, in relation to the expected carbon benefits and the targets defined in the management plan.

The base fund consists of the pre-sale of 80% of the PVCs ex-ante, already net of buffer risk and achievement reserve (~28% out of the total), considering a fixed price of €17 per credit. To be considered, the percentage of pre-sale is forecasted, therefore the final value will be included in the annual report.

The fixed price, stemming from conservative projections of carbon sales, represents the minimum guaranteed price agreed upon with each participant for the initial period of the project agreement (first financial agreement). Any additional profit beyond the €17, calculated as the difference between the final sale price and the agreed-upon base fund price, as well as any additional credits will be allocated to the Additional fund, as described in the paragraph below.

Each project agreement indicates how much will be paid, the payment method, and the corresponding timeframe.

The amount of fPVC generated (and thus the tons of CO2 stored) per hectare varies depending on a set of variables of each plot (such as the forest system and species used).

For 2022, it was decided to use an equal value of fPVC per hectare for all participants, considering that the breakdown of species by participant was conducted before the finalisation of the carbon modelling, from which a large variability in terms of carbon storage between species emerged.

This choice is intended to ensure a fair return for all participants and to avoid conflicts to arise. Starting in 2023, species allocation has ensured a more uniform amount of carbon benefit per hectare for each participant.

Stakeholder consultations have, among other objectives, to convey the operation of the program and to support the organisation and administration of various technical and management activities, including the mechanism of annual carbon payments to be made by zeroCO2.

The payment of the amount over the 7 years is linked to a set of objectives and activities included in the management plan as follows:

Tab 5.4.2: Payments distribution (figures in Annex 12)

Year	Main activities	Payment distribution (%)
1	Planting and maintenance Survival rate Diseases and fire control	7%
2	Replanting and maintenance Survival rate Diseases and fire control	13%
3	Replanting and maintenance Survival rate Diseases and fire control	15%
4	Maintenance Survival rate Diseases and fire control	15%
5	Maintenance Survival rate Diseases and fire control Assisted natural regeneration	15%
6	Maintenance Survival rate Diseases and fire control Assisted natural regeneration	17%
7	Maintenance Survival rate Diseases and fire control Assisted natural regeneration	18%

Each year, the technical staff of zeroCO2 and Vivero Mundo Verde will organize and carry out monitoring activities, including tree counting (and tree replacement if necessary), to verify the survival rate and that the activities included in the management plan are being fulfilled.

If the participant does not achieve the results included in the plan and the survival rate is lower than expected, the following steps are taken:

Firstly, the causes are analysed to ensure that the losses are actually attributable to the participant due to improper plantation management (and not exogenous factors independent of the participant's management, e.g. both natural and anthropogenic force majeure causes).

Once the participant's responsibility has been established, payment will be withheld until the defined objectives are achieved and the activities set out in the management plan are properly completed. The specific functioning of payment and target achievement scenarios is defined within the project agreement.

Once the annual monitoring is completed and the targets are achieved, zeroCO2 staff will transfer the amount for that particular year and pay it directly into the participant's account via bank cheque.

The technical staff will be present and provide support in the distribution of the funds, having calculated the amount corresponding to each participant through their management systems, checking the amount (relative to the area they manage) and making sure that every participant agrees and signs the receipt of payment.

Management of other potential revenue from the sale of the remaining PVCs

Other potential revenues generated from the sale of PVC (both fPVC and vPVC) will be included in the carbon agreement through periodic adjustments e specifically nell'Additional Fund.

The Additional Fund, implemented as an update of the project agreement starting from the eighth year of the project, serves to provide a continuous economic incentive throughout the entire crediting period. It is funded by various sources, including the sale of 20% of post-carbon credits, any additional credits from the Achievement Reserve, post-monitoring overperformance, and ANR practices. Additionally, it includes the extra profit from selling 80% of ex-ante credits (part of the Base Fund) at a final price exceeding 17 euros.

Unlike the Base Fund, the Additional Fund does not allocate funds for expenses paid to the local partner. Therefore, 60% of the generated revenue is directly allocated as payments to the participants. In essence, zeroCO2 commits to distributing 60% of any revenue generated beyond expectations to the participants, excluding the costs related to certain activities covered in the initial agreement.
More details are specified in the Financial Plan attached as annex 16.

5.5 Financial Management

Describe the financial procedures in place for managing income and expenditure of finance generated from the sale of Plan Vivo Certificates. Include details of planned audits of project finances by an independent financial auditor certified by a nationally recognised regulatory body.

In order to ensure maximum transparency and traceability of every cash inflow and outflow, zeroCO2 will open a dedicated current account for the zeroCARBON programme. The current account will not be used for any other project or for operational costs which are not related to zeroCARBON.

In this way, zeroCO2 will be able to guarantee transparency and traceability and to report the incomes from the sale of certificates. The operation of outbound reporting will be guaranteed in the same way, as each transfer to project participants and other parties will be easily traced to demonstrate conformance with the agreed Benefit Sharing Mechanism.
Once the annual monitoring has been completed, the targets have been reached, and the amounts to be transferred have been identified as indicated in Table 10, section 5.4, the

zeroCO2 staff will prepare the individual check for the participants and proceed with the delivery.

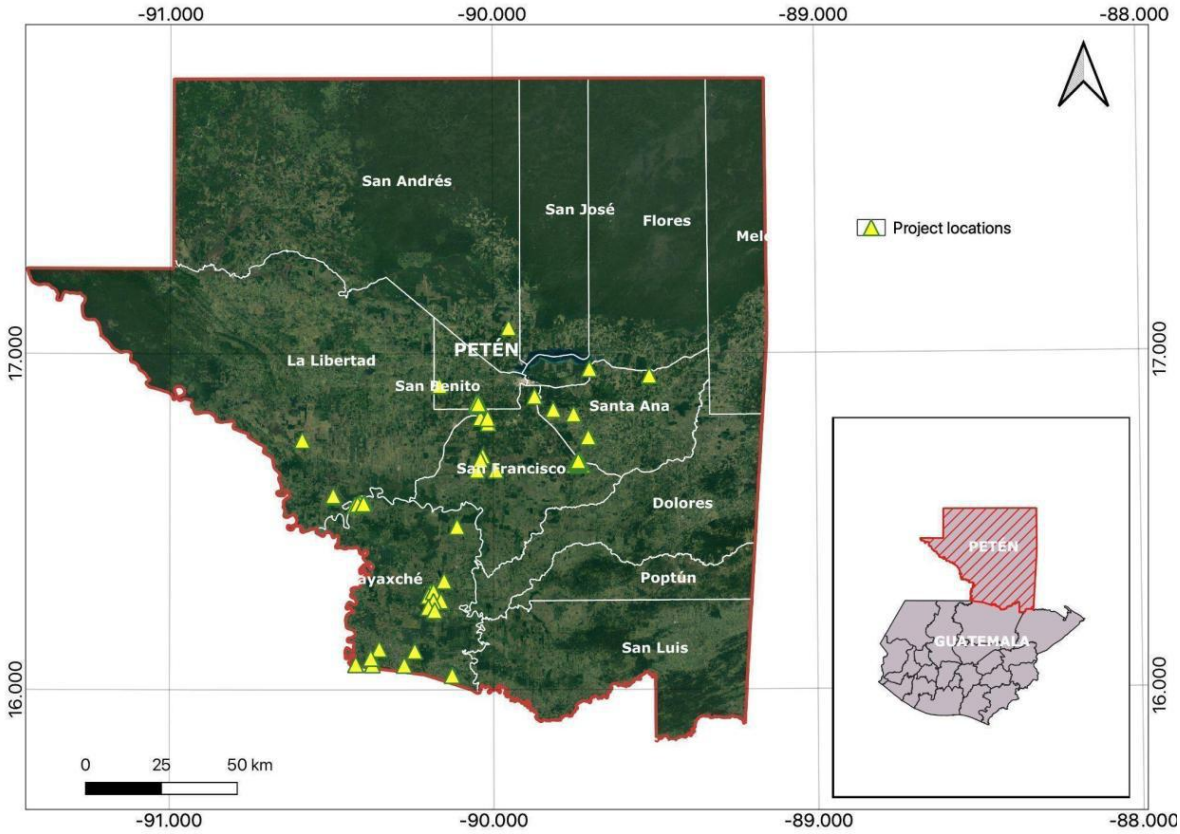
This practice will enable zeroCO2 to draw up the annual financial report for the zeroCARBON programme. The annual audit of zeroCARBON finances will be carried out within 12 months after the end of each financial year. The audit will be conducted by an independent financial auditor certified by a nationally recognised regulatory body.

Annexes

Annex 1 – Project Boundaries

Provide geospatial data files for project region and project area boundaries.

The maps below show the locations of all communities involved.



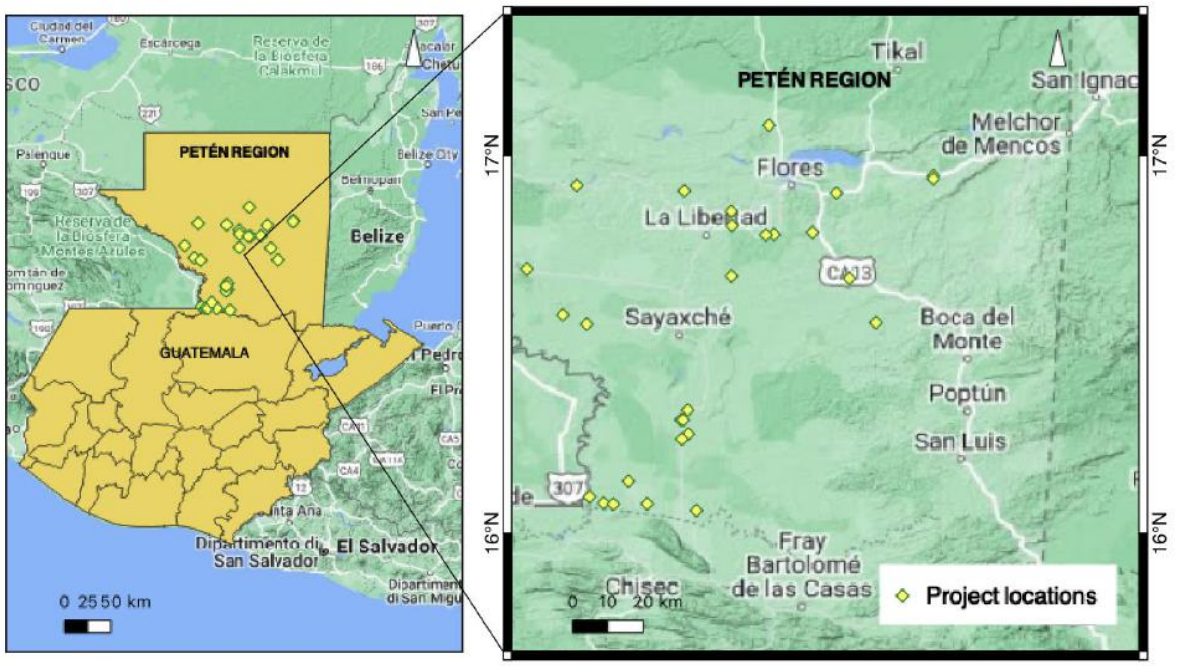
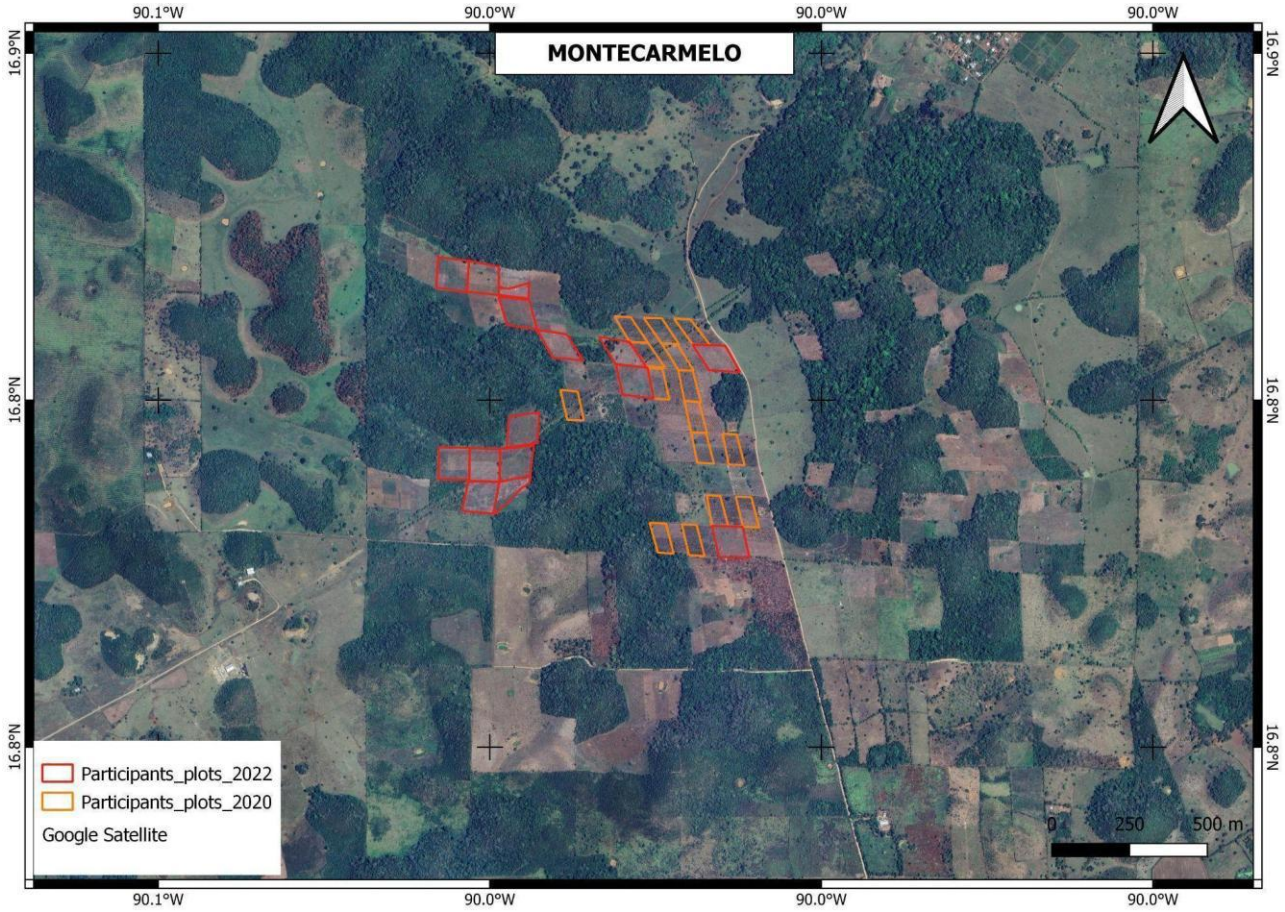
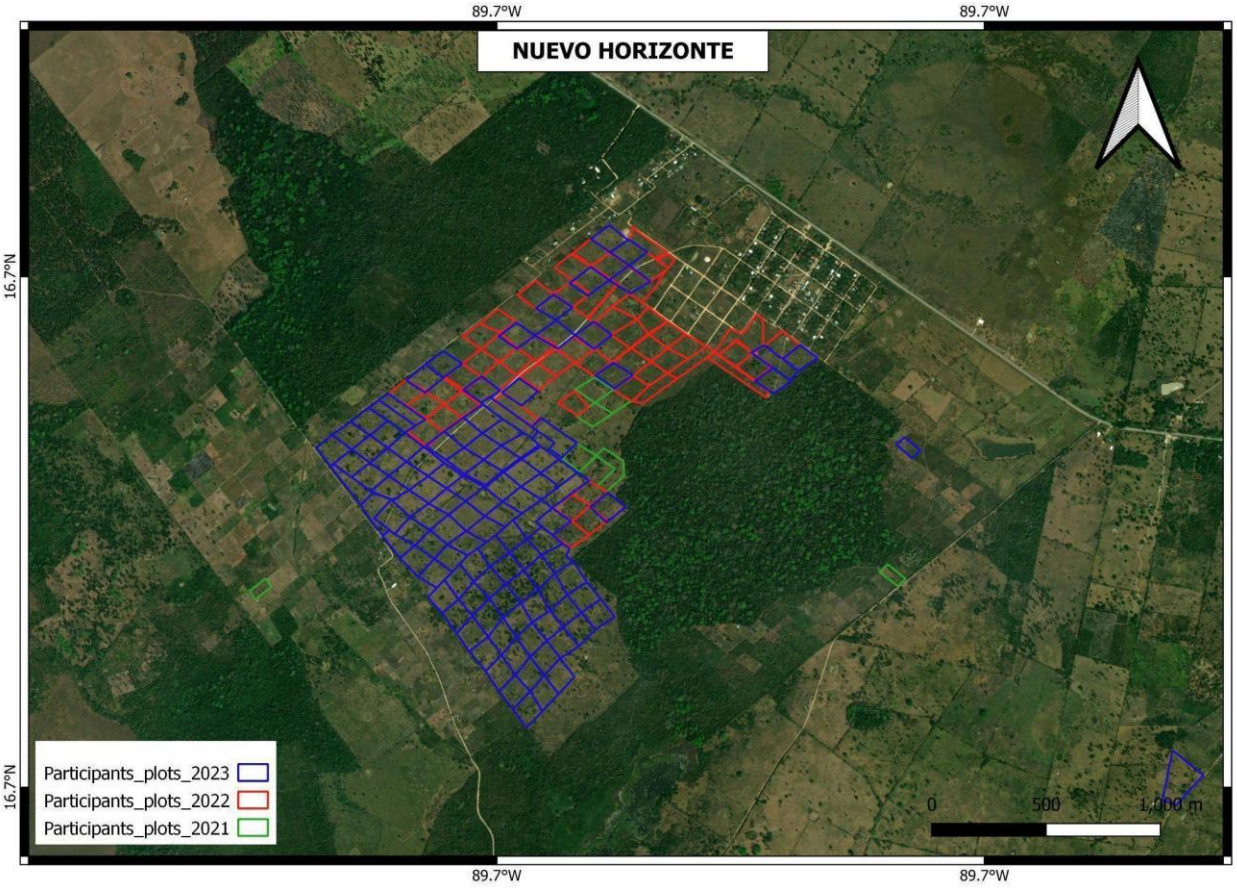
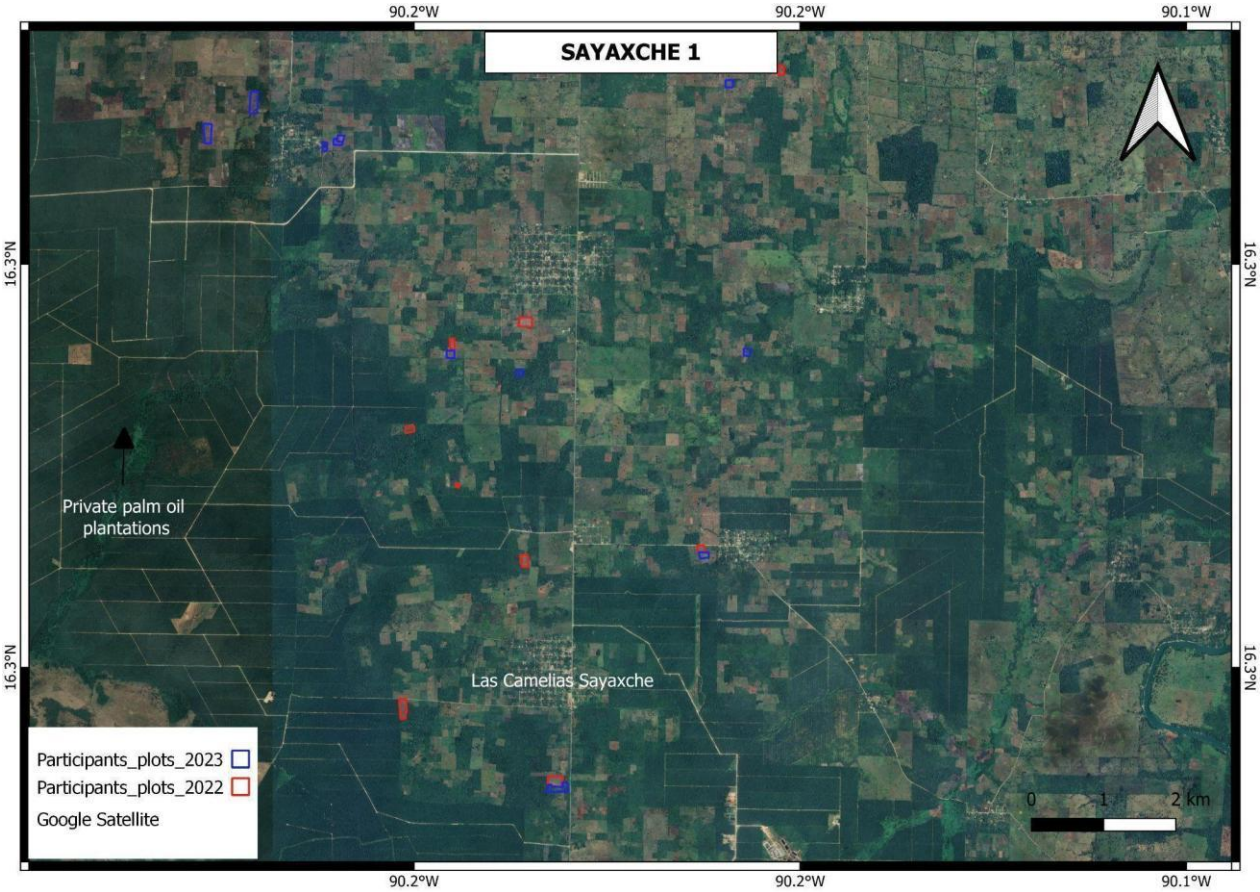


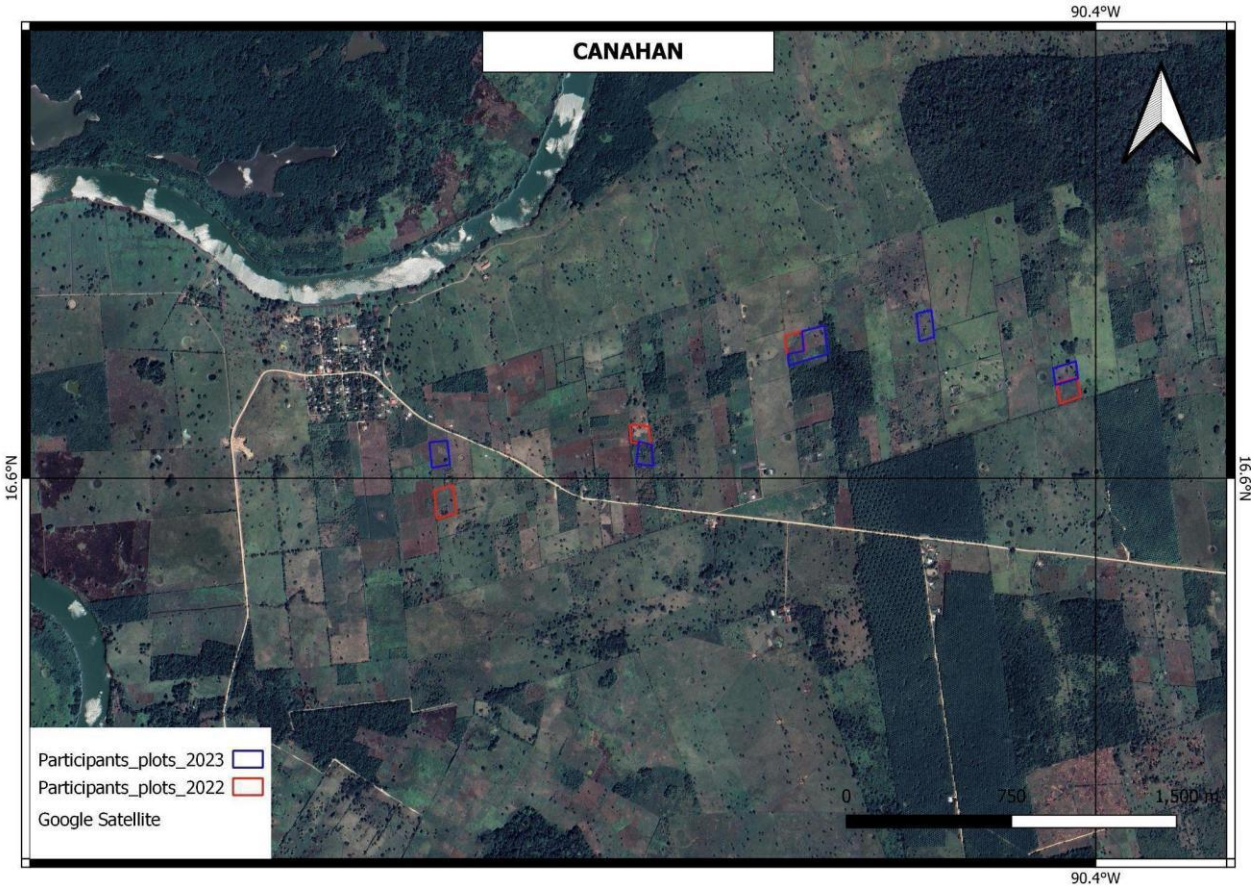
Figure A1.1: Project locations. Source: elaboration of zeroCO2 based on Google satellite imagery

Below are the maps of the main project areas. Some more isolated individual participants are not included in the map representation. However, upon request, we can share separately all georeferenced individual polygons corresponding to the project areas of each participant.




NUEVO HORIZONTE
89.7°W
89.7°W
16.7°N
16.7°N
89.7°W
89.7°W
Participants_plots_2023
Participants_plots_2022
Participants_plots_2021
0
500
1,000 m


SAYAXCHE 1
90.2°W
90.2°W
90.1°W
16.3°N
16.3°N
16.3°N
16.3°N
Private palm oil plantations
Las Camelias Sayaxche
Participants_plots_2023
Participants_plots_2022
Google Satellite
0
1
2 km
90.2°W
90.2°W
90.1°W


CANAHAN
90.4°W
16.6°N
Participants_plots_2023
Participants_plots_2022
Google Satellite
0
750
1,500 m

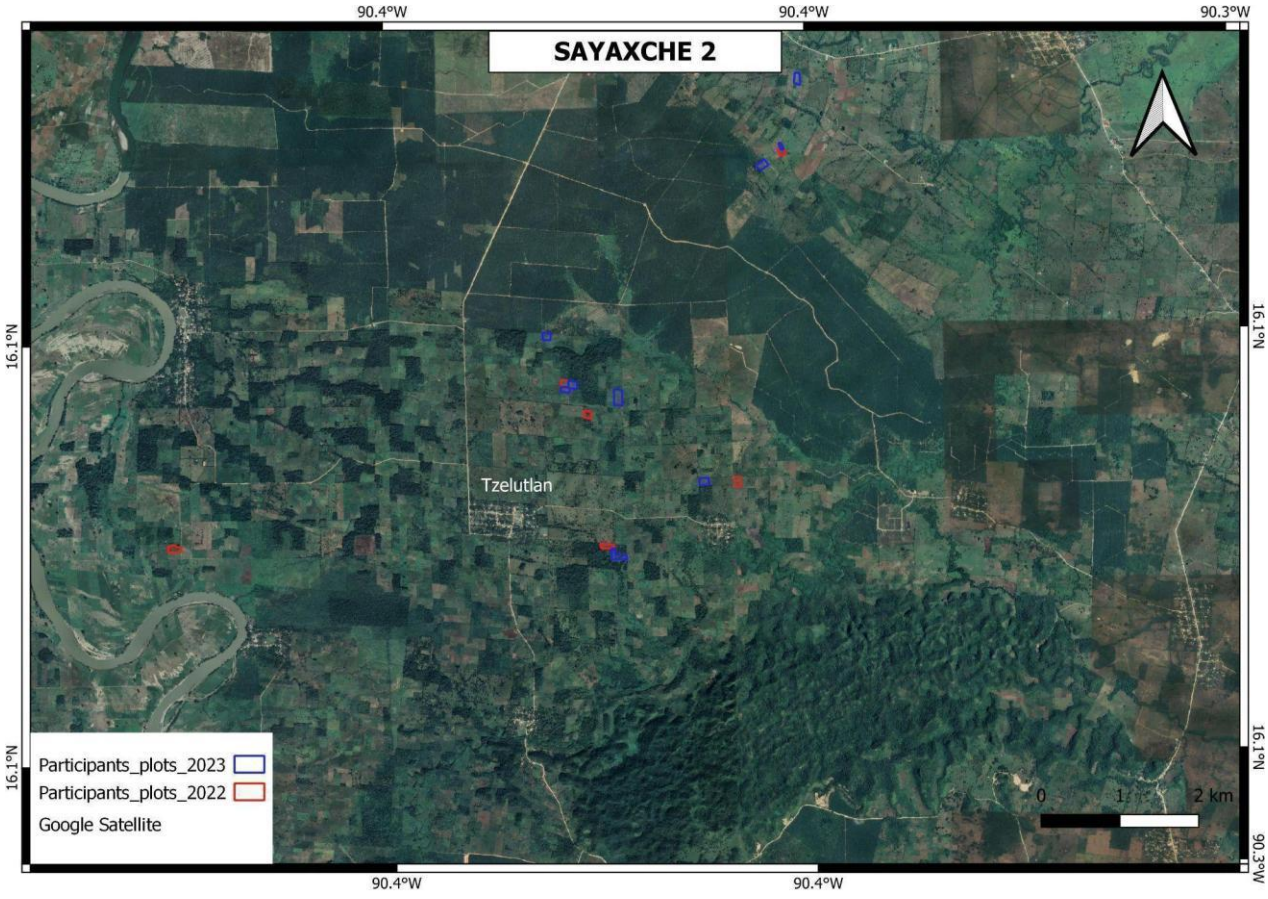

SAYAXCHE 2
90.4°W
90.3°W
16.1°N
Tzelutlan
Participants_plots_2023
Participants_plots_2022
Google Satellite
0
2 km

Figure A1.2: Project areas. Source: elaboration of zeroCO2 based on Google satellite imagery

Annex 2 –Registration Certificate and Partner Agreements

A copy of the requested documents can be shared upon request.

Annex 3 – Initial Project Areas

The following is an excerpt from the database of project participants through 2023. The complete documentation contains sensitive information and can therefore be shared only upon specific request.

Table A3.1: Database project information.

Starting date	Community name	Name of project participant	Participant_ID	Type of participant	Location	Project intervention	Land Use (before zeroCARBON)	Land right	Somma di Quantity	Somma di Caoba	Somma di Cedro	Somma di Extent of project area (ha) tot
2020	Monte Carmelo	[redacted]	00004_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00005_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00006_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00007_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00008_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00015_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00016_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00017_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Nuevo Amanecer		00002_NA_1_2020	Individual	La Libertad	FP - Forest Plantation	Agriculture	Property right/ individual	1111	1111	0	1,00
2020	Purucila		00001_PU_1_2020	Individual	Santa Ana	FP - Forest Plantation	Guamil joven	Possession right/ individual	1111	555	556	1,00
2020	Monte Carmelo		00003_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00013_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00002_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00009_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00012_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00014_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2020	Monte Carmelo		00001_MC_1_2020	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	500	250	250	0,45
2021	Cooperativa La Palma		00001_LP_1_2021	Individual	La Cruces	FP - Forest Plantation	Agriculture	Property right/ individual	1345	400	945	1,21
2021	Nuevo Horizonte		00054_NH_3_2021	Group	Santa Ana	FP - Forest Plantation/mix	Livestock	Property right/ communal	550	0	550	1,00
2021	Nuevo Horizonte		00001_NH_1_2021	Group	Santa Ana	FP - Forest Plantation	Livestock	Property right/ communal	550	0	550	0,50
2021	Nuevo Horizonte		00052_NH_3_2021	Group	Santa Ana	FP - Forest Plantation/mix	Livestock	Property right/ communal	550	0	550	1,00
2021	Nuevo Horizonte		00051_NH_3_2021	Group	Santa Ana	FP - Forest Plantation/mix	Livestock	Property right/ communal	550	0	550	1,00
2021	Nuevo Horizonte		00023_NH_3_2022	Group	Santa Ana	FP - Forest Plantation/mix	Livestock	Property right/ communal	550	0	550	1,00
2021	Parcelamiento Acte		00001_PA_1_2021	Individual	San Andrés	FP - Forest Plantation	Agriculture	Property right/ individual	800	0	800	0,72
2021	San Juan de Dios		00001_SJ_1_2021	Individual	San Francisco	FP - Forest Plantation	Livestock	Property right/ individual	2500	2500	0	2,25
2022	Canahan		00005_CH_1_2022	Individual	Sayaxche	FP - Forest Plantation	Livestock	Property right/ individual	1050	375	675	0,95
2022	Canahan		00001_CB_1_2022	Individual	Sayaxche	FP - Forest Plantation	Agriculture	Property right/ individual	1410	375	1035	1,27
2022	Canahan		00003_CH_1_2022	Individual	Sayaxche	FP - Forest Plantation	Agriculture	Property right/ individual	1050	375	675	0,95
2022	Canahan		00004_CH_1_2022	Individual	Sayaxche	FP - Forest Plantation	Agriculture	Property right/ individual	2100	750	1350	1,89
2022	Cruce Semuy		00001_CS_1_2022	Individual	Sayaxche	FP - Forest Plantation	Agriculture	Property right/ individual	1111	555	556	1,00
2022	El Eden		00001_ED_1_2022	Individual	Sayaxche	FP - Forest Plantation	Livestock	Property right/ individual	989	520	469	0,89
2022	El Eden		00002_ED_1_2022	Individual	Sayaxche	FP - Forest Plantation	Livestock	Possession right	989	520	469	0,89
2022	El Sapote		00001_SP_1_2022	Individual	Santa Ana	FP - Forest Plantation	Agriculture	Property right/ individual	3333	0	3333	3,00
2022	El Sapote		00001_SP_1_2022	Individual	Santa Ana	FP - Forest Plantation	Guamil joven	Property right/ individual	3970	0	3970	3,57
2022	Las Camelias		00001_CA_1_2022	Individual	Sayaxche	FP - Forest Plantation	Guamil joven	Property right/ individual	1111	555	556	1,00
2022	Las Camelias		00004_CA_1_2022	Individual	Sayaxche	FP - Forest Plantation	Guamil joven	Property right/ individual	2222	1105	1117	2,00
2022	Las Camelias		00005_CA_1_2022	Individual	Sayaxche	FP - Forest Plantation	Guamil joven	Property right/ individual	3334	1657	1677	3,00
2022	Monte Carmelo		00018_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00020_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00021_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00004_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	210	210	0	0,19
2022	Monte Carmelo		00024_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	397	397	0	0,36
2022	Monte Carmelo		00034_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00027_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00028_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	229	0	229	0,21
2022	Monte Carmelo		00032_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00036_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00037_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00038_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00039_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Agriculture	Property right/ communal	1111	555	556	1,00
2022	Monte Carmelo		00040_MC_1_2022	Group	La Libertad	FP - Forest Plantation	Livestock	Property right/ communal	1111	555	556	1,00
2022	Nuevo Amanecer		00014_NA_1_2022	Individual	La Libertad	FP - Forest Plantation	Guamil joven	Property right/ individual	1111	1111	0	1,00
2022	Nuevo Amanecer		00002_NA_1_2022	Individual	La Libertad	FP - Forest Plantation	Agriculture	Property right/ individual	2000	2000	0	1,80
2022	Nuevo Amanecer		00011_NA_1_2022	Individual	La Libertad	FP - Forest Plantation	Agriculture	Property right/ individual	500	500	0	0,45
2022	Nuevo Coban		00001_CB_1_2022	Individual	Sayaxche	FP - Forest Plantation	Agriculture	Property right/ individual	1111	555	556	1,00
2022	Nuevo Horizonte		00002_NH_1_2022	Group	Santa Ana	FP - Forest Plantation	Livestock	Property right/ communal	600	0	600	0,54
2022	Nuevo Horizonte		00003_NH_1_2022	Group	Santa Ana	FP - Forest Plantation	Livestock	Property right/ communal	1111	1050	61	1,00

Annex 4 –Participatory Design

Provide evidence of stakeholder involvement in the participatory design process, such as attendance lists, photographs, and videos.

Below are some pictures depicting participatory design activities in some of the communities participating in the project. Additional images and attendance lists can be shared upon request.

Figure A4.1: Meetings with project stakeholders.

Annex 5 – Initial FPIC

Provide evidence of key decisions in the initial FPIC process (e.g. signed meeting minutes and attendance lists), and copies of information provided prior to key decisions being made.

Attached is an example of a community participation list and minute record of an initial meeting held in Monte Carmelo Community, Peten, Guatemala.

Annex 6 – Carbon Calculations Spreadsheet

Below is an excerpt from the carbon model spreadsheet. The full version, including complete carbon calculations and all associated details, is available upon specific request.

Table A6.1: Project PVCs.

Year	Baseline emission and removals (t CO2e)	Project emission (t CO2e)	Potential PVCs annual (tCO2e/year)	Cumulative PVCs (tCO2e)	Credits to buffer (tCO2e)	Potential PVCs annual (tCO2e/year)	Cumulative PVCs (tCO2e)
			Gross		20%	Net	
2020	0	0	19	19	4	14.95	14.95
2021	0	0	129	147	29	102.91	117.86
2022	0	0	635	782	156	508.01	625.87
2023	0	0	2,786	3,569	714	2,229	2,854
2024	0	0	7,837	11,405	2,281	6,269	9,124
2025	0	0	13,152	24,557	4,911	10,521	19,645
2026	0	0	14,015	38,572	7,714	11,212,07	30,857
2027	0	0	10,744	49,316	9,863	8,595.41	39,452
2028	0	0	4,976	54,292	10,858	3,980.93	43,433
2029	0	0	1,216	55,509	11,102	973.11	44,406
2030	0	0	3,131	58,640	11,728	2,505.12	46,911
2031	0	0	6,091	64,731	12,946	4,872.54	51,784
2032	0	0	1,133	65,864	13,173	906,79	52,691
2033	0	0	1,223	67,087	13,417	978,05	53,669
2034	0	0	4,205	71,292	14,258	3.364,17	57,033

2035	0	0	8,679	79,971	15,994	6.943,03	63,976
2036	0	0	850	80,820	16,164	679,66	64,656
2037	0	0	846	81,666	16,333	676,91	65,333
2038	0	0	843	82,510	16,502	674,53	66,007
2039	0	0	1,118	83,628	16,726	894,63	66,902
2040	0	0	1,236	84,864	16,973	988,65	67,890
2041	0	0	5,052	89,916	17,983	4.041,55	71,932
2042	0	0	10,439	100,354.94	20,071	8.351	80,283
Total Project carbon stock with long term average + Sum of other carbon pools (t CO2 ha-1)							**100,354***
Project area (ha)							**438**
Carbon stock per hectare (t C ha-1)							***62.48**
Carbon stock per hectare (t CO2 ha-1)							***229.12**

*gross value (Risk buffer (20%) included in this table)

Annex 7 – Technical Specifications

Use the template below to provide a separate technical specification for each project intervention.

Table A7.1: Technical specifications of project intervention.

Project Intervention:	**Improved land management through forest plantations and agroforestry**
Version:	V2
Date Approved:	Enter the date this version was approved for use by Plan Vivo.
Methodology:	1. Agriculture and Forestry Carbon Benefit Assessment Methodology developed by TLLG & Plan Vivo TAC

Modules/Tools:	Specific Plan Vivo modules and tools of Agriculture and Forestry Carbon Benefit Assessment Methodology TLLG & Plan Vivo TAC methodologies: 1. PU001 - Estimation of baseline and project GHG removals by carbon pools in Plan Vivo projects 2. PU002 Estimation of baseline and project GHG emissions from carbon pools in Plan Vivo projects 3. PU003 Estimation of baseline and project GHG emissions from emission sources in Plan Vivo projects 4. PU004 Estimation of GHG emissions from leakage in Plan Vivo projects 5. PU005 Estimation of uncertainty of carbon benefit estimates in Plan Vivo projects
Certificate Type(s):	Types of PVC the technical specification can be used to generate: fPVC, rPVC and vPVC

Applicability conditions

Specify the baseline scenario(s), geographical area(s) and any other conditions under which the technical specification can be applied, and any exclusion criteria.

This technical specification was developed in relation to agroforestry and forest restoration projects in the Petén region, designed and implemented by zeroCO2 together with Vivero Mundo Verde and managed by local communities. These technical specifications will also serve as a guideline for future activities and additions during monitoring. They may also be adopted for new communities joining the project.

The objective of the project is to restore the ecological function of degraded landscapes and provide a sustainable livelihood for local communities in Petén.
This will be achieved by changing land use through the creation of forestry and agroforestry systems, in areas currently used for extensive livestock farming. Besides, the project will promote agricultural activities that benefit the dynamics of income and subsistence production of households, and the surrounding ecosystems.
The main project intervention is: **Improved land management through forest plantations and agroforestry**

The main planting systems within the general project intervention practices are listed below:

(1) Forest plantation

This will be implemented through planting tree species for the production of wood and other products. This system will mainly include native species such as Cedar (Cedrela odorata), Mahogany (Swietenia macrophylla) and other forest species of economic and cultural value. After the first two years of planting, communities will be encouraged to allow natural revegetation to regenerate the landscape.
From the early years, most participants will incorporate agroforestry systems mainly with maize, yucca and other annual species, without compromising the possibility of obtaining food and limiting the risk of displacement of agricultural activities.
The initial density of the forest plantations will be 1,111 plants per hectare. This type of planting system is expected to increase the amount of carbon storage due to the density of trees per hectare. In turn, livelihoods and ecosystems will be improved through the recovery of forest cover and the gradual integration of other species of flora and fauna. Participants will improve their quality of life by benefiting from the ecosystem services provided by forests and the added value that their land will acquire due to the high commercial value of the cedar and mahogany species.

Figure A7.1: Drone photo of a zeroCO2 forest plantation, Montecarmelo, Petén, Guatemala at 21 months old. Source: zeroCO2

(2) Agroforestry system with intercropping.

Agroforestry system that combines tree plants with annual and permanent crops. These crops and fruit trees will be able to provide additional income in the early years, while the trees will benefit from the cultivation care given to crops. These agroforestry systems will follow the same technical management plan as forest plantations. Therefore, the species that will be used are Cedar and Caoba. The main difference lies that they will be incorporated in plots where fruit trees are already present and, therefore, lower densities per hectare are adopted. Fruit trees associated with forest trees at this stage are not included in the project to generate carbon benefits.

The planting density will be 100 to 400 plants per hectare. This type of planting system will increase carbon storage by including forest species in areas that are solely used for agricultural crops or livestock. Participants will benefit from the improved agricultural practices and from the economic value that the cedar and mahogany forest species will add to their land.

Figure A7.2: Model agroforestry system with herbaceous, fruit species at a stage of high complexity where zeroCO2 integrates fast-growing native species. In these systems, local communities have complete freedom in their design by rediscovering traditional Mayan cultivation systems. In other cases, the agroforestry system is integrated into the surroundings of houses using simpler systems. Source: zeroCO2

Figure A7.3: Agroforestry system managed by communities and zeroCO2 operational team. Same species and management with respect to forestry systems.This system is also used with perennial fruit species. Source: zeroCO2

As previously explained, this second project activity (agroforestry system) will follow the same management plans and the same forest species (Cedar, Mahogany), but when trees are integrated with perennial species the planting density is lower (200-400 trees/ha) while the integration of annual crops (maize, beans, squash, chilli) for both types of intervention is at the discretion of the participants.

zeroCO2 will train communities to promote land use practices that include as many species as possible, increasing the complexity of the system and, thus, its resilience. This process starts at the beginning of the project and will continue during the entire project period, while sensitising communities to allow the gradual natural revegetation of their plots.

The following technical specifications are valid for both planting systems, as the management system is the same. The main changes are related to the planting pattern and the integration of trees into agricultural systems. These changes were considered separately in the carbon modelling and will also be considered in the monitoring phase.

Long term management

With regard to the long term management of their plots, communities will be trained and incentivised to promote a natural and assisted revegetation of the area.
However, each participant will specifically decide whether to only maintain the forest species, Cedar and Mahogany, or enrich the plantation with other species to arrive in the desired scenario at year 20, in which there will be a gradual shift from forest plantation to sustainable forest management.
At this initial project stage, as there are not sufficient elements to determine the different long-term management systems that the participants will adopt, a rotation forestry plantation with a 20-year rotation, referring to Cedar and Mahogany, will be considered.
During annual monitoring, the different management approaches followed by the participants will then be determined and documented.

Assisted Natural Regeneration: implementation and CO2 estimation

The aim of integrating Assisted Natural Regeneration (ANR) is to increase the biodiversity benefits of a conventional forest plantation by allowing a certain level and form of natural regeneration that biologically enriches the forest while increasing its CO2 fixing capacity, as well as being able to replace trees that are harvested for timber and ensure the land use change in the long-term. Two forest rotations will be carried out, one based on planting and the other based on secondary vegetation management after year 20.
Integrating natural regeneration within the forestry plantations will be a gradual process, which will depend on thoughtful management, ensuring a suitable species selection and abundance of regeneration plants. To date, there are no measures defined by Guatemalan forestry institutions regarding the integration of natural regeneration inside forestry plantations, nor reference to other projects in Guatemala that have adopted this model.

Therefore, zeroCARBON will be a pioneer project in implementing this approach in Guatemala. This will require an iterative learning process to find the balance between the successful development of the project interventions, participants' needs, and requirements of Guatemalan forestry institutions. An initial proposal of management plan and implementation actions can be found in the ANR proposal in Annex 18. A detailed management plan that will guide the specific actions to implement ANR is in the development phase, to be approved by INAB.

In order to begin understanding the development, species diversity and CO_2 capture potential of ANR in the project area, three inventories were conducted in Petén in three different plots outside of zeroCARBON. The data collected from the inventories shows a great number of species and structural diversity, which can be reached through natural regeneration in a short period of 5 to 10 years. The total number of species identified was a total of 68 species, which is an average of 33 species per sampled plot, considering the 3 inventories. Several species were recorded in all 3 inventories, which indicates that they are recurrent species in the project area, thus they have a solid chance of establishing in the zeroCARBON plantations through natural regeneration. A detailed explanation of the results from the inventories can be found in Annex 18 in the ANR proposal.

Using dendrometric data collected from these inventories, and based on the initial management plan, a CO_2 model was developed to provide an initial estimation of potential carbon benefits derived from ANR. Three different CO_2 scenarios were modelled, using an average of CO_2 absorption per tree that was calculated from the inventory species that had available data. The medium scenario would bring a cumulative value of 27.8 t CO_2/ha in 20 years, which would amount to approximately 12% of total carbon benefits from the zeroCARBON program. A detailed explanation of the ANR carbon assessment can be found in Annex 18. The relevant carbon calculations included in the carbon model (Annex 6). Carbon quantities from ANR were conservatively excluded from fPVCs pending monitoring of management application rates.

Over the course of the project, the carbon model will be improved using monitoring data from zeroCARBON plots. Overall, integrating ANR within project interventions and in the participant agreements will bring significant added value to the program. Besides the biodiversity benefits and valuable species, ANR carbon benefits will provide medium and long term economic incentives for participants to promote ANR within their forestry plantations, which will add to the project's permanence and continuity.

Figure A7.4: Forest system managed by communities and zeroCO2 operational team with Cedar and Caoba with active natural revegetation with wild species.

Location

The project is being developed in the department of Petén in Guatemala, mainly in 4 of the 12 municipalities of the region - Santa Ana, La Libertad, Sayaxche, and San Luis/Poptun. The region, located in the extreme north of the country, shares borders with Mexico (north and west), Belize (east), and the departments of Izabal and Alta Verapaz (south).
Petén has a territorial extension of 35.854 km2, representing almost a third of the national territory, which makes it, with its 14 municipalities, the largest department in Guatemala and the largest subnational entity in Central America.

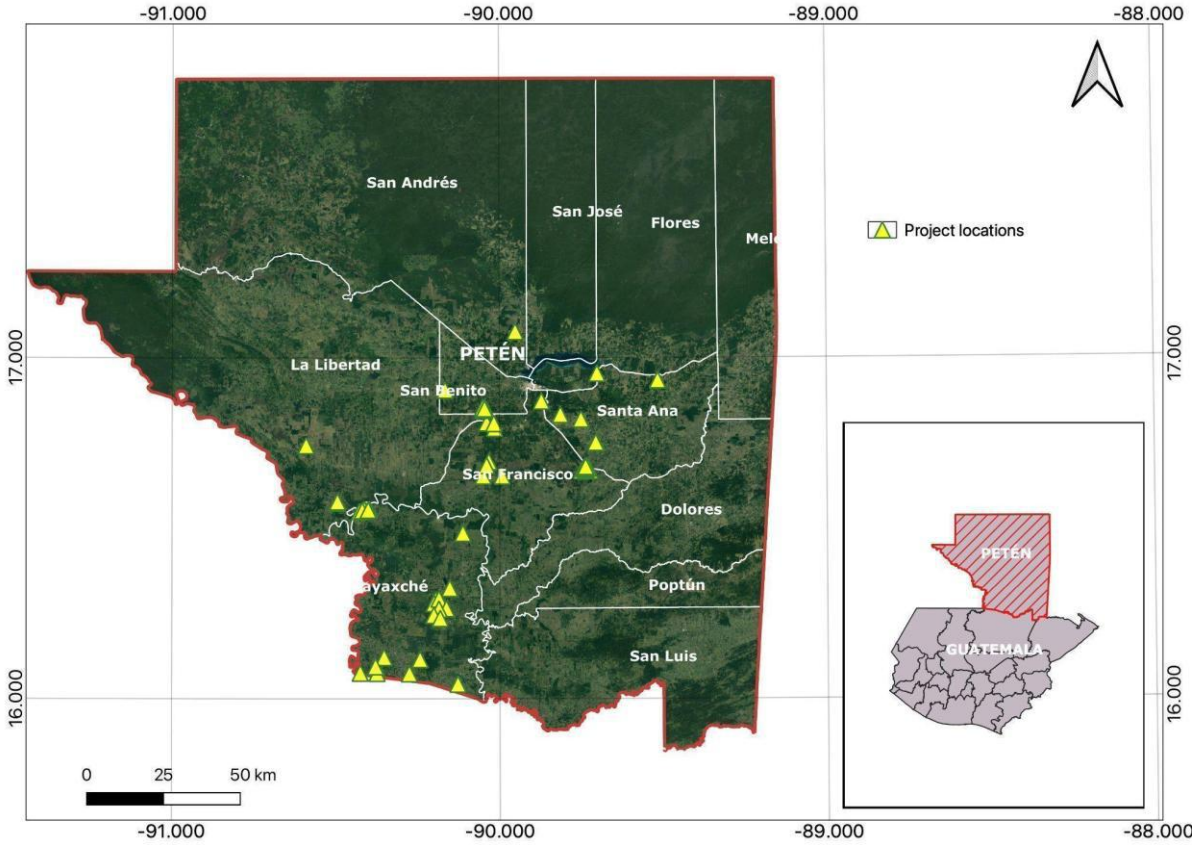


Figure A7.5: Project locations. Source: elaboration of zeroCO2 based on Google satellite imagery

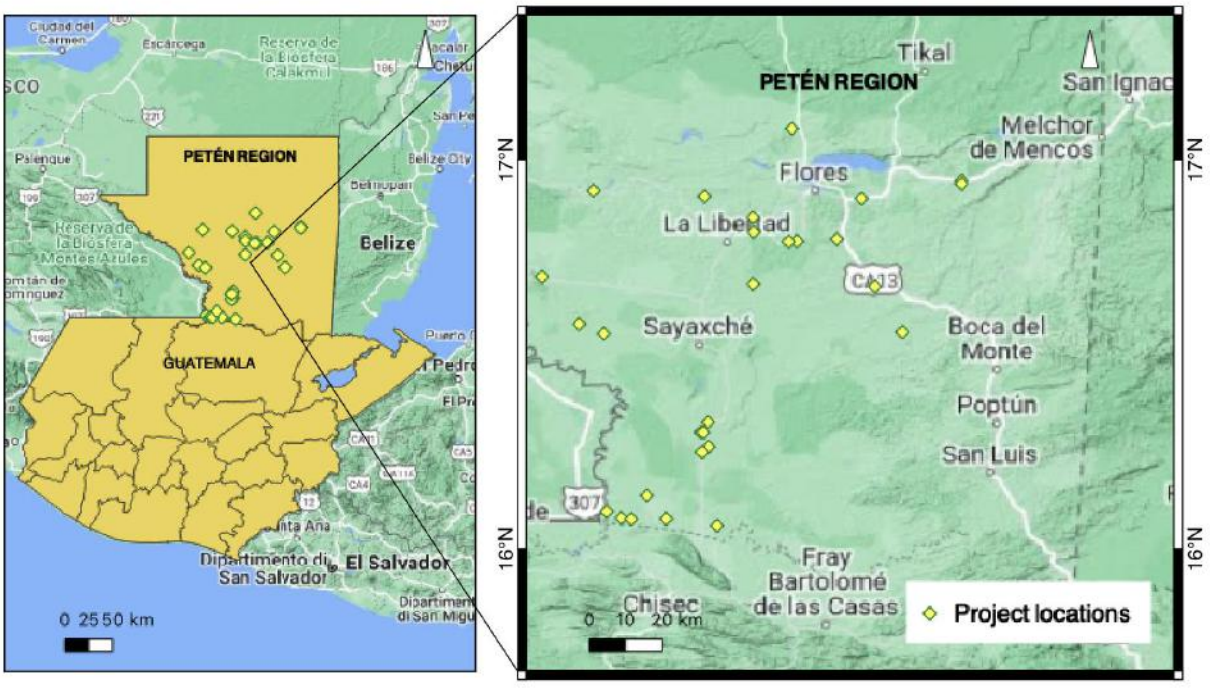


Figure A7.6: Project locations. Source: elaboration of zeroCO2 based on Google satellite imagery

Petén is a low limestone plateau, varying in elevation between 500 and 700 feet (150 and 210 metres) above sea level at the base of the Yucatán Peninsula. Except for areas of savanna

vegetation, the region is covered by dense tropical rainforests. There are few rivers that make their way through Petén, as most of the heavy rainfall is drained underground.
The climate of Petén is hot and humid tropical, commonly in the plains at these latitudes, with a long rainy season and a dry season of variable duration, between December/January and April/May.
This ecoregion is considered to be the most extensive wooded tropical formation in Mesoamerica and functions as the natural northern boundary for tropical vegetation.
There are two protected areas in the Petén region that represent 74% of the territory (25,071 km2): the Maya Biosphere Reserve, the largest block forest area in Mesoamerica, and the Protected Areas of the southern Petén. The protected areas are composed of 3 zones: Buffer Zone (in some of which the project is developed), Multiple Use Zone, and Core Zone.

Baseline scenario(s) of land use

- Agriculture (including livestock) remains the most important economic activity in Petén. Over 67% of the economically active population (aged seven and over) is employed in the primary sector. The main crop in the region has long been white corn, grown on more than 11,000 farms in 2008 [17] (INE, 2008). Besides, black bean production has also been important for both domestic consumption and the market. Indeed, in 2003 (if not earlier), Petén was producing more maize and beans than any other department, accounting for 15% and 27% respectively of the total national production of these crops.
- Livestock has a long history in Petén. In 2003 there were 315,819 heads in the department, more than 19% of all cattle in the country; in 2008 there were more than 1.362 million head, over 31% of the national total. Shiriar, A. J. (2014) reports that in 2014 local officials revealed that there may be 1.5-2 million head of cattle in the department.[18] Local authorities commonly argue that the large increase in the region's cattle population is partly due to the fact that investments in livestock and agricultural land offer an affordable way to ''wash'' money earned through drug trafficking or other illegal activities.

A more detailed analysis of baseline land uses is provided below through the tool AR-ACM0003.

Deforestation

From 2001 to 2021, Petén lost 935 kha of tree cover, equivalent to a 31% decrease in tree cover since 2000, and 410Mt of CO_2e emissions.[19]

[17] INE, 2008. Encuesta Nacional de Agricultura (National Agricultural Survey), 2008. Instituto Nacional de Estadística.

[18] Shriar, A. J. (2014). Theory and context in analyzing livelihoods, land use, and land cover: Lessons from Petén, Guatemala. Geoforum, 55, 152-163.

[19] https://www.globalforestwatch.org

Drivers of deforestation in Petén:[20]

- Extensive cattle production causes forest degradation and clearance of primary forests and secondary vegetation; in certain regions, this is linked with land speculation, drug trafficking and even money laundering.
- Smallholder farming linked to expansion of traditional smallholder agriculture, including shifting cultivation, and extensive cattle production, but also increasingly to cash crop production.
- Large-scale agriculture: Expansion of intensive cropland production (mostly palm oil) over pastures but in certain regions, such as northern Campeche and southern Petén, over forests.
- Fires: Fire is associated with deforestation, as it is often used as a tool to clear land (in both subsistence and commercial farming), but also because large-scale fires affect large areas in the region and may facilitate permanent land-use conversion from forest to agricultural land.
- Logging: Industrial logging has lost importance in the last few years. Negative environmental effects are associated with illegal logging, as well as with some cases of unsustainable community forestry.
- Fuelwood and charcoal: Selective logging for fuelwood and charcoal is common in the region. Under some circumstances, these practices are related to forest degradation.

Target communities of the Project

The average size of communities involved in the project is particularly variable (from 100 to 500 households), with an average of about 150/200 households per community.

The target communities contain a combination of different indigenous groups. The main indigenous groups that inhabit the region are Q'eqchi' (90%) followed by Itza', Mopan and Kaqchikel. In the south of the department, more than 50% of the population is indigenous (mainly composed of Q'eqchi' ethnic groups), especially in municipalities such as San Luis (60%) and Sayaxche (63%) , which are both part of the zeroCARBON project.

Additionality

Provide full details and supporting evidence for the additionality assessment completed following an approved methodology.

Identification of baseline scenario

The most likely land use scenario in the absence of project interventions and the additionality of project interventions were determined using AR-TOOL02 v1.0 with the relevant specifications taken from the Plan Vivo Agriculture and Forestry Carbon Benefit Assessment, methodologies PM001, PU001 and PU002.
The reference scenario and additionality will be re-evaluated at least every 10 years.

[20] https://wwfint.awsassets.panda.org/downloads/deforestation_fronts_factsheet___the_maya_forest.pdf

Table A7.2: Selected baseline scenario: historic use of the land, stratification.

Baseline scenario	*Stratum*	*Area (ha)*
Pastureland	I	297.03
*Cropland**	II	140.97
Total		**438.00**

*Long term cultivation and cultivation with fallow period 'guamil"

As confirmed in section 3.1 of the PDD, the most likely reference scenario is considered to be the land use prior to the implementation of the project activity (pastureland and cropland). Based on information gathered from project participants two reference strata were identified: cultivated land and pastureland. In the first case, two sub-strata can be described according to land management: long-term cultivation and cultivation with fallow periods. The latter is a very common method in Guatemala, called 'guamil'.
In both cases, baseline management involves slash burn and over-exploitation of soil.

Below are the steps that were followed to identify the baseline and assess the additionality of the project:

- Step 0. preliminary screening based on the starting date of the A/R project activity;
- Step 1. Identification of alternative scenarios
- Step 4. Analysis of common practice

Step 0. preliminary screening based on the starting date of the A/R project activity;

The incentive from the planned implementation of a 'carbon credits' programme was conceived in early 2021 between zeroCO2 and Vivero mundo Verde.

After two years of developing reforestation projects dedicated to CSR (corporate social responsibility), zeroCO2 decided to develop a new carbon credit project from the ground up, with the support of its local team and involving the local communities that will manage the land.

In September 2022, the project started the certification process and about 173,000 plants were planted (of which around 127,000 remained in the zeroCARBON program). The project also included in the program a small number of plants from 2021 and 2020, the actual year of project start (corresponding to about 4.5 percent of the project area).

The plants included in the project from the previous two years belong to activities that were excluded from CSR projects prior to their initiation.

Step 1. identification of alternative scenarios;

The following table shows an estimation of the main land uses in the area where the project activity is going to be established. The most common land use is cultivated pasture. This

could be evidenced in the field through the validation visit and using photos that were taken at the project area.

Sub-step 1a. Identify credible alternative land use scenarios to the proposed project activity.

Continuation of pre-project land use

- **Land use scenario A. Cropland**: Subsistence farming: maize, beans, etc. However, the degraded soil conditions, low access to irrigation, climate change effects and low investment opportunities, lead to low yields. "Guamil"
- **Land use scenario B. Extensive livestock** with no pasture improvement.
- **Land use scenario C. Forestation Continuation** in the project area without any incentive from the Plan Vivo Certificates.

Figure A7.7: Monte Carmelo; Petén. Typical land use in the region

Analysis of alternative scenarios

These land uses are in compliance with all legal and regulatory requirements.

The analysis conducted by the Centro de Monitoreo y Evaluación de CONAP (CEMEC) in 2011[21] , concluded that only 40% of the entire department remains forested and 316 km2 of annual net forest loss took place over the previous eight years, or approximately 1% per year.

Agriculture (including livestock) remains the most important economic activity in Petén. Over 67% of the economically active population (aged seven and over) is employed in the primary sector. The main crop in the region has long been white corn, grown on more than 11,000 farms in 2008 (INE, 2008). The black bean has also been important for both domestic consumption and the market. Indeed, in 2003 (if not earlier), Petén was producing more maize and beans than any other department, accounting for 15% and 27%, respectively, of the total national production of these crops.

In the specific case of project areas, among the agricultural uses of land in the reference scenario, two different uses can be distinguished: long-term cultivation and cultivation with fallow periods. The latter is a very common method in Guatemala, called 'guamil'.

Guamil involves periods of land rest alternating with periods of resumption of agricultural activity preceded by slash and burn activities.

The soils of 'Guamil y/o Matorral' in the rest period have shrubby woody plants that do not reach 5m in height in association with weeds of less than 0.5m[22] . After a few years, these plant associations are converted back into arable land by humans.

The production of **cattle** has exploded in the last decade. Livestock production has a long history in Petén.

In 2003 there were 315,819 heads in the department, more than 19% of all cattle in the country; while in 2008 there were more than 1.362 million head, over 31% of the national total. Shiriar, A. J. (2014) reports that in 2014 local officials revealed that there may be 1.5-2 million head of cattle in the department.

Local authorities commonly argue that the large increase in the region's cattle population is partly due to the investments in livestock and agricultural land offering an affordable way to ''wash'' the money earned through drug trafficking or other illegal activities.

As evidenced by the ESA (European Space Agency) world cover map, grasslands and croplands are the most widespread land use. The map does not differentiate grasslands and crops from livestock farming.

[21] SEGEPLAN, 2011. Petén: Proceso de Actualización del Plan de Desarollo Integral. Diagnostico Teritorial, Tomo I. Guatemala City, Guatemala: Secretaria General de Planificación y Programación de la Presidencia, April 2011.

[22] Instituto Nacional de Bosques y Consejo Nacional de Áreas Protegidas. 2020. Manual de campo para el Inventario Forestal Nacional 2020, Grupo Interinstitucional de Monitoreo de Bosques y Uso de la Tierra. Guatemala. 88p.

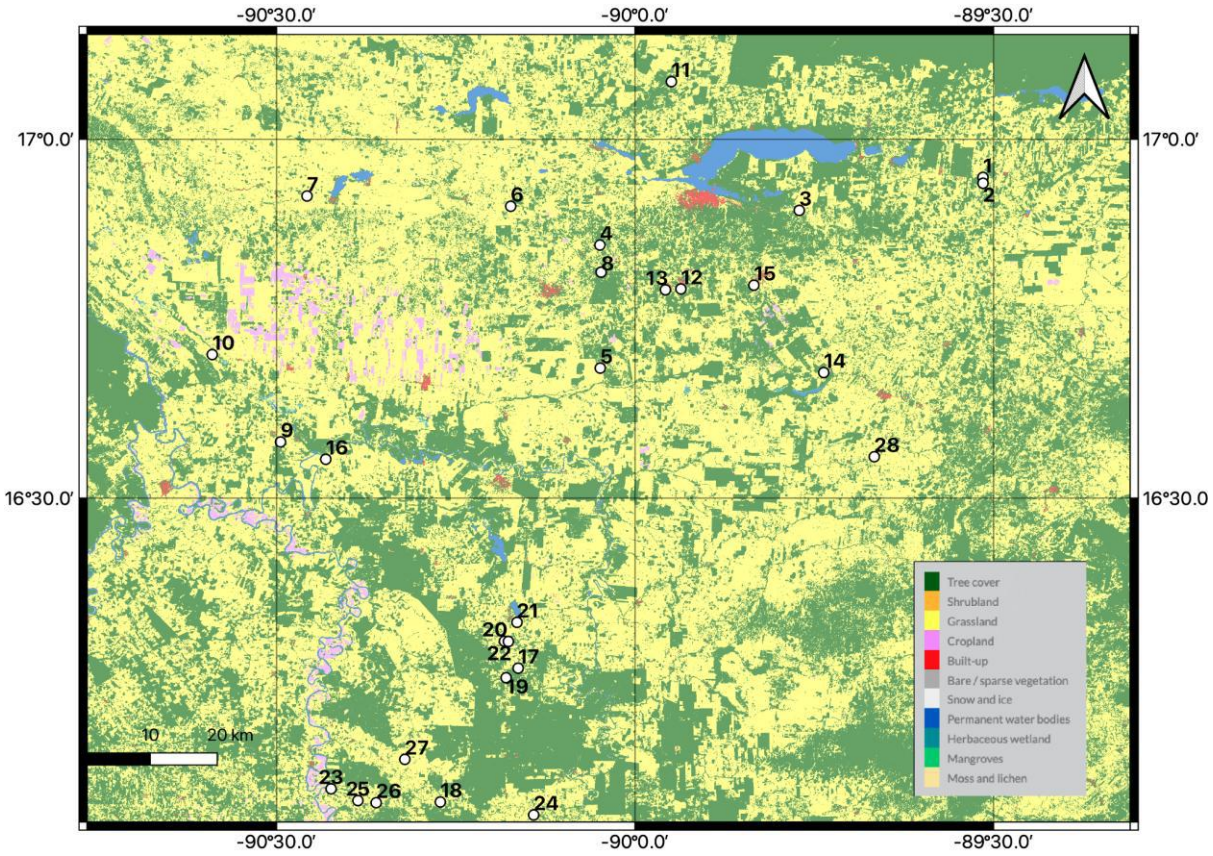


Figure A7.8: Land use satellite map, Guatemala - Petén region. White points represent the project's locations. Source: ESA; World cover project 2021

The ESA WorldCover product (2021) is highly useful for analysing land use over large areas. However, in many cases it fails to distinguish cultivated land from grasslands depending on the period of satellite acquisition and resolution. This is particularly the case in Guatemala, where the low/medium resolution of Sentinel images fails to highlight small plots dedicated to subsistence farming. For this reason, the map shows very few areas dedicated to cropland in the whole of Guatemala.

Furthermore, pastures may also contain uncultivated cropland areas (no cropland/ bare land) at the time of satellite imagery acquisition. Therefore, land, even if dedicated to crops, is visualised as grassland. However, stratification based on project-specific boundaries and, thus, analysis of higher resolution images, will enable more specific land use maps to be constructed.

Finally, a percentage of the land baseline (14%) is dedicated to Guamil.

- **Land use scenario C. Forestation Continuation** of the project activity without any incentive from the Plan Vivo certificates.

Without Plan Vivo, communities could still benefit from INAB subsidies related to the PRO BOSQUE programme.

However, the programme grants are not sufficient to cover the start-up costs of such a project, especially with the involvement of many communities.

Reforestation projects require significant upfront investments that are often seen as unattractive to communities living on low economic standards. In addition, timber prices are low in the region due to the high inflation rate generated by illegal logging and deforestation.

Over the last 15 years, deforestation and forest disturbance have affected all forested areas in Guatemala, even protected areas, with deforestation rates of around 846,000 ha in the period 2000 - 2015 as reported by the FAO (MacDicken et al. 2016)

Therefore, communities are much more likely to adopt subsistence land management systems that provide steady income but, simultaneously, lead to inevitable land degradation and decrease soil fertility.

In conclusion, the most likely baseline scenario is degraded agricultural land. Based on the information gathered by the zeroCO2 operations team, and the experience gained from direct contact with the Petén communities, two reference strata were identified within the project: cultivated land and grassland. In the first case, two sub-strata can be described according to land management: long-term cultivation and cultivation with fallow periods, also known as 'guamil'.

Sub-step 1b. Consistency of credible alternative land use scenarios with enforced mandatory applicable laws and regulations

All land-use alternatives identified above comply with all mandatory regulations in the country.

No alternative has been eliminated under this criterion.

Step 2. barrier analysis;

Sub-step 2a. Identification of barriers that would prevent the implementation of at least one alternative land use scenario.

Below is a list of possible barriers for the land-use alternatives identified above:

- **Barriers due to local ecological conditions**, including:
    - Degraded soils (overgrazing, desertification, prolonged summer drought, flooding):
    - High erosion risk

The soils of the Petén can be classified into two main groups. The first group consists of well-drained, mainly sloping soils that do not allow for modern agriculture and, in most cases, not even to ploughing due to their high stone concentration. The soils, although fertile, are found on steep slopes, which makes them highly vulnerable to erosion.

The other types of soils are found in flood plains and valleys, which, although fertile, are challenging for agriculture as they require high investments in drainage. The plasticity of these soils also limits their mechanisation.

According to the soil classification of the Guatemalan Ministry of the Environment, more than two thirds of the Petén area is not suitable for agricultural practices. The remaining portion can be used but with the limitations already presented (stagnation, slope, erosion).

Consequently, the most common type of land use is subsistence farming and grazing[23]. ()

- **Investment barriers**
    - Not enough money to develop the project completely. Current forms of subsidies are not sufficient.
    - Long-term return on investment.

The project will be co-financed by the PROBOSQUE programme.

PROBOSQUE, created by Legislative Decree No. 2-2015, is a national forestry policy instrument that came into force in 2017 and is designed to last for 30 years. PROBOSQUE promotes reforestation, forest creation and sustainable forest management. The programme is administered by INAB (Guatemalan National Forest Institute), which is the state body created to administer the PROBOSQUE programme.

The incentive is granted once a management plan is approved by INAB. For a given landowner, the grant application must be made through an official form prior to planting operations. This includes a suitability analysis of the land and a commitment to implement a sustainable management plan for the area to be reforested.

INAB approves the application in the same calendar year. Thereafter, the landowner has one year to carry out the reforestation plans. Once the reforestation is completed, INAB evaluates the execution of the project with a field visit and initiates annual payments to the landowner.

However, this incentive has proved to be insufficient to ensure the creation of large-scale, long-term, community-based projects. By only using this form of financing, there would be major cash flow problems. An ARR project such as the one proposed in this PDD requires major upfront investments that cannot be covered by national subsidies alone.

The project is made possible due to direct investments by zeroCO2, which it will be able to cover through the sale of fPVCs and, thus, vPVCs. In addition, the project in the initial stages will only be implemented through zeroCO2's own funds.

The possibility of relying on PVCs incentives will also be crucial to make the project attractive to communities that often see these projects as uneconomical and with excessively long rates of return on investment.

PVCs will also enable monitoring, training and general management of such a large and constantly expanding project that aims to involve hundreds of households with the constant operational support of a specialised team on site.

- **Technological barriers**
    - Lack of access to necessary materials, such as planting materials.
    - Lack of infrastructure for technology implementation.
    - Lack of expertise in plant management.
    - Local communities usually do not have access to sources of quality seeds or seedlings and lack the skills needed to produce them and successfully execute

[23] SEGEPLAN, 2013

tree planting, especially in drought climatic conditions. They also lack the knowledge and experience to prevent fire and pest and disease attacks.

Project activities

Provide a detailed description of all activities and input needed to implement the project intervention, including species selection, establishment, and long-term management.

The following activities will take place during the establishment and management of the agroforestry plantations:

a. Project intervention

Improved land management through forest plantations and agroforestry

b. Planting systems

System 1: Forest plantations

Improved management of the fallow lands exploited by years of monoculture, through the planting of tree species for the production of wood and other products. In the first year of planting, native species such as Cedar (*Cedrela odorata*), Caoba (*Swietenia macrophylla*) will be used. In future planting years, integrating additional native species will be considered, both forest and fruit species. Cedar and Caoba can easily be associated with other forest species and annual or perennial agricultural crops in different stages of development (newly planted, young plantations and advanced plantations) depending on the requirements of the species which they are intended to be associated with. However, it is necessary to favour their growth during the first four to five years by removing other vegetation in the understory. In summary, although the starting point of the project interventions is limited in regards to the number of species, the goal is to increase this number over time through natural regeneration and the planting of other suitable species. This will be done by identifying which species are adapted to the project sites and evaluating the benefits to project participants, the project and biodiversity, as well as determining the appropriate methodology.

In most regenerative forest systems, annual herbaceous species and wild species will be included in order to recreate a naturalised environment which is also productive for the local communities. The planting density will be approximately 1,111 trees per hectare.

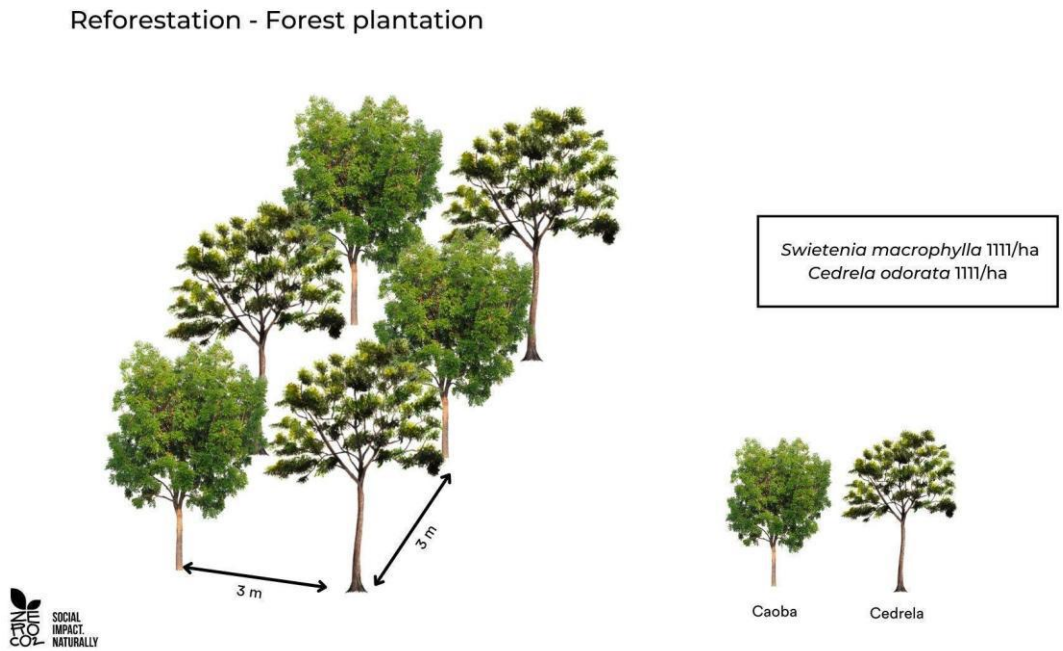


Figure A7.9: System 1: Forest plantation.

System 2: Agroforestry with fruit species intercropping.

Agroforestry system that combines tree plants with annual crops and fruit trees (lemon, orange, chicozapote, caffè). These crops will be able to provide additional income in the early years, while the trees will receive the benefit of the cultivation care given to herbaceous crops. The planting density will be 100 to 400 plants per hectare.

This second system follows the same management plans and the same forest species (Cedar, Mahogany), but when trees are integrated with perennial species the planting density is lower (200-400 trees/ha) while the integration of annual crops (maize, beans, squash, chilli) for both types of planting system is at the discretion of the participants.

Only Cedar and Caoba species planted for the purposes of the Plan vivo project will be considered for carbon benefit estimates.

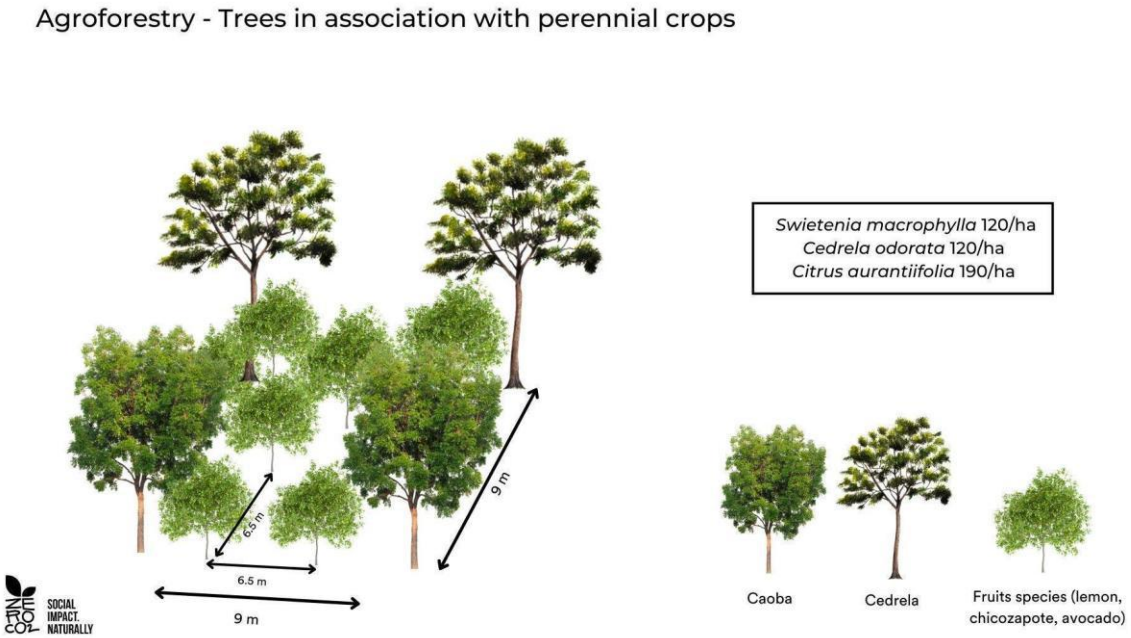


Figure A7.10: System 2: Agroforestry plantation.

c. Species selection

The main species that will be used in the project are *Cedrela odorata* (Cedar) and *Swietenia macrophylla* (Mahogany). ZeroCO2 and Vivero Mundo Verde have, from the outset, established a direct relationship with the communities to define the species to be included and the most suitable systems. This approach enables an active decision-making role for the local operations team and, first and foremost, the local communities.

The nursery activity is expanding towards the production of new native forest species that will be integrated in future project areas. With regard to agroforestry systems, zeroCO2 supports communities in the integration of fruit plants such as Limon, Chicozapote, Orange, Avocado and Coffee.
These plants are used for zeroCO2's CSR projects and, thus, excluded from the project's carbon benefit generation. Nevertheless, they are considered as an important co-benefit as a source of income and additional food for the communities.

MAHOGANY

Scientific name: *Swietenia macrophylla* King

Common names: “Caoba del Petén”. It should be clarified that the precision "Caoba del Petén" is necessary to differentiate the species from "Caoba del Pacífico", the common name given in Guatemala to Swietenia humilis Zucc.

Family: Meliaceae

Distribution:It is native to seasonally dry tropical forests, from southern Mexico (Yucatan peninsula), Belize, the Atlantic coast of Guatemala, Honduras and Nicaragua, to northern Costa Rica.

Precipitation: 1100-1400 millimeters

Description: The tree reaches heights between 25 and 40 metres

Pests: The main drawback of the species outside its natural conditions is its susceptibility to the pyralid Hypsipyla grandella, a shoot-borer that attacks and kills young shoots causing excessive branching. This only takes place during the first 2 to 3 years and thus requires pruning. This species should not be planted in monocultures.

Uses: According to Whitmore (2003)[24], Swietenia macrophylla holds great promise for the future due to the unique properties of its high quality wood, its rapid growth, its high full light requirements (it is considered shade intolerant) and its ability to adapt to a variety of site conditions (a combination of characteristics that make it a good subject for plantations).

Rotation time: 20 - 50 years

Growth parameters

Table A7.3: Mean annual increment (MAI) of the main growth parameters of Swietenia macrophylla in Guatemala, according to INAB sampling carried out in forest plantations of Guatemala (INAB, 2018). Productivity classes or site categories, in metres, were divided by the dominant plant height at a base age of 10 years.

Site category	MAI DAP (cm)	MAI total height (m)	MAI basal area (m2/ha)	MAI total volume (m3/ha)
Bad	0.39	0.30	0.09	0.27
Poor	0.53	0.51	0.17	0.66
Average	0.73	0.72	0.31	1.63
Good	1.00	0.93	0.57	4.14
Excellent	1.37	1.14	1.06	10.50

Source[25]: Departamento de Investigación Forestal, INAB, 2018; (Site Index at a base age of 10 years);
* MAI estimates for the mean SI of each category of 6, 8, 11, 11, 14 and 18 m respectively.

[24] Whitmore, TC. 2003. Mahogany: tree of the future. In: Lugo, AE; Figueroa Colón, JC; Alayón, M (eds.). Bigleaf mahogany: genetics, ecology and management. New York, US, Springer. p 1-5.

[25] Instituto Nacional de Bosques. 2019. Paquete Tecnológico Forestal para Caoba de Petén Swietenia macrophylla King. Guatemala, Departamento de Investigación Forestal. 85 p. (Serie técnica DT-026-2019).

Figure A7.11: Mahogany in zeroCO2's plantation of 2 years, Petén, Guatemala

CEDAR

Scientific name: *Cedrela odorata* L.

Common names: In Guatemala, the species is called "cedro" or "cedro rojo" (red cedar).

Family: Meliaceae

Distribution: Cedar is a neotropical tree species, growing naturally from 26° N latitude on the Pacific coast of Mexico to about 28° S latitude in northern Argentina, including the Caribbean islands. Its geographical range is larger than that of the Petén mahogany, as it can be found further north, further south and extends further into the center, as far as the Antilles, the Guianas and the Brazilian Atlantic forest.

Precipitation: 1100-1400 millimetres

Description: Deciduous tree up to 25-30 [40] m tall and 0.6-2 [3] m diameter at breast height.

Pests: The biggest problem in cedar planting is its susceptibility to the stem borer *Hypsipyla grandella*. This moth can attack various structures of the tree, but the main damage is caused by boring the main shoot in young trees, which causes branching, forking and consequently, the commercial value of the tree is diminished or nullified. However, once the vulnerable sapling stage is overcome, the species can develop its full productive potential.

Uses: Cedar is a fast-growing species that is excellent for the production of quality timber and the regeneration of degraded ecosystems. With regard to susceptibility to the European corn borer, integrated pest management prevention measures are needed, especially in the first few years, with a view to controlling the pest. In addition to this, monoculture should be avoided to limit susceptibility to pests. In some projects, Cedar may be used in agroforestry systems with perennial or annual crops, as a shade species for coffee or cocoa, in borders or live fences.

Rotation time: 20-30 years

Growth parameters

Table A7.4: Mean annual increment (MAI) of the main growth parameters of Cedrela Odorata in Guatemala, according to INAB sampling carried out in forest plantations of Guatemala. (INAB, 2018). Productivity classes or site index, in metres, were divided by the dominant plant height at a base age of 10 years.

Site index (SI)	MAI DAP (cm)	MAI total height (m)	MAI basal area (m^2/ha)	MAI total volume (m^3/ha)
Bad	0.51	0.35	0.10	0.29
Poor	0.65	0.49	0.16	0.59
Average	0.82	0.63	0.26	1.20
Good	1.12	0.83	0.50	3.19
Excellent	1.54	1.03	0.94	8.50

Source[26]: Departamento de Investigación Forestal, INAB, 2018; (Site Index at a base age of 10 years); * MAI estimates for the mean SI of each category of 6, 8, 11, 11, 14 and 18 m respectively.

[26] Instituto Nacional de Bosques. 2019. Paquete Tecnológico Forestal para Cedro Cedrela odorata L. Guatemala, Departamento de Investigación Forestal. 87p. (Serie técnica DT-029-2019).

Figure A7.12: Cedar in zeroCO2's plantation of 2 years in association with Caoba, Petén, Guatemala. Plantation system of Figure 6.

Table A7.5: Ranges of optimum conditions in which mahogany grows

Variables	Temperature (°C)	Precipitation (mm)	Altitude (msnm)	Drainage	pH	Slope (%)	Texture
Cedrela odorata (cedro)	20-28	1,200-5,000	0-1,200	Excessive, good drainage and regular	5-7	0-60	loam soils, loam sandy and clayey
Swietenia macrophylla (caoba)	22-28	1,000-6,000	0-1,400	Drainage excessive, drainage regular, good drainage and drainage moderate	4.5-7.7	0-60	loam soils, loam sandy and clayey

(INAB, 2019; Albizu, 2009;INAB 2021)

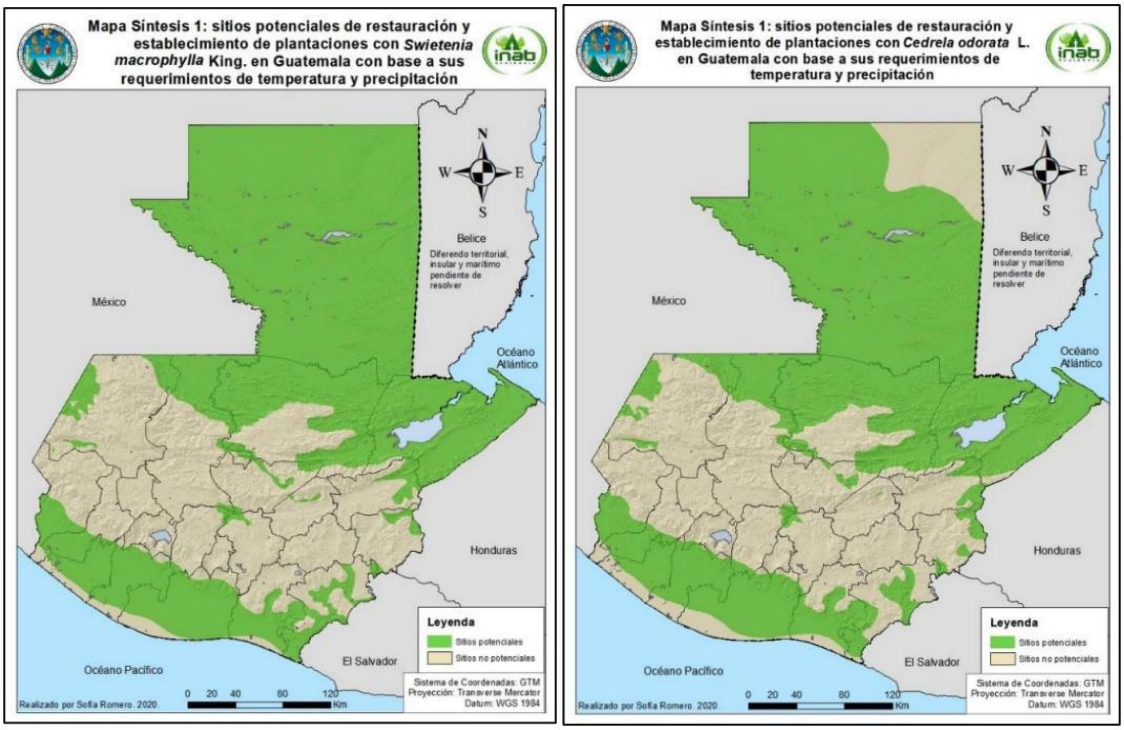


Figure A7.13: Map of potential sites for restoration and planting of *Swietenia macrophylla King* (Mahogany) and *Cedrela odorata L.* (Cedar) according to their optimal temperature and rainfall ranges. Source: INAB 2021

d. Production of seedlings

Mahogany and Cedar can be propagated by seed or by vegetative propagation. In this project, it is propagated by direct sowing in containers (e.g. plastic bags).

The nursery production of mahogany and cedar is simple: without requiring any pre-treatment, the seeds can be sown in germination beds for later replanting or directly in beds or bags, in a slightly shady place and in a substrate with good moisture.

When the first leaves appear, the seedlings are ready for repotting in bags or beds, for the production of bare-root plants or seedlings to be planted directly from the plastic bag. Immediately after repotting, they require strong shade (70%), to be reduced to 30% after one week and exposed to full light after 3-4 weeks.

zeroCO2 is responsible for all stages in nursery production, taking place at its nursery in the community of Nuevo Horizonte. The team takes care of certified seed procurement, germination, repotting and phytosanitary management and fertilisation.

For the latter two aspects, only organic products are used. Specifically the microbiological fertiliser Bonasol and the microbiological fungicide Trihn 35EW.

Figure A7.14: Organic products (Microbiological products) used in zeroCO2's nursery

The seedlings produced are then donated to all the communities around Guatemala that have joined the project.

Figure A7.15: Sprouting pallet

Figure A7.16: Drone imagery of zeroCO2 nursery

e. Planting operations

Planting is done by sowing bagged plants of the species to be used in the plantation. The distance between rows is 3 metres and between plants 3 metres (3*3), i.e. the planting will be carried out in a square pattern.

There are several ways of preparing the ground which are applied by the communities that have joined the project:

1) The traditional agricultural method (slash and burn): all vegetation is cut down, left to dry and then burned.

2) The same approach, but without burning (slash and burn): all vegetation is cut down, a small part is removed from the plot, and most of the vegetation residue is left at the site.

3) Mechanical preparation: the vegetation is cut down with a tracked tractor and piled up on the edges of the plot (with the possibility of shallow ploughing and deep scarification with a subsoiler also being performed)

4) Do nothing, leaving the plot in its current condition.

Figure A7.17: Manual planting in zeroCO2 project.

f. Long term management

Once the seedlings are planted, the following activities are carried out to ensure their survival.

- ***Weed control***

For the first years, till the moment the tree canopy will be closed, the project area is cleared by removing weeds that might compete with the planted species, in order to avoid competition for light, space, nutrients and moisture.

The almost simultaneous settlement of mahogany and traditional crops, such as corn, reduces initial maintenance costs.

Figure A7.18: Manual weed control in Montecarmelo zeroCO2 project.

- ***Pest management***

Table A7.6: Pest management activities

ACTIVITY	DESCRIPTION	ACTIONS TO PERFORM
Monitoring	It consists of carrying out visits to the project sites in order to detect the presence or attack of any pest or disease at least three times a year and take the corresponding actions in control and management.	Collect information on the pest or disease that is present in the plantation in order to make management and control decisions.
Trap placement	Placement of traps to prevent Hypsipyla attacks on Mahogany and Cedar species.	Traps will be installed to capture Hypsipyla butterflies, the traps will contain a mixture of alcohol with molasses.

ACTIVITY	DESCRIPTION	ACTIONS TO PERFORM
Preventive management	Application of organic compounds every fifteen (15) days to prevent pests and diseases that may affect the plantation	The preventive product used is Neem oil with potassium soap.
Plague and illness management	It consists of the application of sanitation pruning, cutting for the control and elimination of pests or diseases.	When detecting a pest to control and eliminate the pest or disease, if necessary, sanitation pruning and elimination of infected or damaged residues will be carried out.

g. Fertilization

The purchase of synthetic fertilisers is almost always prohibitively expensive for communities' finances.

zeroCO2 will monitor this and continue to train communities to adopt nature-based solutions and eliminate the use of synthetic products (both pesticides and fertilisers) where their use occurs.

zeroCO2 will also provide and develop organic alternatives for fertilisation such as green manure, composting of maize residues, bio-fertilisation and climate-smart fertilisation (biochar).

h. Pruning and thinning

Pruning

Pruning is one of the key activities in the management of forest species in order to obtain quality products in the medium and long term. This activity will be carried out using pruning saws, selecting the trees with the greatest number of branches to show competition for space and light, and will be carried out during the summer season.

Table A7.7: Pruning phases

Programmed activity	Species	Projected year	*Pruning intensity

Pruning 1	Cedro and Caoba	1	25%
Pruning 2	Cedro and Caoba	2	30%
Pruning 3	Cedro and Caoba	3	30%
Pruning 4	Cedro and Caoba	4	30%

Thinning

The purpose of thinning activities is to open up the space between plants and minimize competition for space, light and nutrients. In order to carry out this activity, trees with undesirable characteristics, such as winding, forked and suppressed trees are selected. If there are trees that are dominant, co-dominant or suppressed, they can be eliminated when it is determined that they don't benefit the stand.

Table A7.8: Thinning phases

Programmed activity	**Species**	**Projected year**	**Thinning intensity**	**Trees/ha**		***Tree characteristics for thinning**
				Inicial	**Final**	
Thinning 1	Cedro and Caoba	5	19%	1111	900	Sinuous, bifurcated and suppressed
Thinning 2	Cedro and Caoba	9	33.3%	900	600	Sinuous, bifurcated and suppressed
Thinning 3	Cedro and Caoba	13	50%	600	300	Suppressed

*Characteristics of the trees to be thinned, specify shape (sinuous, forked, straight) and sociological position (dominant, co-dominant, suppressed).

Carbon benefits

Crediting Period

State the crediting period over which carbon benefits are estimated.

The crediting period selected is 20 years.

Carbon Pools and Emission Sources

List the carbon pools and emission sources included in the estimation of carbon benefits and provide justification for any excluded carbon pools or emission sources.

Table A7.9: Relevant GHG sources, sinks and reservoirs for the project and baseline scenarios

Pools		Gas	Included/ Excluded	Justification/ Explanation
Baseline	**aboveground woody biomass**	CO_2	Included	The project satisfies both points (11 and 12) of AR- tool 14. In particular the trees present in the project area in the baseline before the project were neither harvested, nor cleared, nor removed. These didn't suffer mortality because of competition from trees planted in the project, or damage because of implementation of the project activity and they are not inventoried along with the project trees in monitoring of carbon stocks throughout the crediting period of the project activity. Therefore, carbon stock in the baseline can be accounted as zero. If any trees are cut down, they will be taken into account in the monitoring and the baseline updated.
	belowground biomass	CO_2	Included	
	soil organic carbon	CO_2	Included	These carbon pools are not expected to decrease due to the project activity.
	litter	CO_2	Included	

	dead wood	CO_2	Included	
Project intervention	**aboveground woody biomass**	CO_2	Included	Major carbon pool in the project activity
	belowground biomass	CO_2	Included	Major carbon pool in the project activity
	soil organic carbon	CO_2	Included methodology of assessment Excluded from the carbon benefit.	A significant increase in this carbon pool is expected due to the project activity. However, at this stage the value was considered conservative as zero waiting for specific and geolocalized land use information.
	litter	CO_2	Included	A significant increase in this carbon pool is expected due to the project activity.
	dead wood	CO_2	Included	A significant increase in this carbon pool is expected due to the project activity.
	Harvested wood product	CO_2	Included	A significant increase in this carbon pool is expected due to the project activity.

Baseline Emissions/Removals

Provide full details of the calculation of baseline emissions/removals for each baseline scenario the technical specification is applicable to, following an approved methodology. Include details of all assumptions and data sources and demonstrate that these meet the requirements of the approved methodology. Include a spreadsheet with all calculations.

The most likely land use scenario in the absence of project interventions and the additionality of project interventions were determined using AR-TOOL02 v1.0 with the relevant specifications taken from the Plan Vivo Agriculture and Forestry Carbon Benefit Assessment, methodologies PM001, PU001 and PU002.

The reference scenario and additionality will be re-evaluated at least every 10 years.

Calculation of baseline removals by carbon pools

Baseline removals developed following Equation 1 according to Plan vivo Methodology “Agriculture and Forestry Carbon Benefit Assessment Methodology” Version 0.1 01 May

2022 and specific methodologies procedures for estimating parameters in Equation 1 provided in modules PU001 and PU002 respectively of the same methodology.

For zero baseline claim, AR-TOOL14 v4.2 Section 5 was followed.

(Equation 1)

$$BRa,y = BRWB,a,y + BRNB,a,y + BRBG,a,y + BRLI,a,y + BRDW,a,y + BRSO,a,y + BRWP,a,y$$

(Equation 1)

Where:

BRa,y	Net GHG removals under the baseline scenario for project area a up to year y (t CO2e)
$BRWB,a,y$	Net GHG removals in aboveground woody biomass under the baseline scenario for project area up to year y (t CO2e; see PU001). AR-TOOL14 v4.2 Section 5 was followed.
$BRNB,a,y$	Net GHG removals in aboveground non-woody biomass under the baseline scenario for project area a up to year y (t CO2e;)
$BRBG,a,y$	Net GHG removals in belowground biomass under the baseline scenario for project area a up to year y (t CO2e;)
$BRLI,a,y$	Net GHG removals in litter under the baseline scenario for project area a up to year y (t CO2e;)
$BRDW,a,y$	Net GHG removals in dead wood under the baseline scenario for project area a up to year y (t CO2e)
$BRSO,a,y$	Net GHG removals in soil organic carbon under the baseline scenario for project area a up to year y (t CO2e)
$BRWP,a,y$	Net GHG removals in wood products under the baseline scenario for project area a up

	to year y (t CO2e; see PU001) If there is harvesting of trees in the baseline scenario

It has been assumed that there is no variation in the carbon stocks of woody biomass ($BRWB,a,y$).

As confirmed in section 3.1 and in section Additionality of this Annex, the most likely reference scenario is considered to be the land use prior to the implementation of the project activity (pastureland and cropland). Based on information gathered from project participants, two reference strata were identified: cultivated land and grassland. In the first case, two sub-strata can be described according to land management: long-term cultivation and cultivation with fallow periods. The latter is a very common method in Guatemala, called 'guamil'.

In some cases, the biomass stock in the project area is different from zero, due to the presence of scattered trees or fallow areas.

In the specific case of the 'guamil' base layer, during the fallow phase, carbon stocks and their variation may be significant. However, in the long term, the carbon stocks in this layer will be in a steady state, with some areas losing biomass and others gaining in the same year.

This is all the more so considering that, once the fallow period is over, all trees are harvested and slash and burn practices with high emission levels are adopted.

In conclusion, in line with the above and following the Methodological Tool A/R "Estimation of carbon stocks and carbon stock variation of trees and shrubs in CDM A/R project activities" (Version 04.2.), the ex-ante and ex-post variation of carbon stocks of trees and shrubs in the baseline can be considered as zero (for the three base layers considered).

To arrive at this statement it has been verified that conditions present in AR-TOOL14 v4.2 Section 5 (point 11 and 12) were satisfied.

In particular:

Point 11

(a) The pre-project trees are neither harvested, nor cleared, nor removed throughout the crediting period of the project activity;

(b) The pre-project trees do not suffer mortality because of competition from trees planted in the project, or damage because of implementation of the project activity, at any time during the crediting period of the project activity;

(c) The pre-project trees are not inventoried along with the project trees in monitoring of carbon stocks but their continued existence, consistent with the baseline scenario, is monitored throughout the crediting period of the project activity.

Furthermore, the AR-Tool 14 mentions at point 12 for zero baseline estimations of carbon stock changes the following criteria:

"12. Changes in carbon stocks in trees and shrubs in the baseline may be accounted as zero for those lands for which the project participants can demonstrate, through documentary evidence or through participatory rural appraisal (PRA), that one or more of the following indicators apply:

(a) Observed reduction in topsoil depth (e.g. as shown by root exposure, presence of pedestals, exposed sub-soil horizons);
(b) Presence of gully, sheet or rill erosion; or landslides, or other forms of mass movement erosion
(c) Presence of plant species locally known to be indicators of infertile land;
(d) Land comprises of bare sand dunes, or other bare lands;
(e) Land contains contaminated soils, mine spoils, or highly alkaline or saline soils;
(f) Land is subjected to periodic cycles (e.g. slash-and-burn, or clearing-regrowing cycles) so that the biomass oscillates between a minimum and a maximum value in the baseline;
(g) Conditions (a), (b) and (c) under paragraph 11 apply. "

The project satisfies both points (11 and 12) of AR- tool 14.

Regarding point 11, the project is not harvesting the remaining large trees in the project area, the large trees will not be affected by planting, and the project will not count the carbon of the large trees. However, the survival of the remaining trees will be monitored. Regarding item 12, the project is likely to fulfil most of these sub-items, but the clearest is 12F. Felling and burning for basic land management are commonly used in the baseline scenario. The same applies to grazing, the other main type of baseline scenario.

Due to the dynamics of this practice, fallow periods are short and insufficient for forest regeneration or establishment of local flora. The alternative land use is generally fallow or the absence of agricultural crops. Therefore, the change in baseline emissions due to changes in tree carbon stocks was assumed to be zero.

Also carbon pools of dead wood, litter and SOC ($BRLI,a,y$; $BRDW,a,y$; $BRSO,a,y$) are assumed to be zero in the baseline scenario due to the fact that the baseline scenario was degraded pasture and cropland with common use of slash and burn practices. Therefore, it is prudent to assume that the sum of changes in deadwood, litter and SOC carbon stocks is zero for the reference scenario.

Baseline monitoring data will be collected and updated whenever changes are highlighted during the project activity. This monitoring will be shared with the Plan Vivo Secretariat as soon as possible through the annual reporting process, at the latest by the second annual report.

This baseline stratification carried out in the field by the operations team was then confirmed by the GIS analysis of the individual georeferenced plots for each participant.

Calculation of baseline emissions from carbon pools

According to the A/R Large-scale Consolidated Methodology, Afforestation and Reforestation of lands except wetlands (Version 02.0), the baseline estimation is given as follows (equation X of the AR-ACM0003 methodology) retrieved from TLLG and Plan vivo Methodoology “Agriculture and Forestry Carbon Benefit Assessment Methodology” :

$$BECP,a,y = BEWB,a,y + BENB,a,y + BEBG,a,y + BELI,a,y + BEDW,a,y + BESO,a,y + BEWP,a,y$$

(Equation 2)

Where:

$BECP,a,y$	Net GHG emissions from carbon pools under the baseline scenario for project area a up to year y (t CO2e)
$BEWB,a,y$	Net GHG emissions from aboveground woody biomass under the baseline scenario for project area a up to year y (t CO2e; see PU002)
$BENB,a,y$	Net GHG emissions from aboveground non-woody biomass under the baseline scenario for project area a up to year y (t CO2e; see PU002)
$BEBG,a,y$	Net GHG emissions from belowground biomass under the baseline scenario for project area a up to year y (t CO2e; see PU002)
$BELI,a,y$	Net GHG emissions from litter under the baseline scenario for project area a up to year y (t CO2e; see PU002)
$BEDW,a,y$	Net GHG emissions from dead wood under the baseline scenario for project area a up to year y (t CO2e; see PU002)
$BESO,a,y$	Net GHG emissions from soil organic carbon under the baseline scenario for

	project area a up to year y (t CO2e; see PU002)
$BEWP,a,y$	Net GHG emissions from wood products under the baseline scenario for project area a up to year y (t CO2e; see PU002)

Baseline emissions from carbon pools are conservatively assumed to be zero considering that net-emissions are expected from the baseline scenario and the project intervention is expected to generate net-removals.

Calculation of baseline GHG emissions from emission sources

According to TLLG and Plan Vivo Agriculture and Forestry Carbon Benefit Assessment Methodology (PM001) and to A/R Large-scale Consolidated Methodology, Afforestation and Reforestation of lands except wetlands (Version 02.0), the baseline estimation is given as follows:

$$BEES,a,y = BENF,a,y + BENS,a,y + BEBB,a,y + BEFF,a,y + BEEF,a,y + BEMD,a,y + BESM,a,y$$

(Equation 3)

Where:

$BEES,a,y$	Net GHG emissions from emission sources under the baseline scenario for project area a up to year y (t CO2e)
$BENF,a,y$	Net GHG emissions from nitrogen fertiliser under the baseline scenario for project area a up to year y (t CO2e; see PU003)
$BENS,a,y$	Net GHG emissions from nitrogen fixing species under the baseline scenario for project area a up to year y (t CO2e; see PU003) PM001, Version 0.1
$BEBB,a,y$	Net GHG emissions from biomass burning under the baseline scenario for project area a up to year y (t CO2e; see PU003)

$BEFF,a,y$	Net GHG emissions from fossil fuel use under the baseline scenario for project area a up to year y (t CO2e; see PU003)
$BEEF,a,y$	Net GHG emissions from enteric fermentation under the baseline scenario for project area a up to year y (t CO2e; see PU003)
$BEMD,a,y$	Net GHG emissions from manure decomposition under the baseline scenario for project area a up to year y (t CO2e; see PU003)
$BESM,a,y$	Net GHG emissions from soil methanogenesis under the baseline scenario for project area a up to year y (t CO2e; see PU003)

This value is conservatively taken to be zero.

In the baseline scenario the practice of burning is widely used to burn vegetal litter, deforest and stimulate the regrowth of pasture when it becomes hard and fibrous, since the beginning of the project no activity will involve the use of fire. As a result, emissions are expected to decrease due to project activities.

Expected Project Emissions/Removals

Provide full details of the calculation of expected project emissions/removals, following an approved methodology. Include details of all assumptions and data sources and demonstrate that these meet the requirements of the approved methodology. Include a spreadsheet with all calculations.

Calculation of project relevant emission

The actual net GHG removals by sinks are estimated using the equations in section 5 of the methodology AR ACM0003 (Version 02.0). The actual net GHG removals by sinks are calculated using equation 2 of the methodology.

$$\Delta CACTUAL,t = \Delta CP,t - GHGE,t$$

(Equation 4)

Where:

ΔCACTUAL,t = Annual actual net greenhouse gas removals by sinks at time t; t CO2-e yr-1

ΔCP,t = Change in carbon stocks in project, occurring in the selected carbon pools, at time t; t CO2-e yr-1

GHGE,t= Increase of non-CO2 GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t, t CO2-e

a) Increase of non-CO_2 GHG emissions within the project boundary - GHGE,t

Increase of non-CO2 GHG emissions is estimated using the CDM A/R Methodological Tool "*Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity*" Version 04.0.0. Following equation 1 of the tool:

$$GHGe,t = GHGSPF,t + GHGFMF,t + GHGFF,t$$

(Equation 5)

$GHGe,t$ = Emission of non-CO2 GHGs resulting from burning of biomass and forest fires within the project boundary in year t; t CO2-e.

$GHGSPF,t$ = Emission of non-CO2 GHGs resulting from use of fire in site preparation in year t; t CO2-e.

$GHGFMF,t$ = Emission of non-CO2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land or other forest management, in year t; t CO2-e.

$GHGFF,t$ = Emission of non-CO2 GHGs resulting from fire in year t; t CO2-e.

It can be assumed that emissions of non-CO2 GHGs resulting from use of fire in site preparation in year t are zero (GHGSPF,t = 0) following in the tool (Paragraph 7, a): *For all areas of land where: (i) Slash-and-burn is a common practice in the baseline, and (ii) Fire has been used in the area at least once during the period of ten years preceding the start of the A/R CDM project activity*: GHGSPF,t = 0.

Emissions of non-CO2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land is estimated using equations 4 and 5 of the tool.

$$GHG_{FMF,t} = 0.07 \times \frac{44}{12} \times B_{HARVEST,t} \times f_{BL} \times CF_{TREE}$$

(Equation 6)

Where:

$GHGFMF,t$ = Emission of non-CO2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land, in year t; t CO2-e.

$BHARVEST,t$ = Biomass harvested from an area subjected to use of fire to clear the land of harvest residue prior to replanting of the land in the year t; t d.m.

$f\ BL$ = The fraction of aboveground tree biomass out of total harvest left on-site; dimensionless. A value of 0.25 for tropical forest is used. These values of the parameter have been conservatively adapted from Table 3A.1.11 of the IPCC GPG LULUCF 2003.

$CFTREE$ = Carbon fraction of biomass of trees harvested; t C (t d.m)-1. IPCC default value of 0.50 t C (t d.m)-1 is used.

$$B_{HARVEST,t} = \frac{bFOREST}{BEF2} \times A_{FMF,t}$$

(Equation 7)

Where:

$BFOREST$ = Default above-ground biomass content in forest in the region/country where the A/R CDM project is located; t d.m. ha-1.

BEF_2 = The biomass expansion factor for trees harvested; dimensionless. A value of 1.25 is used.

$AFMF,t$ = Area of land subjected to use of fire to clear the land of

Fire will not be used to clear the land of harvest residues, therefore **GHGFMF,t = 0.**

If forest fires occur they will be reported and monitored. Emission of non-CO2 GHGs resulting from forest fire (GHGFF,t) will be calculated ex-post using specifically equations 6, 7 and 8 of the mentioned A/R CDM Methodological tool.

$$GHG_{FF,t} = GHG_{FF\_TREE,t} + GHG_{FF\_DOM,t}$$

(Equation 8)

$$GHG_{FF\_TREE,t} = 0.001 \times \sum_{i=1}^{M} A_{BURN,i,t} \times b_{TREE,i,tL} \times COMFi \times (EF_{CH4,i} \times GWP_{CH4} + EF_{N20,i} \times GWP_{N20})$$

i=1

(Equation 9)

$$GHG_{FF\_DOM,t} = 0.07 \times \sum_{i=1}^{M} ABURN,i,t \times (C_{DW,i,tL} + C_{LI,i,tL}) \quad \text{(Equation 10)}$$

$GHG_{FF\_TREE,t}$ = Emission of non-CO2 GHGs resulting from the loss of aboveground biomass of trees due to forest fire, in year t; t CO2-e.

$GHG_{FF\_DOM,t}$ = Emission of non-CO2 GHGs resulting from the loss of dead organic matter due to forest fire, in year t; t CO2- e.

$A_{BURN,i,t}$ = Area burnt in stratum i in year t; ha.

$bTREE,i,tL$ = Mean aboveground tree biomass per hectare in stratum i in year tL which is the year in which last verification was carried out before occurrence of the fire; t d.m. ha-1. Where aboveground biomass of living trees is not burnt by fire $bTREE,i,tL$ may be set equal to zero.

$COMF_i$ = Combustion factor for stratum i; dimensionless

$EF\ CH_4,i$ = Emission factor for CH4 in stratum i; g CH (kg dry matter burnt)$^{-1}$.

$GWP\ CH_4$ = Global warming potential for CH_4 ; dimensionless, Default value of 21 is used

$EF\ N_20,i$ = Emission factor for N_2O in stratum i; g N_2O (kg dry matter burnt)$^{-1}$.

$GWP\ N_20$ = Global warming potential for N_2O; dimensionless 2 Default value of 310 is used.

CDW,i,tL = Carbon stock in dead wood in stratum i in year tL which is the year in which last verification was carried out before occurrence of the fire, as estimated using the .Tool for estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities.; t CO2-e

CLI,i,tL = Carbon stock in litter in stratum i in year tL which is the year in which last verification was carried out before occurrence of the fire, as estimated using the .Tool for estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities.; t CO2-e.

For ex ante estimations emission of non-CO2 GHGs resulting from fires will be considered zero, GHGFF,t = 0. There is no information about forest fires inside the project area, therefore in the ex- ante estimations it is not possible to estimate potential emissions due to this type of fires.

Throughout the project, the tool presented in the following section: “Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity. Version 4.0” will be applied to all fire events that may occur within the project boundary.

Thus Project emissions ($GHGe,t$) are accounted as zero.

b) Emissions from fertiliser and herbicide use

Despite the fact that zeroCO2 does not provide farmers with synthetic fertilisers and herbicides, in some cases farmers in the communities may resort to their use.

This is a very conservative assumption considering that farmers generally use them very little or not at all due to cash flow problems. The planting will not require large amounts of fertiliser and weed control will only be reserved for the first two years after planting to ensure rooting.

Therefore, as a mitigation measure, zeroCO2 seeks to promote the elimination of agrochemicals in favour of exclusively organic practices through a careful and iterative process.

This already takes place entirely during the seedling production stage in nurseries where all production is organic. Training projects will also be set up for communities on alternative practices to the use of chemical fertilisers (biochar, manure, etc.), also promoting the rediscovery of indigenous ancestral knowledge.

However, for the purposes of carbon stock assessment, they can be considered zero. Depending on the baseline in which they were used anyway. Without taking into account additional emissions related to pre-project land use where continuous slash and burn cycles ensured additional emissions.

Calculation of project relevant carbon pools removals

$$PRa,y = PR_{WB,a,y} + PR_{NB,a,y} + PR_{BG,a,y} + PR_{LI,a,y} + PR_{DW,a,y} + PR_{SO,a,y} + PR_{WP,a,y}$$

(Equation 11)

Where:

$PR_{WB,a,y}$	Net GHG removals in aboveground woody biomass under the project scenario for project area a up to year y (t CO2e; see PU001)
$PR_{NB,a,y}$	Net GHG removals in aboveground non-woody biomass under the project scenario for project area a up to year y (t CO2e; see PU001)

$PR_{BG,a,y}$	Net GHG removals in belowground biomass under the project scenario for project area a up to year y (t CO2e; see PU001)
$PR_{LI,a,y}$	Net GHG removals in litter under the project scenario for project area a up to year y (t CO2e; see PU001)
$PR_{DW,a,y}$	Net GHG removals in dead wood under the project scenario for project area a up to year y (t CO2e; see PU001)
$PR_{SO,a,y}$	Net GHG removals in soil organic carbon under the project scenario for project area a up to year y (t CO2e; see PU001)
$PR_{WP,a,y}$	Net GHG removals in wood products under the project scenario for project area a up to year y (t CO2e; see PU001)

Expected project removals in woody biomass can be estimated with the following the procedures of AR-TOOL14 v4.2 as reported by TLLG & Plan Vivo TAC in PU001 Methodology.

The project scenario involves the harvesting of trees; approaches to define long-term average project yields were included in part a.

$$PR_{WB,,a,y} = \sum_{t=1}^{y} \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t}$$

(Equation 12)

Where:

$PR_{WB,a,y}$ Net GHG removals in aboveground and belowground woody biomass under the project scenario for project area a up to year y (t CO2e)

$\Delta C_{TREE\_PROJ,t}$ Change in carbon stock in tree biomass under the project scenario within the project area in year t (t CO2e; from AR-TOOL14 v4.2, excluding uncertainty adjustment)

$\Delta C_{SHRUB\_PROJ,t}$ Change in carbon stock in shrub biomass under the project scenario within the project area in year t (t CO2e; from AR-TOOL14 v4.2, excluding uncertainty adjustment).

Calculation of long-term average removals in woody biomass with long-term management

The long-term average shall be calculated following the AFOLU requirements when harvesting is applied.

The management of the project involves a continuous process of natural regeneration through coppicing. The silvicultural system therefore remains in a stable mosaic of harvesting and silvicultural succession, rather than going through a clean rotation cycle.

$$PR_{WB\_LTA,a,y} = \frac{\sum_{t=1}^{z} PR_{WB\_LTA,a,y}}{z} \quad \text{(Equation 13)}$$

Where:

$PR_{WB\_LTA,a,y}$ Maximum net GHG removals in aboveground woody biomass under the project scenario for project area a up to year y (t CO2e)

$PR_{WB,a,t}$ Net GHG removals in aboveground woody biomass under the project scenario for project area a in year t (t CO2e; see Section 5.1.3)

z Number of years in one or more full rotations (years)

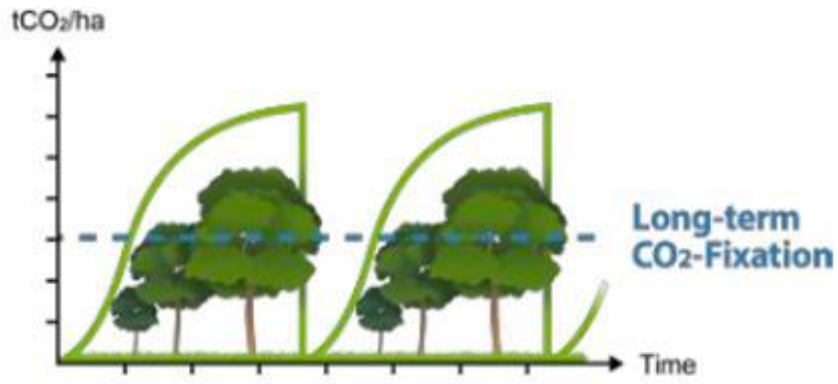


Figure A7.19: Long term average fixation with Rotation Forestry. Source[27]: Gold Standard

Stratification

[27]The Gold Standard Afforestation/Reforestation (A/R) Requirements, 2013 available at: https://globalgoals.goldstandard.org/standards/PRE-GS4GG-AF/ar-requirements_v0-9.pdf

According to the methodology AR-ACM0003, if biomass distribution over the project area is not homogeneous, stratification should be carried out to improve the precision of biomass estimation. Different stratifications may be appropriate for the baseline and project scenarios to achieve optimal precision of the estimation of net GHG removals by sinks. For actual net GHG removals by sinks, the stratification for ex-ante estimations is based on the project planting plan (Table 9).

Table A7.10: Stratification of first project activity instance

Planting year	Planting system	Stratum	Area (ha)	Area (%)
2020	Forest plantation	**I**	**8.75**	**2 %**
2021	Forest plantation	**II**	**10.79**	**2 %**
2022	Forest plantation	**III**	**114.92**	**26 %**
2023	Forest plantation	**IV**	**303.54**	**69 %**
Total			**438.00**	**100 %**

Calculation of above ground biomass

For Caoba and Cedro, a general equation retrieved from Chave et al. (2014) for total biomass for moist tropical forests was the following:

$$B_{AG} = 0{,}0673 \cdot (\varrho \cdot D^2 H)^{0{,}976}$$

(Equation 14)

Where:

B_{AG} Above ground biomass

ϱ Wood density. Density values, were taken from the Global wood density database [28] that collects the main studies on the subject specific for Central America as listed in the table 7.11..

[28] Zanne, Amy E. et al. (2009), Data from: Towards a worldwide wood economics spectrum, Dryad, Dataset, https://doi.org/10.5061/dryad.234

D Diameter at breast height

H Height

The Chave equation is among the most widely used. A literature search was conducted to see if there were any species-specific equations. Considering that equations were found relating to completely different ecological zones (South-East Asia mainly), the Chave equation was used, which by including wood density also allows species-specific variability to be modelled.

Given the amount of literature present for the specific country context of Guatemala (both Cedro and Caoba) described in the respective INAB documents, the equations given in the INAB documents were used for estimating the annual diameter increase (DBH) and height increase (A). This practice of preferring the use of equations derived from local data to describe the DBH-H relationship is emphasised not only by the IPCC but also by Chave et al. 2014, in order to improve the adaptability of the equation to the selected context.

Thus, compared with the tabular data present, for example, in the IPCC tables concerning the average annual increase in specific volume in forest plantations, or with other recognised models in the forestry sector (Winrock), the Chave equation presents itself with certainly conservative outputs, especially in those cases where forests are strongly influenced by environmental variables and specific growth parameters (e.g. the DBH-H relationship cited in the INAB documents).

The Chave model with the INAB growth curves also makes it possible to have a model dependent on the abundance parameter of the plants present on the site, a very important parameter for management choices.

Table A7.11: Output parameters of the zeroCarbon model (Chave), compared with the models (Brown et al 1997), and the approach proposed by USAID and Winrock (Chapman) also applied to the zeroCarbon project context

estimated tCO2e/ha at end of cycle (20 years)					
Cedar - *Cedrela odorata*			***Swietenia macrophylla***		
Chave, 2014	Brown, 1997	Winrock (Afolu) model	**Chave**	Brown, 1997	Winrock (Afolu) model
155,63	211	302	81,49	93,20	302

The density of the two species are retrieved from the Global wood density database and othe scientific resources specifics for Guatemala as shown in the table below.

Table A7.12: Wood density retrieved from the Global wood density database and region and species-specific peer reviewed studies

Species	wood density (ρ)	Region	Source
Cedrela odorata	0.41	Central America	[29]
Cedrela odorata	0.58	Costa Rica	[30]
Cedrela odorata	0.50	Guatemala	[31]
Cedrela odorata	0.57; 0.58; 0.60	Nicaragua	[32]
Average	**0,53**		
Swietenia macrophylla	0,50	Central America	[25]
Swietenia macrophylla	0,50	Guatemala	[28]
Average	**0,500**		

*density values, shown in Tab 9., were taken from the Global wood density database, which collects the main studies on the subject.

Calculation of belowground biomass

$$B_{BG} = B_{AG} \cdot R_j$$

(Equation 15)

[29] Zanne, Amy E. et al. (2009). Data from: Towards a worldwide wood economics spectrum [Dataset]. Dryad. https://doi.org/10.5061/dryad.234

[30] Segura-Elizondo, B. (2019). Propiedades de la madera de Cedrela odorata de nueve y diez años en un SAF con Theobroma cacao, comparado con una plantación pura de diez años. Turrialba, Costa Rica.

[31] Augusto, C. I. M. S. B., & Paiz, M. CARACTERIZACIÓN DE PLANTACIONES FORESTALES CON ESPECIES NATIVAS VALIOSAS EN LAS TIERRAS BAJAS DEL NORTE DE GUATEMALA.

[32] González-Luna, H. M., & Cruz-Castillo, J. B. (2021). Anatomía y propiedades físicas de dos especies forestales comerciales Cedro (Cedrela odorata L.) y Laurel (Cordia alliodora (Ruiz & Pav.) Oken) en Nicaragua. *La Calera*, *21*(37), 81-86.

Where:

B_{BG} Belowground biomass of woody or non-woody vegetation (t CO2e)

B_{AG} Aboveground biomass of woody or non-woody vegetation (t CO2e)

R_j Root:shoot ratio (t root dry matter/t shoot dry matter) Root:shoot ratios can be obtained from the following sources: i) Data collected within the project area; ii) Published studies specific to the project region and vegetation type; or iii) Global default values for specific vegetation types or ecoregions e.g. from IPCC 2003.

Calculation of total biomass

$$B_T = B_{AG} + B_{BG}$$

(Equation 16)

Where:

B_T total biomass

B_{BG} Belowground biomass of woody or non-woody vegetation (t CO2e)

B_{AG} Aboveground biomass of woody or non-woody vegetation (t CO2e)

Calculation of total fixed carbon

As reported by the Intergovernmental Panel on Climate Change (7), total carbon is calculated using the following expression:

$$\Delta C_{TREE\_PROJ,t} = B_T \cdot (0.47)$$

(Equation 17)

Where:

C_T Total carbon (Mg C ha^{-1})

B_t total biomass (t)

0.47 Carbon fraction; IPCC[33]

Calculation of CO2 equivalent

[33] IPCC (2006). default value - Guidelines for National Greenhouse Gas Inventories. Volume 4 Agriculture, Forestry and Other Land Use. p.73.

$$\Delta C_{TREE\_PROJ,t}\ CO_2\ eq\ = C_T \cdot (3.6667)$$

(Equation 18)

Where:

CO_2eq Total carbon dioxide (Mg CO_2 eq ha^{-1})

C_T Total carbon (Mg C ha^{-1})

3.6667 conversion factor resulting from the molecular weight of carbon dioxide

Table A7.13: Root to shoot and CO2 conversion parameter.

Parameter	Value
Root-to-shoot ratio[a]	0.489 x $AGB^{0.890}$
Carbon fraction[b]	0.47
Conversion factor from C to CO_2[c]	3.667

Source[34]: a. Mokany K, Raison RJ, Prokushkin AS (2006) Critical analysis of root : shoot ratios in terrestrial biomes. Global Change Biology 12: 84-96. b.[35] IPCC "Good Practice Guidance for LULUCF". 2003. Equation 3.2.3 c. IPCC default value.

Ex ante estimation of carbon stocks - Local Growth Models

For the ex-ante estimation, local growth models developed by INAB (Instituto Nacional de Bosques) of Guatemala were used, for the specific ecological conditions of Guatemala and specific to the tree species under study. These are based on long-term ground sampling on plantations similar to the one under study.

These models were used to describe the yield curve and determine the long-term average of available carbon credits. Local growth models will not be used for ex-post estimation, as this calculation will be based on field measurements: DBH, height and allometric estimation equations.

An ex-ante estimation (projection) of the carbon stock in the biomass of the project trees was conducted following the guidelines in AR-TOOL 14 of the CLEAN DEVELOPMENT MECHANISM - UNFCCC. This method uses existing data in combination with tree growth models to predict future growth and stand development over time (20 years).

[34] *Mokany K, Raison RJ, Prokushkin AS (2006) Critical analysis of root : shoot ratios in a terrestrial biomes. Global Change Biology 12: 84-96*

[35] *IPCC "Good Practice Guidance for LULUCF". 2003. Equation 3.2.3*

The stand parameters are simulated based on tree planting and management practices (e.g. planting density, survival rate, thinning). Tree growth (specifically, the increase in diameter and height) is simulated by taking into account local tree growth data (e.g. age-diameter curves, yield tables, yield curves), while also taking into account site-relevant factors and stand-specific parameters.

The ex-ante estimation (projection) of the carbon stock in tree biomass is not subject to an uncertainty check. The condition required by the UNFCCC methodology is to use the best available data and models for the project site and the species under study.

The UNFCCC text specifies how the ex-ante estimate, allometric equations, or volume table applied to a tree species is selected from the following sources (the preferred source is listed first):

(a) Existing data applicable to the local situation (e.g. represented by similar ecological conditions);

(b) National data (e.g. from the national forest inventory or national greenhouse gas inventory);

(c) Data from neighbouring countries with similar conditions;

(d) Globally applicable data

In our case, all grade (a) data obtained from the Instituto Nacional de Bosques (INAB) of Guatemala specific to the species and regions under study were used [36] [37](10).

Below are the families of accretion models for the species present at the study site.

The models were developed by the Instituto Nacional de Bosques (INAB) of Guatemala and were used to make an estimate of ex ante stocking for a period of 20 years.

Table A7.14: Growth models 1 for Caoba del Petén, Swietenia macrophylla related to Guatemala

Variable	Growth model	r2
Total height (m)	$= exp\ (ln(S) - 2.398073 * \ (1/T - 0.1))$	0.47
Diameter (cm)	$= exp\ (1.724193 - 2.74867/T + 0{,}0838 * s - 0.000075 * N)$	0.89

Where: T= age in years; N= trees/ha; S= site index
Source: Departemento de Investigación Forestal (INAB), Guatemala, 2018

Predicted Growth for Caoba

[36] Instituto Nacional de Bosques. 2019. Paquete Tecnológico Forestal para Cedro Cedrela odorata L. Guatemala, Departamento de Investigación Forestal. 87p. (Serie técnica DT-029-2019).

[37] Instituto Nacional de Bosques. 2019. Paquete Tecnológico Forestal para Caoba de Petén Swietenia macrophylla King. Guatemala, Departamento de Investigación Forestal. 85 p. (Serie técnica DT-026-2019).

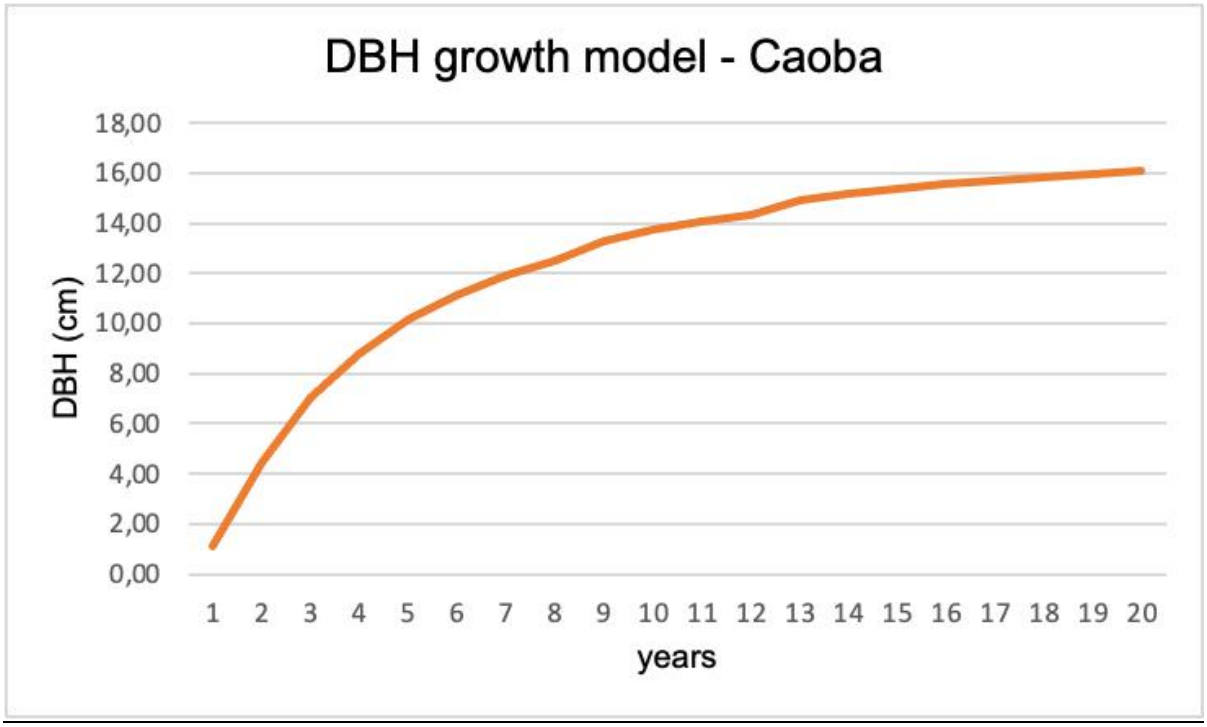


Figure A7.20: Diameter growth model - Mahogany

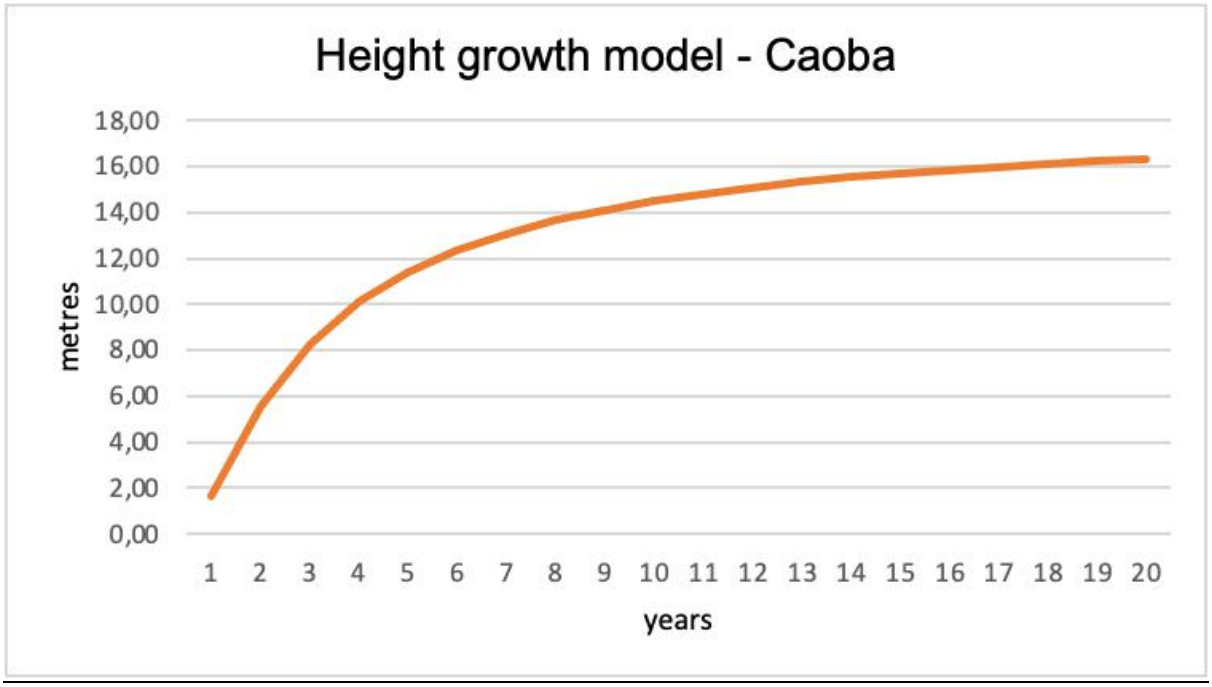


Figure A7.21: Height growth model - Mahogany

Table A7.15: Growth models 1 for Cedar, Cedrela odorata related to Guatemala

Variable	Growth model	r^2
Total height (m)	$= exp\ (ln(S) - 2.129485 * \ (1/T - 0.1))$	0.48
Diameter (cm)	$= exp\ (2{,}86717 - 2.865757/T + 0{,}079924 * S - 0.000238 * N)$	0.91

Where: T= age in years; N= trees/ha; S= site index
Source: Departemento de Investigación Forestal (INAB), Guatemala, 2018

Predicted Growth for Cedar

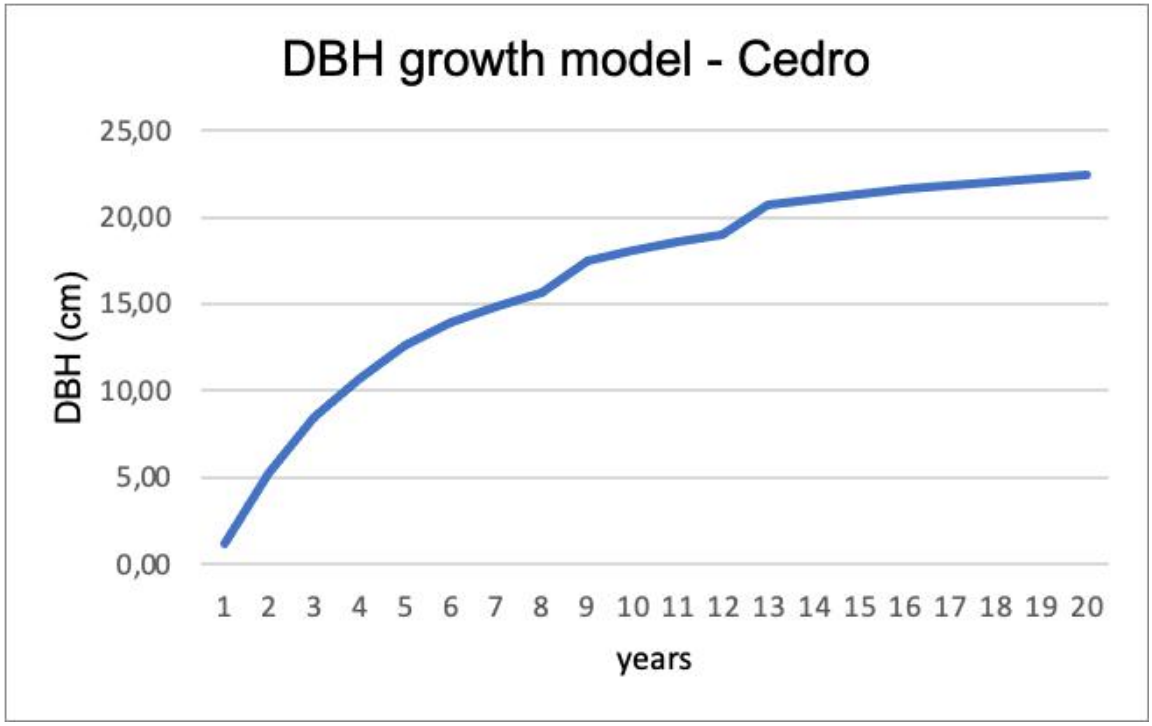


Figure A7.22: Growth model; DBH (diameter at breast height) - Cedar

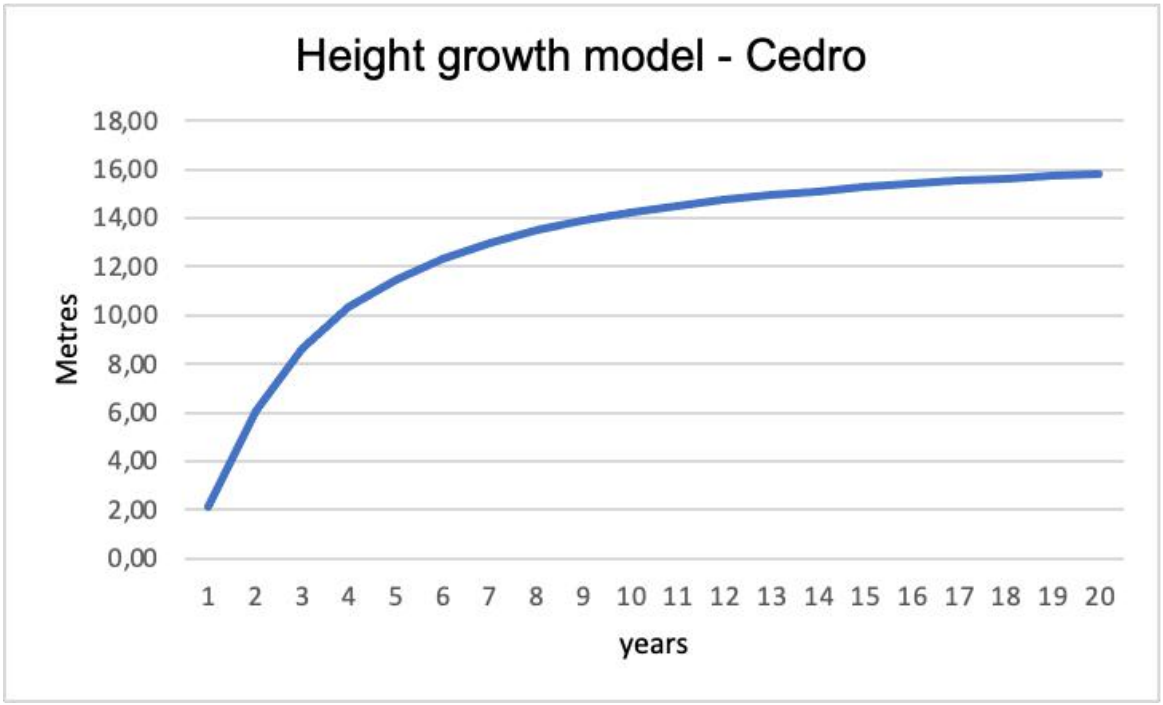


Figure A7.23: Growth model; Height (diameter at breast height) - Cedar

Site index selection

The analysis of the dasymetric database (PPMF of Mahogany and Petén Cedar on pure forest plantations, status as of 31 December 2017) carried out by Instituto Nacional de Bosque de Guatemala (INAB), led to the differentiation of productivity intervals, called site categories (the site index was determined at a base age of 10 years), based on the height reached by the stand and its age. These analyses were carried out on the basis of 92 measurements in 24 permanent forest measurement plots, with the youngest PPMF being 1 year old and the oldest 20.4 years old.

Considering, however, that the management characteristics and specific data of the projects monitored by INAB are unknown (planting, type of management, disease management, etc.), it was decided to average the INAB value with the data collected in the field by zeroCO2 in June 2022 on a 1.5-year old plant managed by the farming communities and the zeroCO2 team. This plantation is part of the zeroCARBON project and encompasses all the management and design features listed in the following PDD.

Site sampling on project site at 21 months

Sampling carried out by zeroCO2 in June 2022 on a 21-month-old plantation with the same characteristics and in the same ecological scenario, showed that the storage per hectare (on average 4.95 tonnes/ha) was higher than the conservative projection based on the site indexes of the Petén INAB sampling plots.

The study site carried out by zeroCO2 in June 2022 consisted of a forest plantation of 20.31 ha located in the community of Montecarmelo in the commune of La Libertad in the Petén department, Guatemala (16 ° 50'59.57 "N; 90 ° 2'39.24" W). The study area included 1111 trees for each hectare, for a total of about 20.31*1111=22,564 trees. Each tree is given 3 x 3

metres of space. Half of the trees in the study area were cedar (*Cedrela odorata*) and the remaining half was mahogany (*Swietenia macrophylla*).

In a defined representative area, ground data was acquired at 20 random points.

To acquire the data:

1. Two operators went to each of the 20 points and acquired GPS coordinates on the ground.

2. Test areas with a radius of 10 metres were created.

3. Within each area, the diameter and height of each tree was measured.

A uniform area of 20 hectares was chosen that was significant for the typical zeroCO2 planting.

The value measured through ground sampling was also compared through the use of sentinel satellite images to improve the efficiency of estimation. This methodology can be examined in detail in the attached publication produced together with the University of Florence (Annex 17) and soon to be published.

Sampling specifications are collected in the additional documentation in Annex 17

Through periodic sampling and monitoring, the project-specific site index will be updated.

Below in Table 4. are the site indexes for the different plots in the specific project of zeroCO2.

Table A7.16: Field site index - growth performance in Cedrela odorata and Swietenia macrophylla forest plantations at 1.5 years managed and monitored by zeroCO2.

Site (plot)	Field site index CAOBA	Field site index CEDRO
1	17.97	
2	15.136	16.07907035
3		16.94232166
4	20.16555664	17.00164396
5	20.92127416	19.36082445
6		14.63882577
7		
8	16.96783429	
9	18.80822871	
10	16.31650128	
11	19.11874794	
12		15.46737914
13		15.50571478
14	19.35847009	
15	15.83936199	14.36320096
16	17.70379449	
17	16.60759248	13.85140626
18	19.15957973	14.50674972

19		16.08914395
20	20.77968003	
21	22.95100957	
AVG	18.52	15.80

Below are the site indexes for the different plots in the specific regions of Guatemala, elaborated by INAB.

Table A7.17: INAB site index- growth performance in Cedrela odorata forest plantations monitored from permanent forest measurement plots in Guatemala by Instituto Nacional de Bosque.

Departament	Municipality	Plot	Site index	Site category
Guatemala	Chuarrancho	Hidroeléctrica Rio Las Vacas	8.71	Bad
Alta Verapaz	San Cristóbal Verapaz	San Joaquín	17.16	Excellent
Alta Verapaz	Tucurú	Guaxpom	15.32	Good
Zacapa	Gualán	Finca la Cartuchera	16.14	Excellent
Zacapa	Gualán	Finca la Cartuchera	16.31	Excellent
Zacapa	Gualán	Finca la Cartuchera	17.73	Excellent
Santa Rosa	Taxisco	Finca Monte Carlos	6.94	Bad
Petén	Santa Ana	Chultunes	10.67	Medium
Petén	Santa Ana	El Limón	8.29	Bad
Petén	San Francisco	Pilones de Antigua	8.82	Bad
Petén	San Francisco	Pilones de Antigua	8.82	Bad
Petén	Poptún	Odilia Telón Álvarez	10.67	Medium
Petén	Poptún	Odilia Telón Álvarez	12.09	Medium

Petén	San Francisco	Las Dos Marías	17.85	Excellent
Petén	La Libertad	Finca El Ramonal III	13.99	Good
Petén	San José	Finca El Triunfo	22.74	Excellent
Retalhuleu	Retalhuleu	Tomatales	13.15	Good

Table A7.18: INAB site index - Current state of growth performance in forest plantations of Swietenia macrophylla, monitored from permanent forest measurement plots in Guatemala by Instituto Nacional de Bosque.

Departament	Municipality	Plot	Site index	Site category
Guatemala	Chinautla	Hyroeléctrica Rio Las Vacas	7.35	Bad
Alta Verapaz	Tucurú	Guaxpom	6.13	Very bad
Alta Verapaz	Fray Bartolomé de las Casas	Rancho Noe	9.51	Bad
Izabal	Livingstón	Hacienda Rio Dulce	23.63	Excellent
Izabal	El Estor	Finca Tablitas	12.90	Medium
Izabal	El Estor	Finca Tablitas	12.54	Medium
Izabal	El Estor	Finca Tablitas	16.57	Good
Izabal	El Estor	Finca Tablitas	15.91	Good
IZABAL	Livingstón	Río Seja	13.48	Medium
IZABAL	Livingstón	Río Seja	15.36	Good
Zacapa	Gualán	La Estrella	9.28	Bad

Chiquimula	Concepción Las Minas	Finca San Jose Las Minas	10.08	Bad
Petén	Santa Ana	Chultunes	10.73	Bad
Petén	Santa Ana	Chultunes	9.36	Bad
Petén	Flores	Finca Virginia	7.43	Bad
Petén	San Francisco	Pilones De Antigua	9.56	Bad
Petén	San Francisco	Pilones De Antigua	9.79	Bad
Petén	San Francisco	Pilones De Antigua	9.44	Bad
Petén	San Francisco	Nabah	8.88	Bad
Petén	San Luis	Prendisa	12.99	Medium
Petén	San Luis	Prendisa	13.38	Medium
Petén	San Francisco	Finca El Ramonal III	13.10	Medium
Retalhuleu	Retalhuleu	Hacienda El Establo La Cuchilla	13.86	Medium
Retalhuleu	Retalhuleu	Tomatales	9.88	Bad

Table A7.19: Site index summary for Petén INAB

	Caoba	Cedro
Petén reference permanent plot site index (INAB, 2019)	10.73	10.67
	9.36	8.29
	7.43	8.82
	9.56	8.82
	9.79	10.67

	9.44	12.09
	8.88	13.99
	12.99	17.85
	13.1	22.74
	13.38	
Average	**10.466**	**12.66**
Standard deviation	2.031858	4.836639

Site index. INAB parameter and field data

As mentioned above, considering that the management characteristics and project-specific data monitored by INAB (planting, type of management, disease management, etc.) are not known other than the site index (dominant height at year 10), it was decided to average the INAB value with the data collected in the field by zeroCO2 in June 2022 on a 1.5-year old planting managed by the farming communities and the zeroCO2 team (Table 4.). This plantation is part of the zeroCARBON project and includes all the management and design features listed in the following PDD.

Table A7.20: Site Index retrieved from INAB and parameters calculated from field data collected on species planted after 1.75 years of age. Sampling specifications of field inventory are collected in the additional documentation in Annex 17.

Species	Site index (INAB)	Site index (field data collected by zeroCO2)
Cedro	12.66	15.8
Caoba	10.47	18.52
TOTAL AVERAGE (INAB + field data)	**14.49**	**14.23**

Predicted Growth for Caoba (Calculation on excel spreadsheet)

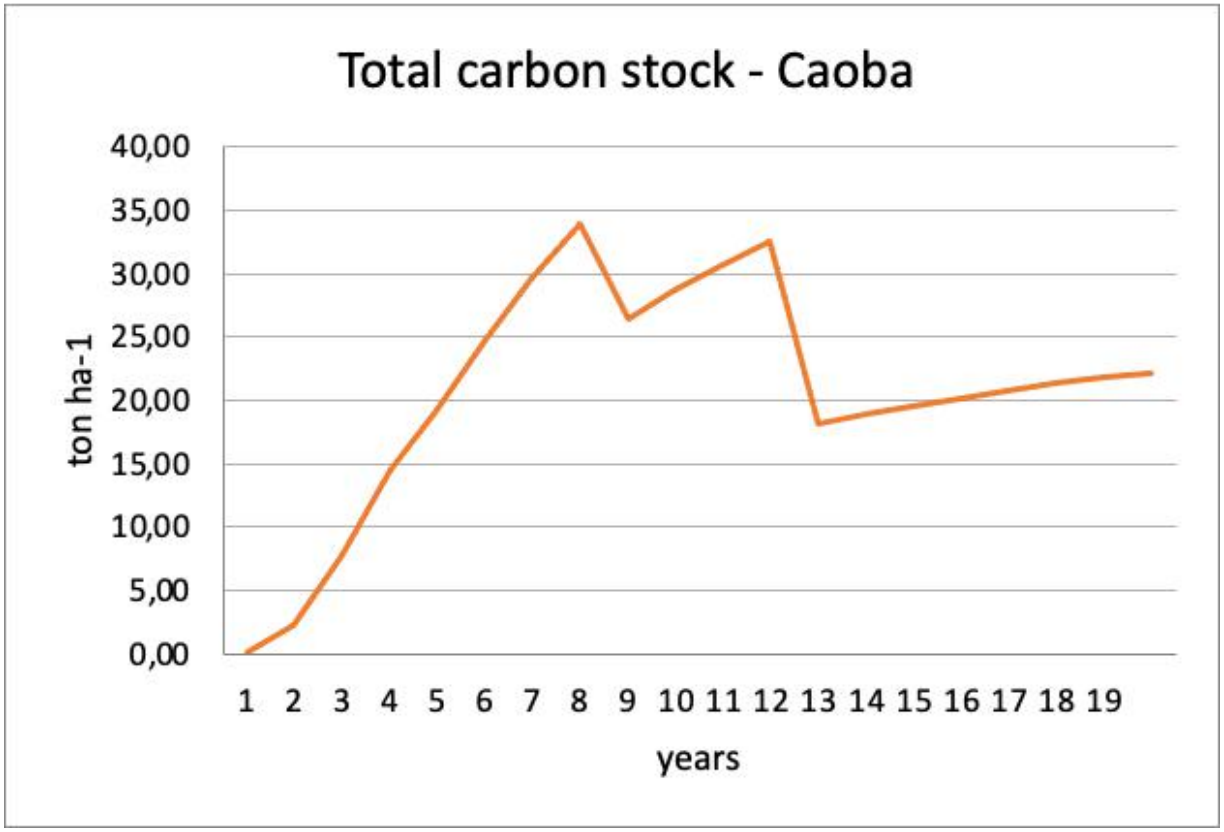


Figure A7.24: Carbon stock (ton C ha-1) by Caoba trees with management

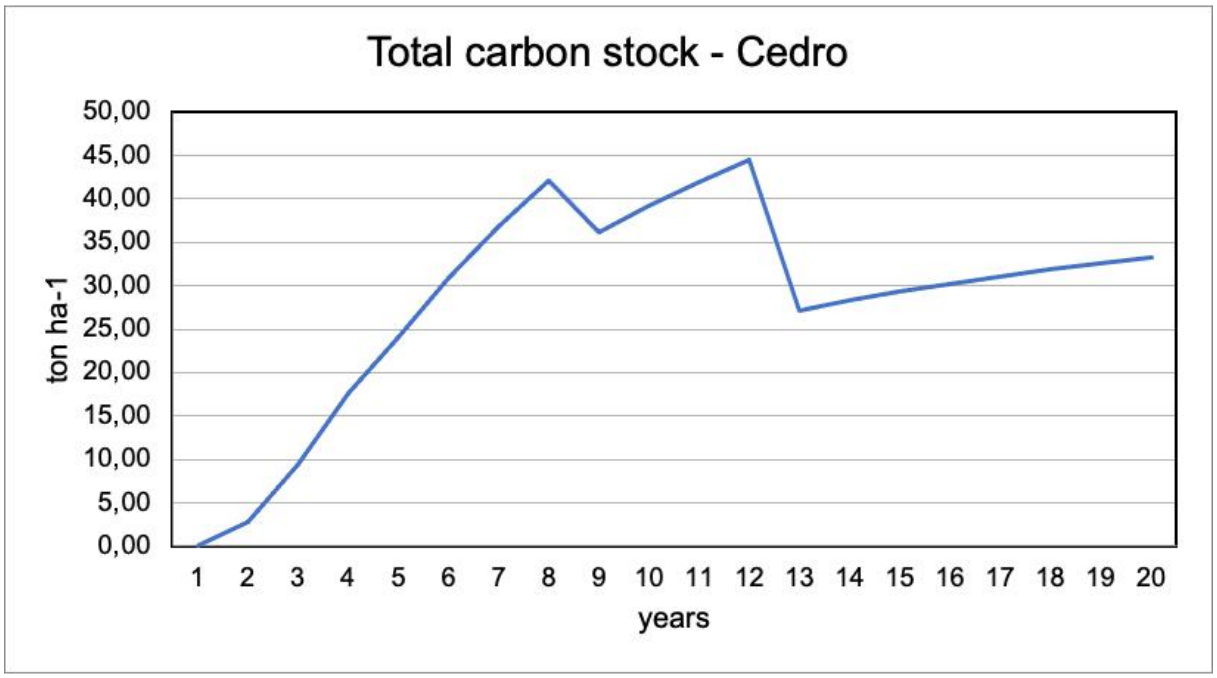


Figure A7.25: Carbon stock (ton C ha-1) by Cedro trees with management

Table A7.21: Estimated tree growth - Carbon modelling (Caoba)

Mahogany - *Swietenia macrophylla*										
Project yeaR (t)	Number of trees (n°)	Indice de sitio (site index)	DBH (cm)	height (h)	Wood density ρ	AGB (kg tree-1)	AGB Mg ha-1	BGB Mg ha-1	Net C Mg ha-1	Total CO2 ha-1
			cm	m		kg C tree -1	Mg C ha-1	Mg C ha-1	C Mg ha-1	
1	1111	14.49	1.11	1.67	0.50	0.07	0.08	0.05	0.06	0.22
2	1000	14.49	4.43	5.55	0.50	3.34	3.34	1.43	2.24	8.21
3	1000	14.49	7.01	8.28	0.50	12.05	12.05	4.48	7.77	28.49
4	1000	14.49	8.81	10.11	0.50	22.90	22.90	7.94	14.49	53.14
5	900	14.49	10.19	11.40	0.50	34.16	30.75	10.31	19.30	70.76*
6	900	14.49	11.17	12.35	0.50	44.17	39.75	12.96	24.78	90.85*
7	900	14.49	11.92	13.07	0.50	53.06	47.76	15.26	29.62	108.61
8	900	14.49	12.52	13.65	0.50	60.89	54.80	17.25	33.87	124.18
9	600	14.49	13.30	14.11	0.50	70.81	42.49	13.76	26.43	96.93
10	600	14.49	13.72	14.49	0.50	77.14	46.29	14.84	28.73	105.35
11	600	14.49	14.06	14.81	0.50	82.74	49.65	15.80	30.76	112.78
12	600	14.49	14.36	15.08	0.50	87.72	52.63	16.64	32.56	119.38
13	300	14.49	14.95	15.31	0.50	96.30	28.89	9.76	18.16	66.60
14	300	14.49	15.17	15.52	0.50	100.46	30.14	10.13	18.93	69.40
15	300	14.49	15.37	15.70	0.50	104.22	31.26	10.47	19.61	71.92
16	300	14.49	15.55	15.85	0.50	107.62	32.28	10.77	20.24	74.20
17	300	14.49	15.71	15.99	0.50	110.71	33.21	11.05	20.80	76.28
18	300	14.49	15.85	16.12	0.50	113.53	34.06	11.30	21.32	78.17
19	300	14.49	15,98	16.23	0.50	116.12	34.84	11.53	21.79	79.90
20	300	14.49	16.10	16.34	0.50	118.50	35.55	11.74	22.22	81.49
Long term average (t CO2 eq)										**75.84**

*Long term average reached

Table A7.22: Estimated tree growth - Carbon modelling (Cedar)

Cedar - *Cedrela odorata*										
Project year (t)	Number of trees (n°)	Indice de sitio (site index)	DBH (cm)	height (h)	Wood density ρ	AGB (kg tree-1)	AGB Mg ha-1	BGB Mg ha-1	Net C Mg ha-1	CUM CO2 ha-1 (Chave)
			cm	m		kg C tree -1	Mg C ha-1	Mg C ha-1	Mg C ha-1	
1	1111	14.23	1.21	2.09	0.53	0.11	0.12	0.07	0.09	0.33
2	1000	14.23	5.22	6.07	0.53	5.27	5.27	2.15	3.48	12.78
3	1000	14.23	8.42	8.66	0.53	18.93	18.93	6.70	12.04	44.16

4	1000	14.23	10.69	10.34	0.53	35.87	35.87	11.83	22.42	82.20
5	900	14.23	12.64	11.50	0.53	55.15	49.63	15.80	30.75	112.75*
6	900	14.23	13.90	12.35	0.53	71.22	64.09	19.83	39.45	144.63*
7	900	14.23	14.89	12.99	0.53	85.49	76.94	23.33	47.13	172.81
8	900	14.23	15.67	13.49	0.53	98.04	88.24	26.36	53.86	197.49
9	600	14.23	17.51	13.90	0.53	125.38	75.23	22.87	46.11	169.06
10	600	14.23	18.08	14.23	0.53	136.53	81.92	24.67	50.10	183.70
11	600	14.23	18.55	14.51	0.53	146.40	87.84	26.25	53.62	196.62
12	600	14.23	18.96	14.74	0.53	155.16	93.10	27.65	56.75	208.08
13	300	14.23	20.74	14.95	0.53	187.35	56.21	17.64	34.71	127.27
14	300	14.23	21.07	15.12	0.53	195.42	58.63	18.32	36.16	132.60
15	300	14.23	21.36	15.28	0.53	202.69	60.81	18.92	37.47	137.41
16	300	14.23	21.62	15.41	0.53	209.28	62.78	19.47	38.66	141.75
17	300	14.23	21.85	15.53	0.53	215.26	64.58	19.97	39.74	145.70
18	300	14.23	22.05	15.64	0.53	220.73	66.22	20.42	40.72	149.30
19	300	14.23	22.24	15.74	0.53	225.74	67.72	20.83	41.62	152.60
20	300	14.23	22.41	15.83	0.53	230.34	69.10	21.21	42.45	155.63
Long term average (t CO2 eq)										**133.34**

*Lont term average (LTA) reached

The project will validate the models by measuring the trees at various ages and comparing them with the site index, to verify that the carbon sequestered matches the predictions. In comparison to the field measurements that were taken at 21 months, our estimates are conservative.

Estimation of carbon stocks in tree with Long term management of 50 years

At this stage of the project we have considered and applied for carbon calculation a Rotation Forestry management cycle of 20 years. This was applied to maintain an initial conservative approach as, at this stage, it is difficult to determine which communities will adopt a natural revegetation of their plots with additional species to Cedar and Caoba.

zeroCO2 target is to achieve an alternative management system, which is modelled in figure 22. The operational team of zeroCO2 and Vivero Mundo Verde will promote in participants an approach that includes a gradual transition to a sustainable forest management system from year 20, using the support of carbon payments. From year 20 onwards, the remaining commercial trees will be gradually thinned out, at which point the spontaneous and assisted natural regeneration will be initiated after the Cedar and Caoba have taken root. This process will ensure the establishment of natural vegetation in the project sites.

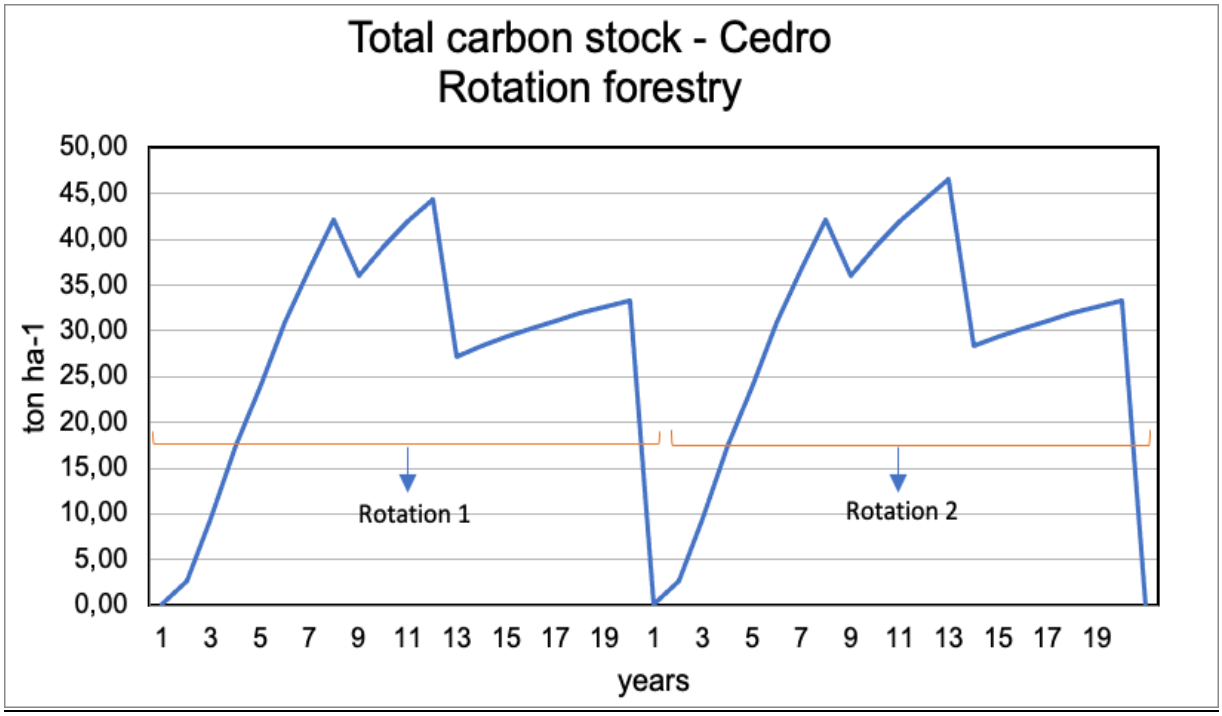


Figure A7.26: Scenario 1, Applied by the project. Rotation forestry

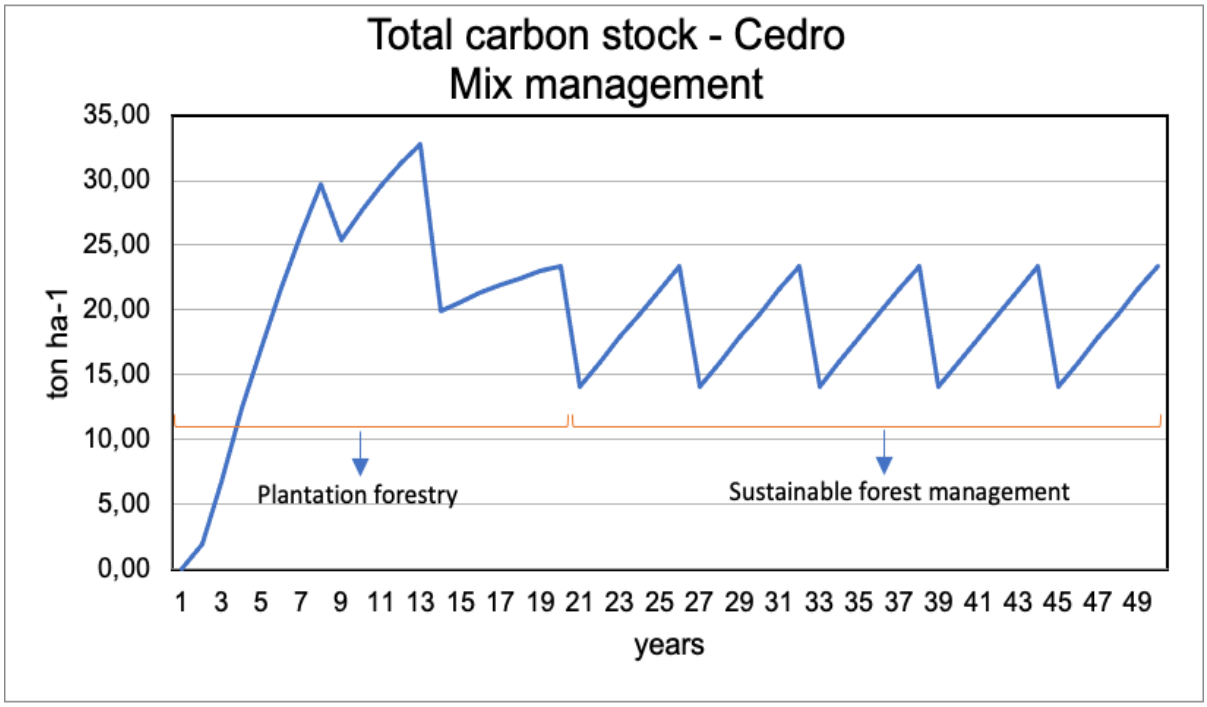


Figure A7.27: Alternative Scenario; zeroCO2 target. zeroCO2 will encourage communities to ensure that no clear-cutting takes place in year 20 and to facilitate natural regeneration from this year, to allow a gradual transition to a sustainable forest management system.

Other carbon pools

Estimation of carbon stocks in litter

As reported in Planvivo methodologies, PU001 "Estimation of baseline and project GHG removals by carbon pools in Plan Vivo projects" project removals in litter has to be reported following this equation:

(Equation 19)

$$PR_{LI,,a,y} = \sum_{t=1}^{y} \Delta C_{LI\_PROJ,t}$$

Where:

$PR_{LI,,a,y}$ Net GHG removals in deadwood under the project scenario for project area a up to year y (t CO2e)

$\Delta C_{LI\_PROJ,t}$ Change in carbon stock in deadwood under the project scenario within the project area in year t (t CO2e; from AR-TOOL12 v3.1)

Carbon in litter is calculated using equations 15 of the tool "A/R Tool 12 of the AR-ACM0003 methodology, which accepts the use of a conservative default value by estimating the carbon content (in dead wood and litter) as a percentage of the total carbon of the tree biomass.

$$C_{LI,i,t} = C_{TREE,i,t} \; x \; DF_{LI}$$

(Equation 20)

Where:

$C_{LI,i,t}$ Carbon stock in litter in stratum i at a given point of time in year t; tCO2e.

$C_{TREE,i,t}$ Carbon stock in tree biomass in stratum i at a point of time in year t; tCO2e.

DF_{LI} Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass; tCO2e

For ex ante and ex post estimations in the first project activity instance, the conservative value for tropical biome, elevation below 2000 m and precipitation between 1000-1600 mm yr-1 has been selected from the table 6 of section 8 of the tool, resulting in a value of 1%.

Estimation of carbon stocks in dead wood

Carbon in dead wood is calculated using equations 9 of A/R Tool 12 as reported in Planvivo methodologies, PU001 "Estimation of baseline and project GHG removals by carbon pools in Plan Vivo projects" :

$$PR_{DW,a,y} = \sum_{t=1}^{y} \Delta C_{DW\_PROJ,t}$$

(Equation 21)

Where:

$PRDW,a,y$ Net GHG removals in deadwood under the project scenario for project area a up to year y (t CO2e)

$\Delta CDW\_PROJ,t$ Change in carbon stock in deadwood under the project scenario within the project area in year t (t CO2e; from AR-TOOL12 v3.1)

$$C_{DW,i,t} = C_{TREE,i,t}\ x\ DF_{DW}$$

(Equation 22)

Where:

$\boldsymbol{CDW,i,t}$: Carbon stock in dead wood in stratum i at a given point of time in year t; tCO2e.

$\boldsymbol{CTREE,i,t}$: Carbon stock in tree biomass in stratum i at a point of time in year t; tCO2e.

$\boldsymbol{DFDW}$: Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass; tCO2e.

For ex ante and ex post estimations in the first project activity instance, the conservative value for tropical biome, elevation below 2000 m and precipitation over between 1000-1600 mm yr-1 has been selected from the table 5 of section 8 of the tool, resulting in a value of 1%. [38]

Estimation of carbon stocks in SOC

Changes in carbon stocks in the SOC pool is calculated as indicated in the A/R tool 16 "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (Version 01.1.0) as suggested by Module "Estimation of baseline and project GHG removals by carbon pools in Plan Vivo projects" - PU001 of developed by TLLG & Plan Vivo TAC.

$$PR_{SO,a,y} = \sum_{t=1}^{y} \Delta SOC_{AL,t}$$

(Equation 23)

The change in SOC stock for all the strata of the areas of land, in year t, is calculated applying equation 8:

$$\Delta SOC_{AL,t} = \frac{44}{12} \times \sum_{t=1}^{t} A_i \times dSOC_{t,i} \times 1year$$

[38] http://www.insivumeh.gob.gt/hidrologia/ATLAS_HIDROMETEOROLOGICO/Atlas_Hidrologico/isoyetas.jpg

(Equation 24)

Where:

$\Delta SOC_{AL,t}$= Change in SOC stock in areas of land meeting the applicability conditions of this tool, in year t; t CO2-e.

A_i = The area of stratum i of the areas of land; ha.

$dSOC_{t,i}$ = The rate of change in SOC stocks in stratum i of the areas of land; t C ha-1 yr-1.

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20\ years} \quad for\ t_{PREP,i} < t \leq t_{PREP,i} + 20$$

(Equation 25)

Where:

$dSOCt,i$ = The rate of change in SOC stock in stratum i of the areas of land, in year t; t C ha-1 yr-1.

$tPREP,i$ = The year in which first soil disturbance takes place in stratum i of the areas of land.

$SOCLOSS,i$ =Loss of SOC caused by soil disturbance attributable the A/R CDM project activity, in stratum i of the areas of land; t C ha-1.

$SOCREF,i$ = Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation . normally forest) by climate region and soil type applicable to stratum i of the areas of land; t C ha-1.

SOCINITIAL,i = SOC stock at the beginning of the A/R CDM project activity in stratum i of the areas of land; t C ha-1.

Following equation 3 of the tool $SOCLOSS,i$ = 0 in all baseline strata. The area disturbed in the baseline is less than 10% of the stratum area. This is because soil preparation is made by manual hole digging in less than 10% of the plantation area.

$$SOCINITIAL,i = SOCREF,i \times fLU,i \times fMG,i \times fIN,i$$

(Equation 26)

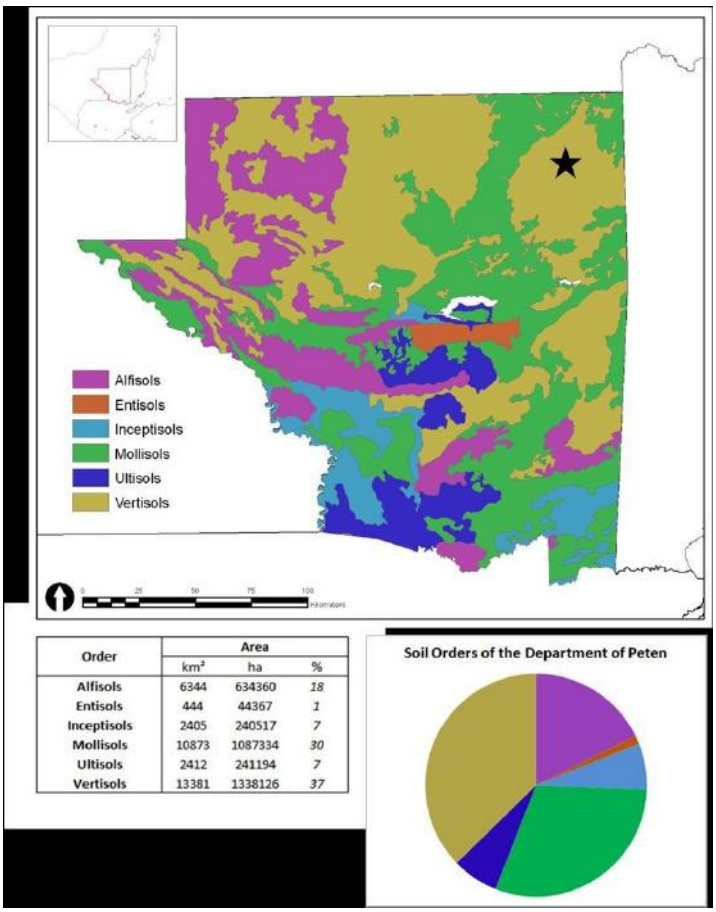
Where:

$f_{LU,i}$ = Relative stock change factor for baseline land-use in stratum i of the areas of land; dimensionless.

$f_{MG,i}$ = Relative stock change factor for baseline management regime in stratum i of the areas of land; dimensionless.

$f_{IN,i}$ = Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in stratum i of the areas of land; dimensionless.

For ex ante estimations SOCREF and stock change factors (fLU, fMG and fIN) have been obtained from tables 3, 4, 5 and 6 of the tool.



Order	Area		
	km²	ha	%
Alfisols	6344	634360	18
Entisols	444	44367	1
Inceptisols	2405	240517	7
Mollisols	10873	1087334	30
Ultisols	2412	241194	7
Vertisols	13381	1338126	37

Figure A7.28: Map of soil orders of the Department of Petén. Source[39]: Griffin, R.E. (2012)

- $SOCREF$: 65.
  Value from table 3 for tropical moist climate region (tropical monsoon group Am Koppen climate classification) of and HAC soils (Soils with high activity clay) based

[39] Griffin, R. E. (2012). The carrying capacity of Ancient Maya swidden maize cultivation: A case study in the region around San Bartolo, Petén, Guatemala.

on map of soil orders of the Department of Petén. Map based on the data of Guatemala's Ministerio de Agricultura, Ganaderia, y Alimentacion (MAGA).

- f_{LU} :
  - Cropland: 0.57. Value calculated based on values of table 4. 60,4 % of baseline land use
  - Grassland: 1. Value from table 6, unique value.39,6 %of baseline land use

At this stage we consider everything to be grassland in order to take an approach that is as conservative as possible.

- fMG,i :
  - Grassland 0.97. Value from table 6,Overgrazed or moderately degraded grassland, with somewhat reduced productivity (relative to the native or nominally managed grassland) and receiving no management inputs 39,6 %
  - Cropland 1.08 Value from table 4. Primary and/or secondary tillage but with reduced soil disturbance (usually shallow and without full soil inversion). Normally leaves surface with >30% coverage by residues at planting 60,4%
- $f_{IN,i}$
  - Cropland: 0.92. Value from table 5, low nutrient input in tropical moist/wet climate region
  - Grassland: 1. Value from table 6, low nutrient input in tropical moist/wet climate region

Value based on the stratification below:

Table A7.23: Area and percentage per stratum.

Baseline scenario	*Stratum*	*Area (ha)*	*%*
Pastureland	I	297.03	55.5
Cropland	II	140.97	44.5
Total		**438.00**	**100**

The baseline scenario is based on the Guatemalan team's knowledge of the territory and numerous field visits that were conducted over time. This will be monitored and updated as differences emerge following the definition of polygons for the project area.

At this stage, therefore, an ex ante and ex post conservative value was used based on the A/R Methodological Tool 'Tool for estimating the change in soil organic carbon stocks due to the implementation of CDM A/R project activities' and the first stratification.
The final conservative value is Δ**C= 0.51 t C ha^{-1} year^{-1}** and $t_{equilibrium}$ = 20 years is used.

Harvested Wood products

As evidenced in INAB's technical specifications for Cedro [40] and Caoba[41] , which provide a detailed analysis of the characteristics, management and uses of each species, it is proven that the main use for both species is commercial timber used for furniture, building and cabinetry. Both species are highly valued species in the international market commonly known under the trade names "Spanish Cedar" for Cedro and "Honduran Mahogany" for Caoba.

In order to ensure a long-term permanence of the carbon storage, zeroCO2 is working to establish fixed contracts between communities and small local lumber mills to secure the allocation of wood to furniture and housing construction. This will guarantee that carbon is stored in the long run, ensuring carbon permanence and economic benefits for communities.

In this initial project phase, we have included the value for harvested wood products using the following approach:

For the estimation of carbon stock in the long lived wood products the VCS module VMD0026 [42]adapted from Wijnum 1998 [43] was used , as suggested in the Specific Plan Vivo modules and tools of Agriculture and Forestry Carbon Benefit Assessment Methodology TLLG & Plan Vivo TAC methodologies (PU001 - Estimation of baseline and project GHG removals by carbon pools in Plan Vivo projects).

Below we have reported the main steps to assess this carbon pool according to the methodologies:

Step 1: Calculate the biomass carbon of the volume extracted by wood product type over a given period *p* from within the project area

$$C_{XB,ty,p} = \sum_{j}^{S} (V_{ex,ty,j,p} * D_j * CF_j)$$

(Equation 27)

Where:

$C_{XB,ty,p}$ = Total carbon stock of extracted biomass from within the project area by class of wood product ty over a given time period p; t C

[40] Instituto Nacional de Bosques. 2019. Paquete Tecnológico Forestal para Cedro Cedrela odorata L. Guatemala, Departamento de Investigación Forestal. 87p. (Serie técnica DT-029-2019)

[41] Instituto Nacional de Bosques. 2019. Paquete Tecnológico Forestal para Caoba de Petén Swietenia macrophylla King versión 1.0. Guatemala, Departamento de Investigación Forestal. 85 p. (Serie técnica DT-026-2019).

[42] VCS MODULE VMD0026; ESTIMATION OF CARBON STOCKS IN THE LONG LIVED WOOD PRODUCTS POOL; version 1.0; 16 November 2012

[43] Winjum, J.K., Brown, S. and Schlamadinger, B., 1998. Forest harvests and wood products: sources and sinks of atmospheric carbon dioxide. Forest Science, 44(2), pp.272-284.https://doi.org/10.1093/forestscience/44.2.272

$V_{ex,ty,j,p}$ = Volume of timber extracted from within the project area (does not include slash left onsite) by species j and wood product class ty over a given time period p; m3

Dj = Wood density (specific gravity) of species j; t d.m.m-3

CFj = Carbon fraction of biomass for tree species j; t C t-1 d.m.

j = 1, 2, 3 … S tree species

ty = Wood product class – defined here as sawnwood, wood-based panels, other industrial round wood, paper and paper board, and other

Step 2: Calculate the proportion of biomass carbon extracted during the time period p that remains sequestered in long-term wood products after a number of years *y* since the wood products were initially created. All factors are derived from Winjum et al.1998.

$$Cwp_y = \sum_{ty}^{z}\left(\left(\left(C_{XB,ty,p} - WW_{ty}\right) - SLF_{ty}\right) - OF_{ty,y}\right)$$

(Equation 28)

Where:

Cwpy = Carbon stock sequestered in wood products created over a given period p, that remain sequestered after a number of years y since the wood products were created; t C

CXB,ty,p = Total carbon stock of extracted biomass from within the project area by class of wood product ty over a given period p, t C

WWty(*) = Wood waste fraction of wood products ty immediately emitted through mill inefficiency; t C*

SLFty(**) = Short-lived fraction of wood products of type ty that will be emitted to the atmosphere within 3 years of timber harvest; t C **

OFty,y(***) = Oxidized fraction of wood products of type ty whose carbon will be emitted between 3 and 100 years after creation of the harvested wood product, remaining at year y after the wood products were created; t C

ty = Wood product class (defined here as sawnwood, wood-based panels, other industrial round wood, paper and paper board, and other)

z = number of wood products classes ty

y = 1,2,3… y years elapsed since the wood products were created.

**Wood waste fraction (WW)*

Winjum et al 1998 indicate that the proportion of extracted biomass that is oxidized (burning or decaying) from the production of commodities to be equal to 19% for developed countries, 24% for developing countries. WW is therefore equal to $C_{XB,ty,p}$ multiplied by 0.19 for developed countries and 0.24 for developing countries.

**Short-lived fraction (SLF)*: Fraction of wood products that are oxidized within 3 years after creation, assumed to be 3/5 of the wood products that would have been oxidized within 5 years of creation, as per the estimates of the short lived proportion (slp) given in Winjum et al 1998 (applicable internationally):

Estimate the short-lived fraction using the following short lived proportion (slp) factors by wood product class:

a. Sawnwood = 0.12
b. Woodbase panels = 0.06
c. Other industrial round wood = 0.18
d. Paper and Paperboard = 0.24

Therefore Short lived Fraction will be equal to:

$$SLF_{ty} = (C_{XB,ty,p} - WW_{ty}) \cdot slp$$

(Equation 29)

Where:

SLFty = Short-lived fraction of wood products that will be emitted to the atmosphere within 3 years of timber harvest from wood product ty; t C

CXB,ty,p = Total carbon stock of extracted biomass from within the project area by class of wood product ty over a given period p; t C

WWty = Wood waste - fraction of extracted biomass carbon immediately emitted through mill inefficiency from wood product ty; t C

slp = Short-lived proportion: Using the factors for the product classes.

ty = Wood product class (defined here as sawnwood, wood-based panels, other industrial round wood and paper and paperboard)

****Additional oxidized fraction (OF):*

Winjum et al 1998 gives annual oxidation fractions for each class of wood products split by forest region (boreal, temperate and tropical). This methodology projects these fractions over 97 years to give the additional proportion that is oxidized between 3 and 100 years after initial harvest (Table 1) of the tool.

OF is therefore equat to:

$$OF_{ty,y} = ((C_{XB,ty} - WW_{ty}) - SLF_{ty}) \cdot (fo \cdot (m/20))$$

(Equation 30)

Where:

OFty,y = Oxidized fraction of wood products of type ty created during period p whose carbon will be emitted between 3 and 100 years after creation of the harvested wood product, remaining at year y after the wood products were created; t C

CXB,ty.p = Total carbon stock of extracted biomass from within the project area by class of wood product ty over a given period p; t C

WWty = Wood waste fraction of wood products ty immediately emitted through mill inefficiency; t C

SLFty = Fraction of wood products of type ty that will be emitted to the atmosphere within 3 years of timber harvest; t C

fo = Fraction oxidized – see Table 1 for defaults; t C t C-1

ty = Wood product class (defined here as sawnwood, wood-based panels, other industrial round wood, paper and paper board, and other)

y = the number of years since the wood products were created.

m = the number of years since the wood products were created, y, where for all y >20, m=20

Step 3: Calculate the total HWP remaining t years after the project start date, consisting of the HWP remaining out of the products created during each period p since project commencement (t=0), using the following equation.

$$Cwp_t = \sum_p Cwp_y$$

(Equation 31)

Where:

Cwpt = The total carbon contained in harvested wood products at time t, tC

Cwpy = Carbon stock sequestered in wood products created over a given period p, that remain sequestered after a number of years y ; t C

y = The number of years since the wood products in the given period p were created

Parameter used for calculation

Table A7.24: Parameters for calculation of Harvested wood products carbon benefits.

Parameter		Value	Relative abundance	Value based on
Short lived fraction	Sawn wood	0.12	50%	(36); (37) ; (38)
	Other industrial wood	0.18	50%	

Parameter	Value	Justification
Oxide fraction	0.86	Fixed value from Winjum et al. 1998 and VCS module VMD0026
Wood waste fraction	0.24	Fixed value from Winjum et al. 1998 and VCS module VMD0026
Fuel wood excluded from calculation	20 %	Conservative assumption. Communities do not use high value species such as Cedar and Caoba as fuel wood. They use these high-value species to ensure sustainable and profitable land use. Assumption based on field evidence and literature (1) (2) (3). Firewood production is less than 10 % in the report (3) for high-value species such as Cedar and Caoba.

The INAB computer system with the list of forest species shows that Cedar and Caoba are species of high commercial value that are mainly used for: construction Timber, Ornamental Timber, House Timber, (1) Furniture, Commercial Timber. [44]

Also from report[45]: "EXPORTACIÓN DE PRODUCTOS FORESTALES" (available at https://www.inab.gob.gt/images/boletines/industria/Boletin%20exportaciones%20123.pdf);

[44] https://consultaespecies.inab.gob.gt/

[45] EXPORTACIÓN DE PRODUCTOS FORESTALES (available at https://www.inab.gob.gt/images/boletines/industria/Boletin%20exportaciones%20123.pdf) of INAB

2021 of INAB it emerges that the use of both species in Guatemala is exclusively for timber uses where carbon is permanently stored.

While the “Boletin informativo sobre comercio forestal; Oferta y demanda de la industria forestal "Región VIII Petén";Departamento de Comercio Forestal -INAB- Diciembre 2021 [46]shows the differentiation of the different uses of the commercial species in the region of Petén .

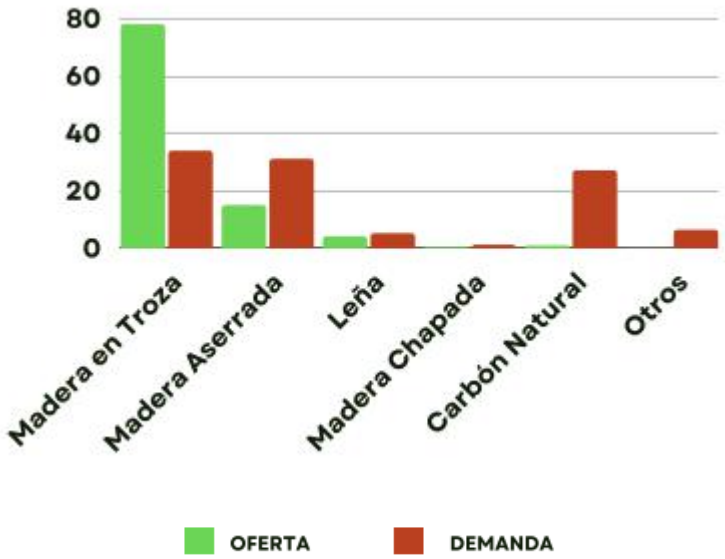


Figure A7.29: Wood products marketed in the Petèn region in 2020 (%) Source: SISTEMA DE INFORMACIÓN FORESTAL DE GUATEMALA - REGISTRO NACIONAL FORESTAL reported in source (3)

Timber utilisation and allocation parameters will be monitored and confirmed during project activities.

In addition to this, the beneficiary's responsibility was included in the project agreements to undertake to sell at least 80 per cent of the biomass collected during the 20-year rotation to the furniture and construction industry in order to guarantee the stability of the storage and to comply with the assumptions defined in the project design.

Assisted Natural Regeneration

In order to begin understanding the development, species diversity and CO_2 capture potential of ANR in the project area, three inventories were conducted in Petén in three different plots outside of zeroCARBON. The data collected from the inventories shows a great number of species and structural diversity, which can be reached through natural regeneration in a short period of 5 to 10 years. The total number of species identified was a total of 68 species, which is an average of 33 species per sampled plot, considering the 3 inventories. Several species were recorded in all 3 inventories, which indicates that they are recurrent species in the project area, thus they have a solid chance of establishing in the zeroCARBON plantations

[46] Boletin informativo sobre comercio forestal; Oferta y demanda de la industria forestal "Región VIII Petén";Departamento de Comercio Forestal Diciembre 2021. Available at https://www.sifgua.org.gt/Noticia/Boletin_Peten_2021.aspx

through natural regeneration. A detailed explanation of the results from the inventories can be found in Annex 18 in the ANR proposal.

Using dendrometric data collected from these inventories, and based on the initial management plan, a CO_2 model was developed to provide an initial estimation of potential carbon benefits derived from ANR. Three different CO_2 scenarios were modelled, using an average of CO_2 absorption per tree that was calculated from the inventory species that had available data. The medium scenario would bring a cumulative value of 27.8 t CO_2/ha in 20 years, which would amount to approximately 12% of total carbon benefits from the zeroCARBON program. A detailed explanation of the ANR carbon assessment can be found in Annex 18. The relevant carbon calculations included in the carbon model (Annex 6). Carbon quantities from ANR were conservatively excluded from fPVCs pending monitoring of management application rates.

Over the course of the project, the carbon model will be improved using monitoring data from zeroCARBON plots. Overall, integrating ANR within project interventions and in the participant agreements will bring significant added value to the program. Besides the biodiversity benefits and valuable species, ANR carbon benefits will provide medium- and long-term economic incentives for participants to promote ANR within their forestry plantations, which will add to the project's permanence and continuity.

Table A7.25: Resume of value used for additional carbon pool

Parameter	Value	Source
DF_{DW}	1 %	Tropical sites with elevation values less than 2,000 meters above sea level and rainfall between 1000 and 1,600 mm/year due to the annual rainfall of 1,730 mm 118 (according to the historical average of 2010-2019), and the average elevation of 101 meters above sea level.[47]
DF_{LI}	1 %	
ΔSOC	0,51 ton C ha^{-1} $year^{-1}$	Value based on

[47] T. Tadono, H. Ishida, F. Oda, S. Naito, K. Minakawa, H. Iwamoto : Precise Global DEM Generation By ALOS PRISM, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.II-4, pp.71-76, 2014.

Wood products	Calculation on excel spreadsheet	Parameters based on Winjum 1998 and VCS module VM0026
Assisted natural regeneration (ANR)	27.8 t CO_2/ha in 20 years	Excluded conservatively at this stage from the calculation of carbon benefits

Potential Leakage

Provide full details of potential leakage estimation, following an approved methodology. Include details of all assumptions and data sources and demonstrate that these meet the requirements of the approved methodology. Include a spreadsheet with all calculations.

The following methodologies were used for this section:

- Plan Vivo Agriculture and Forestry Carbon Benefit Assessment Methodologies PU004 which in turn refers to the following methodologies
- AR-TOOL15 Estimation of the increase in GHG emissions attributable to displacement of preproject agricultural activities in A/R CDM project activity, 2 Version 2.0

According to the “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity” tool, leakage emission attributable to the displacement of agricultural activities due to implementation of an A/R CDM project activity is estimated as the decrease in carbon stocks in the affected carbon pools of the land receiving the displaced activity.

Leakage emission attributable to the displacement of grazing activities under the following conditions is considered insignificant and hence accounted as zero:

a. Animals are displaced to existing grazing land and the total number of animals in the receiving grazing land (displaced and existing) does not exceed the carrying capacity of the grazing land;

b. Animals are displaced to existing non-grazing grassland and the total number of animals displaced does not exceed the carrying capacity of the receiving grassland;

c. Animals are displaced to cropland that has been abandoned within the last five years;

d. Animals are displaced to forested lands, and no clearance of trees, or decrease in crown cover of trees and shrubs, occurs due to the displaced animals;0

e. Animals are displaced to a zero-grazing system.

As per point a., for our project, animals are moved to existing pastures and the total number of animals in the receiving pasture (moved and existing) does not exceed the carrying capacity of the pasture;

With regard to cultivated land, the project interventions are additional to existing agricultural systems rather than agricultural activities.

In areas where there is cropland, there is also the possibility of using agroforestry or silvopastoral systems to avoid having to shift cultivation.

No leakage is expected in the first project activity instance. Displacement of pre-project agricultural activities is not expected and if it occurs it will be to lands with SOC and biomass stocks equal or lower to the ones in original agriculture lands. Therefore, leakage in the first instance will be set equal to zero (LK,t =0).

In future project activity instances, if displacement of agricultural activities does occur, then leakage will be calculated using AR-TOOL.

Risk of leakage in-depth analysis

The participants or beneficiaries of the zeroCARBON project allocated the areas of the farms according to their use and the potential of the area while ensuring the economic viability of their properties.

A basic requirement is that the individual participants have title or ownership rights to the land.

In all cases, communities are divided into agricultural areas, livestock areas and forest areas (unmanaged or managed forests).

As a measure to mitigate the risk of leakage from the zeroCARBON project, the entry of participants with very small areas of land of less than one hectare is restricted, while entry is considered possible for people with two hectares or more of land, depending on the current use and productive capacity of the land.

The land use scenarios in the communities in the baseline scenario are as follows:

1. 100% agricultural

2. 100% livestock

3. Agricultural 50% livestock 50%

4. Agriculture, livestock and forest (unmanaged or poorly managed forest)

a. For the owners of two hectares, 50% of the land is part of the zeroCarbon project and 50% is left to its previous use.

This allows the person to continue the productive activity they were engaged in before the project.

b. For entities with areas greater than two hectares, the four criteria described above shall be considered, taking into account the percentage occupied by each land use on the farm or property,

with the aim of enabling the beneficiaries to continue to carry out the production activities they were engaged in prior to the zeroCarbon project.

In other words, they choose which percentage of the area of the farm occupied by agriculture or livestock farming will be part of the project ensuring that there is no alteration of the economic and/or family subsistence of their property

c. In the event that the beneficiary's land is not agriculturally productive, it can be included in the zeroCarbon project. If the area is agriculturally productive, it will be determined what percentage of the area to allocate to the project based on the history of the area and the beneficiary's observations on the condition of the area (relief, stoniness, drainage, etc.) made during the visit by the Zeroco2 technical team.

Geographically, leakage is very hard to conceptualise, especially for smaller projects.
In our case, we work with communities that have land ownership. We'll monitor in the field that deforestation does not occur in non-owned areas through recurring satellite analysis and constant training and updates in the field.

In the chapter 4.1 Progress indicator, we have incorporated a parameter for monitoring deforestation in the area based on remote sensing data and data truth based on field visits.
A numerical ratio between annual deforestation rates before and after the project start date in the project surroundings and the specific drivers may be the only method to have a reference on potential geographical losses (however, this figure is subject to a rate of uncertainty).

Uncertainty

Provide full details of uncertainty assessment, following an approved methodology. Include details of all assumptions and data sources and demonstrate that these meet the requirements of the approved methodology. Include a spreadsheet with all calculations.

For carbon pools assessed in this technique specification, the percentage uncertainty with a 90% confidence interval will be calculated, following the first monitoring, following the PU005 methodology, version 0.1, developed by PlanVivo and TLLG, as follows:

Calculation of uncertainty for the project intervention

$$Ux = z \cdot \frac{SD}{\sqrt{n}} \cdot \frac{1}{CDx}$$

Uncertainty Adjustment

$$UD_T = 0.25 \cdot \frac{\sqrt{\sum_v [(CB_{v,t2} - CB_{v,t1}) \cdot U_{v,T}]^2}}{(CB_{t2} - CB_{t1})} - 0.5$$

However, AR-Tool14 states in §8.2: "*Ex-ante estimation (projection) of carbon stock in tree biomass is not subjected to uncertainty control, although the project participants should use the best available data and models that apply to the project site and the tree species*". It is therefore not necessary to control for uncertainty estimations as described in PU005.

The main sources of uncertainty in our climate benefit estimates are natural project variability and model parameter assumptions. In the context of the methodologies used, the main sources of uncertainty relating to changes in the carbon stock in the living biomass pool include: natural factors such as fire and pest outbreaks; stand variables such as variation in yield tables, the allometric equation, biomass expansion factor (BEF) (if used), wood density and carbon fraction.

A conservative approach has always been adopted in the choice of parameters.

In addition to these existing measures of uncertainty, in the future zeroco2 will continue to analyse and respond to uncertainty through the following measures:

- Growth and model assumptions will be updated at the time of field verifications, based on actual growth and activities realised in the project.

- Following this analysis, the according adjustments will be made to the risk buffer; and to the available fPVCs, which in any case will be allocated in advance in the project agreements for a share of less than 90 % (maximum share allowed by the protocol).

- Respond to uncertainty through a clear process of deliberative and iterative adaptive management at project and plot levels, where project actors will continue to learn from experience and respond to variability as suggested in Williams & Brown, 2014 [48].

Expected Carbon Benefits

Provide full details of calculation of expected carbon benefits, following an approved methodology. Include details of all assumptions and data sources and demonstrate that these meet the requirements of the approved methodology. Include a spreadsheet with all calculations.

The net-increase in carbon stocks and/or reduction in greenhouse gas emissions relative to the carbon baseline as a result of project Interventions (or 'carbon benefit') is calculated with Equation 7 of Agriculture and Forestry Carbon Benefit Assessment Methodology developed by TLLG and Plan Vivo TAC

$$CB_{CPa,y} = PR_{a,y} - BR_{a,y} - LE_{CPa,y}$$

(Equation 32)

Where:

$CBCP,y$ Carbon benefit of the project from carbon pools up to year y (t CO2e; see Equation 8)

PRa,y Net GHG removals under the project scenario for project area a up to year y (t CO2e; see Equation 4)

[48] Williams, B.K. and Brown, E.D., 2014. Adaptive management: from more talk to real action. Environmental Management, 53(2), pp.465-479.

BRa,y Net GHG removals under the baseline scenario for project area a up to year y (t CO2e; see Equation 1)

$LECP,a,y$ Net GHG emissions due to carbon pool leakage from project area a up to year y (t CO2e; see Section 9)

Refer to Annex 6 and for specifics to calculation on the attached spreadsheet.

Table A7.26: Estimated GHG emission removals (tCO2e) in the crediting period

Year	Estimated GHG emission removals (tCO2e)
2020	19
2021	147
2022	782
2023	3,569
2024	11,405
2025	24,557
2026	38,572
2027	49,316
2028	54,292
2029	55,509
2030	58,640
2031	64,731
2032	65,864
2033	67,087
2034	71,292
2035	79,971
2036	80,820
2037	81,666
2038	82,510
2039	83,628

Year	Estimated GHG emission removals (tCO2e)
2040	84,864
2041	89,916
2042	100,354
TOTAL	100,354

Monitoring

For each indicator that will be used to monitor carbon benefits: i) describe how they will be assessed, with details of all measurements and calculations; and ii) demonstrate that the data sources and measurement approaches meet the requirements of the approved methodology.

Data/Parameter	*A*
Units	ha
Description	Project area (planted area)
Source of data	Project database. A complete GPS reconnaissance was requested from the operations team in order to obtain the most accurate polygons per participant for each project site.
Value	438
Frequency of monitoring/recording	At the beginning of the project and adjusted annually from GPS data from the field and remote sensing check
Monitoring equipment	GPS and remote sensing data.
Purpose of Data	Calculation of project carbon benefit
Comments	-

Data/Parameter	*Ai*
Units	Hectares (ha)
Description	Area of Stratum i
Source of data	Project database. A complete reconnaissance was requested from the operations team in order to obtain the most accurate polygons per participant for each project area.
Value	1. 2020, Forest Plantation 8.75 ha. 2. 2021, Forest Plantation 10.79 ha 3. 2022, Forest Plantation, 114.92 ha 4. 2022, Agroforestry 0 ha 5. 2023; Forest Plantation 305,54 ha
Frequency of monitoring/recording	
Monitoring equipment	GPS and remote sensing data.
Purpose of Data	Calculation of project emission removals
Comments	-

Data/Parameter	*DBH*
Units	cm
Description	*Diameter breast height*
Source of data	Measured in permanent sample plots by operational team

Value	Ex-post
Frequency of monitoring/recording	*At each verification*
Monitoring equipment	Measuring tape or caliper
Purpose of Data	Calculation of project carbon benefit
Comments	-

Data/Parameter	*H*
Units	Metres (m)
Description	*Total height of the trees*
Source of data	Measured in permanent sample plots by the operational team. Details on technical specifications
Value	Ex-post
Frequency of monitoring/recording	*At each verification*
Monitoring equipment	Measured in the field by an hypsometer or generated from models. When not measured, heights are generated from hypsometric curves or from studies and trends of other plantations.
Purpose of Data	Calculation of project carbon benefit
Comments	-

Data/Parameter	*Plot location*
Units	Latitude, longitude

Description	*Plot location coordinates*
Source of data	Operational team measurements
Value	Variable. Permanent sampling plots location will be updated and listed in Annex 13. Monitoring Plan
Frequency of monitoring/recording	Once in the lifetime of the project
Monitoring equipment	GPS device
Purpose of Data	Permanent sampling plots identification
Comments	-

Data/Parameter	*Disturbed area*
Units	Hectare (ha)
Description	*Areas affected by any form of disturbance (fire, pest, mortality etc.)*
Source of data	Field monitoring assessment
Value	Ex post
Frequency of monitoring/recording	At each verification
Monitoring equipment	Field verification, GPS locations. GIS monitoring
Purpose of Data	Calculation of project carbon benefit
Comments	-

Data/Parameter	*Wood products*
Units	Volume (m^3)
Description	-
Source of data	sales contracts and monitoring
Value	Ex post
Frequency of monitoring/recording	At each verification
Monitoring equipment	sales contracts
Purpose of Data	Calculation of project carbon benefit
Comments	-

Data and Parameters Available at Validation

Data/Parameter	*A*
Units	ha
Description	Project Area
Source	The value refers to the current management plan and agreements with communities. Monitoring of strata and stand boundaries is active, using Geographical Information Systems (GIS) to obtain GIS data in maps of all plots.
Value	438

Justification of choice of data or description of measurement methods and procedures applied	
Purpose of Data	Definition of Project boundaries
Comments	-

Data/Parameter	*Rj*
Units	dimensionless
Description	Root-shoot ratio for tree species j
Equations	Equations 15
Source	Mokany K, Raison RJ, Prokushkin AS (2006) Critical analysis of root : shoot ratios in a. terrestrial biomes. Global Change Biology 12: 84-96
Value	Rj= 0,489 x $AGB^{0,890}$
Justification of choice of data or description of measurement methods and procedures applied	See Annex 7 - Technical Specifications
Purpose of Data	Calculation of carbon stocks (below ground biomass)
Comments	-

Data/Parameter	B_{AG}
Units	t d.m.ha^{-1}
Description	Above ground biomass for tree species j

Equations	Equations 15
Source	Chave, J., Réjou-Méchain, M., Búrquez, A., Chidumayo, E., Colgan, M.S., Delitti, W.B., Duque, A., Eid, T., Fearnside, P.M., Goodman, R.C., Henry, M., Martínez-Yrízar, A., Mugasha, W.A., Muller-Landau, H.C., Mencuccini, M., Nelson, B.W., Ngomanda, A., Nogueira, E.M., Ortiz-Malavassi, E., Pélissier, R., Ploton, P., Ryan, C.M., Saldarriaga, J.G. and Vieilledent, G. (2014), Improved allometric models to estimate the aboveground biomass of tropical trees. Glob Change Biol, 20: 3177-3190. https://doi.org/10.1111/gcb.12629
Value	$B_{AG} = 0{,}0673 \cdot (\varrho \cdot DBH \cdot 2H)^{0{,}976}$
	See Annex 7 - Technical Specifications
Purpose of Data	Calculation of ex-ante and ex-post project removals
Comments	

Data/Parameter	ϱ

Units	Dimensionless
Description	Above ground biomass for tree species j
Equations	N/A
Source	(2) Malavassi, I.M.C. (1992). Maderas de Costa Rica: 150 Especies forestales, Editorial de la Universidad de Costa Rica. (3) Wiemann, M.C. and Williamson, G.B. (1989). Wood specific gravity gradients in tropical dry and montane rain forest trees. American Journal of Botany 76(6): 924-928; (4) Little, E.L., Jr., and F.H. Wadesworth. (1964). Common trees of Puerto Rico and the Virgin Islands, US Department of Agriculture, Agricultural Handbook 249, Superintendent of Documents, US Government Printing Office, Washington DC. (2); (3); (4) Retrieved from Global wood density database: Zanne et al. 2009
Value	0,53 Cedro ; 0,50 Caoba
Justification of choice of data or description of measurement methods and procedures applied	See Annex 7 - Technical Specifications

Purpose of Data	Calculation of ex-ante and ex-post project removals
Comments	-

Data/Parameter	*Rj*
Units	dimensionless
Description	Root-shoot ratio for tree species j
Equations	Equations 15
Source	Mokany K, Raison RJ, Prokushkin AS (2006) Critical analysis of root : shoot ratios in a. terrestrial biomes. Global Change Biology 12: 84-96
Value	$Rj=0,489 \times AGB^{0,890}$
Justification of choice of data or description of measurement methods and procedures applied	See Annex 7 - Technical Specifications
Purpose of Data	Calculation of carbon stocks (below ground biomass)
Comments	-

Data/Parameter	*CFj*
Units	t C t^{-1}d.m.
Description	Average carbon fraction of biomass for tree vegetation
Source	IPCC (2006). default value - Guidelines for National Greenhouse Gas

	Inventories. Volume 4 Agriculture, Forestry and Other Land Use. p.73.
Value	*0,47*
Justification of choice of data or description of measurement methods and procedures applied	Default value of carbon biomass vegetation derived from the IPCC literature
Purpose of Data	Calculation of carbon stocks (below ground biomass)
Comments	-

Data/Parameter	CO_2e
Units	t CO_2/tC
Description	Factor applied to convert the tree carbon stock to tree CO2e sequestered
Source	IPCC default value
Value	*44/12*
Justification of choice of data or description of measurement methods and procedures applied	Default value from IPCC
Purpose of Data	Estimation of GHG Emission Reductions and Removals
Comments	-

Data/Parameter	DF_{DW}
Units	per cent

Description	Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass.
Equations	Equations 21
Source	AR-TOOL12, Data / Parameter table 5.
Value	*1 %*
Justification of choice of data or description of measurement methods and procedures applied.	See Annex 7 - Technical Specification. The most conservative value for tropical biome, with elevation values less than 2,000 meters above sea level and rainfall between 1000 and 1,600 mm/year due to the annual rainfall of 1,730 mm 118 (according to the historical average of 2010-2019), and the average elevation of 101 meters above sea level.[49]
Purpose of Data	Calculation of carbon stocks (below ground biomass)
Comments	-

Data/Parameter	DF_{LI}
Units	per cent
Description	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass.

[49] T. Tadono, H. Ishida, F. Oda, S. Naito, K. Minakawa, H. Iwamoto : Precise Global DEM Generation By ALOS PRISM, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.II-4, pp.71-76, 2014.

Equations	Equations 22
Source	AR-TOOL12, Data / Parameter table 6.
Value	*1 %*
Justification of choice of data or description of measurement methods and procedures applied.	See Annex 7 - Technical Specification. The most conservative value for tropical biome, elevation below 2000 m and precipitation over 1600mm has been selected from the table.
Purpose of Data	Calculation of carbon stocks (below ground biomass)
Comments	-

Data/Parameter	*Cwp*
Units	Ton CO_2 ha-1
Description	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass.
Equations	Equations 22
Source	Winjum et al. 1998 and VCS module VMD0026
Justification of choice of data or description of measurement methods and procedures applied.	See Annex 7 - Technical Specification.
Purpose of Data	Calculation of carbon stocks of harvested wood products
Comments	-

Annex 8 – Exclusion List

Complete the exclusion list by responding 'Yes' if the activity is included in the project and 'No' if the project does not include the activity.

Activities	**Included in Project ('Yes' or 'No')**
Any project activities leading to or requiring the destruction [1] of critical habitat [2] or any forestry project which does not implement a plan for improvement and/or sustainable management.	No
Any activity which could be associated with the significant impairment of areas particularly worthy of protection of cultural heritage (without adequate compensation in accordance with international standards).	No
Trade in animals, plants or any natural products not complying with the provisions of the CITES/Washington convention [3].	No
Destructive fishing methods or drift net fishing with a net more than 2.5 km in length, explosives and/or poison.	No
Large-scale commercial logging operations for use in primary tropical moist forest.	No
Production or trade in wood or other forestry products other than from sustainably managed forests [4].	No
Exploitation of diamond mines and marketing of diamonds where the host country has not adhered to the Kimberley Process.	No
Activities involving harmful or exploitative forms of forced labour [5] or harmful child labour [6].	No
Projects that include involuntary physical displacement and/or forced eviction.	No

Production or activities that encroach on lands owned, or claimed or occupied by Indigenous Peoples, without full documented consent of such peoples.	No
Production, use, sale or trade of pharmaceuticals, pesticides/herbicides, ozone layer depleting substances [7], and other toxic [8] or dangerous materials such as asbestos or products containing PCB's [9], wildlife or products regulated under CITES, including all products that are banned or are being progressively phased out internationally	Yes. The use of pesticides is in no way promoted by the project. The cost of such products for communities is a further deterrent to their use. However, individual participants have a certain degree of freedom in their management practices. zeroCO2 will undertake to provide training and alternatives in this regard as already explained in the body of the PDD.
Production or trade of arms, ammunition, weaponry, controversial weapons, or components thereof (e.g., nuclear weapons and radioactive ammunition, biological and chemical weapons of mass destruction, cluster bombs, anti -personnel mines, enriched uranium).	No
Procurement and use of firearms.	No
Provision of finances to military institutions involved in conservation or security activities.	No

Production or trade of strong alcohol intended for human consumption or other alcoholic beverages (excluding beer and wine).	No
Production or trade of tobacco and other drugs	No
Gambling, gaming establishments, casinos or any equivalent enterprises and undertaking [10].	No
Any trade related to pornography or prostitution.	No
Production or trade in radioactive material. This does not apply to the procurement of medical equipment, quality control equipment or other application for which the radioactive source is insignificant and/or adequately shielded	No
Production or trade in unbound asbestos. This does not apply to the purchase or use of cement linings with bound asbestos and an asbestos content of less than 20%.	No
Production, trade, storage, or transport of significant volumes of hazardous chemicals, or commercial scale usage of hazardous chemicals. Hazardous chemicals include gasoline, kerosene, and other petroleum products.	No
Transboundary trade in wastes, except for those accepted by the Basel Convention and its underlying regulations [11].	No
Any activity leading to an irreversible modification or significant displacement of an element of culturally critical heritage [12].	No
Production and distribution, or investment in, media that are racist, antidemocratic or that advocate discrimination against a part of the population.	No
Projects involving the planting or introduction of invasive species	No
Projects that increase the dependency of primary participants and other stakeholders on fossil fuels.	No

Notes:

[1] Destruction means (1) the elimination or severe reduction in the integrity of a habitat/area caused by a major and long-term/prolonged change in land-use or water resources or (2) the modification of a habitat such that this habitat's ability to fulfil its function/ role is lost.

[2] The term critical habitat encompasses natural and modified habitats that deserve particular attention. This term includes (1) spaces with high biodiversity value as defined in the IUCN's classification criteria, including, in particular, habitats required for the survival of endangered species as defined by the IUCN's red list of threatened species or by any national legislation; (2) spaces with a particular importance for endemic species or whose geographical range is limited; (3) critical sites for the survival of migratory species; (4) spaces welcoming a significant number of individuals from congregatory species; (5) spaces presenting unique assemblages of species or containing species which are associated according to key evolution processes or which fulfil key ecosystem services; (6) and territories with socially, economically or culturally significant biodiversity for local communities. Primary forests or high conservation value forests must also be considered as critical habitats

[3] https://cites.org/eng/disc/text.php

[4] Sustainably managed forests are forests managed in a way that balances ecological, economic and socio-cultural needs.

[5] Forced labour means all work or service, not voluntarily performed, that is extracted from an individual under threat of force or penalty.

[6] Harmful child labour means the employment of children that is economically exploitive, or is likely to be hazardous to, or to interfere with, the child's education, or to be harmful to the child's health, or physical, mental, spiritual, moral, or social development. Employees must be at least 14 years of age, as defined in the ILO’s Declaration on the Fundamental Principles and Rights at Work (C138 – Minimum Age Convention, Article 2), unless local laws require compulsory school attendance or a minimum working age. In such circumstances, the highest age requirement must be used.

[7] Any chemical component which reacts with, and destroys, the stratospheric ozone layer leading to the formation of holes in this layer. The Montreal Protocol lists Ozone Depleting Substances (ODS), their reduction targets and deadlines for phasing them out

[8] Including substances included under the Rotterdam Convention, Stockholm Convention and WHO "Pharmaceuticals: Restrictions in Use and Availability".

[9] PCBs (polychlorinated biphenyls) are a group of highly toxic chemical products that may be found in oil-filled electrical transformers, capacitors and switchgear dating from 1950 to 1985.

[10] Any direct financing of these projects or activities involving them (for example, a hotel including a casino). Urban improvement plans which could subsequently incorporate such projects are not affected.

[11] Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal (1989).

[12] "Critical cultural heritage" is considered as any heritage element recognised internationally or nationally as being of historical, social and/or cultural interest.

Annex 9 - Environmental and Social Screening Report

Complete the template below with details of the environmental and social screening:

Process for use of the E&S questionnaire:

i) The Project Coordinator is to fill in the “Project coordinator response” section of the questionnaire.

ii) Once completed by the Project Coordinator, the Plan Vivo Foundation E&S reviewer is to fill in the “E&S reviewer comments” section of the questionnaire. This includes filling in the “E&S reviewer conclusions”.

iii) The screening report is then completed at the end by the Plan Vivo Foundation E&S reviewer, and the results are shared and discussed with the Project Coordinator.

SECTION A: PROJECT INFORMATION	
Project title:	zeroCARBON
Project coordinator:	zeroCO2 srl SB
Country:	GUATEMALA
Geography/ landscape:	Peten
Project summary:	Provide a short summary of the project, including aim and objectives, expected outcomes, activities, the main project sites, and project partner. zeroCARBON project promotes the restoration and environmental regeneration of degraded lands by planting native trees in new forest and agroforestry systems and donating them to rural farming communities in the Petén Department in Guatemala.
Name and role of project coordinator staff member filling this questionnaire:	Virgilio Galicia Francesco Chi Cecilia Monari Guido Cencini Ignacio Auger

SECTION B: POTENTIAL E&S RISKS AND IMPACTS			
Topic	**Question**	**Project coordinator response**	**E&S reviewer comments**
Vulnerable Groups	Are there vulnerable or disadvantaged groups or individuals, including people with disabilities (consider also landless groups, lower income groups less able to cope with livelihood shocks/ stresses) in the project area, and are their livelihood conditions well understood by the project?	Participants in the zeroCARBON program are low-income farmers and indigenous communities (mainly ethnic Q), identified as vulnerable, in relation to economic conditions, educational poverty and cultural isolation. Since agriculture is the main means of livelihood for these communities, the program aims to increase the value of land and income that can be generated through alternative interventions to classic agriculture and the activation of capacity building programs for communities.	
	Is there a risk that project activities disproportionately affect vulnerable groups,	Vulnerable groups will be the beneficiaries of	

	due to their vulnerability status?	the project, so the risk of negative impacts from the project is very low. The people involved are already farmers, they have land that they mainly grow local annual crops. Participation in the project allows them to diversify production and generate new sources of income from the same plot of land. At no point would the project affect them in any way.	
	Is there a risk that the project discriminates against vulnerable groups, for example regarding access to project services or benefits and decision-making?	No, as the project is built upon a participatory model that encourages vulnerable groups, which are the beneficiaries of this project, to participate in decision-making and benefit from the project.	

E&S reviewer conclusions

Estimated likelihood of risks (1-5) & justification: Reviewer conclusions

Estimated magnitude of risks (1-5) & justification: Reviewer conclusions

Risk significance: Reviewer conclusions

Gender equality	Is there a risk of adverse gender impacts due to the project/ project activities, including for example discrimination or creation/exacerbation or perpetuation of gender-related inequalities?	No, the project will provide the same opportunities and level of participation for both men and women. The project activities will be aligned with cultural gender-based allocation of tasks and specific to each household.	
	Is there a risk that project activities will result in adverse impacts on the situation of women or girls, including their rights and livelihoods? Consider for example where access restrictions disproportionately affect women and girls due to their roles and positions in accessing environmental goods and services?	No, the project provides the same goods and services to women and men equally. Culturally, agricultural work is mainly carried out by the men of the family, but in some communities, the main beneficiaries are the women who directly carry out the project activities.	
	Is there a risk that project activities could cause or contribute to gender-based violence, including risks of sexual exploitation, sexual abuse or sexual harassment (SEAH)? Consider partner and collaborating partner organizations and policies they have in place. Please describe.	No, zeroC02 has a strict policy in this matter which will be followed by project staff throughout the lifetime of the project. Vivero Mundo Verde is part of zeroC02 on the operational level, which means that their staff will follow the	

		same policy and principles in this matter. In order to strengthen the project´s reach in this issue, zeroC02 will hold periodic workshops about gender-based violence. The frequency and content of these workshops is still under development.	
E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Reviewer conclusions Estimated magnitude of risks (1-5) & justification: Reviewer conclusions Risk significance: Reviewer conclusions			
Human Rights	Is there a risk that the project prevents peoples from fulfilling their economic or social rights, such as the right to life, the right to self-determination, cultural survival, health, work, water and adequate standard of living?	No, the project activities will not exclude people from fulfilling their economic or social rights. On the contrary, the project is designed to enable people to exercise their rights and improve their socio-economic standard, by facilitating their access to forest products and benefits from the carbon program, and strengthening local institutions.	

	Is there a risk that the project prevents people from enjoying their procedural rights, for example through exclusion of individuals or groups from participating in decisions affecting them?	No, as the inclusive and participatory nature of the project will prevent this exclusion. As explained in sections 2.4 and 2.5 in the PDD, decision-making will follow a participatory approach, in which individuals and groups that have a stake in the project will have a say in the decisions that affect them. Furthermore, decisions will only affect the plots of individuals which are participating voluntarily in the project.	
	Are you aware of any severe human rights violations linked to project partners in the last 5 years?	No	
E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Reviewer conclusions Estimated magnitude of risks (1-5) & justification: Reviewer conclusions Risk significance: Reviewer conclusions			
Community, Health, Safety & Security	Is there a risk of exacerbating existing social and stakeholder conflicts through the implementation of project activities? Consider for	No, because the participating communities have title and possession rights to their land, so	

	example existing conflicts over land or natural resources, between communities and the state.	there are no existing land conflicts.	
	Does the project provide support (technical, material, financial) to law enforcement activities? Consider support to government agencies and to Community Rangers or members conducting monitoring and patrolling. If so, is there a risk that these activities will harm communities or personnel involved in monitoring and patrolling?	No such risks are expected as part of the monitoring and patrolling activities planned by zeroCO2 and carried out by the technical project team with the support of representatives of the communities involved.	
	Are there any other activities that could adversely affect community health and safety? Consider for example exacerbating human-wildlife conflict, affecting provisioning ecosystem services, and transmission of diseases.	No, the project is not expected to cause any processes that can negatively affect the health and safety of the local community.	

E&S reviewer conclusions
Estimated likelihood of risks (1-5) & justification: Reviewer conclusions
Estimated magnitude of risks (1-5) & justification: Reviewer conclusions
Risk significance: Reviewer conclusions

Labour and working conditions	Is there a risk that the project, including project partners, would lead to working conditions for project workers[3] that are not aligned with national labour laws or the International Labor Organization's (ILO) Declaration on the Fundamental Principles and Rights at Work (discriminatory working conditions, lack of equal opportunity, lack of clear employment terms, failure to prevent harassment or exploitation, failure to ensure freedom of association etc.)?	No, every staff member from zeroC02 and Vivero Mundo Verde is employed under contracts that comply with every norm established by Guatemalan national laws and the ILO Declaration on the Fundamental Principles and Rights at Work, as listed in the 1441 Decree of Guatemala´s Work Code.	
	Is there an occupational health and safety risk to project workers while completing project activities?	No, the equipment and work practices comply with safety regulations listed on the 1441 Decree of Guatemala´s Work Code, to ensure the health and safety of every project worker.	
	Is there a risk that the project support or be linked to forced labour, harmful child labour, or any other damaging forms of labour?	No, the project will not entail any kind of forced labour or any other harmful forms of labour. However, it is highly important to emphasize that the project will not disrupt any cultural traditions	

		that take place in the project area regarding labour. In Mayan culture, every family member contributes to work activities in the land, including under-aged members. These activities are by any means related to what is conceived as forced-labour.	
E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Reviewer conclusions Estimated magnitude of risks (1-5) & justification: Reviewer conclusions Risk significance: Reviewer conclusions			
Resource efficiency, pollution, wastes, chemicals and GHG emissions	Is there a risk that project activities might lead to releasing pollutants to the environment, cause significant amounts of waste or hazardous waste or materials?	No, the main project activity is tree-planting, which does not require a significant quantity of synthetic fertilizers or pesticides. The project will promote the elimination of agrochemicals in favour of exclusively organic practices. No hazardous waste will be generated from project activities.	
	Is there a risk that the project will lead to significant consumption of energy, water or other	No, the project activities will not require a significant use of resources,	

	resources, or lead to significant increases of greenhouse gases?	agrochemical inputs or machinery.	
E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Reviewer conclusions Estimated magnitude of risks (1-5) & justification: Reviewer conclusions Risk significance: Reviewer conclusions			
Access restrictions and livelihoods	Will the project include activities that could restrict peoples' access to land or natural resources where they have recognised rights (customary, and legal). Consider projects that introduce new access restrictions (eg. creation of a community forest), reinforce existing access restrictions (eg. improve management effectiveness and patrolling of a community forest) , or alter the way that land and natural resource access restrictions are decided (eg. through introducing formal management such as co-management).	No. The project does not include activities that restrict people's access to land. Planting activities will be managed directly by the community, where each participant will be responsible for the management of their own plot (as was the case before the project).	
	Is there a risk that the access restrictions introduced /reinforced/altered by the project will negatively affect peoples' livelihoods?	The project does not include access restrictions. Avoiding further deforestation and exploitation of natural resources, such as hunting, is seen as an expected outcome of the project rather than an	

		imposed measure. Providing participants with a sustainable livelihood and benefits from carbon credits will prevent further expansion into forests. Besides, hunting is not part of the traditional livelihoods of the local population.	
	Have strategies to avoid, minimise and compensate for these negative impacts been identified and planned?	No strategies have been planned as livelihoods or access to natural resources will not be negatively impacted by the project.	
E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Reviewer conclusions Estimated magnitude of risks (1-5) & justification: Reviewer conclusions Risk significance: Reviewer conclusions			
Cultural heritage	Is the Project Area officially designated or proposed as a cultural site, including international and national designations?	No, every project site belongs to areas designated for agriculture, silviculture or farming use according to INAB (Guatemalan Forest National Institute)	
	Does the project site potentially include important physical cultural resources, including burial sites and monuments, or natural features or resources of cultural	Yes, the project sites could potentially include buried elements of Mayan culture. Nevertheless, there is no risk that the project	

	significance (eg. sacred sites and species, ceremonial areas) and is there risk that the project will negatively impact this cultural heritage?	will negatively affect elements of cultural heritage. The sites where the project will be implemented have already been managed, so no significant additional disturbance will take place. One of the project´s priorities is to restore and protect the cultural and natural heritage of the area.	
	Is there a risk that the project will negatively impact intangible cultural heritage? Consider for example cultural practices, social and cultural norms in relation to land and natural resources.	No. The project does not include activities that restrict people's access to land. Planting activities will be managed directly by the community, where each participant will be responsible for the management of their own plot (as was the case before the project).	

E&S reviewer conclusions

Estimated likelihood of risks (1-5) & justification: Reviewer conclusions

Estimated magnitude of risks (1-5) & justification: Reviewer conclusions

Risk significance: Reviewer conclusions

Indigenous Peoples	Are there Indigenous Peoples[4] living within the Project Area, using the land or natural resources within the project area, or with claims to land or territory within the Project Area?	Part of the participants belong to Mayan indigenous communities – mainly to the ethnic group Q'eqchi' - but there are no land-related issues and claims (the land is regularly owned by them).	
	Is there a risk that the project negatively affects Indigenous Peoples through economic displacement, negatively affects their rights (including right to FPIC), their self-determination, or any other social or cultural impacts?	No, Indigenous Peoples are the main beneficiaries of the project. The project activities have been thoroughly designed according to FPIC procedures, and built upon the field experience of zeroC02 staff. The project is based on knowledge of local socio-cultural context and the inclusion of rights and needs of Indigenous Peoples.	
	Is there a risk that there is inadequate consultation of Indigenous Peoples, and/or that the project does not seek the FPIC of Indigenous Peoples, for example leading to lack of	No, as explained in section 2.6.2, the FPIC process has been thoroughly planned and implemented to ensure that Indigenous	

	benefits or inappropriate activities?	Peoples which participate in the project are adequately consulted and choose to participate voluntarily.	
E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Reviewer conclusions Estimated magnitude of risks (1-5) & justification: Reviewer conclusions Risk significance: Reviewer conclusions			
Biodiversity and sustainable use of natural resources	Is there a risk that project activities will cause adverse impacts on biodiversity (both in areas of high biodiversity value, and outside of these areas) or the functioning of ecosystems? Consider issues such as use of pesticides, construction, fencing, disturbance etc.	Yes, preventive practices include the use of pesticides (mainly organic) to prevent diseases and pathogens that attack tropical forests	
	Is there a risk that the project will introduce non-native species or invasive species?	No, every species that the project will introduce is native to the region.	
	Is there a risk that the project will lead to the unsustainable use of natural resources? Consider for example projects promoting value chains and natural resource-based livelihoods.	No, the project will be implemented in plots that will be actively monitored in accordance to the land management plans, which prevent unsustainable practices.	

E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Estimated magnitude of risks (1-5) & justification: Risk significance:			
Land tenure conflicts	Has the land tenure and use rights in the project area been assessed and understood?	Yes	
	Is there a risk that project activities will exacerbate any existing land tenure conflicts, or lead to land tenure or use right conflicts?	A low risk in this regard may be related to the presence of interests by large landowners in the acquisition of community land. However, the project allows for a diversification of production and therefore increases the value of the land in economic terms, thus reducing the interest in acquiring.	
E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Reviewer conclusions Estimated magnitude of risks (1-5) & justification: Reviewer conclusions Risk significance: Reviewer conclusions			
Risk of not accounting for climate change	Have trends in climate variability in the project areas been assessed and understood?	Yes, assessments of planting areas have been carried out, mainly in areas flooded by tropical storms	

		that may affect the project.	
	Has the climate vulnerability of communities and particular social groups been assessed and understood?	Yes, it has always been taken into account that there are communities that have more climate vulnerability. So there may be certain minimal risks.	
	Is there a risk that climate variability and changes might influence the effectiveness of project activities (eg. undermine project-supported livelihood activities) or increase community exposure to climate variation and hazards? Consider floods, droughts, wildfires, landslides, cyclones, etc.	Possibly, given the vulnerability of Peten region to flood and storms.	
E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Reviewer conclusions Estimated magnitude of risks (1-5) & justification: Reviewer conclusions Risk significance: Reviewer conclusions			
Other – eg. cumulative impacts	Is there a risk that the project will contribute cumulatively to existing environmental or social risks or impacts, for example through introducing new access restrictions in a landscape with existing restrictions	No, the risk assessment did not identify existing risks with the potential to be cumulative. The project activities will be carried out within limited spatial boundaries	

	and limited land availability?	in individually owned plots	
	Are there any other environmental and social risks worthy of note that are not covered by the topics and questions above?	No, all potential risks have been covered in the topics above.	
E&S reviewer conclusions Estimated likelihood of risks (1-5) & justification: Reviewer conclusions Estimated magnitude of risks (1-5) & justification: Reviewer conclusions Risk significance: Reviewer conclusions			
SECTION C: SAFEGUARD PROVISIONS			
Stakeholder engagement	Has a stakeholder analysis been conducted that has identified all stakeholders that could influence or be affected by the project, or is this still to be completed? Please describe.	As described in 2.1 a stakeholder analysis has been conducted to identify every stakeholder. Large landowners are still to be integrated into the analysis and incorporated into the PDD.	Reviewer comments
	Are the local community and indigenous peoples statutory or customary rights to land or resources within the project area already clear and documented, or is further	Every project participant holds statutory rights to the sites in which the project will be implemented. These rights are	Reviewer comments

	assessment required? Please describe.	defined, well documented and a key component for the foundation of this project.	
	Are local governance structures and decision-making processes described and understood (including details of the involvement of women and marginalized or vulnerable groups), or is further assessment required? Please describe.	The local governance structures are well understood by the project coordinator and project developer and will form the basis for community involvement in the project. A diagram summarizing these structures will be included in 5.1.	Reviewer comments
	Are past or ongoing disputes over land or resources in the project area known and documented, or is there need for further assessment? Please describe.	After the assessment conducted in 2.1.3, there were no land or resource disputes identified in the project area. The participant´s title deeds provide clearly defined boundaries over land and its resources, which prevents conflicts from occurring.	Reviewer comments

Stakeholder consultation	Does the project have a Stakeholder Engagement Plan with clear measures to engage Vulnerable Groups, or is this plan still to be developed? Please describe.	Every participant of this project can be considered as Vulnerable groups and the stakeholder engagement plan in 2.5.2 has been designed accordingly.	Reviewer comments
	Has the Project Coordinator informed all stakeholders of the project, through providing relevant project information in an accessible format, or does this still need to be completed? Please describe.	Yes, stakeholders were informed accordingly during the design consultation phase (see 2.5.1).	Reviewer comments
Free, Prior and Informed Consent	Has the project analysed and understood national and international requirements for Free Prior and Informed Consent (FPIC)? Please describe.	Yes, the project complies with all regulations regarding FPIC, as described in 2.6.1	Reviewer comments
	Has the project identified potential FPIC rights holders and potential representatives in local communities and among indigenous peoples, or is this still to be completed? Please describe.	Yes, the potential FPIC rightholders have been identified during the stakeholder assessment while the potential representatives during the consultation and organization of the groups (see 2.6.2)	Reviewer comments

	Has the project worked with rights holders and representatives of local communities and indigenous peoples to understand the local decision-making process and timeline (ensuring involvement of women and vulnerable groups), or is this still to be completed? Please describe.	Each beneficiary community will be organised according to a Board of Directors. This board is composed by community members elected through a general assembly held with all members. Women are required to form part of the Board of Directors. (see 2.5.2)	Reviewer comments
	Has the project sought consent from communities to 'consider the proposed Project', and if so, where is this in principle consent documented? Please describe.	As described in 2.5.1, during the design phase consultation, informative meetings were held with community members to provide information about the project and gather their opinion. The documentation is being collected and can be provided upon request of Plan Vivo.	Reviewer comments

Grievance Mechanism	Does the project already have a Grievance Mechanism, or is this still to be established? Please describe.	Yes, a Grievance Mechanism has been established to address concerns from participants, (see 3.17).	Reviewer comments
	For projects with a GRM, is this accessible to project affected people? Please describe.	The GRM system is accessible to all project participants and those interested in participating (see 3.17).	Reviewer comments

E&S reviewer conclusions for safeguard provisions

Are the project Safeguard Provisions adequately addressed, or to be adequately addressed during the project design phase? Reviewer conclusions

What additional actions need to be conducted during the project design phase? Reviewer conclusions

Any other comments: Reviewer conclusions

SECTION D: SCREENING REPORT (E&S REVIEWER TO COMPLETE)

Name of E&S reviewer	**Caroline Stillman and Eva Schoof**
Date of E&S screening:	**15.11.2022**
Project risk rating:	***Low – this is a low risk project that works with farmers who have title deeds to their plots of land.***

Principle risks and impacts

Include summary of key project risks & impacts
Populate summary table with risk significance

E&S topic/ risk area	Likelihood (1-5)	Magnitude (1-5)	Significance (low, moderate, severe, high)
Vulnerable Groups	1	1	Low
Gender equality	2	2	Low
Human Rights	1	1	Low
Community, Health, Safety & Security	1	1	Low
Labour and working conditions	1	1	Low
Resource efficiency, pollution, wastes, chemicals and GHG emissions	2	2	Low
Access restrictions and livelihoods	1	1	Low
Cultural heritage	1	1	Low
Indigenous Peoples	2	2	Low
Biodiversity and sustainable use of natural resources	3	3	Moderate
Land tenure conflicts	2	3	Moderate
Risk of not accounting for climate change	2	4	Moderate

Other – eg. cumulative impacts	1	1	Low

E&S assessment required	*Summarise the type of E&S assessment required, and provide recommendations on the scope of the E&S assessment, including the key areas of likely focus* *As this is a low risk project, a full E&S risk assessment is not required. However, the project should assess all moderate risks at PDD design stage.* *Areas of likely focus:* *- Pesticide poses a risk if the project increases the use of pesticides (either organic or non-organic). In this case, the project should clarify whether alternatives have been considered and the project should include a risk assessment of pesticide use at PDD stage.* *- Impacts of climate change (flooding) seem to have been understood but are the potential impacts on proposed project activities understood. In PDD clarify if they are to be monitored, and what mitigation measures are in place.* *- Clarify the ecosystem protection component of the project: activities, access restrictions, potential affected groups*
Likely safeguard plans required	*Indicate if the ESMP section of the PDD will likely be necessary, and any other safeguard plans that could be relevant to the project; justify & explain*

	ESMP section of PDD should be filled out, with focus on moderate risks identified above. Low risks must also be included. Areas to include: - *Indigenous peoples: stakeholder engagement plan for engaging with Mayan communities. This plan is to define the project's FPIC process (including any community-level decision making versus individual decision-making).* - *Vulnerable Groups – how to ensure access to participate in the project for vulnerable groups. In the case that it is about ability to participate in the project (due to vulnerability status), it could be due to marginalisation and/or discrimination.* - *Gender equality – how is data disaggregated/women engaged separately* - *Land tenure conflicts – from the PIN, it seems that there are large landowners who want to acquire more land, posing a risk to the project if community members choose to sell their land to these larger owners. This is also something community members need to consider when signing a Plan Vivo agreement, as that would potentially prohibit sale of the land.* *Climate change – monitor risks of flooding*

Annex 10 – Environmental and Social Assessment Report

In this Annex an assessment of the themes identified by Plan Vivo during the ES screening for further analysis is provided.

Flooding (climate change risks)

The topography, increasing unpredictability of climate and degraded soils makes the project area susceptible to flooding. According to the Climate Change Knowledge Portal[50] Guatemala is considered as a highly vulnerable country regarding natural hazards associated with climate change, particularly flooding. Flooding risk in the project area was assessed using the findings provided by the Strategic Information System of Rafael Landívar University in Guatemala (see Figure 10.1) and by studying the flooding history of the project area, which is well known by zeroCO2 field staff after their close involvement in the local context.

[50] https://climateknowledgeportal.worldbank.org/country/guatemala/vulnerability

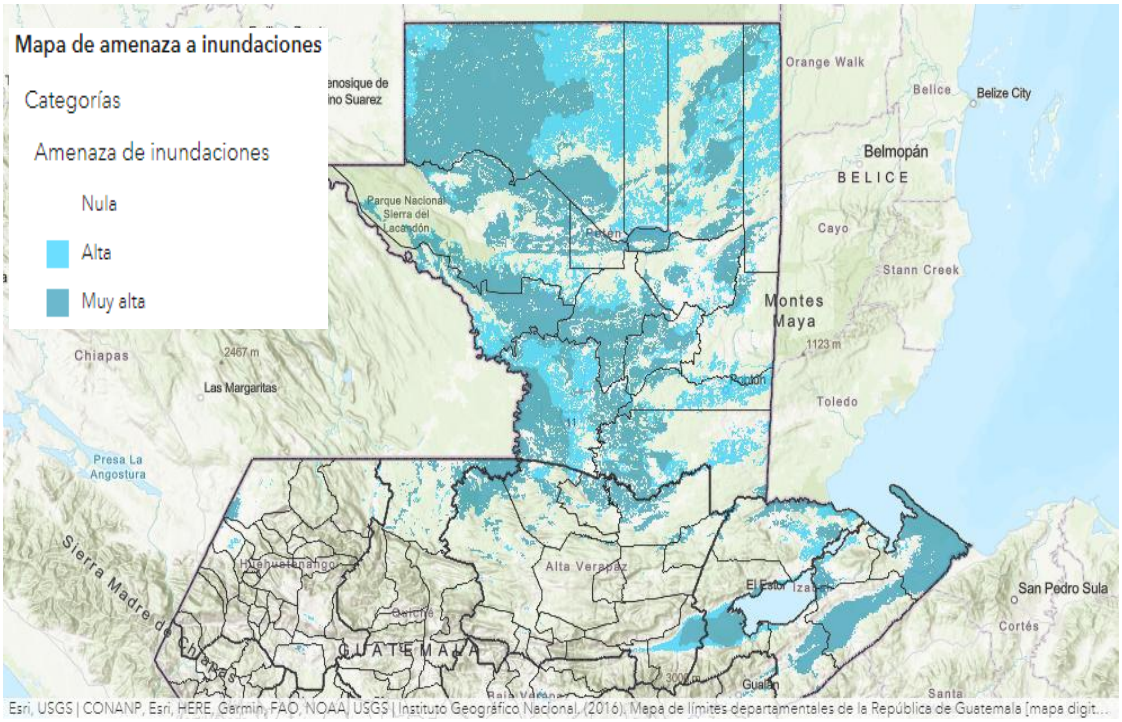


Figure A10.1: Flooding risk in northern Guatemala. Source: Sistema Información Stratégica, Universidad RafaelLandívar.

Even though the project area is located in a high risk of flooding department, it is not expected to affect project activities negatively. ZeroCARBON will be implemented acknowledging the flooding risk in every project activity and closely monitoring its development. In order to minimize the potential impacts on project sites, trees will be planted strategically based on their resistance to flooding. Cedrus (*Cedrela odorata*) tolerates partial flooding, so, once established, these trees will pose a low risk of being affected by flooding. Besides, tree planting will be adjusted to the most vulnerable locations for flooding of each project site, which will be assessed in consultation with project participants.

It is expected that flooding risks will be reduced over the course of the project, as tree establishment and growth is proven to be an effective measure to increase water infiltration and reduce soil erosion, thus preventing run-off and damages from flooding. Therefore, the project also aims to increase the overall flooding resilience of the project area, to safeguard livelihoods and the environment in the long-term.

Pesticides and fertilizers

ZeroCO2 does not provide farmers with synthetic fertilisers and herbicides. Nevertheless, in some cases, farmers living in the project area might resort to their use, as there is no access to other alternative methods or the knowledge to implement them. This is a very conservative assumption considering that farmers generally use them very little or not at all due to cash flow problems.

This being considered, after careful assessment, the risk posed by the use of pesticides and fertilizers as a result of this project is minimal. The planting will not require large amounts of fertiliser and weed control will only be reserved for the first two years after planting to ensure rooting. For more information on quantities, frequency and types of inputs please see the management plan in Annex 11.

As a mitigation measure, zeroCO2 seeks to promote the elimination of agrochemicals in favour of exclusively organic practices through a careful and iterative process. This already takes place entirely at the seedling production stage in nurseries where all production is organic. Training projects will also be set up for communities on alternative practices to the use of chemical fertilisers (biochar, manure, etc.), also rediscovering indigenous ancestral knowledge.

At this stage of the project, zeroco2 and Vivero Mundo Verde are studying and developing an approach to implement these sessions, particularly regarding access to alternative methods and capacity building for field staff to deliver these training sessions.

Ecosystems and biodiversity

Project sites are distributed across diverse locations within the Petén department. This being considered, no specific data from species flora and fauna surveys is available for the project area. Instead, an overview of endangered and vulnerable key fauna species found in the Petén department is documented below, using the list provided by INaturalist (https://www.inaturalist.org/), which is based on reported species observations in Petén and the distribution area of each species.

Table A10.1: Fauna species and distribution in Peten. Source: INaturalist

Category	**Name of Species**	**Status (IUCN Red List)**
Birds	*Ocellated turkey (Meleagris ocellata)*	Near Threatened
	Orange-breasted Falcon (Falco deiroleucus)	Near Threatened
	scarlet macaw (Ara macao)	Vulnerable
	great curassow (Crax rubra)	Vulnerable
	olive-throated parakeet	Near Threatened

	(Eupsittula nana)	
	agami heron (Agamia agami)	Vulnerable
	southern mealy parrot (Amazona farinosa)	Endangered
	white-crowned parrot (Pionus senilis)	Endangered
	ornate hawk-eagle (Spizaetus ornatus)	Near Threatened
	great tinamou (Tinamus major)	Near Threatened
	eastern meadowlark (Sturnella magna)	Near Threatened
	olive-sided flycatcher Contopus cooperi	Near Threatened
	Chuck-will's-widow (Caprimulgus carolinensis)	Near Threatened
	harpy eagle (Harpia harpyja)	Near Threatened
	eastern whip-poor-will (Caprimulgus vociferus)	Near Threatened
	golden-winged warbler (Vermivora chrysoptera)	Near Threatened
	cerulean warbler (Setophaga cerulea)	Near Threatened
	yellow-headed amazon (Amazona oratrix)	Endangered
	keel-billed motmot (Electron carinatum)	Vulnerable
	crested eagle (Morphnus guianensis)	Near Threatened
Mammals	*Geoffroy's spider monkey (Ateles geoffroyi)*	Endangered

	Yucatán black howler (Alouatta pigra)	Endangered
	Baird's tapir (Tapirus bairdii)	Endangered
	Jaguar (Panthera onca)	Near Threatened
	Neotropical otter (Lontra longicaudis)	Near Threatened
	Margay (Leopardus wiedii)	Near Threatened
	White-lipped peccary (Tayassu pecari)	Vulnerable
	Thomas's sac-winged bat (Balantiopteryx io)	Vulnerable
	Yucatan brown brocket (Odocoileus pandora)	Vulnerable
	Spectral bat (Vampyrum spectrum)	Near Threatened
	Van Gelder's bat (Bauerus dubiaquercus es)	Near Threatened
Reptiles	*furrowed wood turtle (Rhinoclemmys areolata)*	Near Threatened
	Tabasco mud turtle (Kinosternon acutum	Near Threatened
	Hickatee (Dermatemys mawii)	Critically Endangered
	Mexican musk turtle (Staurotypus triporcatus)	Near Threatened

	American crocodile (Crocodylus acutus)	Vulnerable
	narrow-bridged musk turtle (Claudius angustatus)	Near Threatened
Amphibians	*Doflein's salamander (Bolitoglossa dofleini)*	Near Threatened
	Bolitoglossa mulleri	Vulnerable

The project activities will be carried out in project sites that are located in degraded agricultural plots with low levels of biodiversity, with no further extension into surrounding natural forests or other ecosystems. The diverse project locations and the unavailability of site-specific data on flora and fauna species, makes it challenging to determine which specific species will be influenced by the project and in which way. Nevertheless, as explained in Project Logic, the project aims at increasing biodiversity and restoring ecosystem services in the area, which can benefit a wide range of species. The table below provides an overview of the expected biodiversity benefits and ecosystem services that zeroCARBON aims to achieve.

Table A10.2: Expected biodiversity benefits and ecosystem services from zeroCARBON

Project Intervention	**Biodiversity**	**Ecosystem services**
Improved land management through forest plantations and agroforestry	-Habitat. Even though the project will only make use of two tree species, it is expected that tree planting will enhance the gradual establishment of other native species in between trees which, in turn, can provide habitat for wildlife. -Wildlife corridors. The increased vegetation will enhance wildlife movement across the landscape.	-Decreased soil erosion and better soil quality. The improved soil cover will reduce erosion and the decomposition of weeds, grasses and dead wood will enhance the establishment of microorganisms and organic matter in the soil. -Carbon capture will increase with tree growth, resulting in more above and below ground biomass production. -Water retention.The increased tree cover and plant establishment will reduce run-off and improve water infiltration.

		-Improved air quality. Trees will provide oxygen and shade, while filtering pollutants and reducing temperatures.
	-Pollination will be enhanced by the increased plant diversity in the agricultural plots, providing habitat and pollination opportunities. -Wildlife corridors that can enhance species movement across the broader fragmented landscape. -Shade and shelter	-Decreased soil erosion and better soil quality. The improved soil cover in the plots will reduce erosion, while decomposition of weeds, grasses and dead wood will enhance the establishment of microorganisms and organic matter in the soil. This, in turn, increases soil fertility and the agricultural productivity of the plot. -Carbon capture will increase with tree growth, resulting in more above and below ground biomass production. -Water retention.The increased tree cover and plant establishment will reduce run-off and improve water infiltration. -Air quality. Trees will provide oxygen and shade, while filtering pollutants and reducing temperatures.

Annex 11 – Land Management Plans

Attached is a model of Land Management Plan developed within zeroCARBON program.

Annex 12 – Project Agreements

Attached is a model project agreement with zeroCARBON program participants.

Annex 13 – Monitoring Plan

The monitoring plan is designed to collect information useful for assessing progress, carbon, ecosystem and livelihood indicators. The objectives of the monitoring plan are to obtain a reliable overview of each participating smallholder's plot by monitoring indicators to:

- estimate the provision of ecosystem services (carbon, livelihood, ecosystem indicators);
- conduct a forest inventory to understand project performance and adaptive management interventions;
- determine whether each participant has met minimum payment targets through specific milestones to be achieved.

The monitoring plan includes the following details for each indicator:

- Sampling approach (if applicable)
- Methods used
- Duration and frequency of assessment
- Groups or individuals responsible for monitoring
- Resource and capacity requirements
- Plan for communicating monitoring progress to all stakeholders

a. Management Plan General Monitoring

The general monitoring of all forest plantations takes place 4 times a year. This monitoring serves to collect data on the following topics: Plantation information, fire protection, pest and disease control, silvicultural activities and cultural activities and on this basis to provide management recommendations to the participants. This helps to better understand the needs and problems of the participants so that targeted training can be offered. A form that is used to record this data can be found in a separate attachment.

b. Carbon Monitoring

Sampling approach and method: Systematic with random start
Sampling unit: 238 m2 (14 x 17 metres)
Frequency of assessment: Annual
Plot types: Permanent sample plots (PSP)
Sampling intensity: 1%
Sampling error: verifiable sampling error equal to or less than 10%.
Number of sample: Minimum 1% of the total project area.
Population: All trees included in the project

Sampling design

Project boundaries are defined during the early stages of the project and updated during the accreditation period. The boundaries may change or new layers may be created as a result of disturbance effects (pests, drought, fire) and the boundaries will be redefined. Geographic coordinates will be established, recorded and archived.

Permanent plots will be used for sampling over time to measure and monitor changes in the carbon stock of biomass above and below ground. Stratification will also be carried out considering the age class (planting data) and species planted in addition to the type of intervention (forest or agroforestry stands). The stratification may be subdivided or merged if unforeseen disturbances (e.g. forest fires) occur or insignificant intra-layer variability in the annual variation of carbon pools is detected. Regarding plot selection, the IPCC Good Practice Guidance for LULUCF, Chapter 4.3, recommends the use of a single plot ranging from 100 m2 to 600m2.

The locations of these permanent sample plots are randomized using GIS software. The carbon sequestration measurement plot will have an area of 238 m2 i.e. fourteen metres long by seventeen metres wide (14 x 17 m). A minimum of twenty (20) trees or planting sites shall be identified within the plot and the corresponding tree data shall be recorded.

Sampling Procedure and Stratification

The maximum relative error, i.e. the uncertainty of mean change in tree biomass, must be less or equal 10% at a 90% confidence-level. These values are set to achieve a compromise between precision and costs of measurement. Following the tool "Calculation of the number of sample plots for measurements within A/R CDM project activities", the ex-ante number of required sample plots for achieving this precision is calculated iteratively using equation 2 of the the tool, that it's used when the area sampled is expected to be less than 5% of the project area, the following simplified equation has to been used for estimating the number of sample plots:

$$n = \left({}^{t_{val}}/_{E}\right)^2 \times (\sum w_i \times s_i)^2$$

Where:

Parameter	Description	Value
n	Number of sample plots required for estimation of biomass stocks within the project boundary, dimensionless	24,57
t_{VAL}	Two-sided Student's t-value at infinite degrees of freedom for the required confidence level;dimensionless	1.645
E	Acceptable margin of error (i.e. one-half the confidence interval) in estimation of biomass stock within the project boundary; t d.m	0.1
w_i	Relative weight of the area of stratum i (i.e. the area of the stratum i divided by the project area); dimensionless	
s_i	Estimated standard deviation of biomass stock in stratum i; t d.m	0,35

i	1,2,3… biomass stock estimation strata within the project boundary	4

Data and parameters used from A/R Methodological Tool "Calculation of the number of sample plots for measurements within A/R CDM project":

t_{VAL} 1.645 (value at infinite degrees of freedom and 90% confidence level) (Source: Calculation of the number of sample plots for measurements within A/R CDM project activities).

E 0.1 (acceptable error of 10%).

S Approximate value of the standard deviation of biomass stock in each stratum is either known from existing data related to the project area or existing data related to a similar area or is estimated from a preliminary sample. Used value: 0.35 (coefficient of variation for artificial stands) (Source: According to the "Manuel d'inventaire forestier", Annex 14, the CV of artificial stands can vary between 20% and 50%. An intermediate value of 37% has been chosen for estimation of required sample size).

Monitoring carried out in October 2023

Planting year	Planting system	Stratum	Area (ha)	wi	ni
2020	Forest plantation	I	8.75	0.07	0.12
2021	Forest plantation	II	10,79	0.08	0.07
2022	Forest plantation	III	114,92	0.85	26.40
2022	Agroforestry	IV	0.00	0.0	0.00
Total			**134.45**	**1**	**24.57**

Table A13.1: Number of sample plots per stratum (2020 - 2022).

Monitoring to be carried out in September-October 2024

Table A13.2: Number of sample plots per stratum (2023).

Planting year	Planting system	Stratum	Area (ha)	wi	ni
2023	Forest plantation	V	303.54	1	33.15
2023	Agroforestry	VI	0.00	0.0	0.00
Total			**303.54**	**1**	33.15

Plot location and set-up

For the establishment of the permanent plots, the location is identified using a handheld GPS and marked on-site using a thick wooden stake inserted into the ground, painted with spray with the corresponding plot number.

For the installation of the plot it is necessary to determine the direction of the planting furrows (north-south, east to west). The main corner of the plot should be placed on the left side, i.e. if the rows are from north to south, the plot should be installed in that direction, and if the rows are from east to west, the plot should be installed in that direction.

The corners shall be placed in the centre of the furrow and in the centre between the plants with dimensions of fourteen (14) metres above the furrows, i.e. from north to south or from east to west and seventeen (17) metres between the plants, i.e. from west to east or from north to south.

Identification and measurement of trees

To number the selected trees, a scheme is created to ensure that the numbering can be maintained in subsequent years. Considering that the established plantations are three (3) metres between rows and three (3) metres between plants, 20 trees or twenty planting points (planting points: place where a tree was planted, but no longer exists when the plot is established) will be selected in the plot described above. The identification and measurement of the trees starts in the northeast or southeast corner of the plot according to the direction of the planting furrows.

Considering that there are four plants on the furrow, the measurement begins in the trees that are in the first furrow within the plot and then returns to measure in the next furrow, until completing the five furrows of four plants each. A sketch of the plot is attached.

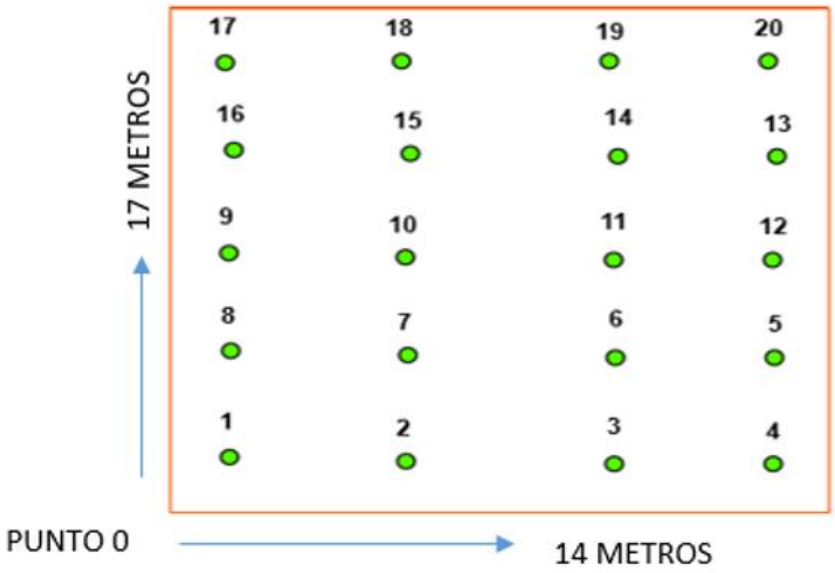


Figure A13.1: Monitoring plan in relation to the planting scheme

Dasometric data to be measured

Of the selected trees, first the tree number and species, then the height, trunk diameter, canopy width and a code for dead trees are recorded:

1 = Natural dead,
2 = Dead due to forest fires,
3 = Dead due to human intervention not approved in the forest management plan,
4 = Dead due to thinning application.

Tree height is measured with a clinometer. If a clinometer is not available or the trees are still very small, a stick is used for the measurement. In the event that the height cannot be measured with the following instruments, peer reviewed hypsometric curves are used. The aim is to estimate 40 % of the tree height with a clinometer and 60 % with hypsometric equations. Tree canopy diameter is best measured with a hypsometer or a tape measure by two people standing vertically under the outermost points of the tree. The outermost points of the tree canopy are measured in four different directions and the mean value is recorded (see Figure 13.2).

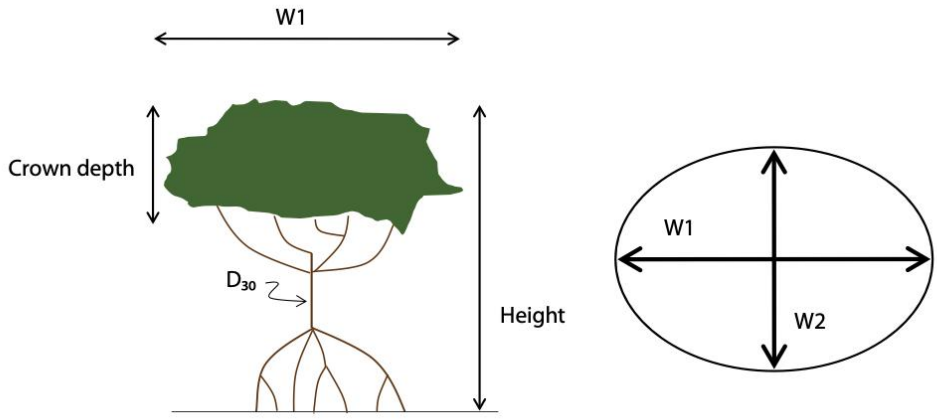


Figure A13.2: Measurements collected during monitoring

Trunk diameter (DBH) is measured on the bark of the tree at breast height (approx. 1.30 m; see Figure 13.3); trees with a diameter less than 1.30 m are noted as <. If a tree trunk is thinner than the little finger, the diameter cannot be determined using a measuring tape. In this case, the minimum value, which in this case is 0.5 cm, is recorded. Measured trees are marked with a spray.

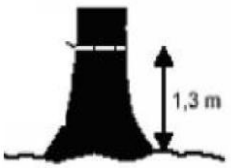


Figure A13.3: DBH measurement in individual trees

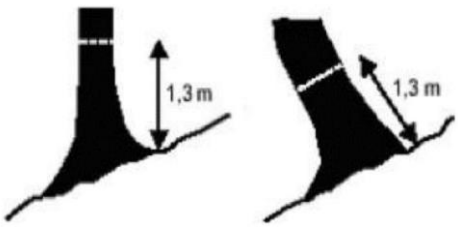


Figure A13.4: DBH measurement on sloping lands.

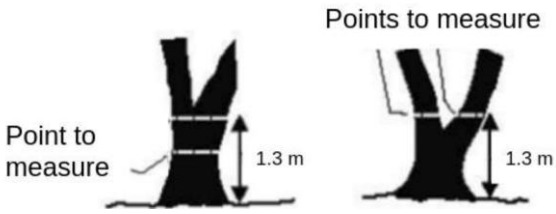


Figure A13.5: DBH measurement in forked trees

In case it is the first measurement and a planting point is identified in the plot and the tree does not exist, the tree number should be assigned to this spot and the corresponding code should be assigned.

Only above-ground and below-ground biomass of trees established in the project will be monitored. Therefore, only individual growth of each tree in the plots will be monitored. This value will be estimated from the increase in the determined measured stem and height in each monitoring.

The carbon content in dead wood, litter and soil attributable to project activities will not be monitored. These will be estimated by using default values and suggested methods in the tools “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities” and “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”.

Monitoring instrumentation

- Diametric tape or Caliper
- Suunto Hypsometer; Arboreal phone lidar app; Clinometer
- Calibrated stick or measuring tape (for trees smaller than 6 metres)
- GPS to record geo-position of permanent sampling plots
- Paint/spray
- Phone/tablet for data collection; Printed data logging tables

Duration and frequency of assessment

The plot ID of the different parcels and the location of the parcels will be defined and geolocalized with a GPS device and registered in the GIS database. Based on this analysis, we will monitor the area of each parcel of the entire project area using the corresponding coordinates. DBH and height at the permanent sampling points will be measured annually, the data will be recorded on paper and then transferred to a GIS database. A comprehensive analysis of each area affected by major failures related to deforestation, plantation failure, pests or diseases is conducted every five years. The number of dead trees is monitored every year.

Table A13.3: Data collection

Parameter	Unit	Method	Monitoring frequency	Responsibility
Trees planted	n°	Documentation; inventory; monitoring	annual	zeroCO2 operational team /Vivero Mundo Verde
Tree height	m	Field inventory	annual	zeroCO2 operational team /Vivero Mundo Verde
DBH	cm	Field inventory	annual	zeroCO2 operational team /Vivero Mundo Verde
Number of dead trees (incl. cause of death)	n°	Field inventory	annual	zeroCO2 operational team /Vivero Mundo Verde
Plot location	Shape file; Latitude; Longitude	GPS device	annual	zeroCO2 operational team /Vivero Mundo Verde
Disturbed area	ha	Satellite analysis; field inventory	annual	zeroCO2 operational team /Vivero Mundo Verde

Operational and Management structure for monitoring of all indicators

zeroCO2 has an operations unit in Italy and one in Guatemala, which is responsible for all on-site monitoring and reporting. The team is organised as follows:

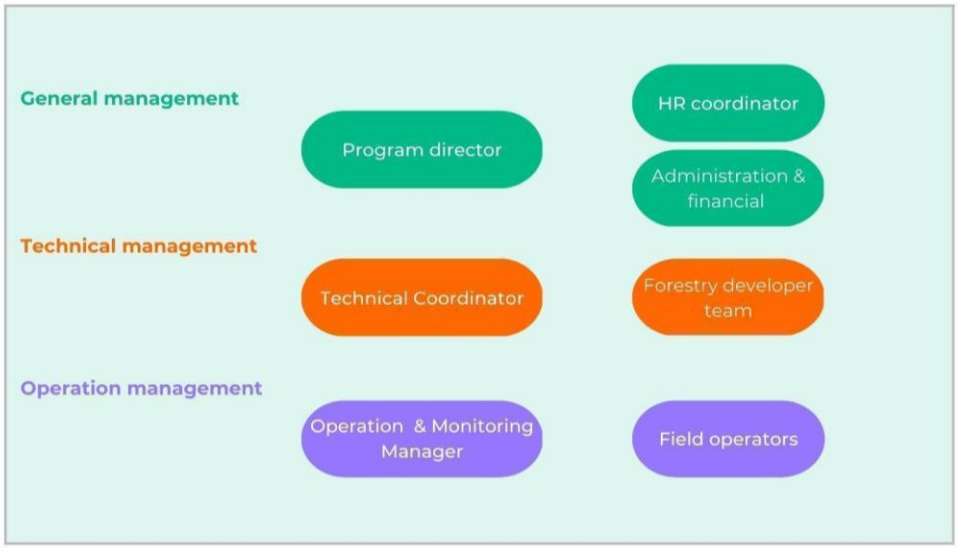


Figure A13.6: Operational and management structure

- Cecilia Monari, Program Director zeroCO2
- Guido Cencini, Technical Director zeroCO2
- Ignacio Auger, Technical Project Manager
- Virgilio Galicia, Program director Vivero Mundo Verde
- Francisco Chi, Technical Director Vivero Mundo Verde
- Walter Aguilar, Operation & monitoring manager Vivero Mundo Verde

Local communities and landowners are directly involved in monitoring carbon benefits and therefore in the forest inventory. For the forest inventory, given the dispersed location of the communities involved in zeroCO2, external consultants may be contracted to carry out the field work. If the work is delegated to local communities or stakeholders, training will be provided beforehand based on the following procedures and principles:

- Training is given to each community technician on the methods to accurately record all required field measurements.
- When community technicians are participating themselves in the project and have responsibilities under a Project Agreement, they do not carry out monitoring of their own activities.
- Communities understand and have agreed upon any payment or incentive they are to receive for participating in monitoring.
- A register is kept of community technicians authorised to carry out monitoring, along with what training they have received (important for verification).
- There is an internal process for the periodic evaluation of performance and accuracy of community monitoring (e.g. an annual review of a 10% sample of the work of the communities' technicians)

c. Ecosystem monitoring

The monitoring plan include the following details for each indicators:

- Sampling approach (if applicable)
- Methods
- Duration and frequency of assessment
- Groups or individuals responsible for monitoring
- Resource and capacity requirements
- Plan for communicating monitoring progress with all stakeholders

Table A13.4: Ecosystem monitoring data collection

Parameter	Unit	Method	Monitoring frequency	Responsibility
Total area of implementation	ha	Project database; GPS monitoring	all year	zeroCO2 operational team /Vivero Mundo Verde
Disturbed area (wildfires, flooding, pests, deforestation, abandonment)	ha	Field monitoring; satellite analysis	all year	zeroCO2 operational team /Vivero Mundo Verde; project participants
Area on which agrochemicals (pesticides, fertilizers) were applied	ha	Field monitoring; surveys	annual	zeroCO2 operational team /Vivero Mundo Verde; project participants
Area on which weeding was carried out	ha	Field monitoring; surveys	annual (from year 3)	zeroCO2 operational team /Vivero Mundo Verde; project participants
Presence of birds	n°	Field monitoring	annual (from \	zeroCO2 operational team /Vivero Mundo Verde
Presence of mammals	n°	Field monitoring	annual (from year 5)	zeroCO2 operational team /Vivero Mundo Verde
Number of species present in soil macrofauna	n°	Field monitoring; Soil analysis	annual (from year 3)	zeroCO2 operational team

Parameter	Unit	Method	Monitoring frequency	Responsibility
				/Vivero Mundo Verde
Number of tree species planted	n°	Project database	annual	zeroCO2 operational team /Vivero Mundo Verde
Area on which assisted natural regeneration (ANR) is applied	ha	Field monitoring; satellite analysis	annual	zeroCO2 operational team /Vivero Mundo Verde
Number of farmers that apply ANR	n°	Project database; field monitoring; surveys	annual	zeroCO2 operational team /Vivero Mundo Verde; project participants
Number of ANR species	n°	Field monitoring; surveys	annual	zeroCO2 operational team /Vivero Mundo Verde
CO2 sequestration through ANR	t CO2/ha	Field monitoring	annual	zeroCO2 operational team /Vivero Mundo Verde
Number of farmers applying measures for climate change adaptation (AFS, buffer zones, firebreaks, adapted crops)	n°	Project database; field monitoring; surveys	annual	zeroCO2 operational team /Vivero Mundo Verde; project participants

d. Livelihood monitoring

The monitoring plan includes the following details for each indicator:

- Sampling approach (if applicable)
- Methods
- Duration and frequency of assessment
- Groups or individuals responsible for monitoring
- Resource and capacity requirements
- Plan for communicating monitoring progress to all stakeholders

The zeroCO2 and Vivero Mundo Verde team will monitor the qualitative and quantitative livelihood indicators every year. The methods used are surveys and interviews with the participants, literature and market analyses as well as the project database and its documentation. The plan is created together with the Board of Directors of the community and shared with each participant to define the best and most effective method for each specific context.

Table A13.5: Livelihood monitoring data collection

Parameter	Unit	Method	Monitoring frequency	Responsibility
Number of participants (per gender, indigenous group)	n°	Project database	all year	zeroCO2 operational team /Vivero Mundo Verde
Number of farmers collaborating among each other (e.g. working groups, farmer groups, cooperatives; per gender, indigenous group)	n°	Project database; surveys	annual	zeroCO2 operational team /Vivero Mundo Verde; project participants
Number of trainings planned for participants	n°	Project database	annual	zeroCO2 operational team /Vivero Mundo Verde
Number of trainings actually provided	n°	Project database	annual	zeroCO2 operational team /Vivero Mundo Verde
Number of participants in courses (per gender, indigenous group)	n°	Project database	annual	zeroCO2 operational team /Vivero Mundo Verde; project participants
Number of evaluation field visits carried out by local staff	n°	Project database	annual	zeroCO2 operational team /Vivero Mundo Verde
Number of local employees	n°	Project database	annual	zeroCO2 operational team /Vivero Mundo Verde
Value of additional income received by participants (carbon payments)	$	Project database	annual	zeroCO2 operational team /Vivero Mundo Verde

Parameter	Unit	Method	Monitoring frequency	Responsibility
Products generated by the project (wood and non-wood)	t	Project database; surveys	annual	zeroCO2 operational team /Vivero Mundo Verde
Value created by the commercialisation of products (e.g. from thinning)	$	Project database; surveys	annual (if applicable)	zeroCO2 operational team /Vivero Mundo Verde; project participants
Number of international partnerships	n°	Project database	annual	zeroCO2 operational team /Vivero Mundo Verde

Annex 14 – Project Database

The following is an excerpt from the database of project participants through 2023. The complete documentation contains sensitive information and can therefore be shared only upon specific request.

BASE DE DATO ZEROCARBON		ANAGRAFICA						LEGAL & FINANCIERO		INTERVENCIÓN										Monitoreo
ID Proyecto	Nombre participante	NDPI	Etnia	Genero	Comunidad	Muncipio	Tipo participante	Derecho sobre la tierra	Copia titulo (si/no)	Linea de base	Poligono	Año de plantacion	Sistema	Tipo arbol	# caoba	# cedro	Tot arboles	ha caoba	ha cedro	Tot ha	VISITA 4/4 Hecha? (SI/No)
2020																	9.722	4,9	3,9	8,8	H2 2023
00004_MC_1	[redacted]	1945	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00005_MC_1		2460	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00006_MC_1		2246	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00007_MC_1		1675	Q qchi	Hombre	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Agricultura	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00008_MC_1		2365	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00015_MC_1		1865	Q qchi	Hombre	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00016_MC_1		1720	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00017_MC_1		2608	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00003_MC_1		2255	Ladino	Mujer	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00013_MC_1		2448	Ladino	Mujer	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Agricultura	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00002_MC_1		2419	Ladino	Mujer	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00009_MC_1		2607	Ladino	Mujer	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00012_MC_1		1771	Ladino	Mujer	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00014_MC_1		2357	Q qchi	Mujer	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00001_MC_1		2628	Ladino	Mujer	Monte Carmelo	La Libertad	Grupal	Propriedad/comunal	si	Ganaderia	Si	2020	Plantacion forestal mixta	Forest	250	250	500	0,23	0,23	0,5	Si
00002_NA_1		1653	Ladino	Hombre	Nuevo Amanecer	La Libertad	Individual	Propriedad/individual	si	Agricultura	Si	2020	Plantacion forestal caoba	Forest	1111	0	1111	1,00	0,00	1,0	Si
00001_PU_1		3281	Ladino	Hombre	Purucila	Santa Ana	Individual	Possion/individual	si	Agricultura	Si	2020	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si
2021																	7.395	2,6	6,1	8,7	H2 2023
00001_LP_1		2212	Ladino	Hombre	Cooperativa La Pa	Las Cruces	Individual	Propriedad/individual	si	Ganaderia	Si	2021	Plantacion forestal mixta	Forest	400	945	1345	0,36	0,85	1,2	Si
00054_NH_3		2333	Ladino	Hombre	Nuevo Horizonte	Santa Ana	Grupal	Propriedad/comunal	si	Ganaderia	Si	2021	Plantacion forestal cedro	Forest	0	550	550	0,00	1,00	1,0	Si
00001_NH_1		2212	Ladino	Hombre	Nuevo Horizonte	Santa Ana	Grupal	Propriedad/comunal	si	Ganaderia	Si	2021	Plantacion forestal cedro	Forest	0	550	550	0,00	0,50	0,5	Si
00052_NH_3		2606	Ladino	Hombre	Nuevo Horizonte	Santa Ana	Grupal	Propriedad/comunal	si	Ganaderia	Si	2021	Plantacion forestal cedro	Forest	0	550	550	0,00	1,00	1,0	Si
00051_NH_3		2384	Ladino	Hombre	Nuevo Horizonte	Santa Ana	Grupal	Propriedad/comunal	si	Ganaderia	Si	2021	Plantacion forestal cedro	Forest	0	550	550	0,00	1,00	1,0	Si
00023_NH_3		2508	Ladino	Hombre	Nuevo Horizonte	Santa Ana	Grupal	Propriedad/comunal	si	Ganaderia	Si	2021	Plantacion forestal cedro	Forest	0	550	550	0,00	1,00	1,0	Si
00001_PA_1		1878	Ladino	Hombre	Parcelamiento Act	San Andrés	Individual	Propriedad/individual		Agricultura	Si (2)	2021	Plantacion forestal cedro	Forest	0	800	800	0,00	0,72	0,7	
00001_SJ_1		1652	Ladino	Hombre	San Juan de Dios	San Francisco	Individual	Propriedad/individual		Ganaderia	Si	2021	Plantacion forestal caoba	Forest	2500	0	2500	2,25	0,00	2,3	

2022																									M2 2023
																			35,4	84,7	120,1				
00005_CH_1	[redacted]	UNE	2717	Ladino	Hombre	Canahan	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	375	675	1050	0,34	0,61	1,0	Si			
00003_CH_1		UNE	1722	Ladino	Hombre	Canahan	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	375	675	1050	0,34	0,61	1,0	Si			
00004_CH_1		UNE	1974	Ladino	Hombre	Canahan	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	750	1350	2100	0,68	1,22	1,9	Si			
00002_CH_1		UNE	1967	Ladino	Mujer	Canahan	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	375	675	1050	0,34	0,61	1,0	Si			
00001_CS_1		UNE	1770	Q'qchi	Hombre	Cruce Semuy	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00001_ED_1		UNE	1730	Q'qchi	Hombre	El Eden	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	520	469	989	0,47	0,42	0,9	Si			
00002_ED_1		UNE	1715	Q'qchi	Hombre	El Eden	Sayaxche	Individual	Posesion/Individual	No	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	520	469	989	0,47	0,42	0,9	Si			
00001_CA_1		UNE	2501	Q'qchi	Hombre	Las Camelias	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00004_CA_1		UNE	2315	Q'qchi	Hombre	Las Camelias	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	1105	1117	2222	0,99	1,01	2,0	Si			
00005_CA_1		UNE	1593	Q'qchi	Hombre	Las Camelias	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	1657	1677	3334	1,49	1,51	3,0	Si			
00002_CA_1		UNE	1664	Q'qchi	Mujer	Las Camelias	Sayaxche	Individual	Propiedad/Individual	si	Agricoltura	Si	2022	Plantacion forestal mixta	Forest	1657	1677	3334	1,49	1,51	3,0	Si			
00018_MC_1		UNE	2212	Q'qchi	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00020_MC_1		UNE	2709	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00021_MC_1		UNE	2402	Q'qchi	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00004_MC_1		UNE	1945	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal caoba	Forest	210	0	210	0,19	0,00	0,2	Si			
00024_MC_1		UNE	2317	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal caoba	Forest	397	0	397	0,36	0,00	0,4	Si			
00034_MC_1		UNE	2226	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00027_MC_1		UNE	1586	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00028_MC_1		UNE	1588	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal cedro	Forest	0	229	229	0,00	0,21	0,2	Si			
00032_MC_1		UNE	2576	Q'qchi	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00036_MC_1		UNE	2153	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00037_MC_1		UNE	2330	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00038_MC_1		UNE	2517	Q'qchi	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00039_MC_1		UNE	2301	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00040_MC_1		UNE	2785	Ladino	Hombre	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Ganaderia	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00019_MC_1		UNE	2676	Ladino	Mujer	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			
00012_MC_1		UNE	1771	Ladino	Mujer	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal caoba	Forest	60	0	60	0,05	0,00	0,1	Si			
00033_MC_1		UNE	1785	Ladino	Mujer	Monte Carmelo	La Libertad	Grupal	Propiedad/comunal		Agricoltura	Si	2022	Plantacion forestal mixta	Forest	555	556	1111	0,50	0,50	1,0	Si			

2023																									
																			159,8	146,7	306,5				
	[redacted]	2546	Q'qchi	Hombre	Agua Chiquita	Sayaxche	Individual	Propiedad/Individual		agricola		2023	Plantacion forestal mixta	Forest	1350	1350	2700	1,2	1,2	2,4	Si			
		Ivuoto	Q'qchi	Hombre	Agua Chiquita	Sayaxche	Individual	Propiedad/Individual		agricola		2023	Plantacion forestal mixta	Forest	556	555	1111	0,5	0,5	1,0	Si			
		1762	Q'qchi	Hombre	Agua Chiquita	Sayaxche	Individual	Propiedad/Individual		agricola		2023	Plantacion forestal mixta	Forest	1550	1550	3100	1,4	1,4	2,8	Si			
		Ivuoto	Q'qchi	Hombre	Agua Chiquita	Sayaxche	Individual	Propiedad/Individual		agricola		2023	Plantacion forestal mixta	Forest	556	555	1111	0,5	0,5	1,0	Si			
		1698	Q'qchi	Hombre	Canahan	Sayaxche	Individual	Propiedad/Individual		agricola		2023	Plantacion forestal mixta	Forest	556	555	1111	0,5	0,5	1,0	Si			
		1967	Q'qchi	Hombre	Canahan	Sayaxche	Individual	Propiedad/Individual		agricola		2023	Plantacion forestal caoba	Forest	1111	0	1111	1,0	0,0	1,0	Si			
		1967	Q'qchi	Hombre	Canahan	Sayaxche	Individual	Propiedad/Individual		agricola		2023	Plantacion forestal cedro	Forest	0	1111	1111	0,0	1,0	1,0	Si			
		3730	Q'qchi	Hombre	Caserio La Isla	Sayaxche	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal caoba	Forest	16670	0	16670	15,0	0,0	15,0	Si			
		3730	Q'qchi	Hombre	Caserio La Isla	Sayaxche	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal cedro	Forest	0	33330	33330	0,0	30,0	30,0	Si			
		1770	Q'qchi	Hombre	Cruce Semuy	Sayaxche	Individual	Propiedad/Individual		agricola		2023	Plantacion forestal mixta	Forest	556	555	1111	0,5	0,5	1,0	Si			
		1691	Ladino	Hombre	El Buen retiro	Santa Ana	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal mixta	Forest	1000	5555	6555	0,9	5,0	5,9	Si			
		2296	Ladino	Hombre	El Buen retiro	Santa Ana	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal cedro	Forest	0	5555	5555	0,0	5,0	5,0	Si			
		1748	Ladino	Hombre	El Caoba	Flores	Individual	Propiedad/Individual		area agricola en descans		2023	Plantacion forestal mixta	Forest	1111	2222	3333	1,0	2,0	3,0	Si			
		2382	Ladino	Hombre	El Caoba	Flores	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal mixta	Forest	300	811	1111	0,3	0,7	1,0	Si			
		1806	Q'qchi	Hombre	El Eden	Sayaxche	Individual	Propiedad/Individual		agricola		2023	Plantacion forestal cedro	Forest	0	2222	2222	0,0	2,0	2,0	Si			
		2576	Ladino	Hombre	El Julogue	Santa Ana	Individual	Propiedad/Individual		area agricola		2023	Plantacion forestal mixta	Forest	556	555	1111	0,5	0,5	1,0	Si			
		Ivuoto	Ladino	Hombre	El Polol	La Libertad	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal mixta	Forest	2777	2778	5555	2,5	2,5	5,0	Si			
		2574	Ladino	Hombre	El Rosalito	Sayaxche	Individual	Propiedad/Individual		area agricola		2023	Plantacion forestal cedro	Forest	0	1111	1111	0,0	1,0	1,0	Si			
		2574	Q'qchi	Hombre	El Rosalito	Sayaxche	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal caoba	Forest	1111	0	1111	1,0	0,0	1,0	Si			
		2697	Q'qchi	Hombre	El Rosalito	Sayaxche	Individual	Propiedad/Individual		area agricola en descans		2023	Plantacion forestal mixta	Forest	1667	1667	3334	1,5	1,5	3,0	Si			
		2372	Q'qchi	Hombre	El Rosalito	Sayaxche	Individual	Propiedad/Individual		area agricola en descans		2023	Plantacion forestal mixta	Forest	1667	1667	3334	1,5	1,5	3,0	Si			
		2228	Q'qchi	Hombre	Entre Rios	Sayaxche	Individual	Propiedad/Individual		area agricola		2023	Plantacion forestal cedro	Forest	0	1111	1111	0,0	1,0	1,0	Si			
		Ivuoto	Ladino	Hombre	Km 40	Santa Ana	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal cedro	Forest	0	2434	2434	0,0	2,2	2,2	Si			
		Ivuoto	Ladino	Hombre	Km 40	Santa Ana	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal cedro	Forest	0	6501	6501	0,0	5,9	5,9	Si			
		1673	Ladino	Hombre	La Laguna Perdida	San Andrés	Individual	Propiedad/Individual		Ganaderia		2023	Plantacion forestal mixta	Forest	3600	2000	5600	3,2	1,8	5,0	Si			

Annex 15 – Letter of Approval

Below is the zeroCARBON program launch notification to the relevant institutions. Additional documentation is available upon specific request.

RIFORESTAZIONE AD ALTO IMPATTO SOCIALE

Petén, Guatemala, 19 de mayo de 2022.

Ing. Wyllsson Adiel Martínez Gómez
Director INAB
Región VIII, Petén
San Francisco, Petén.

Es grato dirigirme a usted, esperanto que sus actividades al frente de Instituto Nacional de Bosques Región VIII Petén, se desarrollen de la mejor manera.

El motivo de la presente es para hacer de su conocimiento que la empresa italiana ZeroCO2 SRL SB, en el presente año estará implementando un proyecto de captación de carbono denominado *ZEROCARBON,* a través del establecimiento de plantaciones forestales, sistemas agroforestales y restauración del paisaje, mediante el cual se estará beneficiando a personas individuales y comunidades rurales con bonos de carbono, en el departamento de Petén.

Me suscribo de usted.

ZERØCO2
Vian Giam Giacomo
Gerente de Operaciones
Roma, Italia

Virgilio Santos Galicia Gregorio
ZeroCO2 SRL SB
Cel. 4287 2809

INSTITUTO NACIONAL DE BOSQUES
DIRECCIÓN REGIONAL VIII
RECIBIDO
19 MAY 2022
HORA: 14:11pm FIRMA:

Annex 16 – Financial Plan

This documentation contains confidential information and is not publicly available. It can be shared upon specific request.

Annex 17 – Species List Natural Regeneration

The following is an excerpt from the species list of 40 species that appear through Natural Regeneration in the project area and will be promoted. The complete documentation is available upon request.

A	B
RESUMEN DEL INVENTARIO FORESTAL	
Nombre Común	**Nombre Científico**
Aguacatillo	Licaria campechiana
Amapola	Pseudobombax ellipticum
Amate	Ficus obtusifolia
Bojon negro	Cordia gerascanthus
Cacho de venado	Eugenia cervina
Canxan	Terminalia amazonia
Caoba	Swietenia macrophylla
Cedro	Cedrela odorata
Chacaj colorado	Bursera simaruba
Chichipate	Acosmium panamense
Chintoc blanco	Wimmeria concolor
Cola de pava	Cupania Glabra
Cotonrón	Luehea speciosa
Cushin	Inga vera
Guayabillo	Myrcianthes storkii
Hoja de queso	Miconia argentea
Jobillo	Astronium graveolens
Jobo	Spondias mombin
Laurel	Cordia alliodora
Laurel blanco	Nectandra membranacea
Manchiche	Lonchocarpus castilloi
Manchiche de bajo	Lonchocarpus rugosus
Palo de clavo	Spp.
Pasac hembra	Simarouba glauca
Pucte	Terminalia buceras
Roble	Cordia diversifolia
Sacuayum	Matayba oppositifolia
Sacuche	Bourreria oxyphylla
Saltemuche	Simira salvadorensis
Santa maria	Calophyllum brasiliense
Sastante	Xylopia frutescens
Son	Alseis yucatanensis
Sosni	Nectandra coriacea
Tamahay	Zuelania guidonia
Tecomasuche	Cochlospermaceae

Annex 18 - Assisted Natural Regeneration Proposal and CO2 estimation

The following is an excerpt from the timber economic evaluation document. The complete documentation is available upon request. An update of ANR studies and estimates is in progress.

Objetivo	**Integrar la Regeneración Natural Asistida (ARN)** en todas las plantaciones que se registraron en el proyecto zeroCARBON en el año 2022 y 2023.
Hectáreas y Participantes	• **2022: 143.3 ha, 119 participantes** • 2023. pendiente de análisis de datos
Periodo de implementación	**A partir del año 4,** en lugar del año 5**.** En ese periodo si la plantación ha sido bien manejada, los árboles de Cedro y Caoba habrán alcanzado la suficiente altura y madurez como para no ser afectados por la competencia con otras especies. En plantaciones exitosas, como la de Monte Carmelo, se ha demostrado que en 3 años se puede alcanzar este escenario. Evidencia fotográfica será proporcionada.
Método	**El método de integración de ANR se hará de forma gradual y selectiva complementaria con las plantaciones forestales,** en el estrato del sotobosque. Fomentando las especies de valor comercial y ecológico. Los planes de Manejo y documentos INAB serán utilizados como referencia para definir las actividades específicas.
Monitoreo	**Monitoreo anual a partir del año 4.** Número de especies, identificación de especies de acuerdo con el plan de monitoreo de regeneración natural establecido por zeroCO2
Participación beneficiarios	• La ANR está incluida en los acuerdos con los participantes como requisito para la participación en el proyecto zeroCARBON. Se realizará una cuantificación del carbono proporcional a los resultados del monitoreo e incluido en el sistema de beneficios. • Se considerará el ingreso en INAB PROBOSQUE, en la modalidad de Restauración Forestal, dependiendo de si las parcelas cumplen con los requisitos, y solo en el caso de que no hayan participado anteriormente en el programa de incentivos. (Esto se podría hacer a partir después de la primera rotación (año 20) o antes. • Los beneficiarios se podrán beneficiar de la explotación de especies arbóreas nativas que aparezcan por medio de la regeneración, en el caso de que cumplan con lo establecido en la Ley Forestal para la explotación de los recursos forestales. • Se incorporará taller de ANR para sensibilización dentro de las actividades de capacitación. • Los beneficiarios estarán incentivados a mantener la regeneración natural, ya que formará parte de un único sistema que incluye cedro y caoba, especies de alto valor comercial. En el área del proyecto, la práctica más común es eliminar la regeneración porque no contiene especies de alto valor comercial, y porque no es compatible con la agricultura o ganadería.

Year	Trees / ha [n]	ANR trees/ha [n]	Year ANR intergation	CO2 [Mg/tree]	CO2 [Mg/ha]
1	1111	-	-	-	-
2	1000	-	-	-	-
3	1000	-	-	-	-
4	1000	25	1	0.0218	0.5452
5	900	25	2	0.0436	1.0903
6	900	35	3	0.0654	2.2897
7	900	35	4	0.0872	3.0529
8	900	45	5	0.1090	4.9065
9	600	55	6	0.1308	7.1961
10	600	55	7	0.1526	8.3955
11	600	55	8	0.1745	9.5948
12	600	65	9	0.1963	12.7568
13	300	65	10	0.2181	14.1742
14	300	75	11	0.2399	17.9903
15	300	75	12	0.2617	19.6258
16	300	*	13	0.2835	21.2613
17	300	*	14	0.3053	22.8968
18	300	*	15	0.3271	24.5323
19	300	*	16	0.3489	26.1678
20	300	*	17	0.3707	**27.8033**

CO2 storage [Mg/ha] after 20 years of ANR integration	
Low	22.243
Medium	27.8033
High	33.364

Annex 19 - Timber Economic Evaluation

The following is an excerpt from the timber economic evaluation document. The complete documentation is available upon request.

Escenario 1

- Precio corta final: 6Q/Pie tablar (2317 Q/m3).
- Condiciones: Desarrollo malo de plantación (Índice de sitio 8-12)

REVENUE. ESCENARIO 1 (valor mínimo: 6Q/pie tablar)					
Edad de plantación (t)	**Actividad**	**Valor madera en pie (Q/m3)**	**Volumen comercial (m3/ha)**	**Valor comercial (Q/ha)**	**Valor comercial (€/ha)**
5	**Raleo 1**	0	0	0	€ 0,00
8-12	**Raleo 2**	1158,5	10,52	12187,42	€ 1.433,81
15-18	**Raleo 3**	1737,75	17,04	29611,26	€ 3.483,68
20	**Corta final**	2317	20,59	47707,03	€ 5.612,59
				Q 89505,71	**€ 10.530,08**

Escenario 2

- Precio corta final: 9Q/pie tablar.
- Condiciones: Desarrollo normal de plantación (Índice de sitio 12-16)

REVENUE. ESCENARIO 2 (valor medio: 9Q/pie tablar)					
Edad de plantación (t)	**Actividad**	**Valor madera en pie (Q/m3)**	**Volumen comercial (m3/ha)**	**Valor comercial (Q/ha)**	**Valor comercial (€/ha)**
5	**Raleo 1**	0	0	0	€ 0,00
8-12	**Raleo 2**	1906,5	10,52	20056,38	€ 2.359,57
15-18	**Raleo 3**	2859,75	17,04	48730,14	€ 5.732,96
20	**Corta final**	3813	20,59	78509,67	€ 9.236,43
				Q 147296,19	**€ 17.328,96**