



REFORESTATION WITH TEAK – CO₂E TEAKMEX

Document Prepared by
Swiss Carbon Value Ltd.

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Reforestation with Teak – CO₂e TEAKMEX is an AR grouped project located in the Mexican states of Tabasco, Chiapas, and Campeche. Its main objective is to mitigate climate change through the carbon sequestration with *Tectona grandis* forest plantations. The project aims to promote the sustainable development of the forestry sector by providing fair job opportunities, recovering degraded soils from livestock and agriculture, and conserving natural forest areas within the project areas to enhance and protect the local biodiversity.

The crediting period of the project is 36 years; it started on June 30th, 2013 and will end on May 31st, 2049. On average, it has a net emission removal potential of 29,588.22¹ tCO₂e/year with a total for the entire period² of 1,238,344.35 tCO₂e. The project eligible area has an extension of 6,098.7 ha, of which 3,743.06 ha represent Instance No. 1 and 2,355.67 ha represent Instance No. 2, established during the second monitoring period in 2017, 2018, and 2019. The first instance consists of 97 properties distributed across the municipalities of Tenosique, Huimanguillo, Balancán, Candelaria, and Carmen y Palenque, and the second consists of 31 properties across the municipalities of Balancán, Candelaria, Carmen, Escárcega, Tenosique, Salto de Agua, and Palenque.

The objective of this document is to describe project activities implemented during the second monitoring period, which started on October 16th, 2017 and ended on October 21st, 2020, and verify the 344,072 tCO₂e net GHG emissions reduction achieved from *T. grandis* plantations. The activities developed during the monitoring period were related to protocols for soil selection, nursery improvements, water supply and management, the control of pests and diseases, the mechanization of thinning, and workers and communities. Ultimately, the project generated 900 jobs and supported local communities in attaining basic needs, such as providing formal employment opportunities in regions largely characterized by informality, especially during planting, monitoring activities, and in the maintenance of its conservation areas.

1.2 Sectoral Scope and Project Type

The project corresponds to VCS scope 14 “Agriculture, Forestry and Other Land Use” as an Afforestation, Reforestation and Revegetation (ARR). The project is a grouped project.

¹ According to Ex ante estimations updated for present verification. See section 3.2.2.1 Ex-ante estimations for net GHG emission reductions and removals.

² Until reaching the Long Term Average (LTA).

1.3 Project Proponent

Organization name	Agropecuaria Santa Genoveva S.A.P.I. de C.V.
Contact person	Víctor Hugo Fernández
Title	General Director
Address	Carretera Cayal Nohyaxche Km 87 Location Alfredo V Bonfil C.P. 24570 Campeche México
Telephone	+(52) 981 813 2066
Email	victor.fernandez@genoveva.com.mx

1.4 Other Entities Involved in the Project

Organization name	Swiss Carbon Value Ltd.
Role in the Project	South Pole creates and oversees the development of appropriate project design and monitoring techniques in line with the guidelines of the VCS.
Contact person	Maria Fernanda Buitrago
Title	Forest and Land Use Adviser
Address	Rio Magdalena 117, 103 Progreso, Tizapan Distrito Federal 01080, México
Telephone	+(52) 55 55 31 90 13
Email	m.buitrago@southpole.com

1.5 Project Start Date

The project began on June 30th, 2013. Seeding activities began on this date in Doña Carmina ³ farm.

³ Supporting documents [Start date]

1.6 Project Crediting Period

For the current grouped project, the crediting period will be 36 years. The period starts on June 30th, 2013, and ends on May 31st, 2049.

1.7 Project Location

The region of expansion of the grouped project covers the states of Tabasco, Chiapas, and Campeche in Mexico (Figure 1).

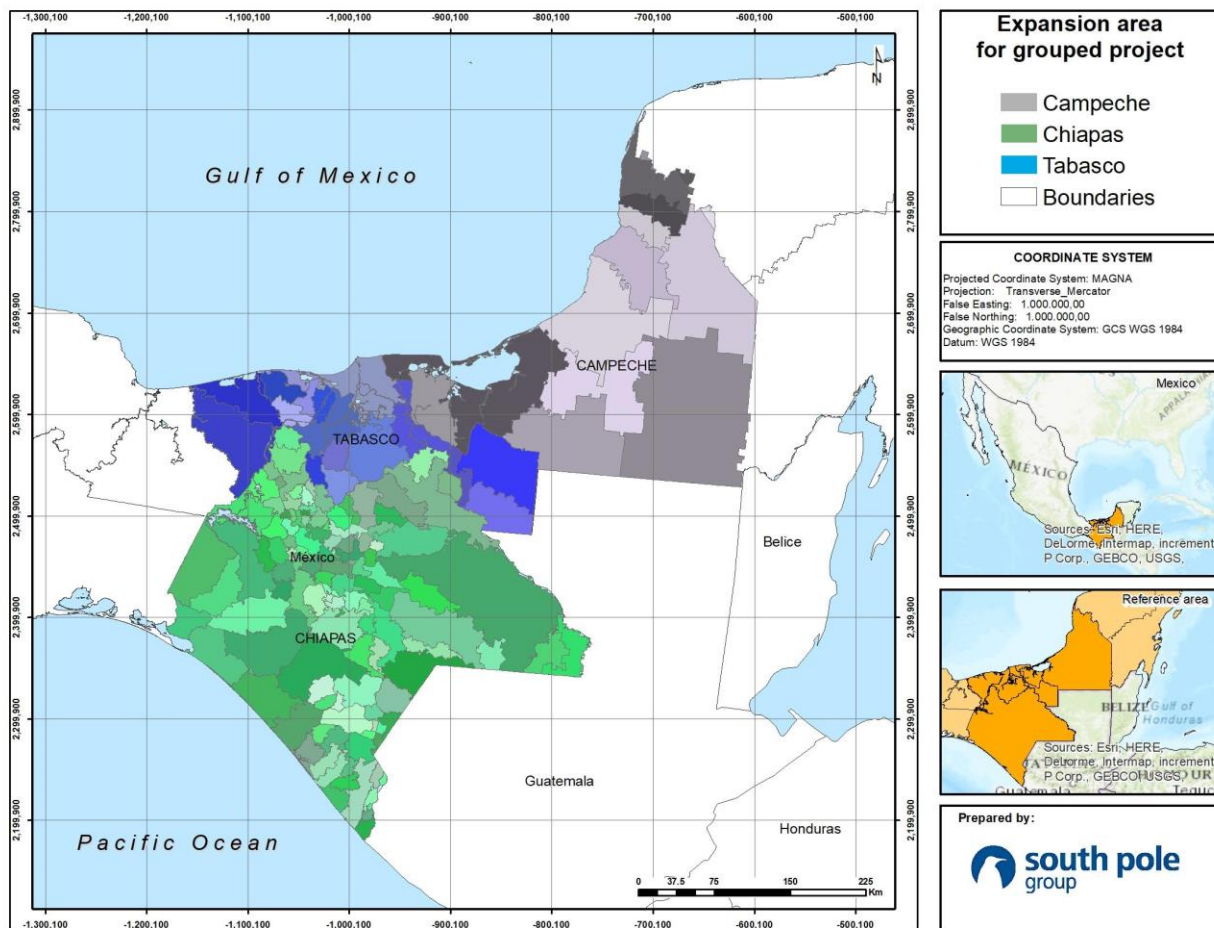


Figure 1: Project Area

1.7.1 Project area

The project area⁴ included during the first phase of the grouped project spans 3,743.06⁵ ha, across 97 instances (properties) located in five municipalities: 16 properties in Balancán (Tabasco), 54 properties in Huimanguillo (Tabasco), 13 properties in Tenosique (Tabasco), two properties in Palenque (Chiapas), and 12 properties in Candelaria (Campeche).

⁴ Eligible area.

⁵ Project Description & Monitoring Report, Reforestation with teak CO₂e TEAKMEX. 2018

During the second phase, the grouped project spans 2,355.67 ha across five properties in the municipalities of Balancán (Tabasco), 11 properties in Candelaria (Campeche), three properties in Carmen (Campeche), four properties in Escárcega (Campeche), six properties in Tenosique (Tabasco), one property in Salto de Agua (Chiapas), and one property in Palenque (Chiapas).

The location of the project area of the first and second phase of the grouped project is presented below:

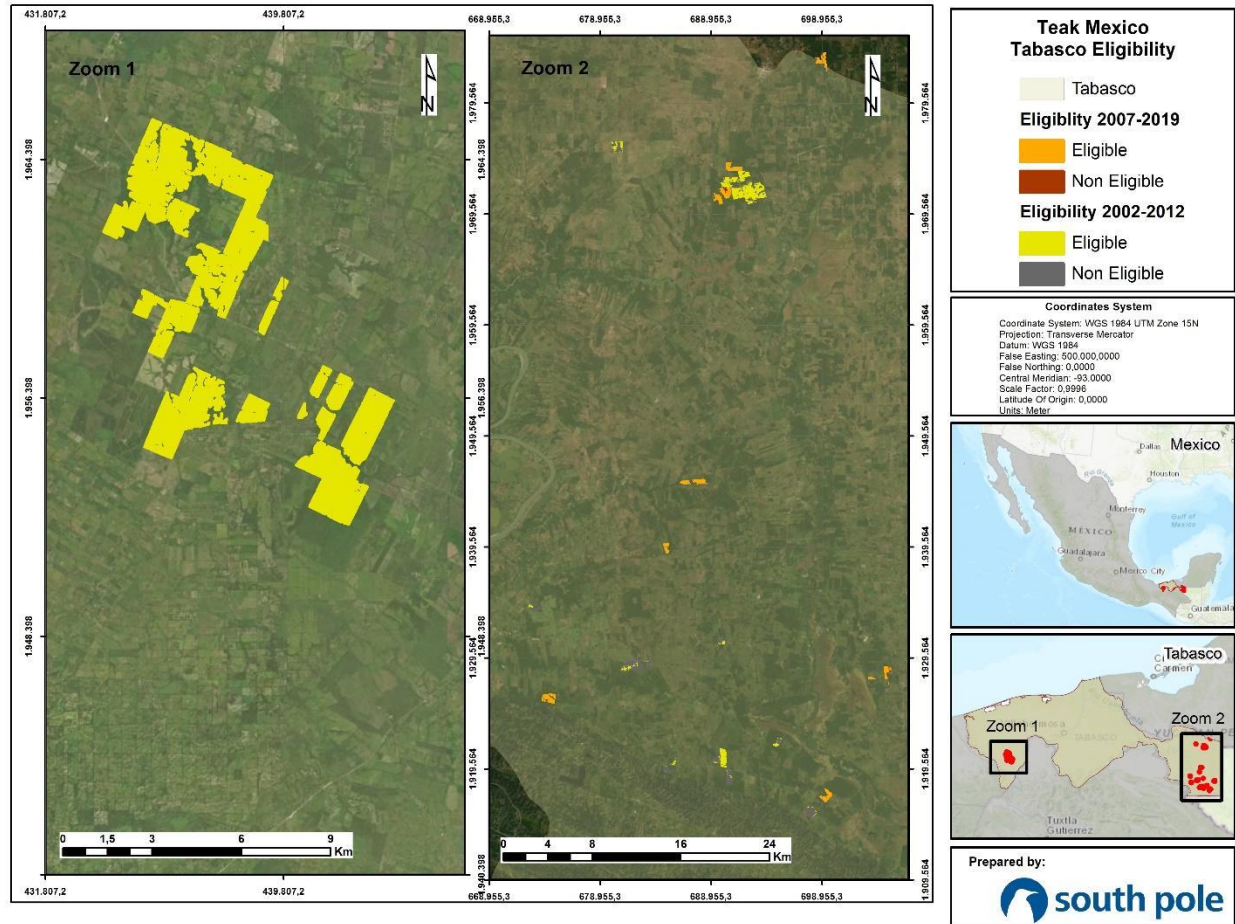


Figure 2: Project area first and second phase Tabasco

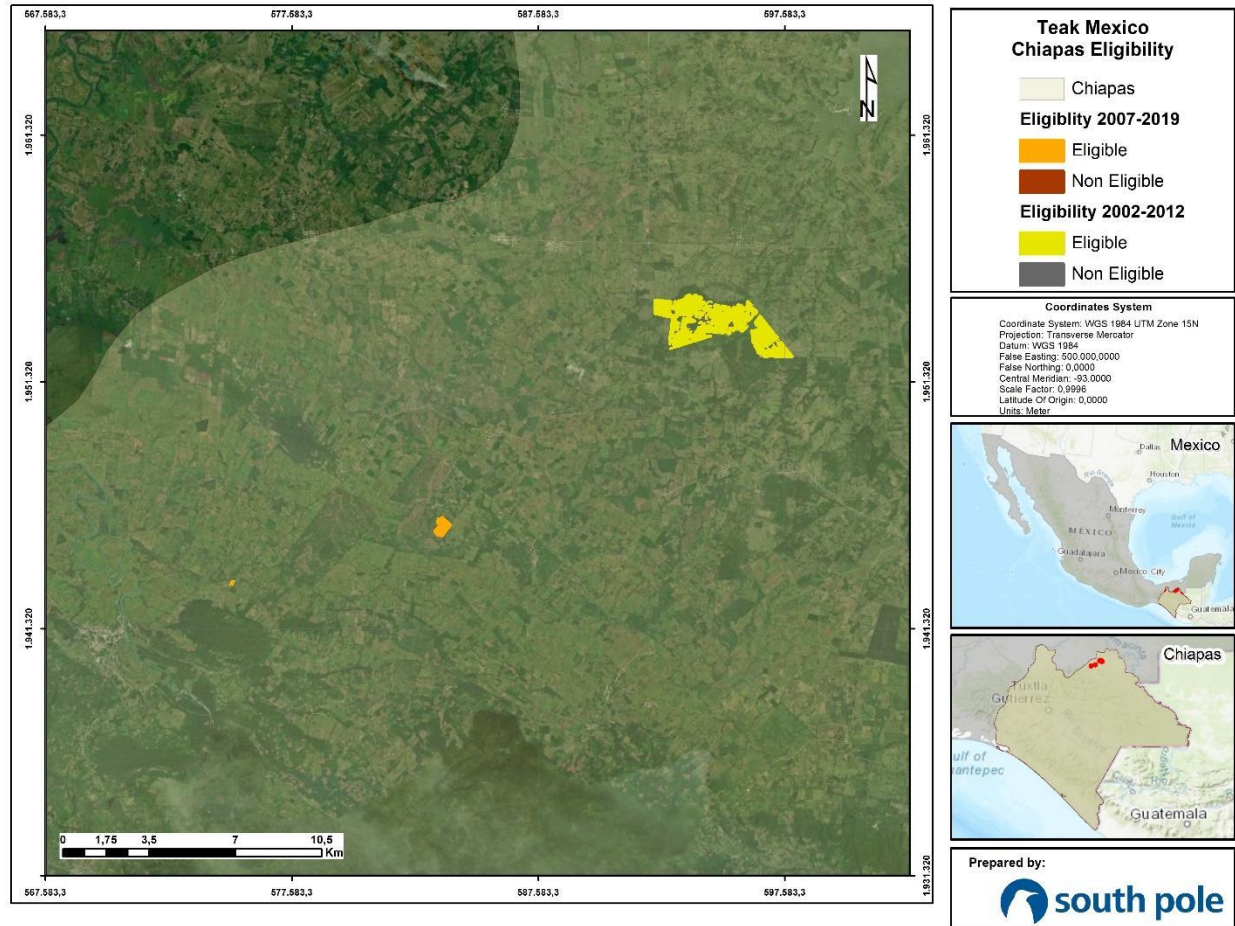


Figure 3: Project area first and second phase Chiapas

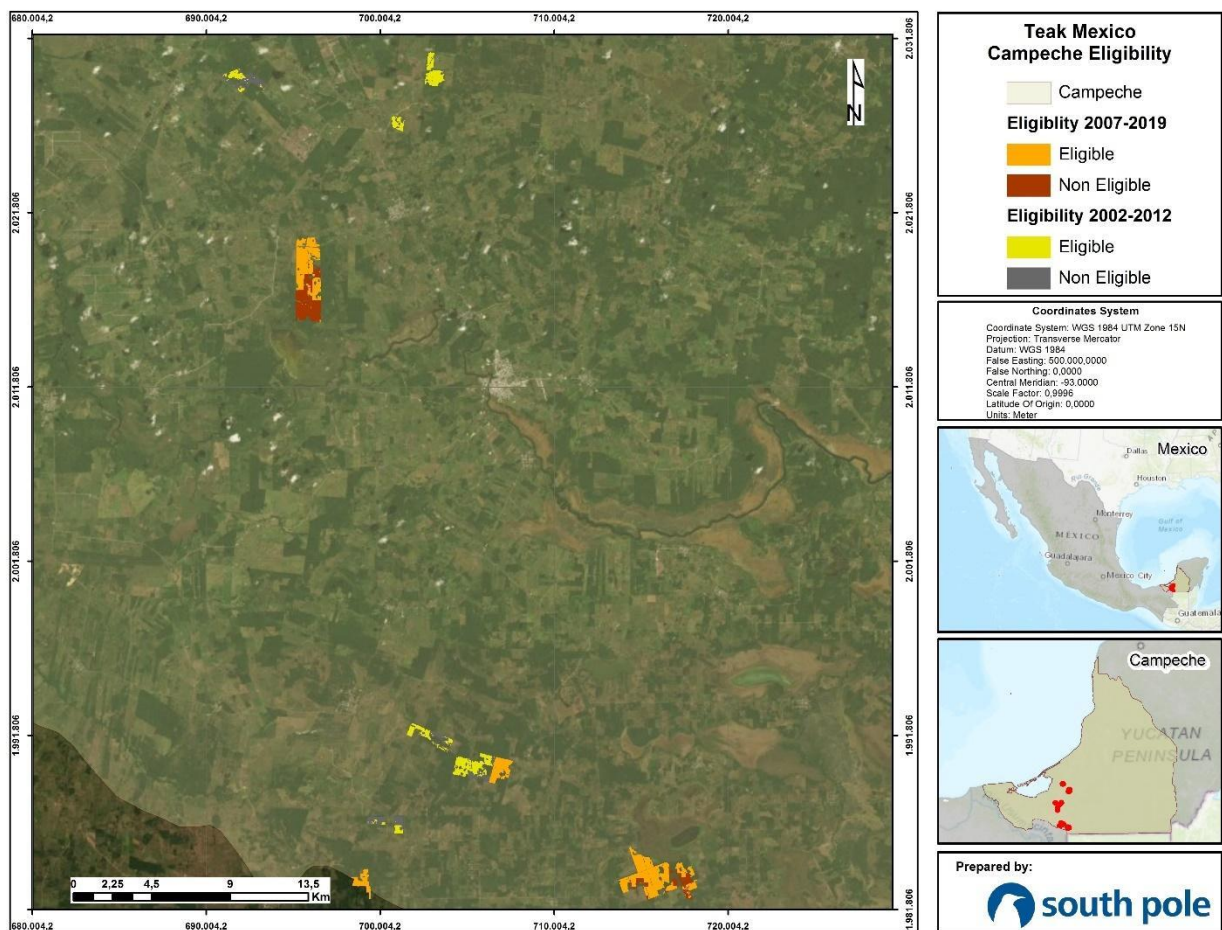


Figure 4: Project area first and second phase Champeche

1.8 Title and Reference of Methodology

AR-ACM0003. Afforestation and reforestation of lands except wetlands. Version 2.0⁶

Applied tools⁷:

The applied tools are the following:

“Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities Version 01”.

CDM_AR-TOOL12 “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities Version 03.1”.

⁶ This methodology is available online at: <http://cdm.unfccc.int/eference/index.html>.

⁷ These documents are available online at: <http://cdm.unfccc.int/Reference/index.html>.

CDM_AR_tool_14 “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities Version 04.2”.

CDM_AR-TOOL15 “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity Version 02.0”.

“Estimation of non-CO₂ greenhouse gas (GHG) emissions resulting from burning of biomass attributable to an A/R CDM project activity Version 04.0.0”.

1.9 Participation under other GHG Programs

The project has not been registered, nor is it seeking registration under any other GHG program.

1.10 Other Forms of Credit

The project has not sought or received any other GHG environmental credit either non GHG environmental credits. GHG emission removals are issued only as VCUs under VCS certification. No other types of GHG credits or other forms of environmental credit are trading by other programs or mechanisms.

1.11 Sustainable Development

Given its expected outcomes, the project will contribute to the following United Nations Sustainable Development Goals.

	The project provides new opportunities for formal employment in the region, contributing to an improved quality of life for the local population. Currently, AGSA provides 900 permanent jobs, thus promoting regional economic growth. Approximately 90% of the workers are from the states of Campeche, Tabasco, and Chiapas, and most workers are hired from the towns surrounding the plantation facilities.
	New employment opportunities provide the community with greater economic and food security.
	The project provides job opportunities for women. In 2020 48 women hired, distributed in: Campeche, Tabasco, and Chiapas



In the region, informal work is a common pattern, led by the state of Chiapas with 78%, followed by the state of Tabasco with 67.2%, and finally, by the state of Campeche with 64.3%, exceeding the national average. Workers generally work under high-risk conditions in terms of occupational safety.⁸

In the region, people are often hired without being offered social security or a lasting job, something that is reflected in the statistics provided by the Ministry of Labor and Social Security (2017)⁹, where the percentage of workers assigned to the Institute Mexican Social Security in the state of Chiapas is only 26.1%, 27.2% in the state of Tabasco, and 49.3% in the state of Campeche. Therefore, if a workplace accident occurs, the worker is typically affected further because they must assume financial responsibility for their medical costs and missed days of work.

Currently, AGSA provides 424 permanent jobs with all benefits, thus promoting regional economic growth. Staff are granted the following additional benefits to those established in the Federal Labor Law, such as: loans for workers; recreational activities, financial support¹⁰, life insurance, and rewards for time spent at the company.



The project promotes the sustainable development of its value chain. Proof of this is the monitoring of FSC requirements in the implementation of forestry activities. In addition to this, AGSA is the first company in the agricultural sector in Mexico to obtain the Environmental Compliance Certificate granted by the Ministry of Environment and Natural Resources (SEMARNAT) through the Federal Environmental Protection Agency (PROFEPA) for the management of forest plantations.



The project is concerned with the sustainable development of its activities and its contribution to the mitigation of climate change. The project area for the first instance has the potential to reduce 116,628, 24 tCO₂e, and for the second instance, has the potential to reduce 409,261.40 tCO₂e of GHG emissions.



PROFEPA granted AGSA/the project owner an environmental certification in 2013 for Forest Conservation of Natural Areas. Currently, PROFEPA is in the process of re-certifying this project, giving recognition to its continued conservation commitments.¹¹

⁸ STPS. (2017). Tabasco, Labor Information. STPS. Retrieved from [http://www.stps.gob.mx/gobmx/estadisticas/pdf/perfiles/perfil tabasco.pdf](http://www.stps.gob.mx/gobmx/estadisticas/pdf/perfiles/perfil%20tabasco.pdf)

⁹ STPS. (2017). Tabasco, Labor Information. STPS. Retrieved from [http://www.stps.gob.mx/gobmx/estadisticas/pdf/perfiles/perfil tabasco.pdf](http://www.stps.gob.mx/gobmx/estadisticas/pdf/perfiles/perfil%20tabasco.pdf)

¹⁰ Example: two days with salary and payment for the birth of legally recognized children; two days with salary enjoyment and civil marriage payment; two days with salary enjoyment and payment for the death of a first-degree relative.

¹¹ Proof of certification is presented as a supporting document [Supporting documents\PROFEPA certification].

2 SAFEGUARDS

2.1 No Net Harm

According to the analysis developed during the validation process, the project has generated through the implementation of its activities some negative impacts that have been monitored and mitigated through a series of activities (see Table 1).

Table 1: Potential negative impacts of project activities and their mitigation measures

Activity	Impacts	Measures
Land preparation Nurseries Thinning Exploitation	Flora and fauna	Relocation of fauna species
Nurseries Thinning Exploitation	Soils	Improved nursery techniques Mechanized thinning and exploitation activities
Land preparation Thinning Exploitation	Air	Vehicles and equipment are in optimal conditions and their maintenance is adequate.
Nurseries	Water	Strict use of water by micro-sprinklers for irrigation
Plantation Pruning Thinning Fertilization Health Fires Exploitation	Health	Training in different areas such as work posture, personal protective equipment, use of chemical substances, fire control, etc.

During this monitoring period, the project owner developed the following activities as part of the mitigation measures proposed¹².

2.1.1 Selection of land for plantation

Soil selection guaranteeing protocols that optimize the selection of planting areas through verifying topographic conditions and the presence of native vegetation and fauna, and analyzing physical and chemical factors such as permeability degree, susceptibility to ponding/flooding, fertility, and the presence of toxic elements (see Figure 5).

al

¹² See [Supporting documents/ Ppt_Mitigation measures AGSA July2020]

2.1.2 Nursery techniques improvements

Selection of high-quality plates. AGSA has the capacity to produce around 2 million plants per year from a 4 ha nursery. Tissue culture, reproduction by cuttings, and nursery work are combined to improve the yield of the plantations (see Figure 6).



Figure 5: Nursery improvements

2.1.3 Water supply and prevention of water excesses

Production improvements through implementing water supplying irrigation (if necessary), using technology to prevent flooding and water losses (wells and pumping equipment in optimal conditions and

drip irrigation), and creating drainages to control water excess if needed to guarantee humidity and water saturation (see Figure 7).



Water wells and pumps



Drip irrigation



Drainages to control water excess

Figure 6: Water supply and prevention of excesses

2.1.4 Control of pests and diseases

In the control of pests and diseases, priority is given to biological control (see Figure 8), releasing natural predators such as *Cryptolaemus montrouzieri* or *Anagyrus kamali* (a parasite), to control *Maconellicoccus hirsutus* (known in the project area as “cochillilla rosada”).

When insecticides are necessary, the least aggressive and those with less adverse effects on beneficial insects are used (as in the case of the teak defoliator). The insecticide spinetoram is often used, which is based on a fermented product that has shown high effectiveness in low doses and is not harmful to other insects (see Figure 9).



Damages by *Maconellicoccus hirsutus*



Release of *Cryptolaemus montrouzieri*

Figure 7: Biological control of *Maconellicoccus hirsutus*



Hyblaea puera (known as teak defoliator)

Figure 8: Control of pests and diseases – Hyblaea puera

To reduce damage to the ecosystems, for each lot type, protocols are defined to delimit affected or potentially affected areas, and criteria for tree sampling and identification of cochineal are outlined. In addition, monitoring plans¹³ define the specific responsibilities of field staff in the monitoring, reporting and pest control processes. In addition to the control and monitoring protocol of possible Pests and Disease, information of the implementation of these activities are presented in: Supporting documents\NPRT\Natural risk\Pest and Disease. Different records of pest presences can be found on this folder, with the management of pest like *Macconellicoccus hirsutus* and *Anagyrus kamali*, which are controlled with activities in conjunction with the National Reference Center for Biological Control and the Secretariat of Environment and Natural Resources (SEMARNAT).

Other agrochemicals commonly used in plantation management during the monitoring period are listed in Table 2.

Table 2 Agrochemicals commonly used in plantation management

Name of the product	Product Type
UREA 46-00-00	Fertilizer
Korte concentrado	Herbicide
Trompa	Insecticide
Formula 22-16-7 DAP	Fertilizer
Formula 24.3 - 20.3 - 12.2	Fertilizer
Fertilizante DAP fosfato diamonico	Fertilizer
Fertilizante MF 32.1-22.9-0	Fertilizer
Fertilizante 30.8-19.4-4.4	Fertilizer
Fertilizante 27.1-19.3-7.7	Fertilizer
Faena*	Herbicide
Herbipol glifosato*	Herbicide
Prado	Herbicide
Durango*	Herbicide

*These herbicides are used just occasionally in young plantations when rain season

The implementation of any agrochemicals is developed under the requirements of the Voluntary Program of Environmental Audits of PROFEPA (Federal Attorney for Environmental Protection, for its acronym in Spanish), the Forest Stewardship Council (FSC) certification. Also, since 2008, the Human Resources Direction created the section of Industrial Safety and Hygiene, with the aim of establishing the Occupational Safety Program to reduce accidents and occupational risks by voluntarily adhering to the

¹³ Supporting documents\NPRT\Internal risk\Project management\Management plans

Self-Management Program of Safety and Health at Work of the STPS (Ministry of Labor and Social Security)¹⁴.

2.1.5 Community activities

Community activities included support with machinery and materials for road maintenance, support for hurricane response, and support for events and cultural festivals. Through the Mexican Institute of Social Security, health, and vaccination campaigns¹⁵ were carried out for workers and families. Support is also provided when there are shortages in water supply or periods of drought (see Figure 10).



Figure 9: Community activities

During the second verification period, the company has strengthened the following activities with the neighboring community:

- Preferential hiring from nearby residents.
- Supports for the direct benefit of community facilities:
- Support with herbicide for cleaning the central park of the towns and areas surrounding to those parks.
- Wood support for adult education classrooms
- Support with wood for the school
- Support of machinery to bring water to the villages in case their pumps are broken.
- Support with machinery to carry water in pipes for road repairs.

The main communities recently benefited are:

- Huimanguillo (Tabasco): Colonia Agrícola Coronel and the Estación Zanapa Town
- Tenosique, (Tabasco): Emiliano Zapata 3rd Community. Section and the Colonia Agrícola Sueños de oro.

2.1.6 Thinning mechanization

It is crucial to conduct permanent training for field and technical staff. AGSA has focused on the mechanization of thinning and exploitation activities (such as dragging and loading activities), with the implementation of new machinery for this purpose, guaranteeing vehicles and equipment are in optimally

¹⁴ See [Supporting documents\NPRT\External risk\Community Engagement\AGSA Human resources summary v2021]

¹⁵ See [Supporting documents\NPRT\External risk\Community Engagement\ Health campaigns]

maintained, and that responsible practices are put in place for the care of soils and other elements of the plantation environment (see Figure 11).



Figure 10: Thinning Mechanization

2.2 Local Stakeholder Consultation

The first verification, surveys were carried out in farms divided into five municipalities: Balancán (Tabasco), Palenque (Chiapas), Candelaria (Campeche), Huimanguillo (Tabasco), and Tenosique (Tabasco). The surveys were applied to a group of people present in the farms who interact with the company or work for the company. Surveys were also conducted with public employees and employees of the private sector. The objective of the surveys was to determine the perception of the forestry community about the role of forest plantations in climate change, under the assumption that the company's workers are inhabitants of the communities closest to the farms where the plantations to be certified are located. It is important to mention that there is no community inside the properties of the company and they are not reliant to the project.

During the second verification period, there were no relevant changes that could alter the benefits for stakeholders. A telephone contact number located in visible places of the project area serve as communication channel with the community (see Figure 12 below). The company also socializes the carbon project with the workers and develops a survey as a support of the activity¹⁶.

The Human Resources Organizational Development & Management team, which is the division of the company in charge of the relationship with workers, has created an email address, rhagsa@genoveva.com.mx, and together, with the Grievances and Suggestion Procedure¹⁷, workers can report any topic they want to express. These channels guarantee that the information is totally confidential and reaches the HR representative only. The email is also one of the ways to distribute important information on Social Risk Prevention Policy¹⁸ and the Prevention of Discrimination Prevention,

¹⁶ See [Supporting documents/ NPRT/External risk/Community Engagement/ CarbonProjectSurveys]

¹⁷ See [Supporting documents/ NPRT/External risk/Community Engagement/ AGSA_GrievancesSuggestionProcedure]

¹⁸ Available online at the following link: Social Risk Prevention Policy

Workplace Harassment, Sexual Harassment, Workplace Violence Policy.¹⁹ Both are focused on the prevention of related risk factors and the promotion of a favorable organizational environment. The company has also implemented “5 minutes talks” to ensure that employees are kept informed of security best practices before developing field activities²⁰.



Figure 11: Telephone contact number signs

During the second verification period, in November 2019, the community of Crucero San Luis (Campeche) requested support to improve a community road (see communication attached²¹). This request was

¹⁹ Available online at the following link: Discrimination prevention, workplace harassment, sexual harassment, workplace violence policy

²⁰ See [Supporting documents/Five minutes talks]

²¹ See [Supporting documents/ Crucero San Luis communication]

fulfilled. The company provided filler material, fuel, and heavy machinery for the adequations (see Figure 13 below).



Figure 12: Support to community of Crucero San Luis (Campeche)

2.3 AFOLU-Specific Safeguards

In some cases, activities may need to be implemented to mitigate risks posed by project implementation to local stakeholders. However, because this project does not have any kind of risk that could affect local communities, such activities were not implemented.

2.3.1 Property and land use updates

New areas from 2017²² are established in the same territory as previous ones and surround the same local communities – no new surveys were carried out. These new areas are listed in Table 3 and location and maps in Supporting documents²³.

Table 3: New areas 2017-2019

State	Municipality	Name (deed)	Name	Plantation year
Campeche	Candelaria	Lote 5 de Mayo	La Guarida	2017
Campeche	Candelaria	Roma		
Campeche	Candelaria	La Ilusión	La Guarida	2018

²² The applicability of the condition b) as described in PDD section 2.2, still apply for new Project instances since: (b) Soil disturbance attributable to the project activity does not cover more than 10 per cent of area in each of the following types of land, when these lands are included within the project boundary: (i) Land containing organic soils; The soils in the project area had less than 1% of organic matter before the project started. In the land use before the project, the amount of organic matter inputs was low, due to the management practices: slash and burn to prepare the land for livestock and cropland activities. Thus, an increase in the soil carbon stock in the baseline is not expected. (ii) Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 to the methodology. The area of land on which this tool has been applied is not subject to any of the cropland or grassland management practices listed in Table 1 and 2 of the appendices of the methodology. The baseline before the project start date was for livestock and cropland.

²³ See [Supporting documents/ New areas]

State	Municipality	Name (deed)	Name	Plantation year
Campeche	Carmen	La Providencia	La Providencia	2018
Campeche	Carmen	El Texano	Papiro	2018
Campeche	Candelaria	La Martinica		
Campeche	Candelaria	Dos Hermanas		
Campeche	Candelaria	El Recuerdo		
Campeche	Candelaria	La Esperanza		
Campeche	Candelaria	San Juanito		
Campeche	Candelaria	San Roque		
Campeche	Carmen	La Voluntad de Dios	La Franela	2018
Campeche	Escárcega	Los Manantiales	Los Manantiales	2019
Campeche	Escárcega	Doce de Mayo		
Campeche	Escárcega	Rancho Nuevo		
Campeche	Escárcega	Santa Flora		
Campeche	Candelaria	El León	Papiro	2019
Campeche	Candelaria	San Francisco		
Tabasco	Tenosique	San Fernando	San Fernando	2019
Tabasco	Tenosique	Murcia	Murcia	2019
Tabasco	Tenosique	Lote Numero 03	Badulla	2017
Tabasco	Tenosique	Castilla	Kanur	2019
Tabasco	Tenosique	El Palmar 2	Kanur	2019
Tabasco	Tenosique	El Palmar	Kanur	2019
Tabasco	Balancán	La Alondra	La Alondra	2018
Tabasco	Balancán	Lote Número 97	Paríso	2018
Tabasco	Balancán	Pardillos	Pardillos	2018
Tabasco	Balancán	Lote Número 74 Setenta y Cuatro	Paraíso	2017
Tabasco	Balancán	Lote Número 96	Paraíso	2017
Chiapas	Salto de Agua	El Parral	El Parral	2017
Chiapas	Palenque	Finisterra	El Rectángulo	2019

When crossing the new project instances with the dataset of potential and existing wetlands in Mexico (INEGI) using official country dataset from the National Institute of Statistics and Geography (INEGI acronym in Spanish)²⁴, it is evident that they do not intersect with wetland zones (see Figure 14 to Figure 16).

²⁴. The data can be consulted at the following [link](http://www.inegi.org.mx/temas/humedales/): www.inegi.org.mx/temas/humedales/

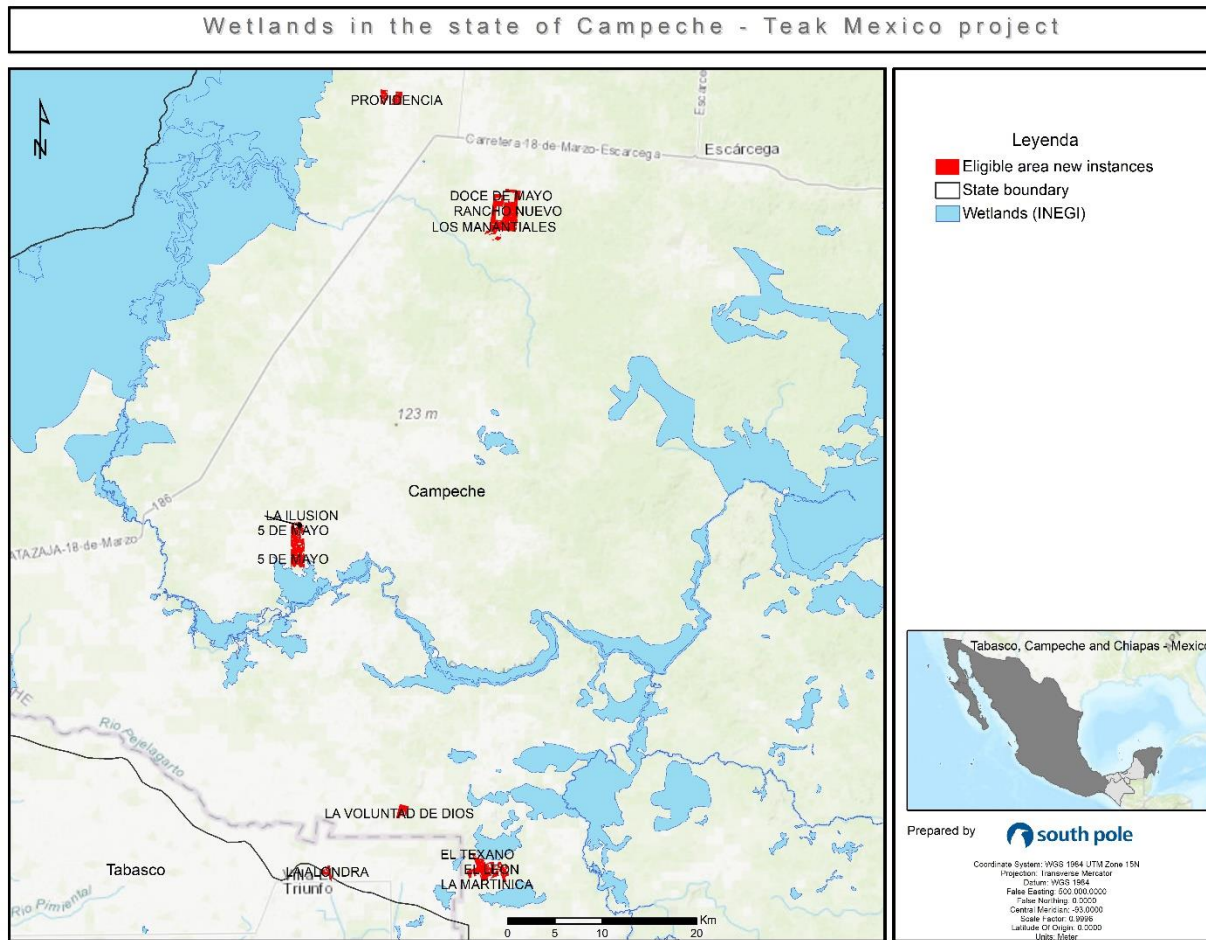


Figure 13: Wetlands in Campeche



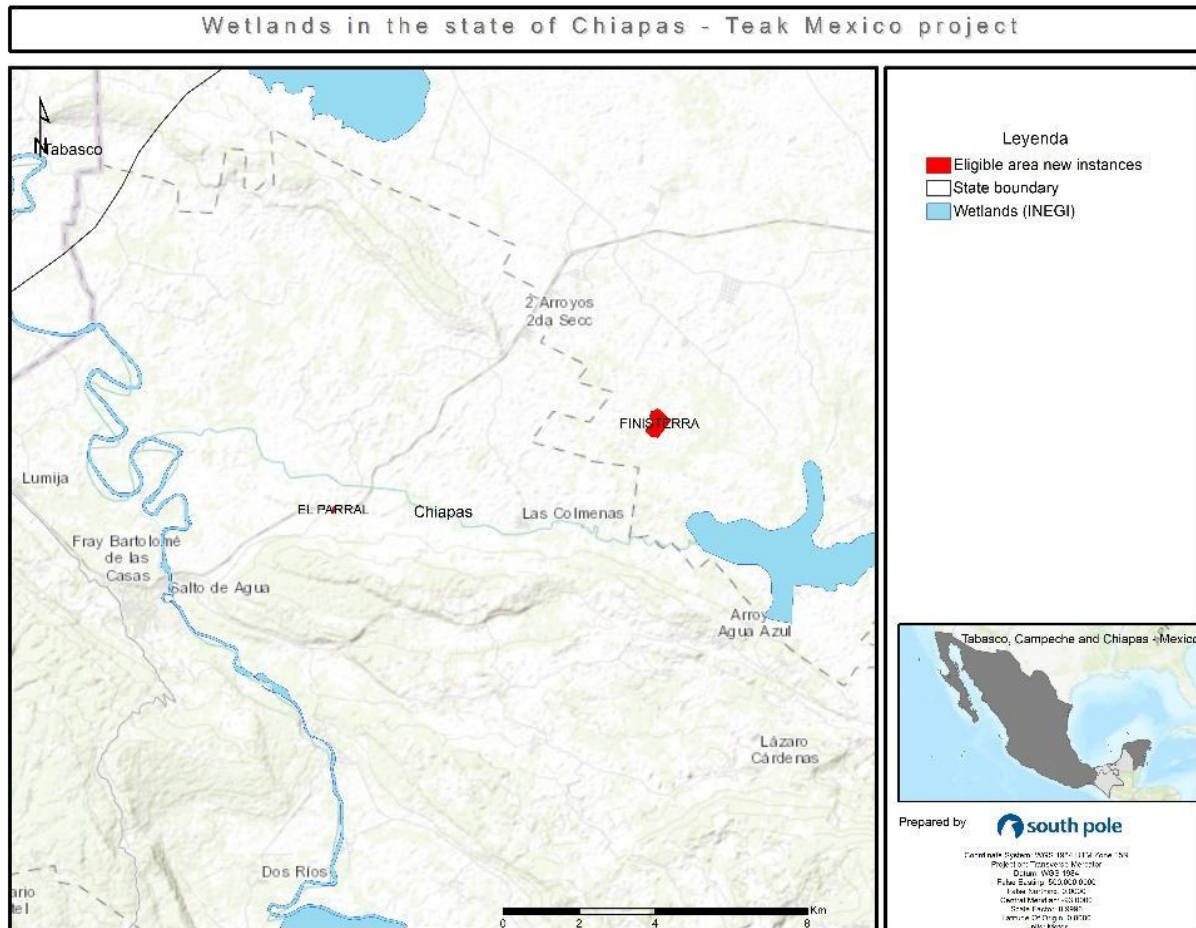


Figure 15: Wetlands in Chiapas

2.3.2 Permanence of the carbon stock

Agropecuaria Santa Genoveva, S.A.P.I. de C.V., establishes that for all commercial forest plantations, there is a Forest Management Program²⁵, which describes the steps for the establishment of the plantation, species, shifts, and estimates of thinning and harvest volumes; as well as the plantation polygons and the areas that are kept in conservation. This program is authorized by means of a plantation registration certificate (authorization to plant), in which an identification code is assigned that legalizes the wood for each property. This registration certificate is issued by the Ministry of the Environment and Natural Resources (SEMARNAT), based on the General Law of Sustainable Forestry Development and its Regulations.

²⁵ Supporting documents\NPRT\Internal risk\Project management\Management plans

The legislation on forestry matters conditions us to present annual reports on the progress of the establishment of the plantation, the volumes of thinning and harvests.

When a plantation reaches its term or its final harvest, the authority is notified in writing to end the validity of the plantation registration. These properties will again start the authorization process to establish new plantations (even manage regrowth), presenting a new Forest Management Program for authorization and assignment of the code that corresponds to the new plantation.

The second shift can be both with the cultivation of shoots or planting material of better genetics next to the harvested tree stump to improve the yield of the plantation in the second shift, taking advantage of the results of research on the yield of clonal plantations making a selection of the best individuals and making vegetative propagation of them.

For all the above, the company intends²⁶ to continue with the establishment of forest plantations indefinitely and the permanence of their carbon stock will be maintained to ensure the carbon against which VCUs are issued is not lost during a final cut with no subsequent replanting or regeneration.

2.3.3 The processes used to communicate and consult with local stakeholders

As mentioned in section 2.2, a telephone contact number is located in visible places in boundaries of the project area, and serves as a channel of communication with the community. Human Resources Organizational Development Management collects any employees requests or complaints via the email rhagsa@genoveva.com.mx and the Grievances and Suggestion Procedure²⁷, is available to report any topic they want to express. The company has also implemented “5 minutes talks” to ensure that employees are kept informed of security best practices before developing field activities.

²⁶ See AGSA indefinite replanting intention letter in Supporting documents\AGSA_IndefiniteReplantingIntentionLetter

²⁷ See [Supporting documents/ NPRT/External risk/Community Engagement/ AGSA_GrievancesSuggestionProcedure]

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

During this monitoring period, activities related to the first instance and outlined in the first verification period were maintained. The most significant change was the establishment of 2,385.4 ha of newly planted areas since 2017. New activities and improvements were mentioned in section 2.1 related to protocols for soil selection, nursery improvements, water supply, water excess prevention, control of pests and diseases, the mechanization of thinning, training of workers and benefits for the communities.

3.2 Deviations

3.2.1 Methodology deviations

There are no Methodology Deviations

3.2.2 Project description deviations

For ex post estimations, Root-shoot-ratio (R) parameter announced in section 4.1, was updated according to CDM_AR_TOOL_14. "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; which states that, unless transparent and verifiable information can be provided to justify a different value, this value can be estimated using the following equation:

$$R = \frac{e^{(-1,085+0,9256 \cdot \ln B)}}{B}$$

Where:

B above-ground tree biomass per hectare (in t d.m. ha-1)

This equation was used in the present monitoring period. The value used in previous verification was a generic value provided by literature which can be used in a very broad and unspecific scope. The formula used now involves the real biomass estimated for the project, which provides a more accurate value for the parameter.

3.2.2.1 Ex-ante estimations for net GHG emission reductions and removals

Ex-ante estimations were updated According to the "AR-ACM0003 A/R Large-scale Consolidated Methodology: Afforestation and reforestation of lands except wetlands Version 02.0".

Stratification based on the project planting/management plan and new areas added in the second instance, stratification included the growth quality from the firsts verification²⁸, the year of establishment

²⁸ [Supporting documents/Estimations/ Growth model explanation]

and the precipitation range (Table 4). Also, this stratification reflects the different categories used in the ex-post estimations in order to keep a consistence line between the two calculations.

Table 4: Stratification for ex ante actual net GHG removals by sinks of the grouped project

Strata	Year of establishment	Area (ha)	Description
I	2013	448.72	High
II	2013	87.81	Low
III	2013	80.67	Excellent Seed
IV	2013	184.67	Mean
V	2014	64.94	Low
VI	2014	831.17	Excellent Clon
VII	2014	307.97	Excellent Seed
VIII	2015	149.42	High
IX	2015	248.04	Excellent Clon
X	2015	622.17	Excellent Seed
XI	2015	126.21	Mean
XII	2016	247.21	High
XIII	2016	71.38	Low
XIV	2016	75.78	Excellent Clon
XV	2016	59.06	Excellent Seed
XVI	2016	137.84	Mean
XVII	2017	93.37	High
XVIII	2017	96.29	Low
XIX	2017	226.13	Mean
XX	2018	126.96	High
XXI	2018	628.32	Low
XXII	2018	43.18	Excellent Clon
XXIII	2018	225.40	Excellent Seed
XXIV	2019	86.64	High
XXV	2019	615.52	Low
XXVI	2019	81.23	Excellent Seed
XXVII	2019	132.62	Mean

- **Thinning:**

For teak, as it was indicated in the PDD section “1.8 Description of the Project Activity”, the thinning practice can vary depending on the growth of the plant and the environmental conditions of the area. Despite that initially thinning schedule, contemplated to be done in years 4, 6 and 11, the calendar and intensity of thinning was adjusted according to the PO experiences with the current management unit and the data registered for project plantations. Table 5, present this information for each type of management strata.

Table 5: Thinning rate for each management profile

management profile (strata)	Year of the thinning	years since the beginning of the plantation	thinning %
Low	2021	8	25%
	2023	10	22%

management profile (strata)	Year of the thinning	years since the beginning of the plantation	thinning %
Mean	2027	14	32%
	2021	8	50%
	2025	12	33%
High	2021	8	38%
	2023	10	40%
	2026	13	20%
Excellent seed	2021	8	43%
	2023	10	34%
	2025	12	33%
Excellent clone	2021	8	58%
	2023	10	28%
	2026	13	29%

- Replanting:**

Every plantation will be subsequently replanting upon final harvest at year 18. This will guarantee that the permanence of their carbon stock against which VCUs are issued is maintained and is not lost during a final cut with no subsequent replanting or regeneration.

To estimate the carbon stock in tree biomass at a point in time, the following tool was used: “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities AR-TOOL14 Version 04.1”. The method “b) Estimation by modelling of tree growth and stand development” was used for ex-ante estimations.

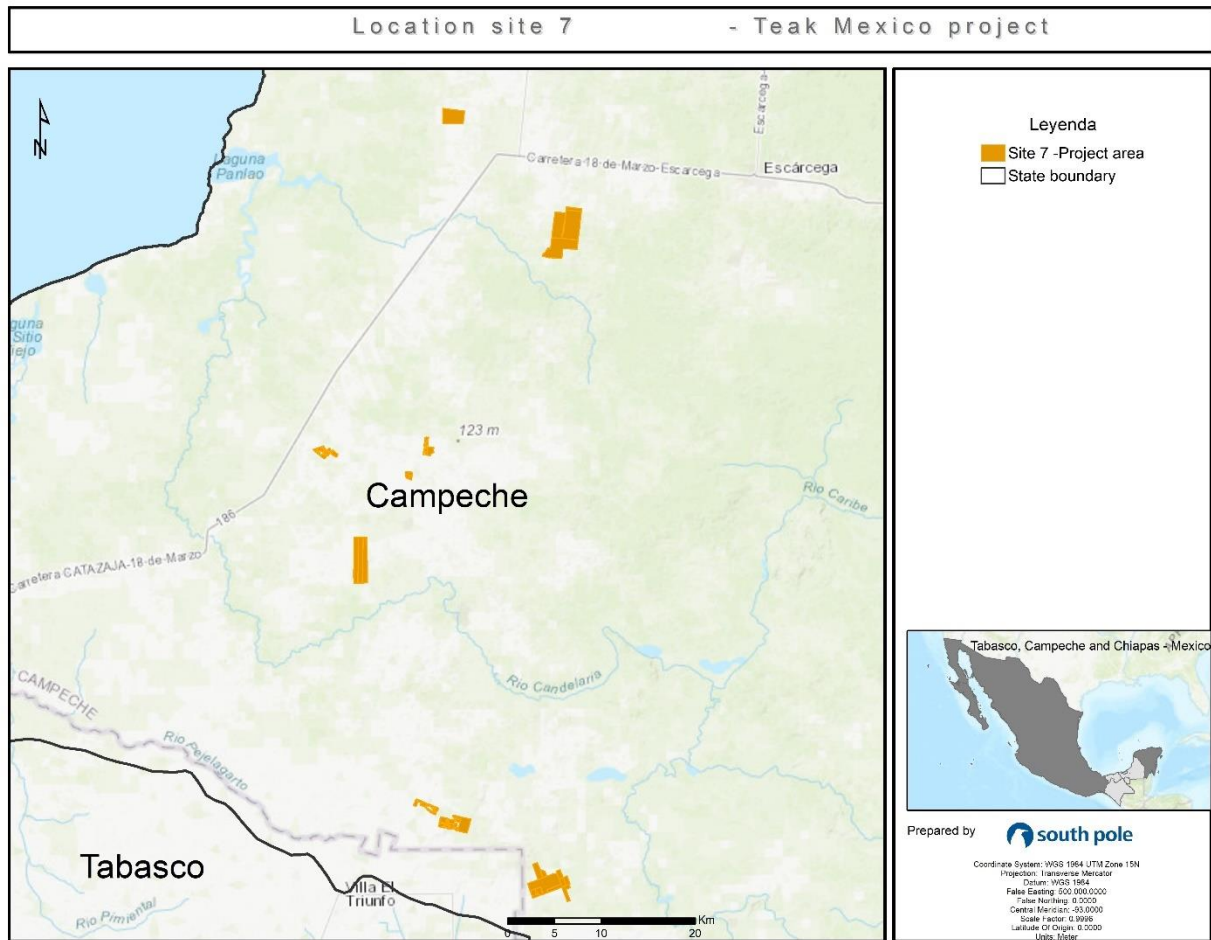


Figure 16: Site 007 location

Step 1: Diameter, high and Volume estimation

Diameter and high estimations

For the diameter and the high estimation on the ex-ante stage, was implemented two models exposed by Tamarit (2013). These models are presented below and for each stratum was used a coefficient that express the tree developed on a specific management profile (Table 6).

$$D = -0.0011x^3 - 0.0146x^2 + 2.5944x$$

D = Tree diameter, m
 x = Coefficients used for each management profile.

$$H = 0.0027x^3 - 0.1277x^2 + 2.6945x$$

H = Tree high, m
 x = Coefficients used for each management profile.

Table 6 Coefficient used in the diameter and high model.

Profile	Diameter coefficient	High coefficient
Low	0.76	0.78
Mean	0.91	0.92
High	1.01	0.98
Excellent seed	1.11	1.25
Excellent clone	1.24	1.25

Volume estimation depending on diameter and height

The volume estimation per tree depending on diameter and height is found using the Tamarit equation (Tamarit, 2013)²⁹:

$$V = 0.000059 * DBH^{1.866203} H^{0.932461}$$

V = Tree volume; m³

DBH = Diameter at Breast Height; cm

H = Total height; m

The Tamarit equation is used to estimate the volume of all the trees of each plot. Subsequently, the volume of all the trees in each plot is summed to calculate the volume per plot and to extrapolate the volume per hectare.

- Step 2: Biomass estimation

The estimation of tree biomass was calculated according to equation 5 Appendix 1 of the AR-TOOL14³⁰:

$$b_{TREE} = [V_{TREE} \times D \times BEF_2] \times (1 + R)$$

b_{TREE} = Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha⁻¹

V_{TREE} = Mean tree volume per hectare in the tree biomass estimation strata; m³ ha⁻¹

D = Basic wood density; t m⁻³

BEF_2 = Biomass Expansion Factor; dimensionless

R = Root-to-shoot ratio; dimensionless

²⁹ See [Supporting documents/Estimations/REPORT OF VALIDATION_ecuacion volumen]

³⁰ Average height and average diameter over each plot are used to calculate average volume and then this average is used to estimate biomass on each strata.

- Step 3: mean carbon stock estimation and mean carbon stock in terms of CO₂e

The estimation of the mean tree carbon per hectare in the tree biomass estimation strata was calculated according to equation 13 of the AR-TOOL14:

$$B_{TREE} = A \times b_{TREE}$$

B_{TREE}	= Tree biomass in the tree biomass estimation strata; t d.m.
A	= Sum of areas of the tree biomass estimation strata; ha
b_{TREE}	= Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha ⁻¹

The estimation of the mean carbon stock in trees within the tree biomass estimation strata was calculated according to equation 12 of the AR-TOOL14:

$$C_{TREE} = \frac{44}{12} \times C_{TREE} \times B_{TREE}$$

C_{TREE}	= Carbon stock in trees in the tree biomass estimation strata; t CO ₂ e
C_{TREE}	= Carbon fraction of tree biomass; t C (t d.m.) ⁻¹
B_{TREE}	= Tree biomass in the tree biomass estimation strata; t d.m.

Table 7 Parameters used for the estimation of tree biomass and mean carbon stock.

Parameter	Symbol	Value	Source
Basic wood density (t m ⁻³)	D	0.59	Rodríguez Anda, Fuentes T., & Silva Guzmán (2012) ³¹
Biomass Expansion Factor (dimensionless)	BEF_2	1.50	IPCC (2003) ³²
Root-to-shoot ratio (R) (dimensionless)	$R = \frac{e^{(-1,085+0,9256*\ln B)}}{B}$		CDM_AR_TOOL_1 4. "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities". Page 25
Carbon fraction of tree biomass; t C (t d.m.) ⁻¹	CF_{TREE}	0.47	IPCC, 2006 ³³ .

- *Step 4: dead wood*

Estimations were done in accordance with the AR -TOOL 12 "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities version 03.1". Values of the conservative default-factors expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass were selected according to the guidance provided in the methodological tool.

Conservative default-factor based method for estimation of carbon stock in dead wood

The project proponent will not make sampling-based measurements to estimate carbon stock in dead wood for all strata to which this default method is applied. The carbon stock in dead wood was estimated as indicated in equation 9 of the tool, using the default values presented in Table 7:

$$C_{DW,i,t} = C_{TREE,i,t} \times DF_{DW}$$

Where:

$C_{DW,i,t}$ = Carbon stock in dead wood in stratum i at a given point of time in year t; t CO₂e

³¹ See supporting folder [Supporting documents\Estimations\Wood density]. The wood density used is the average value found in the AGSA plantations (Rodriguez et al 2012). The value is supported by other findings in teak plantations in Costa Rica (Serrano et al_Pag 104).

³² IPCC 2003. "Good Practice Guidance for LULUCF". The BEF value for Tropical Climatic Zone and Broadleaf Forest Type was used. Table 3A.1.10 of Annex 3A.1.

³³ Table 4.3. http://www.ipcc-ggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf

$C_{TREE,i,t}$	=	Carbon stock in trees biomass in stratum i at a point of time in year t. as calculated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO ₂ e
DF_{DW}	=	Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass; per cent
i	=	1. 2. 3. ... biomass estimation strata within the project boundary
t	=	1. 2. 3. ... years elapsed since the start of the A/R project activity

Step 5: Litter

Estimations were done in accordance with the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities version 03.1”. Values of the conservative default-factors expressing carbon stock in litter as a percentage of carbon stock in tree biomass were selected according to the guidance provided in the methodological tool.

Conservative default-factor based method for estimation of carbon stock in litter (CLI)

Estimations were done in accordance with the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities version 03.0”. For all strata to which this default method is applied, the carbon stock in litter will be estimated as it is indicated in equation 15 of the tool, using the default values presented in Table 8:

$$C_{LI,i,t} = C_{TREE,i,t} \times DF_{LI}$$

Where:

$C_{LI,i,t}$	=	Carbon stock in litter in stratum i at a given point of time in year t; t CO ₂ e
$C_{TREE,i,t}$	=	Carbon stock in trees biomass in stratum i at a point of time in year t. as calculated in tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO ₂ e
DF_{LI}	=	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass; percent
i	=	1. 2. 3. ... biomass estimation strata within the project boundary
t	=	1. 2. 3. ... years elapsed since the start of the A/R project activity

Table 8. Conservative default factor expressing carbon stock in dead wood and litter.

Parameters	Symbol	Value (%)	Comments
Conservative default factor expressing carbon stock in dead wood as a DW percentage of carbon stock in tree biomass.	DF _{DW}	1	Biome: tropical Elevation: <2,000m Precipitation 1000 - 1,600 ³⁴ mm·yr ⁻¹
		6	Biome: tropical Elevation: <2,000m Precipitation >1,600 mm·yr ⁻¹³⁵
Default factor for the relationship between carbon stock in litter and carbon stock in living trees.	DF _{LI}	1	Biome: tropical Elevation: <2,000m Precipitation 1000 -1,600 mm·yr ⁻¹

- *Step 6: baseline emission*

A baseline emissions estimation was carried out using the A/R Methodological AR-TOOL 14 “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities Version 04.2”.

In order to estimate baseline emissions, it is essential to mention the three types of vegetation present in the project area before the start of the project activities:

- Grassland matrix; and
- Scattered trees and shrubs in a grassland matrix: presented in the Dos Hermanas, El Leon, and La Martinica Plantations
- Citrus shrubs in the locality of Huimanguillo: specific in the site 8

$$\Delta C_{BSL,t} = \text{Baseline net GHG removals by sinks. in year } t; t \text{ CO}_2\text{-e}$$

Grassland baseline

According to the section 3.1 Baseline Emissions from the PDD, for the purpose of ex-ante estimations of carbon stock and change in carbon stock in the project scenario would be estimated as zero for the grassland baseline.

³⁴The value of 1% was applied to areas located in Campeche (strata 3) as the precipitation is less than 1,600 mm. See [Supporting documents\Climate_project_area]

³⁵The value of 6% was applied to areas located in Chiapas and Tabasco (Strata 1 and 2) as the precipitation is bigger than 1,600 mm. See [Supporting documents\Climate_project_area]

Shrubs and Citrus crop baseline

According to section 10 of the AR-TOOL 14, the annual change in carbon stock in shrubs must be estimated as follows:

$$\Delta C_{SHRUB,t} = \frac{C_{SHRUB,t_2} - C_{SHRUB,t_1}}{T} \times 1 \text{ year}$$

Where:

$\Delta C_{SHRUB,t}$	Change in carbon stock in shrubs within the project boundary in year t between times t ₁ and t ₂ ; t CO ₂ -e
C_{SHRUB,t_1}	Carbon stock in shrubs within the project boundary at time t ₂ ; t CO ₂ e
C_{SHRUB,t_2}	Carbon stock in shrubs within the project boundary at time t ₁ ; t CO ₂ e
T	Time elapsed between two successive estimations (T= t ₂ - t ₁); yr

The baseline emission for the project was represented firstly for the shrubs areas localized in Dos Hermanas, El Leon, and La Martinica was adopted a value of 57.57 tCO₂e/ha for the Carbon in Aboveground Woody Biomass (ton/ha) plus the Carbon in Roots (ton/ha), according to the FREL for the country³⁶. And secondly, for the citrus crops in Huimanguillo, which for this case was adopted a value of 105.97 tCO₂e/ha according to the information presented by Yepes et al (2011).

- Step 7: carbon stock in trees at a point of time

Change in the carbon stocks in the selected carbon pools in the year t were calculated according to the AR-ACM0003 methodology:

$$\Delta C_{P,t} = \Delta C_{TREE_PROJ,t} + \Delta C_{SHRUB_PROJ,t} + \Delta C_{DW_PROJ,t} + \Delta C_{LI_PROJ,t}$$

Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools. in year t; t CO ₂ -e
$\Delta C_{TREE_PROJ,t}$	=	Change in carbon stock in tree biomass in project in year t. as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO ₂ -e
$\Delta C_{SHRUB_PROJ,t}$	=	Change in carbon stock in shrub biomass in project in year t. as estimated in the tool "Estimation of carbon stocks and change in

³⁶ FREL Mexico. Table 4. Emission factors and their uncertainties for carbon from above-ground woody biomass and roots from "Forest Lands" that changed to "Other Uses" Secondary Deciduous Tropical Forest https://redd.unfccc.int/files/frel_mexico_english_version_jan15f.pdf

		carbon stocks of trees and shrubs in A/R CDM project activities”; t CO ₂ -e
$\Delta C_{DW_PROJ,t}$	=	Change in carbon stock in dead wood in project in year <i>t</i> . as estimated in the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”; t CO ₂ -e
$\Delta C_{LI_PROJ,t}$	=	Change in carbon stock in litter in project in year <i>t</i> . as estimated in the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”; t CO ₂ -e

According to equation 5 of the methodology AR-ACM0003 v2.0, net anthropogenic GHG removals by sinks shall be calculated as follows:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

$\Delta C_{AR-CDM,t}$	=	Net anthropogenic GHG removals by sinks. in year <i>t</i> ; t CO ₂ -e
$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks. in year <i>t</i> ; t CO ₂ -e
$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks. in year <i>t</i> ; t CO ₂ -e
LK_t	=	GHG emissions due to leakage. in year <i>t</i> ; t CO ₂ -e

LK_t can be considered as 0 according to section 5.3, 5.4 and 5.5. Then, $\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t}$

The period over which the long-term average GHG benefit is calculated is 36 years. The total GHG benefit of the first instance calculated as the sum of stock changes along the 36-year period is 1,238,344.35 tCO₂e until reaching LTA (see Excel file –12112021_Ex_ante_update).

Year	Baseline scenario: to date GHG emission reductions and removals at year <i>t</i> (BE) (tCO ₂ e)	Project scenario: to date GHG emission reductions and removals at year <i>t</i> (PE) (tCO ₂ e)	Annual change in GHG benefit (PE _t – PE _{t-1}) (tCO ₂ e)	VCUs including buffer (17%)
2012	0	0	0	0
2013	0	1.112	1.112	923
2014	111,492	-101.433	-102.544	-85.112
2015	121,421	-79.004	22.428	18.615
2016	0	117.317	196.322	162.947
2017	0	249.388	132.070	109.618
2018	7,858	441.016	191.629	159.052

Year	Baseline scenario: to date GHG emission reductions and removals at year t (BE) (tCO ₂ e)	Project scenario: to date GHG emission reductions and removals at year t (PE) (tCO ₂ e)	Annual change in GHG benefit (PET – PET-1) (tCO ₂ e)	VCUs including buffer (17%)
2019	26,239	698.053	257.036	213.340
2020	5,354	1,000.104	302.051	250.703
2021	0	1,247.130	247.026	205.032
2022	0	1,446.599	36.214	30.058
2023	0	1,525.897		
2024	0	1,682.389		
2025	0	1,818.869		
2026	0	1,796.971		
2027	0	1,946.981		
2028	0	2,134.164		
2029	0	2,371.031		
2030	0	2,596.322		
2031	0	2,487.061		
2032	0	1,843.226		
2033	0	879.897		
2034	0	718.341		
2035	0	707.332		
2036	0	493.344		
2037	0	448.874		
2038	0	724.292		
2039	0	1,005.458		
2040	0	1,247.130		
2041	0	1,446.599		
2042	0	1,525.897		
2043	0	1,682.389		
2044	0	1,818.869		
2045	0	1,796.971		
2046	0	1,946.981		
2047	0	2,134.164		
2048	0	2,371.031		
2049	0	2,596.322		
	LTA	1,238,344.35	Total (tCO ₂ e)	1,066,176
			Average tCO ₂ e/year	29,588.22

3.3 Grouped Projects

3.3.1 Eligibility criteria for second instance areas

An eligibility analysis has been developed that considers all the eligibility criteria proposed by VCS to define the project area of the second instance. For the inclusion of any new eligible areas as instances willing to participate within the proposed grouped project, the new areas shall meet the following criteria:

- a) Be within one of the designated geographic areas specified in the project description.
- b) Comply with the following eligibility criteria:
 - 1) All areas to be incorporated into the grouped project must meet the applicability conditions set out in the methodology applied to the project:
 - a) No evidence of forest in the project area at the beginning of the reforestation activities.³⁷ This criterion will be proven by ground-truthing, satellite images, aerial photographs, official maps, or land-use records (as presented in the subsection below).
 - b) The land cannot be categorized as wetlands.
 - 2) The project activity should be under the control of the project participants.
 - 3) Are subject to the baseline scenario determined in the project description for the specified project activity (reforestation); and
 - 4) The new instances shall have characteristics with respect to additionality that are consistent with the initial instance for the specified project activity and geographic area.
- c) Be included in the monitoring report with the sufficient information (technical and geographic) in compliance with the eligibility criteria.
- d) Be validated at the time of verification against the eligibility criteria described in point b.
- e) Have evidence of project ownership, with respect to each project activity instance, held by the project proponent from the respective start date of each project activity instance.
- f) Have a start date that is the same, as later than, the grouped project start date; and
- g) Be eligible for crediting from the start date of the instance through to the end of the project crediting period (only). Note that where a new project activity instance starts in a previous verification period, no credit may be claimed for GHG emission reductions or removals generated. New instances are eligible for crediting from the start of the next verification period.

³⁷ Definition of Mexico's forest according to the Clean Development Mechanism (CDM): defines the forest as a minimum continuous area of 1 hectare, with a crown cover greater than 30% and a minimum potential in situ height of 4 meters. Available in: <https://cdm.unfccc.int/DNA/index.html>;

3.3.2 Analysis of forest/non-forest

3.3.2.1 Methodology

The eligibility process was developed for 29 properties located in the states of Campeche and Tabasco in Mexico with plantation establishment years 2017, 2018 and 2019, which refer to the areas evaluated in the second instance.

For an area to be considered eligible, and thus, included in the project area, it must not meet the definition of forest³⁸ for a minimum period of 10 years prior to the start of the project. To verify this requirement, a historical forest cover search and analysis was carried out using the information from Landsat ETM +, Landsat OLI, and the Mexico Land Cover raster.³⁹ Figure 17 shows the five main steps that make up the methodological flow for the identification of eligible areas for afforestation and reforestation projects: data acquisition from official sources and satellite images (free access), data standardization, forest and non-forest classification by visual inspection of the extreme years of the baseline, identification of the areas that meet the eligibility criteria and finally, verification of the absence of wetlands and forests (intermediate years) in the eligible areas.

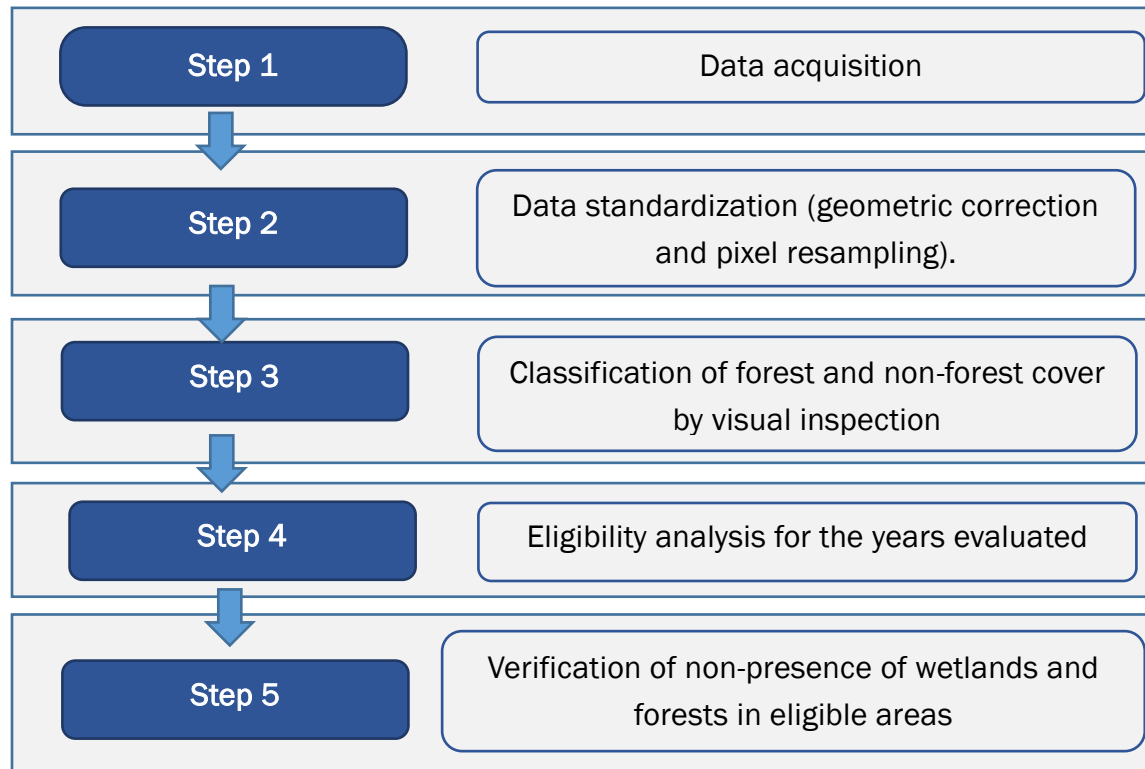


Figure 17: Methodology developed for the eligibility analysis

³⁸ Definition of Mexico's forest according to the Clean Development Mechanism (CDM): defines the forest as a minimum continuous area of 1 hectare, with a crown cover greater than 30% and a minimum potential in situ height of 4 m. Available in: <https://cdm.unfccc.int/DNA/index.html>.

³⁹ <http://www.conabio.gob.mx/informacion/gis/>

- **Step 1: Data acquisition**

Landsat ETM and OLI multispectral images for each year were downloaded for evaluation. The images have a spatial resolution ranging from 15 m to 100 m, and cover an area of 185 km * 185 km, and have a revisit period of 16 days from the same point. These images were provided by the United States Geological Survey (USGS) and can be accessed and downloaded for free at: <https://earthexplorer.usgs.gov/>. Landsat images employed for the task have a spatial resolution of 30 m.

In the case of the Landsat ETM sensor images, the years 2007, 2008 and 2009 were downloaded, considering that the operation period of Landsat ETM runs since 1999, the sensor has acquired and delivered data with data gaps caused by the Scan Line Corrector (SLC) failure, for this reason 3 images were downloaded and processed to fill the gaps.

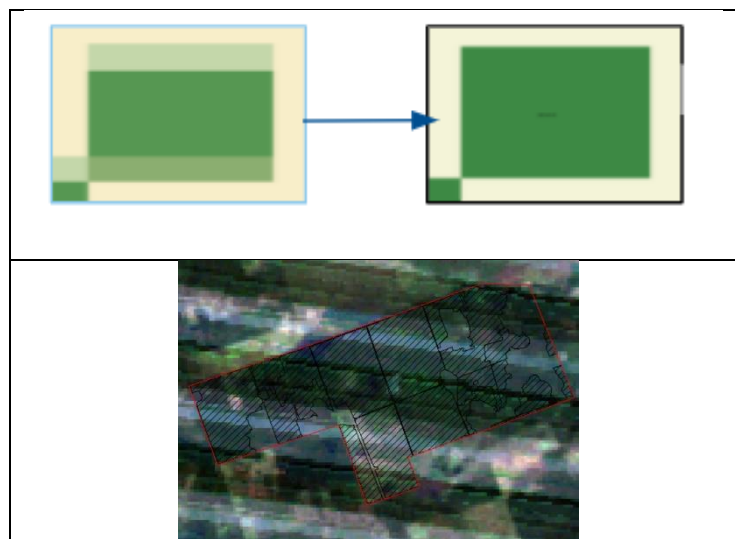
In the same manner, the Landsat OLI images were downloaded for 2017, 2018 and 2019, considering that the operation period of Landsat 8 runs from 2013 up to the present day.

Finally, Mexico Land Cover raster is an official country information at a scale of 250 meters between the years 2005 to 2011 that shows the presence of forest for each year, raster of the years 2007, 2008 and 2009 is downloaded to fill the areas with presence of artifacts (banding), clouds and shadows clouds that are not covered with the images of the available sensors.

- **Step 2: Data standardization**

The standardization of the acquired raster data is composed of four activities: the first is the resampling of the spatial resolution of the Mexico Land Cover raster from 250 m to 30 meters (minimum spatial unit of comparison), second is the masking of clouds, cloud shadows and banding of the Landsat ETM and OLI images, third is the filling of the areas without information from the ETM and OLI sensors with images of nearby months and finally, a geometric correction of the Landsat images 2007,2008,2009, 2017,2018, 2019 and the Mexico Land Cover raster that allows pixel by pixel spatial adjustment between all data sources (Figure 18).

Raster data is evaluated for scale with a constant spatial resolution and the same row and column extents.



Filling of areas without information

Figure 18: Correction of raster data

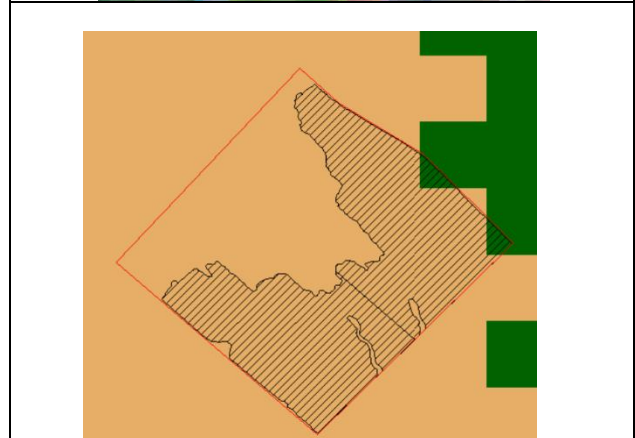
- Step 3: Classification of Forest and Non – Forest

For the classification of land cover for each year, the methodology based on visual inspection and digitizing lot by lot (visual scale 1:25,000) is used to generate land cover such as forest, non-forest, water, clouds, and areas without information for each year with the corrected images. The areas without information (banding), with presence of clouds and cloud shadows of the years 2007, 2008 and 2009 are filled with the official country information for the respective year where the absence of data is presented (Figure 19).

Identification of areas without information in the classification (year 2009)



Filling of areas without information with the official country information (year 2009)



Final classification

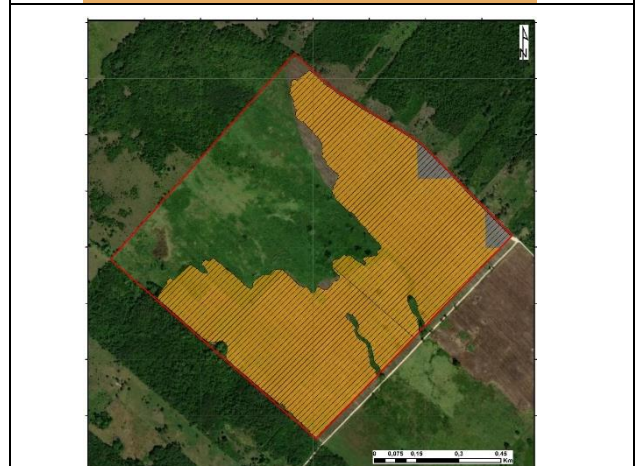


Figure 19: Data filling process in the classification

- **Step 4: Eligibility analysis for the years evaluated**

The interception of forest and non-forest cover between pairs of years (also known as baseline) allows the identification of eligible areas, areas that have not been forest in 10 years from the year of plantation establishment, in the project the following baselines are presented 2007 -2017, 2008 - 2018 and 2009 - 2019, which are applied to the eligibility criteria in Table 9.

Table 9: Combination of years and attainment of eligibility

Initial year class	Final year class	Eligibility
No Forest	No Forest	Eligible
Forest	No Forest	Not Eligible
No Forest	Forest	Not Eligible
Forest	Forest	Not Eligible
Water	No Forest	Not Eligible
No Forest	Water	Not Eligible
Water	Water	Not Eligible

- **Step 5: Verification of non-presence of wetlands and forests (intermediate years) in eligible areas.**

The information on potential and existing wetlands in Mexico, official country dataset (data can be freely consulted online⁴⁰) from the National Institute of Statistics and Geography (INEGI acronym in Spanish) is used to verify the presence of wetlands within the eligible areas through the process of layer interception, generating as a product the areas that should be excluded from eligibility. Likewise, in the land cover classification process explained in step 3, water bodies are identified for each year and are considered as ineligible areas in the eligibility criteria defined in step 4.

Now for the process of verifying the non-presence of forest within a baseline, a lot-by-lot inspection is performed with high spatial resolution multispectral images using the image repository of the Google Earth platform, Microsoft Bing Maps and Esri Basemap , which contains GeoEye image mosaics between the years 2006 and 2019 in the project area with a spatial resolution of 1m, allowing to see in greater detail the presence or absence of forest at a visual scale of 1:5,000 (Figure 20).

⁴⁰ <https://www.inegi.org.mx/temas/humedales/>

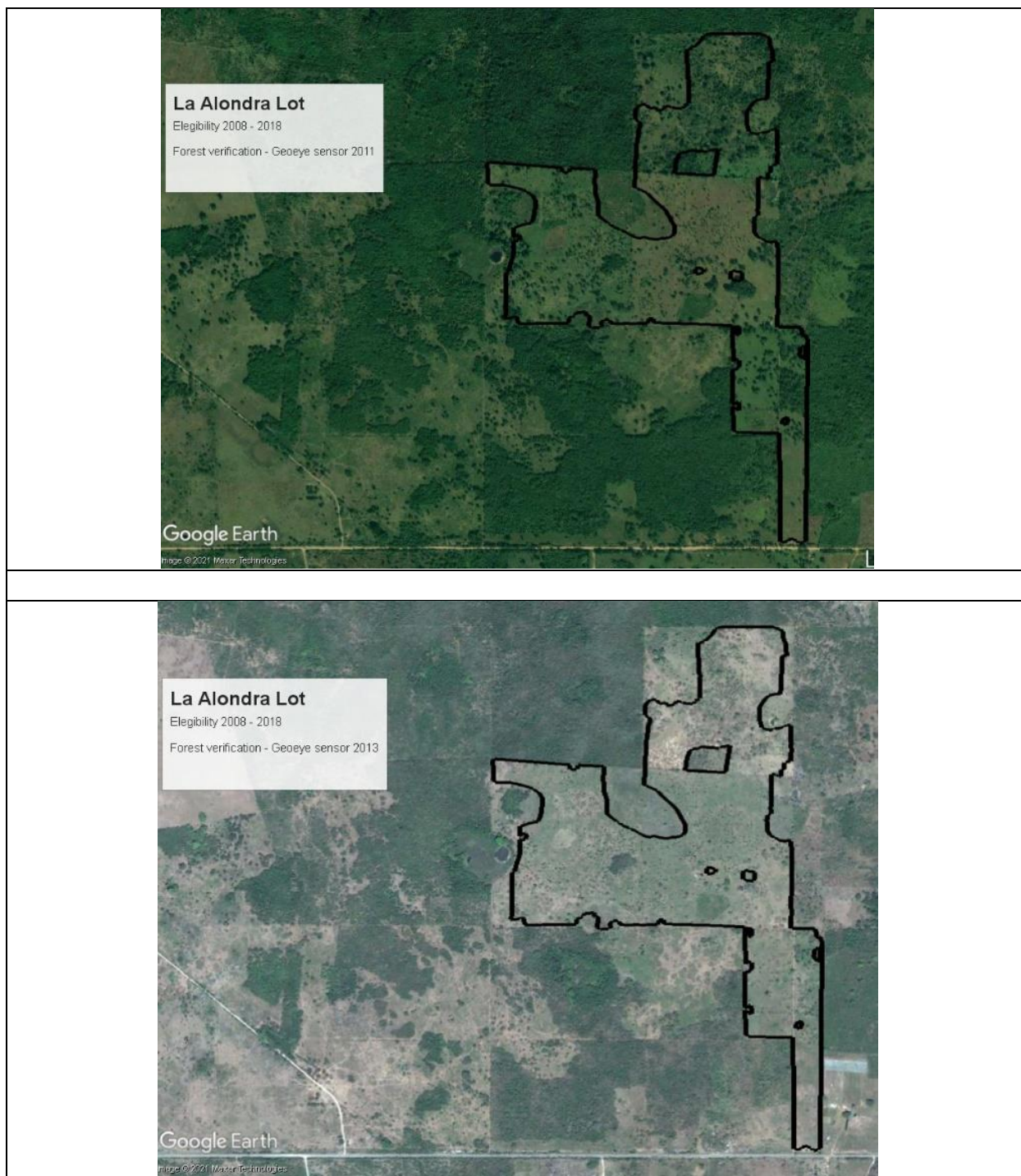


Figure 20 La Alondra lot - verification of non-forest in intervening years in eligible areas 2008 - 2018

3.3.2.2 Results

Areas eligible for a carbon project according to the analysis described above are presented in Table 10. Maps of the eligible areas planted in the period 2017-2020 are available at [Supporting documents/ New areas].

Table 10: Eligibility of the second instance

Strata	Year of establishment	Eligible Area (ha)
1.1	2017	415.79
1.2	2018	1023.86
1.3	2019	916.01
Total		2355.67

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data/parameter	Volume model
Data unit	m ³
Description	Model to estimate volume of trees on the function of their diameter at breast height (DBH) and height
Source of data	Tamarit, 2013 ⁴¹
Value applied	$V = 0.000059 \cdot DBH^{1.866203} \cdot H^{0.932461}$
Justification of choice of data or description of measurement methods and procedures applied	The above-ground tree biomass is calculated using the Biomass Expansion Factor (BEF) and wood density in connection with the volume data. The model was adjusted with AGSA plantation data from the same site of the project area. For ex-post estimates, DBH and height data measured between 2013 and 2017 were used.
Purpose of data	Estimation of GHG emission reductions and removals
Comments	N/A

Data/parameter	Wood density
Data unit	t m ³
Description	Basic density of specific gravity used to estimate stem biomass.
Source of data	Rodríguez Anda, Fuentes T., & Silva Guzmán (2011) ⁴²
Value applied	0.59
Justification of choice of data or description of measurement methods and procedures applied	The above-ground tree biomass is calculated using the BEF and wood density in connection to the volume data.
Purpose of data	Estimation of GHG emission reductions and removals
Comments	N/A

⁴¹ Tamarit, J. (2013). Doctoral Thesis. Volume calculation, growth and timber yield and operative inventory for *Tectona grandis* in southeastern Mexico. Montecillo

⁴² Rodríguez Anda, R., Fuentes T., F., & Silva Guzmán, J. (2011). Technological study for the evaluation and use of *Tectona grandis* wood from thinning of commercial forest plantations in the state of Campeche, as a support for technological and market innovation

Data/parameter	BEF
Data unit	Dimensionless
Description	Ratio of above-ground oven-dry biomass to oven-dry biomass of the stem
Source of data	(IPCC, 2003)
Value applied	1.5
Justification of choice of data or description of measurement methods and procedures applied	The above-ground tree biomass is calculated using the BEF and wood density in connection with the volume data. The BEF value for Tropical Climatic Zone and Broadleaf Forest Type was used.
Purpose of data	Estimation of GHG emission reductions and removals
Comments	N/A

Data/parameter	Root-shoot-ratio (R)
Data unit	Dimensionless
Description	Ratio of the weight of the roots to the weight of the top of the tree. Used for belowground tree biomass estimation.
Source of data	IPCC (2006) ⁴³
Value applied	$R = e^{(-1,085 + 0,9256 \cdot \ln B)} / B$
Justification of choice of data or description of measurement methods and procedures applied	Belowground biomass is usually estimated with this factor, as belowground sampling is ecologically destructive and expensive.
Purpose of data	Estimation of GHG emission reductions and removals
Comments	N/A

⁴³ IPCC. (2006). IPCC Guidelines for National Greenhouse Gas Inventories volume 4: Agriculture, Forestry and Other Land Use.

Data/parameter	Carbon Fraction of dry matter (CF)
Data unit	tC t d.m ⁻¹
Description	Biomass proportion corresponding to carbon. CF is used to convert biomass to carbon.
Source of data	Table 4.3 of IPCC (2006): “Good Practice Guidance for LULUCF”
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	It is the default value from the IPCC.
Purpose of data	Estimation of GHG emission reductions and removals
Comments	N/A

Data/parameter	DF _{DW}
Data unit	%
Description	Conservative default factor expressing carbon stock in dead wood as a DW percentage of carbon stock in tree biomass.
Source of data	AR-TOOL12 “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities, Version 03.1, Section 8.
Value applied	Elevation < 2,000 m, and precipitation > 1,600 mm·yr ⁻¹ = 6 Elevation < 2,000 m, and precipitation 1,000 - 1,600 mm·yr ⁻¹ = 1
Justification of choice of data or description of measurement methods and procedures applied	It is the default value for the tropical biome.
Purpose of data	Estimation of GHG emission reductions and removals.
Comments	N/A

Data/parameter	DF _{LI}
Data unit	%

Description	Default factor for the relationship between carbon stock in litter and carbon stock in living trees.
Source of data	AR-TOOL12 “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”, Version 03.1, Section 8
Value applied	1% and 6%
Justification of choice of data or description of measurement methods and procedures applied	1%: default value for the tropical biome, elevation < 2,000 m, and precipitation between 1,000 and 1,600 mm·yr ⁻¹ . 6%: default value for the tropical biome, elevation < 2,000 m, and precipitation up to 1,600 mm·yr ⁻¹ .
Purpose of data	Estimation of GHG Emission Reductions and Removals.
Comments	N/A

4.2 Data and Parameters Monitored

Data/parameter	A
Data unit	Ha
Description	Project area (planted area)
Source of data	Survey databases of each polygon that is part of the project.
Description of measurement methods and procedures to be applied	Field measurement: the area shall be delineated either on the ground using GPS or from geo-referenced remote sensing data.
Frequency of monitoring/recording	At the beginning of site preparation or at the final establishment of the project
Value monitored	Ex-post
Monitoring equipment	GPS equipment (precision 1-5 m) and remote sensing data
QA/QC procedures to be applied	Internal auditing and QA/QC Procedures from PD
Purpose of data	Calculation of project emissions
Calculation method	Measurement
Comments	N/A

Data/parameter	A _i
Data unit	Ha
Description	Area of stratum i
Source of data	Monitoring of stratum and stand boundaries is done employing Geographical Information Systems (GIS) that allow the integration of data from different sources (including GPS coordinates and remote sensing data).
Description of measurement methods and procedures to be applied	Field measurement: the area shall be delineated either on the ground using GPS or from geo-referenced remote sensing data.
Frequency of monitoring/recording	At the beginning of site preparation
Value monitored	Ex-post
Monitoring equipment	GPS equipment (precision 1-5 m) and remote sensing data
QA/QC procedures to be applied	Internal auditing and QA/QC procedures from the PD
Purpose of data	Calculation of project emissions
Calculation method	Measurement
Comments	The stratification for ex-post estimations is based on the actual implementation of the project planting/management plan. It may even be necessary to evaluate the possibility of re-stratifying the project boundary, according to the development of the stand models, as it would enable the merging of several strata to optimize costs and improve outcomes in forest inventories.

Data/parameter	N
Data unit	Dimensionless
Description	Number of plots to be established in the project area
Source of data	Estimation

Description of measurement methods and procedures to be applied	This value will be estimated based on a pre-sampling developed in the project area before monitoring.
Frequency of monitoring/recording	Each time a verification is conducted
Value monitored	Ex-post
Monitoring equipment	N/A
QA/QC procedures to be applied	Before the monitoring report, the error estimation will be carried out with the last measurements to estimate if additional plots must be established.
Purpose of data	Estimate the number of plots needed for complying with a sampling error of less than 10%
Calculation method	See section 4.3.3.1
Comments	N/A

Data/parameter	n_i
Data unit	Dimensionless
Description	Number of plots to be established in each stratum
Source of data	Estimation
Description of measurement methods and procedures to be applied	This value will be estimated using the total number of plots and the area of each stratum.
Frequency of monitoring/recording	Each time a verification is conducted
Value monitored	Ex-post
Monitoring equipment	N/A
QA/QC procedures to be applied	In each forest management lot, there should be at least one permanent monitoring plots (PPM) per 25 hectares. In cases where the forest management lot has a discontinuous surface, with different soil or growth conditions, another PPM will be

	added. However, not all cases of surface discontinuity will require a PPM in each discontinuous part. As the plantation progresses, the variance of the MPPs of each forest management lot will be analyzed and the appropriate number of PPMs adjusted for that lot.
Purpose of data	Estimation of the number of plots needed for each stratum for complying with a sampling error of less than 10%
Calculation method	See section 4.3.3
Comments	N/A

Data/parameter	Plot location
Data unit	Latitude/longitude
Description	Localization of each sampling plot
Source of data	Data field sampling
Description of measurement methods and procedures to be applied	Measured with GPS
Frequency of monitoring/recording	Each time a verification is conducted
Value monitored	N/A
Monitoring equipment	GPS
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	The sample plot location is registered with a GPS and marked on the project map.

Data/parameter	DBH
Data unit	cm

Description	DBH of the trees
Source of data	Field measurements in sample plots
Description of measurement methods and procedures to be applied	Typically measured 1.3 m above ground. Measure all the trees above a minimum DBH in the permanent sample plots that result from the project activity.
Frequency of monitoring/recording	Each time a verification is conducted
Value monitored	Ex-post
Monitoring equipment	Tape measure
QA/QC procedures to be applied	Workers involved in field measurement work should be fully trained in field data collection. Field measurements shall be checked by a qualified person to correct any technical errors. Additionally, there is a forest auditor that is charged with giving an independent opinion on the quality of the information presented to investors of the company. This is done by randomly selecting 10% of the plots and using 10 trees from each of these plots. From this, a comparative report is issued to compare the information found by the auditor and that found by AGSA. If there are inconsistencies in the diameter data found in the software Mirasilv⁴⁴ (appendix 2), these are referred to the forest supervisor so that they can do a corresponding review in the field.
Purpose of data	Calculation of project emissions
Calculation method	See section 4.3.3
Comments	N/A

Data/parameter	H
Data unit	M
Description	Total height of trees

⁴⁴ **Software Mirasilv** is an application dedicated to the management of arboreal information.

The system facilitates, through a standardized methodology, the establishment of temporary or permanent plots of growth of any shape and size, and for any forest species. It enables the creation of an individual database that facilitates the monitoring and comparison of tree growth. It also facilitates classification by site quality in reforestation programs, and compares increases in volume, height, and diameter found in different plantation systems.

Source of data	Field measurements in sample plots
Description of measurement methods and procedures to be applied	Measure all the tree heights in the permanent sample plots that result in the project activity
Frequency of monitoring/recording	Each time a verification is conducted
Value monitored	Ex-post
Monitoring equipment	Clinometer, measuring tape
QA/QC procedures to be applied	Workers involved in field measurement work should be fully trained in field data collection. Field measurements shall be checked by a qualified person to correct any technical errors. In the software used by the company (Mirasilv), there is a model to review successive measurements to verify the consistency of the recorded increments in terms of diameter and height. This is the first review done in the process (appendix 3). Once again, the forest auditor is charged with giving an independent opinion on the quality of the information presented to investors of the company. This is done by randomly selecting 10% of the plots. From each of these plots, 10 trees are used to create a comparative report for the information found by the auditor and that found by AGSA. If there are inconsistencies in the height data found by Mirasilv, these are referred to the forest supervisor so that they can do a corresponding review in the field (Appendix 4).
Purpose of data	Calculation of project emissions
Calculation method	See section 4.3.3
Comments	N/A

Data/parameter	T
Data unit	Year
Description	Period elapsed between two successive estimations of carbon stock in trees and shrubs
Source of data	Verification records

Description of measurement methods and procedures to be applied	See monitoring plan
Frequency of monitoring/recording	Each time a verification is conducted
Value monitored	Ex-post
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emissions
Calculation method	$T = t_2 - t_1$
Comments	If the two successive estimations of carbon stock in trees are carried out at different points of time in year t_2 and t_1 , (e.g., in the month of April in year t_1 and in the month of September in year t_2), then a fractional value is assigned to T.

4.3 Monitoring Plan

4.3.1 Verification of changes in carbon stocks in the pools selected

This monitoring plan provides guidance on monitoring and standard operational procedures for the ARR project activity. It fulfills the requirement that the project activity should have credible and accurate monitoring procedures in place to enable the evaluation of project performance and verification of the net anthropogenic GHG emission removals.

Only the above-ground biomass of trees established will be measured. Therefore, only the individual growth of trees will be monitored in permanent plots.

The carbon content below-ground (in dead wood and litter) attributable to project activities will not be monitored. These will be estimated by using default values and suggested methods using 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”. The root-to-shoot ratio will be used to estimate belowground biomass based on the above-ground measures.

4.3.2 Stratification

The data sampling will be designed using strata defined for the project according to the planting date, the plots' quality qualification previously defined by AGSA, and the success of growth.⁴⁵

AGSA has a five-level classification of growth: low, medium, high, excellent seed, and excellent clone. This classification corresponds to values of individual trees, which, at 18 years old, have reached 27, 32, 34, 37, and 43 cm in diameter and 17, 20, 22, 26, and 28 m in height (for low, medium, high, excellent seed, and excellent clone respectively). These levels were obtained by analyzing the growth tendencies of established plantations, which revealed five growth curves relating to diameter-height. The growth of the established plots in the different lots was compared with the generated growth curves to estimate the quality of growth.

The strata will be monitored to identify different growth patterns in each stratum that can lead to a unification between strata or a more detailed stratification. An annual update of the project area will be implemented based on the quality qualification of stands used by AGSA, thus allowing for permanent control and monitoring of the area. The process seeks to identify whether the stratums defined in each monitoring period need to be changed. According to changes in the quality qualification and the accumulation of carbon during each monitoring period, a new stratification based on biomass growth can be created. The findings from each monitoring period will allow for a re-stratification in the next one that considers the following parameters:

- Age.
- Quality qualification.
- Silviculture management.
- Carbon stock.
- Cost-effectiveness of the monitoring process; and
- Disturbances (plagues, fire, pathologies, etc.)

4.3.3 Establishment of permanent plots⁴⁶

The activities related to the establishment and measurement of PPMs are then defined to evaluate the development of the plantation.⁴⁷

Responsible

It is the responsibility of the Production Manager, the Forest Manager, the Chief of Quality, and the Chief of Forestry Maintenance to ensure that all the guidelines established in this procedure are properly complied with by plot measurement teams.

⁴⁵ [Supporting documents/Estimations/Growth_model]

⁴⁶ More detailed information about the establishment of the monitoring plots is found as a supporting document in [Supporting documents/Estimations/Plot_establishment].

⁴⁷ Activities for the establishment of PPM were made taking into account the guidance provided by CATIE (2003). Guide for the Establishment and Measurement of Plots for the Monitoring and Evaluation of Tree Growth in Research and Reforestation Programs with the MIRA System Methodology. Luis A. Ugalde Arias. Tropical Agronomic Research and Teaching Center (CATIE), Costa Rica, 2003

Location in the topographic map

Each delimited forest management lot, including its total area, is recorded in the general AGSA plan. Furthermore, each forest management plot or MIRA⁴⁸ lot has a record that includes the location, total area, species planted, and date of planting.

Location of permanent plots at the project level

Depending on the total area of the forest management plot, the number of PPM to be established is determined. The criteria for determining how many PPMs are established in each forest management lot are as follows:

- In each forest management lot, there should be at least 1 PPM per 25 hectares.
- In cases where the forest management lot has a discontinuous surface, with different soil or growth conditions, another PPM will be added. However, not all cases of surface discontinuity will require a PPM in each discontinuous part.
- As the plantation progresses, the variance of the PPMs of each forest management lot is analyzed and the appropriate number of PPMs is adjusted for that lot; and
- The location of each permanent plot must be determined on a map. For each plot, the northwest corner is selected as a reference point to find its location.

Size and shape of plots:

For forest lots in which planting began with 1,250 trees per hectare, permanent plots of 20 m by 40 m have been established, which contained 100 trees in an area of 800 m² at the start. For forest lots in which planting started with 816 trees per hectare, permanent plots of 35 m by 35 m have been established, containing 100 trees in a 1,225 m² area.

All the plots monitored during the period 2013-2017 have an area of 1,225 m².

Establishment of the plot in the field

In the field, the reference point of each PPM has geographical coordinates that correspond to tree 'number one' in the plot. A pole is stuck in each corner of the measuring plot and the forest management lot or MIRA lot is marked, as well as the plot number in the post located in the northwest corner of that parcel.

To identify each PPM within each site, each plot of forest management is assigned a consecutive number and consequently, consecutive numbering of the PPMs is used within each forest management plot.

⁴⁸ Plots of forest management (Plots MIRA) are the minimum units of forest management that correspond to sections of a production order. In some cases this will be equal to a production order, with the same species, approximately the same age and with the same rate of growth.

From the reference tree located in the northwest corner, there are 10 trees to the east and 10 trees to the south, which are numbered as shown in **Figure 21**.

NORTE									
Oeste									Este
1	2	3	4	5	6	7	8	9	10
20	19	18	17	16	15	14	13	12	11
21	22	23	24	25	26	27	28	29	30
40	39	38	37	36	35	34	33	32	31
41	42	43	44	45	46	47	48	49	50
60	59	58	57	56	55	54	53	52	51
61	62	63	64	65	66	67	68	69	70
80	79	78	77	76	75	74	73	72	71
81	82	83	84	85	86	87	88	89	90
10	99	98	97	96	95	94	93	92	91
0									
Oeste									Este
SUR									

Figure 21: Numbering of trees within the PPM

Measuring the trees

The height and diameter of all trees in the plot are measured. With this information, the number of trees in it is determined during the development of the plantation. It is then possible to determine site quality based on growth curves as a function of age.

The data of diameter and height taken in the field should be recorded in the Format MEASUREMENT OF STANDING TREES (APPENDIX 1), generated through MiraSilv software. The forest catcher oversees entering the measurements to Mirasilv.

Measurement of diameter

This is measured at 1.30 m high (chest height), measured from the base of the tree. Here, the diameter of the tree is measured with a diameter tape.

When using the standard tape measure graduated in centimeters and millimeters, the measurement given is the perimeter. The diameter is calculated by dividing the measured value by π (pi). Steel or nylon reinforced plastic tape will be used to avoid damage to the tape that may cause errors in obtaining data (Figure 22). The measurement of diameters is performed according to the process shown in Figure 23.



Figure 22: Measuring tree diameter with a measuring tape

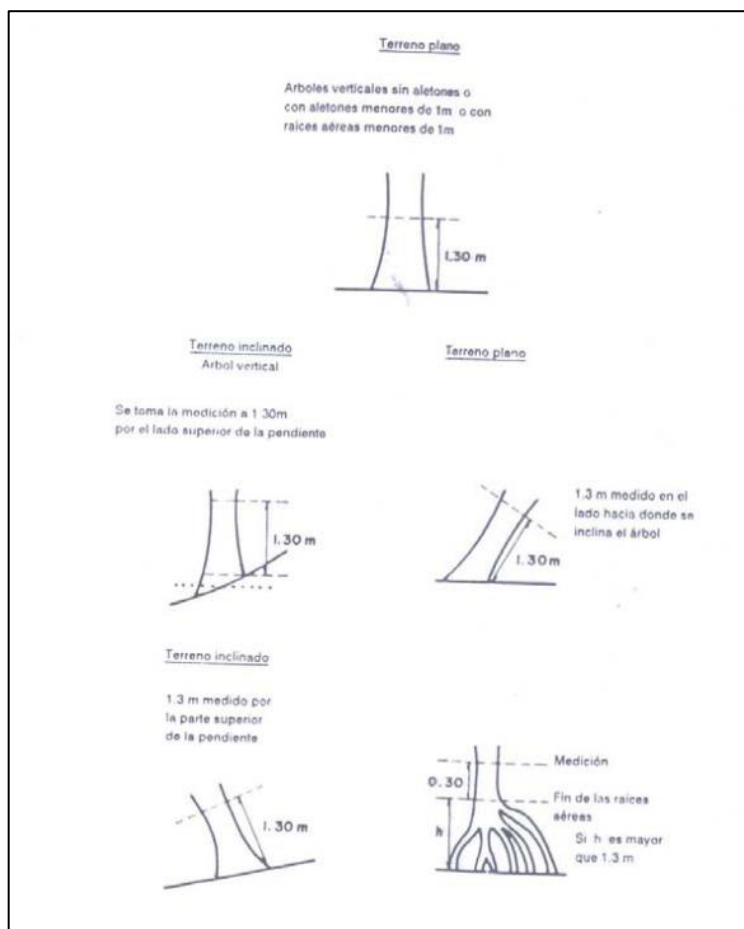


Figure 23: Measuring the diameter according to the inclination of the shaft with respect to the surface

Height measurement

For the commercial case, two readings of tree height are taken. The first one is taken from the top, where the tree trunk reaches a minimum of 10 cm in diameter, and the bottom reading is done at the base of the tree. Height measurements can be taken in two ways, depending on the measuring equipment used:

- 1) **measuring with a 15-meter-high bar:** the person responsible for measuring stands in front of the tree to be measured. They place the bar next to the tree and extend it until the hook reaches the top of the tree. When reading the stamped bar, it is important to remember that the numbering starts at the top of the bar and goes down to the bottom. This instrument measures in meters, decimeters, and centimeters. In the case of small trees that are less than 4 m in height, an aluminum tool of 4 or 5 m can be used (Figure 20).

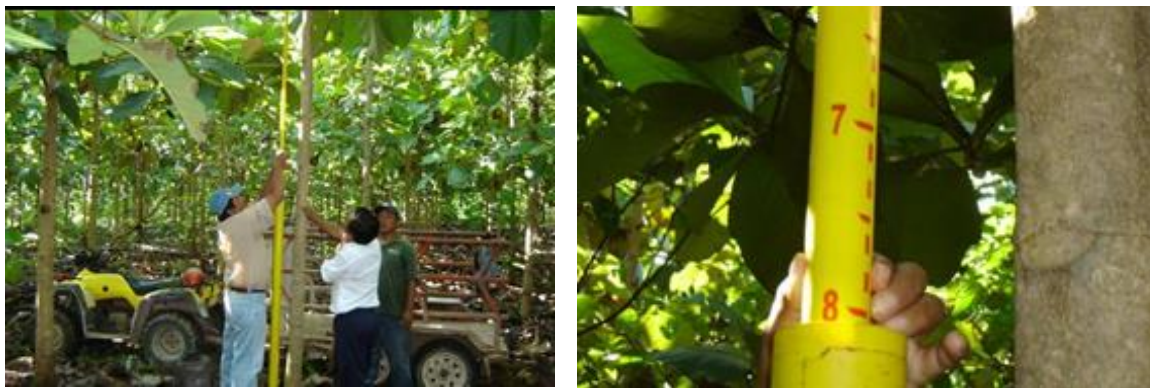


Figure 24: Measuring with a stamped bar

- 2) **Measuring with an electronic clinometer:** for a single reading of the clinometer, the person responsible for the measurement must calibrate it according to their distance from the tree to be measured. This depends on the height of the tree, as the distance should always be greater than the height. Taking the readings from the treetop and the base of the tree, the clinometer reveals the height of the tree (Figure 21).



Figure 25: Measuring with a clinometer

Frequency and use of the data taken in PPMs

The plots are measured annually during the month of October. In addition to estimating the carbon sequestration of plantations, the information generated is used to document the effectiveness of the technology package, to incorporate appropriate adjustments to the management plan, to decide on the type of soils to be planted in the future, to anticipate thinning logistical needs and final harvests, and to develop an updated financial projection of project productivity.

4.3.3.1 Number of plots

The number of plots required for measuring the variation within the project boundary and strata shall be estimated by using the CDM tool “A/R Methodological Tool” for “Calculation of the number of sample plots for measurements within A/R CDM project activities”.⁴⁹

The number of plots to be established and measured will be estimated as follows:

$$n = \frac{N * t^2 * (\sum_{i=1}^I w_i * s_i)^2}{N * E^2 + t^2 * \sum_{i=1}^I w_i * s_i^2}$$

Where:

n	Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless
I	Total number of strata within the project boundary
i	1, 2, 3, ... biomass stock estimation strata within the project boundary
N	Total number of possible sample plots within the project boundary (i.e., the sampling space or the population); dimensionless
t	Two-sided Student's t-value, at infinite degrees of freedom, for the required confidence level; dimensionless
w _i	Relative weight of the area of stratum i (i.e., the area of the stratum i divided by the project area); dimensionless

⁴⁹ CDM “A/R Methodological Tool: Calculation of the number of sample plots for measurements within A/R CDM project activities” available at: <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf>

s_i	Estimated standard deviation of biomass stock in stratum i ; ($t\ ha^{-1}$)
E	Acceptable margin of error in estimations of biomass stock within the project boundary; $t\ d.m.$ (or $t\ d.m.\ ha^{-1}$), i.e., in the units used for s_i

4.3.3.2 Analysis of the monitored data and parameter

The data recorded in the forest inventory (DBH and height) will be the input for the volume model that will define the total biomass accumulated for the project at the time of monitoring.⁵⁰

For ex-post estimates, the default parameters, and equations (sections 4.1 and 4.2) will be the same ones used for ex-ante estimations, unless better values exist at the verification time. These will always be in compliance with the AR tool for carbon stock estimation. See section 5.1 for ex-ante net GHG emission reductions and removals.

4.3.3.3 Procedures for internal auditing and quality assurance (QA) and quality check (QC)

AGSA will be responsible for the centralized documentation of all project planning and implementation. QA/QC procedures will be implemented and monitored to ensure that net anthropogenic GHG removals by sinks are measured and precisely, and are credible, verifiable, and transparent.

- Training will be held for all relevant personnel on all data collection and analysis procedures.
- Steps will be taken to control mistakes in sampling and data analysis to develop a credible plan for measuring and monitoring carbon stock change in the project. The same procedures shall be used throughout the project lifetime to ensure continuity.
 - a) In the software used by the company (Mirasilv), there is a model that can review successive measurements of diameter and height to check their consistency. This is the first review that is done in the process (Appendix 2).
 - b) Furthermore, the forest auditor will issue a comparative report on the height of trees to provide investors with an independent opinion on the quality of the information. This will be based on measurements taken from 10 trees in a randomly-selected 10% of the land plots. If there are inconsistencies between the data and that of Mirasilv, a supervisor shall undertake a field-site revision of the data.

Field data collection

The staff involved in the measurement of carbon pools will be fully trained in field data collection and analysis. To verify that plots have been installed and the measurements taken correctly, a minimum of 10% of randomly selected plots will be re-measured by a supervisor with a team not involved in the initial measurement sampling.

⁵⁰ All the data proposed can be updated.

The re-measurement data will be compared with the original measurement data. Any errors found will be corrected and recorded. The level of errors recorded will be calculated and reported using the following equation:

$$Error\ (\%) = \frac{|Estimate_1 - Estimate_2|}{Estimate_2}$$

The proper entry of data into the data analysis spreadsheets is required to produce reliable carbon estimates. Communication between all staff involved in measuring and analyzing data will be used to resolve any apparent anomalies before a final analysis of the monitoring data will be completed. If there are any problems with the monitoring plot data that cannot be resolved, the plot will not be used in the analysis. Expert judgment and comparison with independent data will be used to try to ensure that data results are in line with expectations. Additionally, field data will be reviewed by the crew leader of the monitoring team (Operational and management structure), further ensuring that the data and analysis are accurate.

Due to the long length of the project (36 years) and the speed at which technology is advancing, data archiving will be an essential component. Data will be archived in several forms. The stored data will include data analysis and models, the final estimate of the amount of carbon sequestered, any GIS products, and the measuring and monitoring reports. Electronic copies of all data and reports will be updated periodically and converted to any new format required by future software or hardware. A project participant involved in the field measurements will be assigned to implement this updating. The data collected shall be archived for at least two years after the end of the last crediting period of the project activity. The main activities to be developed for the QA/QC process are described in Table 11 .

Table 11: Verification and checklist considered to guarantee the quality of the information gathered and its management

QC activity	Procedures
Check that assumptions and criteria for the selection of emission factors and other estimation parameters are documented	• Cross-check descriptions of project activities, emission factors, and other estimation parameters with information on source and sink categories and ensure that these are properly recorded and archived.
Check for transcription errors in data input and reference	• Confirm that bibliographical data references are properly cited in the internal documentation • Cross-check a sample of input data (either measurements or parameters used in calculations) for transcription errors
Check that removals are calculated correctly	• Reproduce a representative sample of removal calculations • Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy
Check that parameter and units are correctly recorded and that appropriate conversion factors are used	• Check that units are properly labeled in calculation sheets • Check that units are correctly carried through from the beginning to the end of calculations • Check that conversion factors are correct • Check that temporal and spatial adjustment factors are used

QC activity	Procedures
	correctly
Check the integrity of database files	• Confirm that the appropriate data processing steps are correctly represented in the database • Confirm that data relationships are correctly represented in the database • Ensure that data fields are properly labeled and have the correct design specifications • Ensure that adequate documentation of database and model structure and operation are archived
Check that the movement of inventory data among processing steps is correct	• Check that removal data are correctly reported when preparing summaries • Check that removal data are correctly transcribed between different intermediate products
Check that uncertainties in removals are estimated or calculated correctly	• Check that qualifications, assumptions, and expert judgments are recorded • Check that calculated uncertainties are complete and calculated correctly, following the methodology requirements
Undertake review of internal documentation	• Check that there is detailed internal documentation to support the estimates and to enable the reproduction of the emission and removal estimates • Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed reviews • Check the integrity of any data archiving arrangements of outside organizations involved in inventory preparation
Check time series consistency	• Check for temporal consistency in time series input data for biomass estimation. • Check for consistency in the algorithm/method used for calculations throughout the time series
Undertake completeness checks	• Confirm that estimates are reported for all years • Check that known data gaps that may result in incomplete emissions estimates are documented and treated conservatively
Compare estimates to previous estimates	• Current inventory estimates should be compared to previous estimates, if available. If there are significant changes or departures from expected trends, re-check estimates and explain the differences

Uncertainty assessment

The project follows the modalities and procedures for A/R project activities to estimate baseline net GHG removal by sinks, leakage, actual net GHG removal by sinks, and net anthropogenic removal by sinks.

Equation 15 of the AR-TOOL 14 was used to calculate the uncertainty in tree volume. The uncertainty value is 3.23%⁵¹, which implies a discount of 0% for the GHG removals of the current monitoring period.

Other elements of monitoring plan

The baseline is to be the continuation of economic activities that were taking place before the project start date, which are unlikely to change due to the historical use of the soil. However, if the Accreditation Period is renewed during the course of the project, the baseline must be reviewed to determine whether the baseline approach used is still valid or if the conditions have changed due to changes in regulations and sectoral policies, or technical, environmental, or market factors.

Verification of project emissions

The project will quantify and monitor the non-CO₂ GHG emissions resulting from any fire occurrences (forest fires) within the project boundary, whose accumulated area affected by such fires in a year is $\geq 5\%$ of the project area. These events will be monitored, and the affected area will be recorded.

Emissions of non-CO₂ GHGs resulting from the loss of above-ground tree biomass due to fire will be calculated in each verification period by using: the above-ground biomass in trees of relevant strata calculated in the previous verification, the default values for the combustion factor, the emission factors, and the global warming potential.

4.3.3.4 Operational and management structure

The operational structure and responsibilities for the project are presented as a supporting document.⁵²

⁵¹ [Supporting documents/Estimations/ Ex_post_2ndVer , Uncertainty tap]

⁵² [Supporting document/ Organization chart]

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

A baseline emissions estimation was carried out using the A/R Methodological AR-TOOL 14 “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities Version 04.2”.

To estimate baseline emissions, it is essential to identify the three types of vegetation present in the project area before the start of the project activities:

- Scattered trees and shrubs in a grassland matrix.
- Trees in conservation areas around the grassland matrix; and
- Citrus shrubs in the locality of Huimanguillo⁵³.

Trees

According to the AR-TOOL 14, carbon stock in trees in the baseline can be accounted as zero if all of the following conditions are met:

- (a) the pre-project trees are neither harvested, 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; and*
- (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.*

The trees present in the project area are mainly located in conservation areas⁵⁴ and are not included in the carbon estimations (Figure 22). In the case of isolated trees, these are maintained during the project

⁵³ Located intabasco site 008

⁵⁴ Due to its importance for the ecology of the territory and even for the well-being of the plantations, the company ensures their continued existence in conservation areas, taking care that they are not disturbed by any other activity. The company has developed studies that involve the study of existing biodiversity as the presence of special fauna such as white-tailed deer, thunderous deer and ocellated turkey and the identification of high conservation value forests. As proof, studies developed can be found in [Supporting documents/ Conservation studies]

lifetime and are not counted in the plot monitoring because only teak trees are quantified (Figure 23). Therefore, the baseline emissions change due to changes in the carbon stocks of trees was accounted as zero.



Figure 26: Areas of conservation and plantation within the site (center of the picture)



Figure 27: Trees remaining in the middle of the plantation

Shrubs

Grassland baseline

According to point 12 of the conditions under which carbon stock and change in carbon stock may be estimated as zero, the tool establishes that trees and shrubs in the baseline may be accounted as zero in the event that the land is subjected to periodic cycles (e.g., slash-and-burn or clearing-regrowing cycles), which is the case for the livestock farming baseline in the project area (see section 3.4). Slash-and-burn is a common practice in the baseline.

According to point 13, for the purpose of ex-ante estimations of carbon stock and changes in carbon stock in the project scenario, change in the carbon stock of shrubs would be estimated as zero for the grassland baseline.

Shrubs areas and Citrus crop baseline

According to equation 25 of section 10 of the AR-TOOL 14, the annual change in carbon stock in shrubs must be estimated as follows:

$$\Delta C_{SHRUB,t} = \frac{C_{SHRUB,t_2} - C_{SHRUB,t_1}}{T} \times 1 \text{ year}$$

Where:

$\Delta C_{SHRUB,t}$	Change in carbon stock in shrubs within the project boundary in year t between times t ₁ and t ₂ ; t CO ₂ -e
C_{SHRUB,t_2}	Carbon stock in shrubs within the project boundary at time t ₂ ; t CO ₂ e
C_{SHRUB,t_1}	Carbon stock in shrubs within the project boundary at time t ₁ ; t CO ₂ e
T	Time elapsed between two successive estimations (T = t ₂ - t ₁); yr

The baseline emission for the project in the second verification was represented only for the shrubs areas identified in new instances. This process was made throw a GIS analysis using a Landsat image from a year previous the plantation (Figure 28 as example). For these areas was adopted a value of 57.57 tCO₂e/ha for the Carbon in Aboveground Woody Biomass plus the Carbon in Roots, according to the FREL for the country⁵⁵.

⁵⁵ FREL Mexico. Table 4. Emission factors and their uncertainties for carbon from above-ground woody biomass and roots from "Forest Lands" that changed to "Other Uses" Secondary Deciduous Tropical Forest https://redd.unfccc.int/files/frel_mexico_english_version_jan15f.pdf

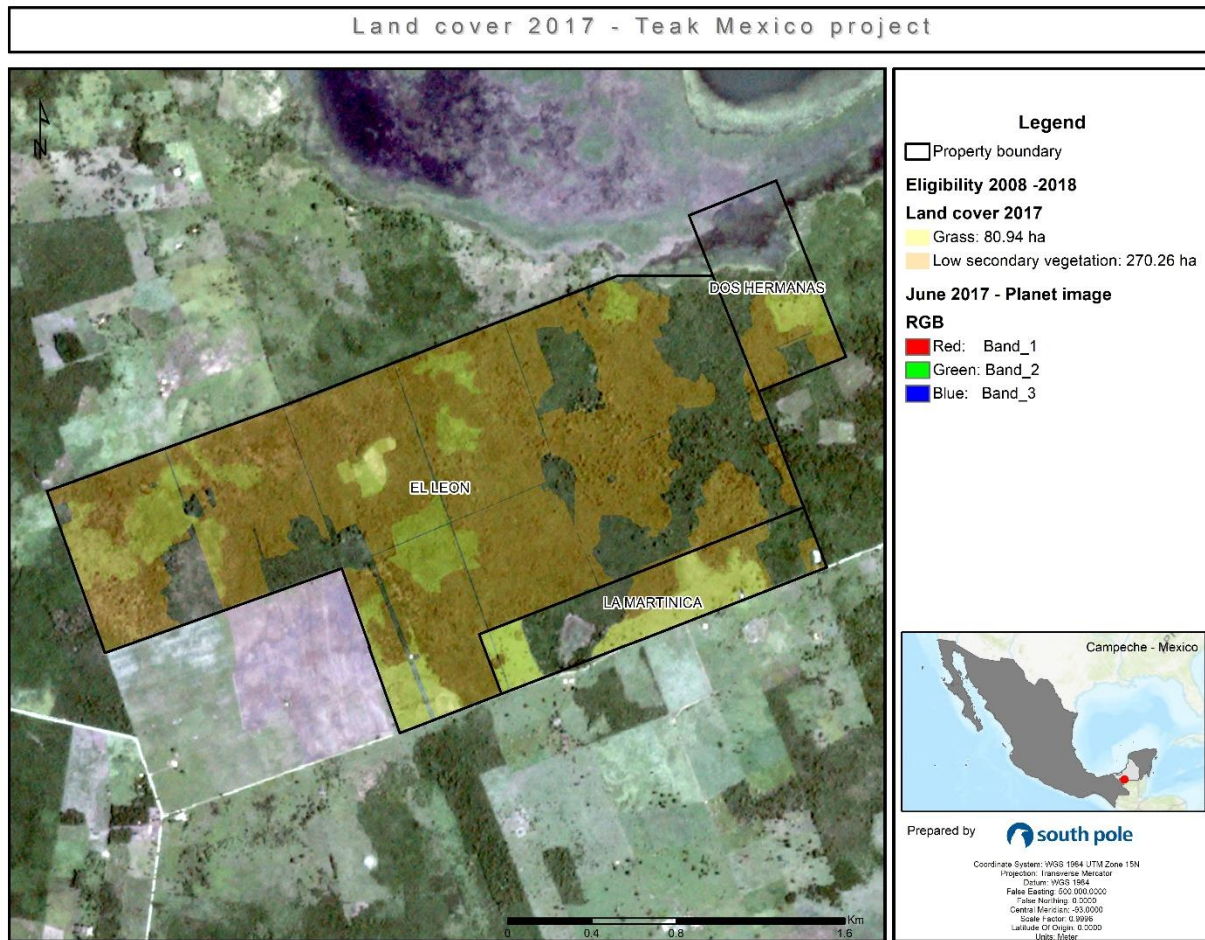


Figure 28: Example of shrubs areas identified in new instances

In the case of certain areas in Huimanguillo, where there is a citrus crop baseline (see site 008 in Figure 29), the citrus increment is considered to be zero as the citrus plantation has managed to maintain tree characteristics that allow harvesting activities.⁵⁶ Then, $\Delta C_{SHRUB,t}$ is assumed to be zero. Additionally, this is consistent with point f of point 12 of the AR-TOOL 14, as the biomass oscillates between a minimum and maximum value in the baseline due to the management activities. As a last point, it is important to mentioned that this baseline emission was already excluded in the first verification in the years 2014 and 2015, because of this, it will be excluded to avoid double count.

⁵⁶ Medina-Urrutia, V. M., S. Becerra-Rodríguez, and E. Ordaz-Ordaz. "Crecimiento y rendimiento del limón mexicano en altas densidades de plantación en el trópico." *Revista Chapingo serie horticultura* 10.1 (2004): 43-49. The document is presented in [Supporting documents\ Estimations\Literature \Medina_Urrutia et al_2003].

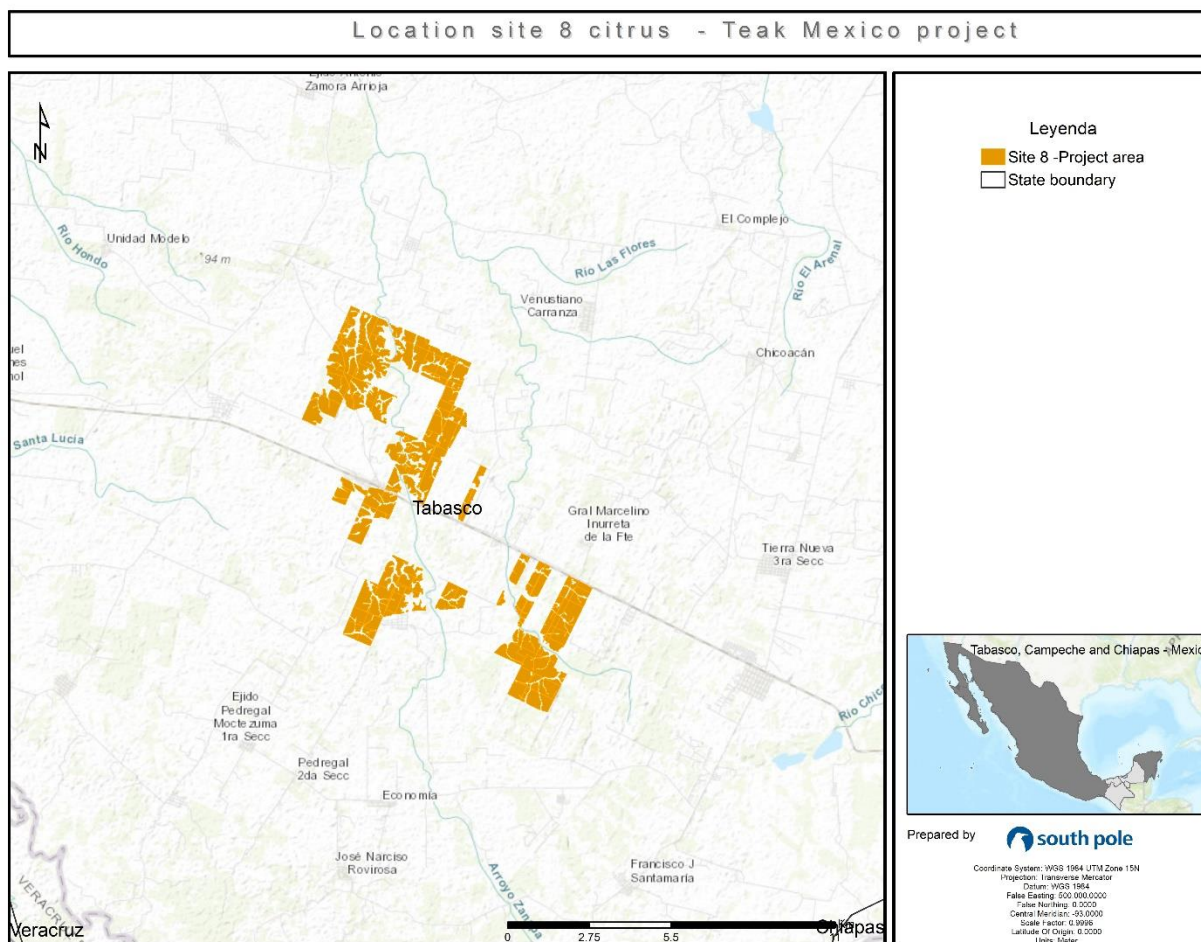


Figure 29: Citrus location site 008

Dead wood and litter

In areas where grassland is the baseline scenario, no emissions or removals are attributed to dead wood and litter, considering the activities used to prepare land and the low amount of woody biomass. Regarding citrus crops, management activities include the cleaning of intercrop corridors, and thus, an accumulation of carbon due to dead wood and litter is not expected.

Soil

In the land use before the project, the amount of organic matter inputs was low due to the management practices: slash and burn to prepare the land for livestock activities and intercrop corridor maintenance in the citrus plantation. Thus, an increase in the soil carbon stock in the baseline is not expected.

As the baseline emissions were assumed to be zero, no calculations were undertaken. However, if new activity instances are to be included, and baseline emissions are found, the equations of 5.4 will be applied to calculate the carbon increase in the baseline scenario.

5.2 Project Emissions

The actual net GHG removals by sinks shall be calculated as follows:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$$

Where:

- $\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks. in year t; t CO₂-e
- $\Delta C_{P,t}$ = Change in the carbon stocks in the project, occurring in the selected carbon pools. in year t; t CO₂-e
- $GHG_{E,t}$ = Increase in non-CO₂ GHG emissions within the project boundary as a result of the implementation of the A/R CDM project activity, in year t as estimated in the tool "Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"; t CO₂-e

5.2.1 Change in the carbon stocks in the project, occurring in the selected carbon pools. In year t; t CO₂-e

Planted area during first verification period (2013-2016)

The eligible planted area per property is presented in Table 12.

Table 12: Eligible planted area 2013-2016

State	Municipality	Property name	Year	Eligible planted area (ha)
Campeche	Candelaria	FRACCI II PREDIO TRES HERMANOS	2014	26.92
		LA ESCONDIDA	2013	20.35
		LA FRANELA	2013	140.90
		LA FRANELA II	2013	8.17
		SAN CARLOS	2013	37.54
		TRES HERMANOS FRACCION I	2013	19.26
	Carmen	EL CHUBASCO	2013	1.75
		FRACCI I PREDIO PASO NUEVO	2013	0.73
		LA ILUSION	2013	42.28
Tabasco	Balancan	EL PARAISO	2016	79.58
		LA CAOBA LOTE 90	2016	90.58
		LOTE 85	2016	71.15
		LOTE NUMERO 84 MACULIS	2016	70.13
		MACHICHE LOTE 79	2016	36.38

State	Municipality	Property name	Year	Eligible planted area (ha)
		PREDIO 78	2014	60.15
		PREDIO 86	2014	64.86
		PREDIO EL REGALO	2016	4.02
		PREDIO RUSTICO A. CASTILLO	2016	39.07
		PREDIO RUSTICO RUPERTO MONTOYA	2016	19.02
		PREDIO RUSTICO SOCRATES SACARIAS	2016	7.04
		RANCHO LA LUZ	2016	1.00
		EL CONQUISTADOR	2016	106.74
	Huimanguillo	EL POMELO	2015	66.37
		LA TRINIDAD	2015	112.58
		LOTE 1	2014	19.90
		LOTE 10	2015	28.31
		LOTE 10 A	2015	31.12
		LOTE 10 GREGORIO M	2014	22.71
		LOTE 11	2014	22.07
		LOTE 11 PINO SUAREZ	2015	85.41
		LOTE 13	2014	42.54
		LOTE 14	2014	42.26
		LOTE 16	2014	26.96
		LOTE 17	2014	29.85
		LOTE 18	2014	32.83
		LOTE 1 ^a	2015	40.98
		LOTE 1 ^a GREGORIO MENDEZ	2014	17.86
		LOTE 1B	2015	51.17
		LOTE 2	2014	42.35
		LOTE 2 MERCEDES GAMAS	2015	71.54
		LOTE 20	2014	31.55
		LOTE 20 PINO SUAREZ	2015	77.70
		LOTE 21	2014	20.52
		LOTE 21 PINO SUAREZ	2015	38.50
		LOTE 21-A	2015	24.87
		LOTE 22	2014	38.73
		LOTE 22-A	2014	36.04
		LOTE 24	2014	38.74
		LOTE 27 Y 28	2014	58.83
		LOTE 3 y 5	2014	39.84
		LOTE 30	2014	39.04

State	Municipality	Property name	Year	Eligible planted area (ha)	
		LOTE 31	2014	41.77	
		LOTE 31 PINO SUAREZ	2015	62.12	
		LOTE 32	2014	17.74	
		LOTE 32 PINO SUAREZ	2015	41.97	
		LOTE 32-A	2015	30.98	
		LOTE 33	2015	36.01	
		LOTE 34	2014	51.74	
		LOTE 37	2014	38.44	
		LOTE 37 MERCEDEZ GAMA	2014	35.20	
		LOTE 38	2014	42.17	
		LOTE 39	2014	44.17	
		LOTE 41	2014	23.14	
		LOTE 42	2014	22.71	
		LOTE 42 PINO SUAREZ	2015	70.15	
		LOTE 48	2014	20.33	
		LOTE 49	2014	19.71	
		LOTE 6	2015	40.97	
		LOTE 64	2014	38.02	
		LOTE 7	2015	34.13	
		LOTE 8	2014	21.79	
		LOTE 9	2014	32.61	
		LOTE 9 PINO SUAREZ	2015	38.59	
		LOTE 9-A	2015	32.68	
		PREDIO SANTA MONICA	2015	64.90	
		PREDIO SANTA PATRICIA	2015	64.79	
		Tenosique	EL PENSAMIENTO	2016	7.47
			EL SACRIFICIO	2016	9.31
			LOTE 1	2016	0.83
	LOTE 11 Y 15		2016	8.12	
	LOTE 15		2016	6.79	
	LOTE 17		2016	88.26	
	LOTE 2		2016	9.03	
	LOTE 20		2016	3.22	
	LOTE 44		2016	13.41	
	SAN OCTAVIO		2016	26.84	
Chiapas	Palenque	DONA CARMINA	2013	292.33	
		HIDALGO	2013	131.80	
Total				3,743.06	

New planted areas during the verification period (2017-2019)

The eligible planted area per property is presented in **Table 13**. The location of the planted areas is presented in section 1.7.1, Figure 2 to Figure 4.

Table 13: Eligible planted area 2017-2019

State	Municipality	Property name	Year	Eligible planted area (ha)
Campeche	Candelaria	PREDIO ROMA	2017	101.00
Campeche	Candelaria	LA ILUSION	2018	86.70
Campeche	Candelaria	5 DE MAYO	2017	121.87
Campeche	Candelaria	SAN ROQUE	2018	17.42
Campeche	Candelaria	SAN JUANITO	2018	26.12
Campeche	Candelaria	SAN FRANCISCO	2019	15.63
Campeche	Candelaria	LA MARTINICA	2018	21.96
Campeche	Candelaria	LA ESPERANZA	2018	8.43
Campeche	Candelaria	EL RECUERDO	2018	13.22
Campeche	Candelaria	EL LEON	2019	261.87
Campeche	Candelaria	DOS HERMANAS	2018	10.47
Campeche	Carmen	PROVIDENCIA	2018	199.26
Campeche	Carmen	LA VOLUNTAD DE DIOS	2018	113.83
Campeche	Carmen	EL TEXANO	2018	64.06
Campeche	Escárcega	DOCE DE MAYO	2019	21.70
Campeche	Escárcega	LOS MANANTIALES	2019	345.73
Campeche	Escárcega	RANCHO NUEVO	2019	328.77
Campeche	Escárcega	SANTA FLORA	2019	13.86
Tabasco	Balancán	LOTE NUMERO 96	2017	62.68
Tabasco	Balancán	LOTE NUMERO 74 SETENTA YCUATRO	2017	70.07
Tabasco	Balancán	LOTE NUMERO 97	2018	44.54
Tabasco	Balancán	LA ALONDRA	2018	68.10
Tabasco	Tenosique	SAN FERNANDO	2019	37.21
Tabasco	Tenosique	EL PALMAR	2019	45.02
Tabasco	Tenosique	EL PALMAR 2	2019	1.77
Tabasco	Tenosique	CASTILLA	2019	11.07
Tabasco	Tenosique	LOTE NUMERO 03	2017	58.92
Tabasco	Tenosique	MURCIA	2019	82.10
Tabasco	Balancán	PARDILLOS	2018	72.34
Chiapas	Palenque	FINISTERRA	2019	28.78
Chiapas	Salto de agua	EL PARRAL	2017	1.25
				2,355.67

Total Eligible planted area 2013-2019	6,098.73
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Stratification

According to the “AR-ACM0003 A/R Large-scale Consolidated Methodology: Afforestation and reforestation of lands except wetlands Version 02.0”: *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 in order to achieve optimal precision of estimation of net GHG removals by sinks. In particular:*

For actual net GHG removals by sinks the stratification for ex post estimations is based on the actual implementation of the project planting/management plan. In the case of project area⁵⁷ monitored for the period 2013-2019, the stratification⁵⁸ included the growth quality and the year of establishment (Table 14).

Table 14: Stratification for actual net GHG removals by sinks of the period 2013-2019

Strata	Year of establishment	Area (ha)	Description
I	2013	448.72	High
II	2013	87.81	Low
III	2013	80.67	Excellent Seed
IV	2013	184.67	Mean
V	2014	64.94	Low
VI	2014	831.17	Excellent Clon
VII	2014	307.97	Excellent Seed
VIII	2015	149.42	High
IX	2015	248.04	Excellent Clon
X	2015	622.17	Excellent Seed
XI	2015	126.21	Mean
XII	2016	247.21	High
XIII	2016	71.38	Low
XIV	2016	75.78	Excellent Clon
XV	2016	59.06	Excellent Seed
XVI	2016	137.84	Mean
XVII	2017	93.37	High
XVIII	2017	96.29	Low
XIX	2017	226.13	Excellent Seed
XX	2017	126.96	Mean
XXI	2018	628.32	High
XXII	2018	43.18	Low
XXIII	2018	225.40	Excellent Clon
XXIV	2018	86.64	Excellent Seed
XXV	2019	615.52	Low
XXVI	2019	81.23	Excellent Seed

⁵⁷ Regarding the assignation of areas to each plot, some lots have more than one sampled plot inside, so when allocating an area to those plots and to avoid double counting, the lot area was divided by the number of contained plots; eligible area was kept constant. This was verified using the eligibility area for each lot per year and coherent with the cartographic information.

⁵⁸ Stratum 2017 Excellent Seed and stratum 2014 High presented just one plot with characteristics to be located in those categories, so those plots were included in stratum 2017 High and stratum 2014 Low respectively, which are lower stratum in order to avoid issues for the deviation estimations.

Strata	Year of establishment	Area (ha)	Description
XXVII	2019	132.62	Mean

Estimating carbon stock in trees at a point in time:

To estimate the carbon stock in tree biomass at a point in time, the following tool was used: *“Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities AR-TOOL14 Version 04.1”*. The method “a) Estimation by measurement of sample plots.

Plot biomass values were estimated from direct measurements conducted on trees in the sampling plots⁵⁹. The establishment of the sampling plots was carried out according to section 4.3.3.

Step 1. Average Diameter and high estimations per plot

With the measure presented for each tree per plot was estimate an average value to be use for the diameter and the high. For this process three point must be taking into account:

- Threes with values diameters“-88”: this indicated that the tree was identifies in the plot, but the measure was not taken, because the three presented a high minor to measured 1.3 m above ground, so the DBH was not possible to be measure.
- Threes with valued of “-99”: this represented a mortality of a specific three
- Threes without high data: these reflected problems at the time of the measure, such as difficulty to identify the cover crop and presence of high brightness. For these cases, an average of three tree for the same plot with similar diameter value was adopted.⁶⁰

Step 2: Volume estimation⁶¹

Volume estimation depending on diameter and height

The volume estimation per tree depending on diameter and height is found using the Tamarit equation (Tamarit, 2013)⁶²:

$$V = 0.000059 * DBH^{1.866203} H^{0.932461}$$

V = Tree volume; m³

DBH = Diameter at Breast Height; cm

H = Total height; m

According to point 1.7 of the Methodological tool *“Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”*, for ex-post estimation, the volume equation

⁵⁹ Number of plots established: 294. The location of the sampling plots can be found in [Supporting documents\SIG\Shape\plots].

⁶⁰ See Sheet DB (column L) in [Supporting documents\Estimations\Ex_post_estimations].

⁶¹ See Sheet PlotsMeasurment2020(column AA) in [Supporting documents\Estimations\Ex_post_estimations].

⁶² See [Supporting documents\Estimations\Literature\REPORT OF VALIDATION_ecuacion volume] and [Supporting documents\Estimations\Literature\Tamarit_2013].

used must be demonstrated to be appropriate for the purpose of estimation of tree biomass by applying the tool “*Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities Version 01.0.1*”⁶³. The equation used complies with the criteria presented in section 5.C: the equation was derived from a data set of at least 30 sample trees⁶⁴, and the value of coefficient of determination (R^2) was not less than 0.85.⁶⁵

Step 3: Biomass estimation⁶⁶

The estimation of tree biomass was calculated according to equation 5 Appendix 1 of the AR-TOOL14⁶⁷:

$$b_{TREE} = [V_{TREE} \times D \times BEF_2] \times (1 + R)$$

b_{TREE}	= Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha ⁻¹
V_{tree}	= Mean tree volume per hectare in the tree biomass estimation strata; m ³ ha ⁻¹
D	= Basic wood density; t m ⁻³
BEF_2	= Biomass Expansion Factor; dimensionless
R	= Root-to-shoot ratio; dimensionless

Step 4: Mean carbon stock estimation and mean carbon stock in terms of CO₂e⁶⁸

The estimation of the mean tree carbon per hectare in the tree biomass estimation strata was calculated according to equation 13 of the AR-TOOL14:

$$B_{tree} = A \times b_{tree}$$

B_{TREE}	= Tree biomass in the tree biomass estimation strata; t d.m.
A	= Sum of areas of the tree biomass estimation strata; ha
b_{TREE}	= Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha ⁻¹

⁶³ <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-18-v1.0.1.pdf>

⁶⁴ See page 25, section 2.4 of the supporting document [Supporting documents/Estimations/Literature/Tamarit_2013].

⁶⁵ See page 31, cuadro 2.4 of the supporting document [Supporting documents/Estimations/Literature /Tamarit_2013].

⁶⁶ See Sheet ΔC in [Supporting documents\Estimations\Ex_post_estimations].

⁶⁷ Average height and average diameter over each plot were used to calculate average volume and then this average is used to estimate biomass on each strata.

⁶⁸ See Sheet ΔC in [Supporting documents\Estimations\Ex_post_estimations].

$$b_{tree} = \sum_{i=1}^M w_i \times b_{tree,i}$$

- b_{TREE} = Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha⁻¹
- w_i = Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata; dimensionless
- $b_{tree,i}$ = Mean tree biomass per hectare in stratum i; t d.m. ha⁻¹

The estimation of the uncertainty was calculated according to equation 15 of the AR-TOOL14⁶⁹:

$$u_c = \frac{t_{VAL} \times \sqrt{\sum_{i=1}^M w_i^2 \times \frac{S_i^2}{n_i}}}{b_{tree}}$$

- u_c = Uncertainty
- t_{VAL} = Two-sided Student's t-value for a confidence level of 90% and degrees of freedom equal to n – M, where n is total number of sample plots within the tree biomass estimation strata and M is the total number of tree biomass estimation strata
- w_i = Ratio of the area of stratum i to the sum of areas of tree biomass estimation strata; dimensionless
- S_i^2 = Variance of tree biomass per hectare across all sample plots in stratum i; (t d.m. ha⁻¹)
- b_{TREE} = Mean tree biomass per hectare in the tree biomass estimation strata; t d.m. ha⁻¹
- n_i = Number of sample plots in stratum i

The estimation of the mean carbon stock in trees within the tree biomass estimation strata was calculated according to equation 12 of the AR-TOOL14:

$$C_{TREE} = \frac{44}{12} \times C_{tree}$$

⁶⁹ See Sheet Uncertainty in [Supporting documents\Estimations\SamplingError&Uncertainty]. Equation 15 of the AR-TOOL 14 was used to calculate the uncertainty in tree volume. The uncertainty value is 7.48%, which implies a discount of 0% for the GHG removals of the current monitoring period.

C_{TREE}	=	Carbon stock in trees in the tree biomass estimation strata; t CO ₂ e
CF_{TREE}	=	Carbon fraction of tree biomass; t C (t d.m.) ⁻¹
B_{TREE}	=	Tree biomass in the tree biomass estimation strata; t d.m.

Table 15: Parameters used for the estimation of tree biomass and mean carbon stock

Parameter	Symbol	Value	Source
Basic wood density (t m ⁻³)	D	0.59	Rodríguez Anda, Fuentes T., & Silva Guzmán (2012) ⁷⁰
Biomass Expansion Factor (dimensionless)	BEF_2	1.50	IPCC (2003) ⁷¹
Root-to-shoot ratio (dimensionless)	R	$R=e^{(-1.085+0.9256*\ln B)/B}$	CDM_AR_tool_14.
Carbon fraction of tree biomass; t C (t d.m.) ⁻¹	CF_{TREE}	0.47	IPCC (2006) ⁷²

Step 5: Dead wood

A conservative default-factor value of 6% and 1% was applied according to the precipitation.⁷³

Step 6: Litter

A conservative default-factor value of 1% was applied.

Step 7: Baseline emission

A baseline emissions estimation was carried out using the A/R Methodological AR-TOOL 14 “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities Version 04.2”. The baseline was represented for this case for the shrubs areas localized in all new instances. The baseline emission represented for the citrus crops in Huimanguillo was already excluded in the first verification in the years 2014 and 2015, because of this, it will be excluded to avoid double count.

⁷⁰ See supporting folder [Supporting documents\Estimations\Literature\Wood density]. The wood density used is the average value found in the AGSA plantations (Rodríguez et al 2012). The value is supported by other findings in teak plantations in Costa Rica (Serrano et al_Pag 104).

⁷¹ IPCC 2003. “Good Practice Guidance for LULUCF”. The BEF value for Tropical Climatic Zone and Broadleaf Forest Type was used. Table 3A.1.10 of Annex 3A.1.

⁷² IPCC, 2006. Table 4.3. http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf

⁷³ See Sheet ΔC (column L-M) in [Supporting documents\Estimations\Ex_post_estimations].

Step 8: Carbon stock in trees at a point in time

Change in the carbon stocks in the selected carbon pools in the year t were calculated according to the AR-ACM0003 methodology⁷⁴:

$$\Delta C_{P,t} = \Delta C_{TREE_PROJ,t} + \Delta C_{SHRUB_PROJ,t} + \Delta C_{DW_PROJ,t} + \Delta C_{LI_PROJ,t}$$

- Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in the project, occurring in the selected carbon pools. in year t ; t CO ₂ -e
$\Delta C_{TREE_PROJ,t}$	=	Change in carbon stock in tree biomass in the project in year t . as estimated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO ₂ -e
$\Delta C_{SHRUB_PROJ,t}$	=	Change in carbon stock in shrub biomass in the project in year t . as estimated in the tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; t CO ₂ -e
$\Delta C_{DW_PROJ,t}$	=	Change in carbon stock in dead wood in the project in year t . as estimated in the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”; t CO ₂ -e
$\Delta C_{LI_PROJ,t}$	=	Change in carbon stock in litter in the project in year t . as estimated in the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”; t CO ₂ -e

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

Increase in non-CO₂ GHG emissions ($GHG_{E,t}$) within the project boundary as a result of the implementation of the A/R VCS project activity in year t . as estimated in the Annex 31 “Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity version 04.0.0”; t CO₂-e. Equation 1 of this tool is as follows:

$$GHG_{E,t} = GHG_{SPF,t} + GHG_{FMF,t} + GHG_{FF,t}$$

Where:

$GHG_{E,t}$	=	Emission of non-CO ₂ GHGs resulting from burning of biomass and forest fires within the project boundary in year t ; t CO ₂ -e
-------------	---	--

⁷⁴ See Sheet ΔC (O) in [Supporting documents\Estimations\Ex_post_estimations].

$GHG_{SPF,t}$	=	Emission of non-CO ₂ GHGs resulting from use of fire in site preparation in year t ; t CO ₂ -e
$GHG_{FMF,t}$	=	Emission of non-CO ₂ 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 CO ₂ -e
$GHG_{FF,t}$	=	Emission of non-CO ₂ GHGs resulting from fire in year t ; t CO ₂ -e
t	=	1.2.3. ... years counted from the start of the project activity

According to the tool "Estimation of non-CO₂ GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity", the emission of non-CO₂ GHGs resulting from burning of biomass and forest fires within the project boundary in year t is an estimate based on three sources: (1) burning of biomass and forest fires within the project boundary; (2) use of fire in site preparation; and (3) use of fire to clear the land of harvest residue prior to replanting of the land or other forest management. Source 1 is considered to be zero as there were no emissions resulting from burning in the project area during the second verification period. Sources 2 and 3 were considered to be zero, as the project activities did not include the use of fires to prepare land. Considering the previous description, non-CO₂ GHG emissions ($GHG_{E,t}$) are considered to be zero.

5.3 Leakage

According to AR-TOOL15 "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity" Version 2.0, and how it was describe in section 3.4 Estimated Net GHG Emission Reductions and Removals from the Project Description & Monitoring Report⁷⁵, leakage is all those emissions which occur when the displacement of pre-project agricultural activities leads to an increase in GHG emissions relative to the GHG emissions attributable to the activity as it exists within the project boundary. According to Equation 1 of AR-TOOL15 and the behavior of the agricultural activities in the project scenario, leakage emissions resulting from displacement of activities are estimated as follows:

$$LK_{AGRIC, t} = \frac{44}{12} * (\Delta C_{BIOMASS,t} + \Delta SOC_{LUC,t}) = 0$$

$$\Delta C_{BIOMASS,t} = [1.1 \times b_{tree} \times (1 + R_{tree}) + b_{SHRUB} \times (1 + R_s)] \times CF \times A_{DISP,t}$$

⁷⁵ Project Description & Monitoring Report, Reforestation with teak CO₂e TEAKMEX. 2018

$$\Delta SOC_{LUC,t} = SOC_{REF} \times (f_{LUP} \times f_{MGP} \times f_{INP} - f_{LUD} \times f_{MGD} \times f_{IND}) \times A_{DISP,t}$$

Where:

$LK_{AGRIC, t}$	= Leakage emissions resulting from displacement of agricultural activities in year t; t CO ₂ e
$\Delta C_{BIOMASS,t}$	= Decrease in carbon stock in the carbon pools of the land receiving the activity displaced in year t; t d.m
CF	= Carbon fraction of woody biomass; dimensionless
$A_{DISP,t}$	= Area of land from which agricultural activity is being displaced in year t; ha
b_{tree}	= Mean above-ground tree biomass in land receiving the displaced activity; t d.m. ha ⁻¹
R_{tree}	= Root-shoot ratio for trees in the land receiving the displaced activity; dimensionless.
b_{SHRUB}	= Mean above-ground shrub biomass in land receiving the displaced activity; t d.m. ha ⁻¹
R_s	= Root-shoot ratio for shrubs in the land receiving the displaced activity; dimensionless
$\Delta SOC_{LUC,t}$	= Change in soil organic carbon (SOC) stock due to land-use change in the land receiving the displaced activity in year t; tC ha ⁻¹
SOC_{REF}	= SOC stock corresponding to the reference condition in native lands by climate region and soil type applicable to the land receiving the displaced activity; t C ha ⁻¹
$f_{LUP}, f_{MGP}, f_{INP}$	= Relative SOC stock change factors for land-use, management practices, and inputs respectively, applicable to the receiving land before the displaced activity is received; dimensionless
$f_{LUD}, f_{MGD}, f_{IND}$	= Relative SOC stock change factors for land-use, management practices, and inputs respectively, applicable to the receiving land after the displaced activity has been received; dimensionless
t	= 1, 2, 3, ...years elapsed since the start of the A/R CDM project activity.

Owners of the acquired livestock lands are adults who sold their lands with the intention of moving away from field-based activities in particular moving to some cities⁷⁶ and/or migrating to areas already degraded which therefore presents no displacement of emissions.

The south of Mexico, where the expansion area of the project is found, has been impacted for decades by policies that incentivize agricultural production. The best example of this is the National Tree Clearing Program (in Spanish, PRONADE), where the Government allocated land to peasants and the National Commission of DESMONTES provided loans to farmers to encourage them to remove vegetation from their lands, as well as the National Farming Program to incentivize changing land use from forest to pasture or agriculture. Following these policies, from the 1970s to 1985, the farming sector showed considerable growth and the area of land devoted to livestock cultivation and foraging increased by more

⁷⁶ http://cuentame.inegi.org.mx/poblacion/rur_urb.aspx?tema=P

than 100%⁷⁷⁷⁸. This resulted in a very high of degraded lands along the country, reducing the risk of the remnant forest lands to be degraded for increasing the agricultural lands.

In the event that the previous owner of the land purchased by AGSA continues with farming activities, these would be transferred to already-degraded areas, where the number of livestock would not exceed the load capacity of the system for the following reasons:

- Availability of area with farming as current land use:

The incentives mentioned above led to the current situation in the states that make up the expansion area of the project: that is to say, that the predominant land use type in these three areas is agricultural. Of the five municipalities that are located in the project area, four are characterized by having large tracts of land dedicated to farming (Table 16). In addition to this, the migration phenomenon mentioned previously has meant that rural land is available at lower prices than in other regions of the country. Finally, the change of land use from areas of natural vegetation to pastures is not a viable scenario due to the high cost of soil preparation and the current legislation that *promotes the conservation of forest ecosystems, encouraging their delimitation and sustainable management, avoiding that the change of land use for agricultural purposes or of any other nature affects their permanence and potential*.⁷⁹.

- Type of farming practiced in the region:

In section 2.5.1 from the Project Description & Monitoring Report⁸⁰, where alternative land uses are described, it was reported that the type of farming practiced in the area is extensive grazing with an average density of one head of cattle per hectare. To increase the load capacity, it would be necessary to increase the number of livestock in the pre-project scenario, which is not expected because the sale of the farms to AGSA was made because the previous owners no longer had the capacity to maintain livestock due to the migration of young people to the cities. So, if animals in the pre-project scenario were displaced to existing grazing lands, the total number of animals in the receiving lands would not exceed the carrying capacity of the land.

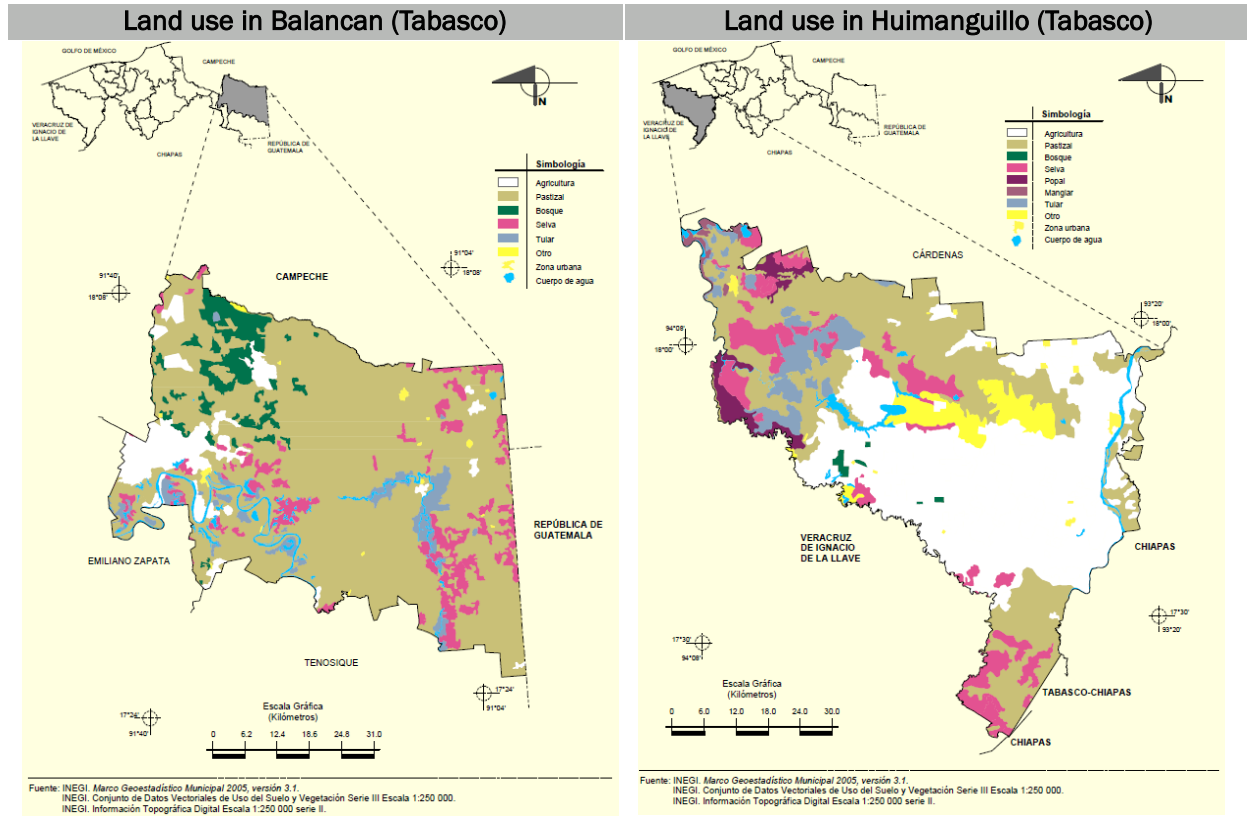
⁷⁷ Cerdeño Gilardi Heidi y Pérez Salicrup Diego R. La legislación forestal y su efecto en la restauración en México. Instituto nacional de Ecología y Cambio Climático. 2007. Disponible en <http://www2.inecc.gob.mx/publicaciones2/libros/467/cedenoyperrez.html>

⁷⁸ Moreno Unda, Arcelia A. Efectos ambientales del Programa Nacional de Desmontes, 1972-1982. 2011. Disponible en <http://ninive.uaslp.mx/jspui/handle/i/3541> y comunidadpmpca.uaslp.mx/documento.aspx?idT=123

⁷⁹ Law of Sustainable Forest Development. Ministry of Environment and Natural Resources of Mexico (Last reform published 04-13-2020). Article 3. Specific objectives: VII). Recover and develop forests on degraded forest lands and preferably forest lands, so that they fulfill the function of conserving soil and water, in addition to boosting rural development. X). Promote the conservation of forest ecosystems, encouraging their delimitation and sustainable management, avoiding that the change of land use for agricultural purposes or of any other nature affects their permanence and potential.

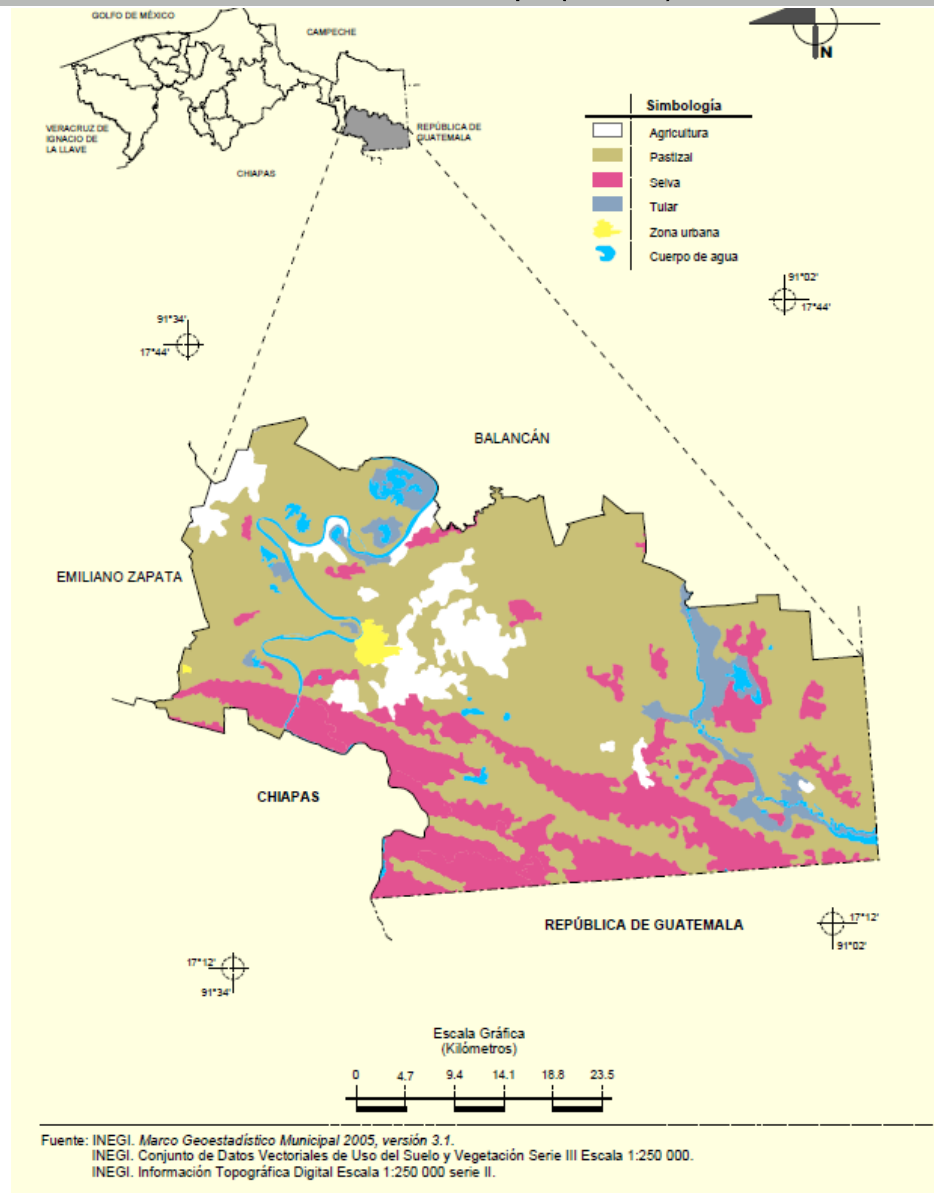
⁸⁰ Project Description & Monitoring Report, Reforestation with teak CO₂e TEAKMEX. 2018

Table 16: Land use map in the municipalities where the project area included in the first phase of the grouped project is located⁸¹

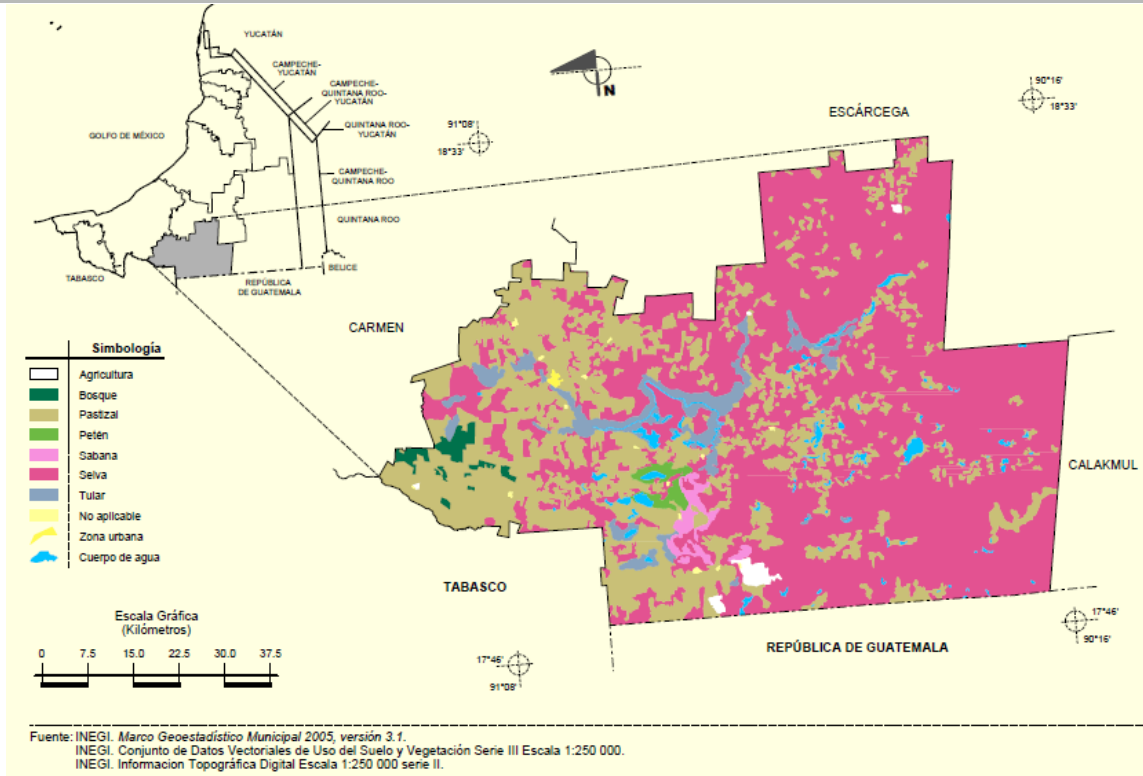


⁸¹Source of maps presented can be found in [Supporting documents\Land Use]

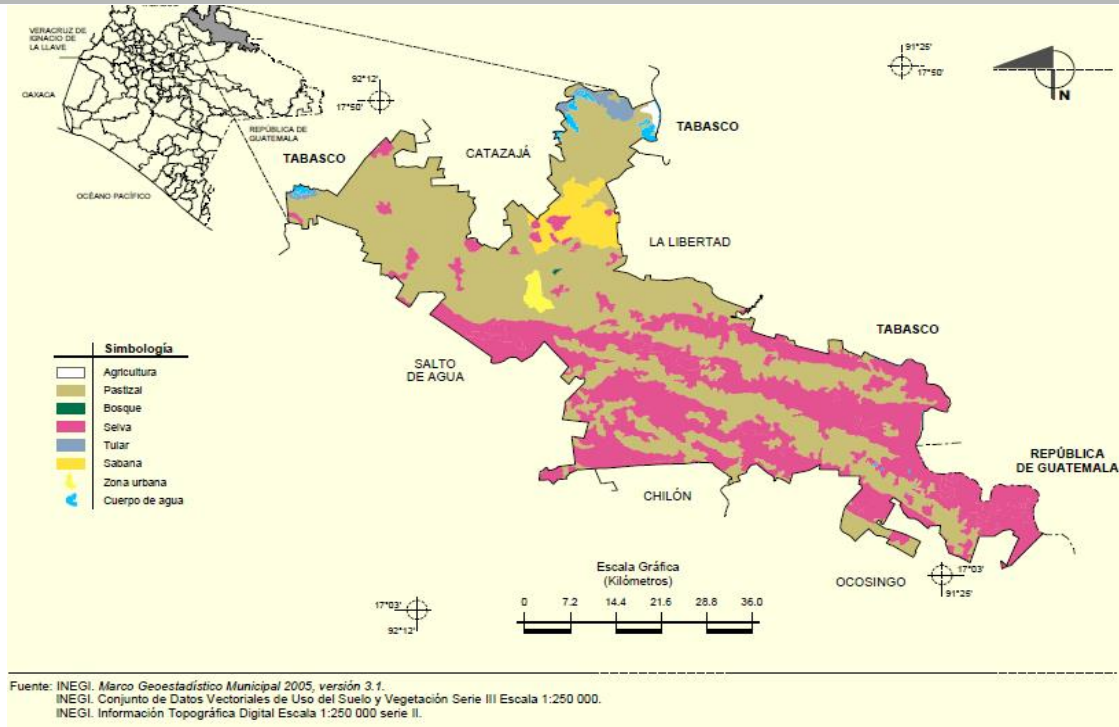
Land use in Tenosique (Tabasco)



Land Use in Candelaria (Campeche)



Land Use in Palenque (Chiapas)



Given the explanation above, the project scenario does not consider likely the displacement of livestock or agricultural activities outside the project boundary towards other forested lands.

Leakage emission is accounted as zero, given that non-decreasing carbon stocks (biomass and SOC) are expected from lands outside the project boundary associated with those activities.

5.4 Net GHG Emission Reductions and Removals

According to equation 5 of the methodology AR-ACM0003 v2.0, net anthropogenic GHG removals by sinks shall be calculated as follows:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where:

$\Delta C_{AR-CDM,t}$ = Net anthropogenic GHG removals by sinks. in year t; t CO₂-e

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks. in year t; t CO₂-e

$\Delta C_{BSL,t}$ = Baseline net GHG removals by sinks. in year t; t CO₂-e

LK_t = GHG emissions due to leakage. in year t; t CO₂-e

LK_t can be considered zero according to section 5.3, 5.4 and 5.5 of the methodology AR-ACM0003 v2.0.

Then, $\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t}$.

The total GHG benefit calculated as the sum of stock changes along the monitoring period (16-10-2017 to 21-10-2020) is 344,072 tCO₂e (see

Table 17 and Excel file “Ex_post_estimations”).⁸²

Table 17: Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net emission reductions or removals (tCO ₂ e)	Buffer pool allocation (17%)	VCUs First Verification (2013-2017)	VCUs eligible for issuance
2013	-	-	-	-	-	15,589	-
2014	-	-	-	-	-	-	-
2015	-	-	-	-	-	-	-
2016	-	-	-	-	-	50,519	-
2017	-	-	-	-	-	50,519	-
2018	7,858	142,237	-	118,057	24,180		118,057
2019	26,239	125,711	-	104,340	21,371		104,340
2020	5,354	146,596	-	121,675	24,921		121,675
Total		414,544	-	344,072	70,472	116,628	344,072

⁸² Estimated net GHG emission reductions or removals (tCO₂e) were calculated based on the information collected in the permanent plots. The number of plots measured in the period 2013-2017 aligns with the requirements of methodology AR-ACM0003 [Supporting documents/Estimations].

APPENDIX 1: MEASUREMENT STANDING TREES⁸³

Sistema MIRA-Silv **MEDICIÓN DE ÁRBOLES EN PIE** **24/08/2020**
AGROPECUARIA SANTA GENOVEVA S.A. P.I. de C.V. **Pág. 1 de 2**
 Código¹ **MX** Código de² **ASC** No. serial del³ **00493** No. del⁴ **002** Código⁵ **66** No. de la⁶ **0**
 de país proyecto experimento tratamiento de lote repetición
 Región⁷ **01-007** Nombre del⁸ **CAMPUSUR** Código de⁹ **TECTGR02**
 sitio sitio tratamiento
 fecha de¹⁰ **15/11/2017** Fecha de¹¹ **25-09-2020** Tipo del¹² **P** P=la altura del pecho (DAP)
 plantación medición diámetro B=Basal del eje T=basal del tocón
 No. de¹³ **00** Especie¹⁴ **TECTGR** Especie¹⁵ **Tectona grandis**
 rotación Parcela
 No. árboles¹⁶ **100** No. árboles¹⁷ **00** Espaciamiento¹⁸ **350** cm X **350** cm X **00**
 originales vivos original

Anotadores²⁵ **2019 GARCIA** Observaciones²⁶

Árbol No.	Eje No.	Diámetro	Altura total	Código de forma y defectos del fuste*	Código de forma y defectos del tocón	Árbol No.	Eje No.	Diámetro	Altura total	Código de forma y defectos del fuste*	Código de forma y defectos del tocón
1	1	20.2	5	L		43	1	23.4	5.20	L	
2	1	20.2	5	L		44	1	23.4	5.20	L	
3	1	20.2	5	L		45	1	23.4	5.20	L	
4	1	20.2	5	L		46	1	23.4	5.20	L	
5	1	20.2	5	L		47	1	23.4	5.20	L	
6	1	20.2	5	L		48	1	23.4	5.20	L	
7	1	20.2	5	L		49	1	23.4	5.20	L	
8	1	20.2	5	L		50	1	23.4	5.20	L	
9	1	20.2	5	L		51	1	23.4	5.20	L	
10	1	20.2	5	L		52	1	23.4	5.20	L	
11	1	20.2	5	L		53	1	23.4	5.20	L	
12	1	20.2	5	L		54	1	23.4	5.20	L	
13	1	20.2	5	L		55	1	23.4	5.20	L	
14	1	20.2	5	L		56	1	23.4	5.20	L	
15	1	20.2	5	L		57	1	23.4	5.20	L	
16	1	20.2	5	L		58	1	23.4	5.20	L	
17	1	20.2	5	L		59	1	23.4	5.20	L	
18	1	20.2	5	L		60	1	23.4	5.20	L	
19	1	20.2	5	L		61	1	23.4	5.20	L	
20	1	20.2	5	L		62	1	23.4	5.20	L	
21	1	20.2	5	L		63	1	23.4	5.20	L	
22	1	20.2	5	L		64	1	23.4	5.20	L	
23	1	20.2	5	L		65	1	23.4	5.20	L	
24	1	20.2	5	L		66	1	23.4	5.20	L	
25	1	20.2	5	L		67	1	23.4	5.20	L	
26	1	20.2	5	L		68	1	23.4	5.20	L	
27	1	20.2	5	L		69	1	23.4	5.20	L	
28	1	20.2	5	L		70	1	23.4	5.20	L	
29	1	20.2	5	L		71	1	23.4	5.20	L	
30	1	20.2	5	L		72	1	23.4	5.20	L	
31	1	20.2	5	L		73	1	23.4	5.20	L	
32	1	20.2	5	L		74	1	23.4	5.20	L	
33	1	20.2	5	L		75	1	23.4	5.20	L	
34	1	20.2	5	L		76	1	23.4	5.20	L	
35	1	20.2	5	L		77	1	23.4	5.20	L	
36	1	20.2	5	L		78	1	23.4	5.20	L	
37	1	20.2	5	L		79	1	23.4	5.20	L	
38	1	20.2	5	L		80	1	23.4	5.20	L	
39	1	20.2	5	L		81	1	23.4	5.20	L	
40	1	20.2	5	L		82	1	23.4	5.20	L	
41	1	20.2	5	L		83	1	23.4	5.20	L	
42	1	20.2	5	L		84	1	23.4	5.20	L	

* Códigos para forma y defectos del fuste: 1=cola de perro, 2=truncado simpático, 3=truncado simpático, 4=torcedura leve, 5=torcedura fuerte, 6=torcedura fuerte, 7=torcedura fuerte, 8=con plagas, 9=coque asimétrica, A=tallo quebrado con recuperación, B=tallo quebrado sin recuperación, C=coque, D=replantación, E=seco natural, F=coque talco, G=regeneración natural, I=dominante, J=co-dominante, K=suprinito, L=seco con y sin defectos en forma

⁸³ The definitions of the fields presented in this form can be found as a support document in [Supporting documents/Estimations/Plot establishment]

Sistema Mirasiv MEDICION DE ARBOLES EN PIE 18/09/2009
AGROPECUARIA SANTA GENOVEVA S.A. P.I. de C.V. Pág. 1 de 2

Código¹ de país **MX** Código de² proyecto **ASG** No. serial del³ experimento **00038** Ns. del⁴ tratamiento **003** Código⁵ de lote **02** Ns. de la⁶ repetición **0**

Región⁷ sitio **01-003** Nombre del⁸ sitio **POLIGONO -1** Código de⁹ tratamiento **TECTGR03**

Fecha de¹⁰ plantación **15/07/2003** Fecha de¹¹ medición **07-10-2009** Tipo de¹² diámetro **F** P=a la altura del pecho (DAP)
B=basal del eje
T=basal del tocón

No. del¹³ rotación **01** Especie-¹⁴ Parcela **TECTGR** Especie¹⁵ **Tectona grandis**

No. árboles¹⁶ originales **100** No. árboles¹⁷ vivos **135** Espaciamiento¹⁸ original **400 cm X 200 cm X** cm

Anotadores²⁵ **Jaime, Joaquín, Gilardo** Observaciones²⁶ **Se midió a 16m**

Árbol No.	Eje No.	Diámetro (mm)	Altura total (dm)	Código de forma y defectos del fuste*	Código de forma y defectos del fuste*	% T	% C
1	1	13.4	13.92	1		78+9	0
2	1	-99.00	-99.00				
3	1	-99.00	-99.00				
4	1	-99.00	-99.00				
5	1	16.7	13.76			77+9	2.72 8+9
6	1	14.6	12.32			63+9	2.24 5+9
7	1	-99.00	-99.00				
8	1	19.1	12.96			72+9	1.92 3+9
9	1	-99.00	-99.00				
10	1	-99.00	-99.00				
11	1	-99.00	-99.00				
12	1	-99.00	-99.00				
13	1	-99.00	-99.00				
14	1	Murafa en H.V.					
15	1	-99.00	-99.00				
16	1	-99.00	-99.00				
17	1	-99.00	-99.00				
18	1	-99.00	-99.00				
19	1	17.0	14.24			80+9	2.40 6+9
20	1	16.7	5.92 A			28+9	0
21	1	-99.00	-99.00				
22	1	-99.00	-99.00				
23	1	-99.00	-99.00				
24	1	14.5	12.64			70+9	2.40 6+9
25	1	14.8	11.52			63+9	3.04 10+9
26	1	-99.00	-99.00				
27	1	15.6	A			33+9	2.24 5+9
28	1	-99.00	-99.00				
29	1	-99.00	-99.00				
30	1	-99.00	-99.00				
31	1	-99.00	-99.00				
32	1	-99.00	-99.00				
33	1	-99.00	-99.00				
34	1	14.8	11.84			65+9	2.72 8+9
35	1	12.7	5.12 A			23+9	0
36	1	-99.00	-99.00				
37	1	-99.00	-99.00				
38	1	M	B				
39	1	-99.00	-99.00				

Árbol No.	Eje No.	Diámetro (mm)	Altura total (dm)	Código de forma y defectos del fuste*	Código de forma y defectos del fuste*	% T	% C
40	1	-99.00	-99.00				
41	1	-99.00	-99.00				
42	1	-99.00	-99.00				
43	1	-99.00	-99.00				
44	1	-99.00	-99.00				
45	1	-99.00	-99.00				
46	1	-99.00	-99.00				
47	1	16.5	5.60 A			26+9	1.76 2+9
48	1	-99.00	-99.00				
49	1	14.2	9.76			52+9	3.36 12+9
50	1	-99.00	-99.00				
51	1	14.7	10.08			54+9	3.84 15+9
52	1	-99.00	-99.00				
53	1	-99.00	-99.00				
54	1	-99.00	-99.00				
55	1	14.8	12.16			67+9	3.20 11+9
56	1	18.0	13.12			73+9	2.08 4+9
57	1	-99.00	-99.00				
58	1	15.8	12.96			72+9	3.04 10+9
59	1	-99.00	-99.00				
60	1	-99.00	-99.00				
61	1	-99.00	-99.00				
62	1	-99.00	-99.00				
63	1	17.2	5.92 A			28+9	1.92 3+9
64	1	-99.00	-99.00				
65	1	20.3	14.72			83+9	3.36 12+9
66	1	-99.00	-99.00				
67	1	17.9	6.08 A			29+9	2.08 4+9
68	1	12.9	5.12 A			23+9	2.40 6+9
69	1	-99.00	-99.00				
70	1	-99.00	-99.00				
71	1	-99.00	-99.00				
72	1	-99.00	-99.00				
73	1	-99.00	-99.00				
74	1	13.7	11.04			60+9	2.40 6+9
75	1	-99.00	-99.00				
76	1	-99.00	-99.00				
77	1	-99.00	-99.00				
78	1	-99.00	-99.00				

Códigos para forma y defectos del fuste: 1=cola de zorro, 2=poco sinuoso, 3=muy sinuoso, 4=torcedura basal, 5=bifurcado, 6=inclinado, 7=enfermo, 8=con plagas, 9=copa asimétrica, A=tallo quebrado con recuperación, B=tallo quebrado sin recuperación, C=sin copa, D=replantación, E=spp extraña, F=rebrote, G=para raleo, H=regeneración natural, I=dominante, J=codominante, K=suprimido, L=ejes rectos y sin defectos de forma, t=indica raleo en la última medición

- 99 MUERTO

APPENDIX 2: VERIFICATION OF CONSECUTIVE MEASUREMENTS

Presentación Preliminar - mira9-medicionconsecutiva.fr - Página 2

Verificación de Medición Consecutiva

Cód. país: MX Proy.: AGROP. SANTA GENOVEVA, S.A. DE (ASG) Lote-Sitio: 10-001

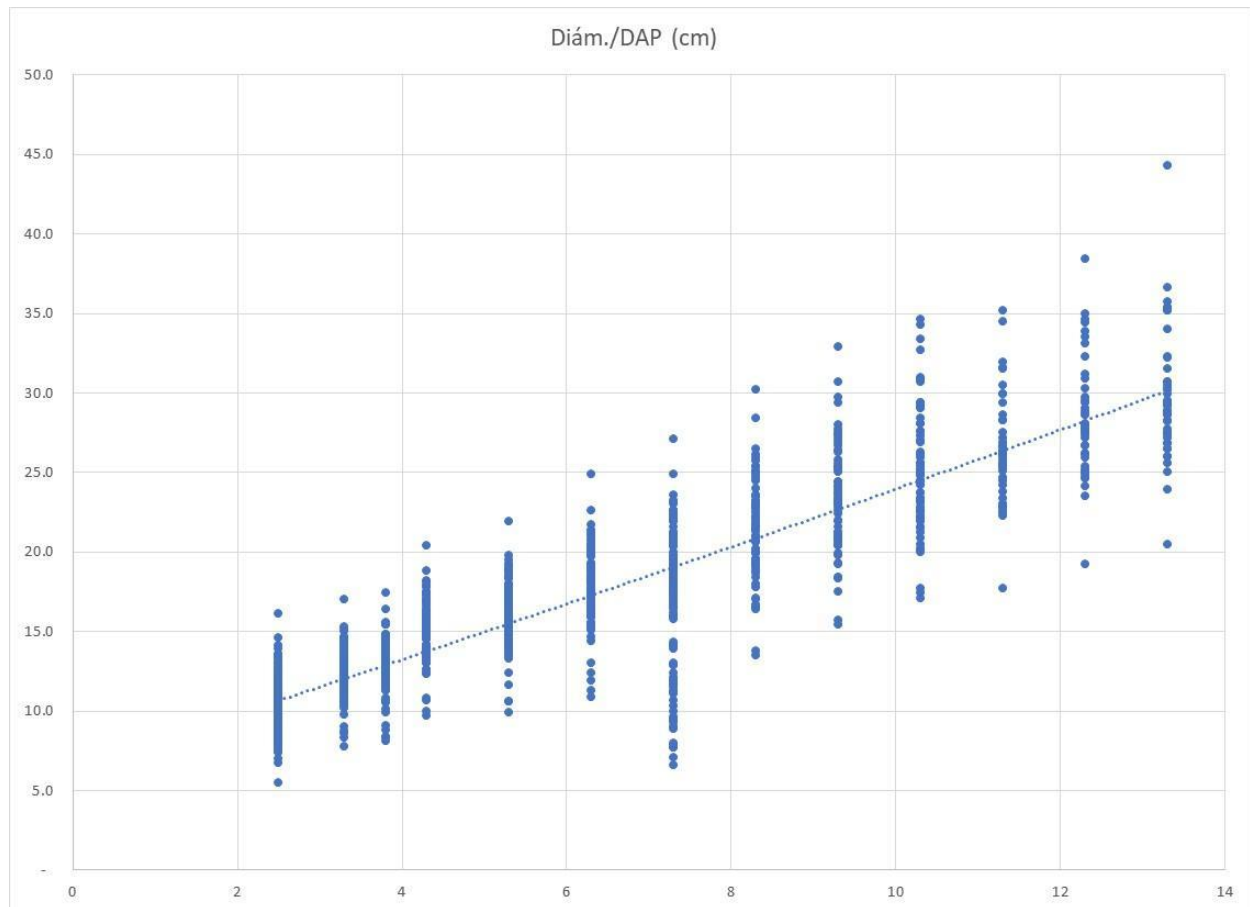
Nombre Lote: Nombre del sitio: COPY

Experimento: 00020 Cód. Tratam.: TECTGR01 Ns. Tratam.: 001 Núm. Repet.: 0

Fecha medición: 15/10/17 Fecha medición anterior: 15/10/16 Δ edad: 12

Especie	Árbol	Eje	Diámetro (cm)				Altura total (m)				Cód. de Forma		Cód. de Sanidad		Raleo
			NS: 15 Edad: 159	NS: 14 Edad: 147	Δ	%	NS: 15 Edad: 159	NS: 14 Edad: 147	Δ	%	NS: 15 Edad: 159	NS: 14 Edad: 147	NS: 15 Edad: 159	NS: 14 Edad: 147	
TECTGR	49	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	50	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	51	1	29.0	27.6	1.4	5.2	16.3	16.0	0.3	1.6	2	2,1			☐
TECTGR	52	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	53	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	54	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	55	1	25.1	23.9	1.2	5.1	14.5	14.4	0.1	0.7	2,6	2,1			☐
TECTGR	56	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	57	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	58	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	59	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	60	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	61	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	62	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	63	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	64	1	29.2	27.1	2.2	8.0	17.5	17.2	0.3	1.7	2	2,1			☐
TECTGR	65	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	66	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	67	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	68	1	26.5	24.8	1.8	7.2	18.0	16.8	1.2	7.1	2	1,2			☐
TECTGR	69	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	70	1	-99	-99	--	--	-99	-99	--	--	G	G			☐
TECTGR	71	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	72	1	25.0	23.2	1.7	7.4	15.5	14.6	0.9	6.2	3				☐
TECTGR	73	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	74	1	23.0	21.6	1.4	6.5	15.8	15.6	0.2	1.0	2	1,2			☐
TECTGR	75	1	-99	-99	--	--	-99	-99	--	--					☐
TECTGR	76	1	-99	-99	--	--	-99	-99	--	--					☐

APPENDIX 3: DATABASE FOR THE USUAL IMA IN ACCORDANCE WITH THE QUALITY OF GROWTH FOR DBH



APPENDIX 4: DATABASE FOR THE USUAL IMA IN ACCORDANCE WITH THE QUALITY OF GROWTH FOR HEIGHT

