2025

BASELINE REPORT

VERIFIED CARBON CREDITS (VCC)

Manejo Forestal y Biodiversidad Pichucalco

BEL-003-MEX-20082024 PICHUCALCO, CHIAPAS, MÉXICO

Desarrollos Sostenibles BELMEX S.A. de C.V.

Chiapas, México

July 2025

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Executive summary

The baseline report for plantation projects is an essential undertaking for their certification process. This step is vital as it lays the groundwork for determining the initial metrics of biomass production and subsequent carbon sequestration in each project. The report will encompass the computation of NDVI and biomass indices, both derived through a specific methodology utilizing satellite imagery and high-resolution ortho-mosaics.

The ecological restoration of a forested area in Pichucalco, Chiapas (Mexico) entailed planting of a total of 15,151 trees of six distinct species. These tree species were chosen as they are mainly native to the region and therefore adapted to the unique environmental conditions of the project area. The primary objective of this initiative was to enhance biodiversity, improve soil quality, water infiltration and create opportunities for environmental education. The project area covers 31.8 hectares.

The moderate-density technique was employed, providing numerous benefits such as improved yield and efficient resource utilization. The average planting density within the plot was one tree per 21.1 square meters, equivalent to an average of 477 trees per hectare in the plot.

The total CO_2 capture for the project area was calculated to be between 5,814.53 and 7,921.70 TCO_2-eq considering survival scenarios of 73.4% and 100% respectively at the end of the 40 years of the project's lifetime. These figures underscore the project's significant contribution to carbon sequestration and overall environmental restoration. The successful reforestation endeavor in Pichucalco demonstrates the positive impact of strategically selecting native species to reclaim and revitalize degraded landscapes, providing ecological, economic, and social benefits for the region and its communities.

I. Project Design

This section is based on the information compiled in the PSF Format - Project Submission Form prepared by the project developer.

I.1. Project location

The project is in Pichucalco, in the Chiapas state of Mexico. The project area encompasses 31.8 hectares of land, of which 30 hectares are stated to be active intervention zones. The project area is further split into four different parcels (La Flor del Limonero (9.5 ha), La Ceiba (10.6 ha), Buenos Aires (6.7 ha), and La Algarabia (5.0 ha)).

A project location map is illustrated in Figure 1. Table 1 shows the coordinates of the reforested Plots.

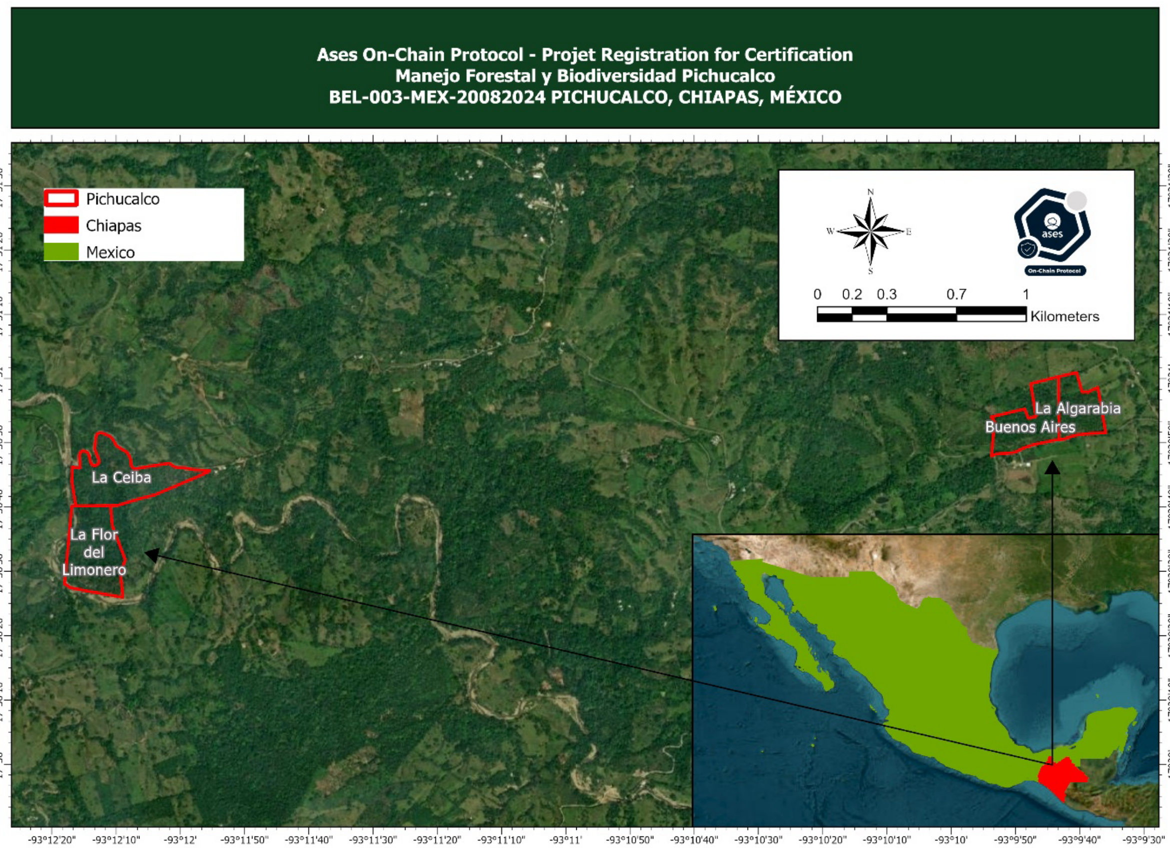


FIGURE 1. PROJECT LOCATION

TABLE 1. CENTRAL COORDINATES OF PROJECT PLOT

Plot	Coordinates (UTM 16N)	
	Latitude	Longitude
1 (La Flor del Limonero)	-159599.2124	1946656.78897
2 (La Ceiba)	-159459.572506	1947012.9458
3 (Buenos Aires)	-155263.865384	1947144.02968
4 (La Algarabia)	-155036.267304	1947195.86607

I.2. ADMINISTRATIVE SPECIFICATIONS

This section introduces the project developer and provides a clear understanding of the roles and responsibilities assigned to each party involved. It also addresses the status of land ownership, ensuring transparency and certainty regarding the agreements made with the landowners.

I.2.1. PROJECT DEVELOPER

Key project	BEL-003-MEX-20082024 PICHUCALCO, CHIAPAS, MÉXICO
Title of the project activity	Manejo Forestal y Biodiversidad Pichucalco
Company	Desarrollos Sostenibles BELMEX S.A. de C.V.
Person responsible	Carlos Alfonso Sandoval Miranda

I.2.2. TYPE OF PROJECT

Project registration year	2025
Project duration	40 years
Issuance of credits	Annual
Methodology applied	*Methodology for estimating carbon removal capacity of projects V2.0*[1]

1 https://www.nat5.bio/wp-content/uploads/2024/03/aOCP-Methodology-for-estimating-the-carbon-removal-capacity-of-projects-V2.0.pdf

Type	☒ Forest management ☐ Regenerative agriculture ☐ Silvopastoral management ☐ Individual tree-based climate action / urban forest ☐ Water flow restoration ☐ Biochar

I.2.3. VNPCs THE PROJECT IS APPLYING TO

Type of VNPCs the project is applying for	☒ Verified Carbon Credits (VCC) ☐ Verified Biodiversiy Based Credits (VBBC) ☐ Verified Water Credits (VWC) ☐ Verified Soil Credits (VSC)

II. PROJECT AREA BASELINE

The project area is in a semi-forested, semi-agricultural region of Chiapas, Mexico, located between 4 and 8 kilometers east of the city of Pichucalco. To further ascertain the project's potential contributions to biodiversity, a survey was conducted to count and identify the plant species present around the project area. This will be further elaborated in the biodiversity section of the baseline report.

II.1. SPECTRAL RESPONSE

When solar radiation interacts with an object, one of three situations can occur, either individually or in combination:

Reflection: The radiation can bounce off the object partially or entirely, resulting in reflection.

Absorption: The object can absorb the radiation, taking in its energy.

Transmission: Radiation can pass through one object and reach another, known as transmission.

The extent to which radiation is reflected, absorbed, or transmitted depends on the specific physicochemical characteristics of the objects involved. However, for object identification purposes, our primary interest lies in the reflected light or radiation at different wavelengths. For instance, vegetation exhibits low reflectance in the visible range, but the presence of chlorophyll in plants increases reflectance in the green channel. On the other hand, plants demonstrate the highest reflectance in the near infrared region of the electromagnetic spectrum.

II.1.1. Index

Vegetation indices (VI) are extensively employed for monitoring and detecting changes in vegetation and land cover. These indices are created by considering the contrasting absorption, transmittance, and reflectance of energy by vegetation across the red and near-infrared portions of the electromagnetic spectrum. Numerous studies have demonstrated that the Normalized Difference Vegetation Index (NDVI) is particularly resilient against the influence of topographic factors. NDVI is commonly utilized as a broad indicator of photosynthetic activity in plants and the corresponding aboveground primary production. It provides information on the quantity and quality of vegetation in a given area. It varies from -1 to +1, where values closer to +1 indicate dense and healthy vegetation, while values close to -1 suggest a lack of vegetation or presence of artificial surfaces.

The calculation of NDVI was performed using Sentinel-2 satellite images in the Google Earth Engine platform. Images with less than 20% cloud cover were selected for each month. Additionally, random control points were created within the reforestation area, and the monthly NDVI and rainfall values at each point were extracted. Google Colab was then used to generate a box plot showing the distribution of NDVI values at the control points. The assessment focused on the average monthly NDVI time series spanning from January 2019 to May 2025. The findings are presented in Figure 2, which covers both pre- and post-project implementation periods. To delineate the pre- and post-project implementation periods, it is important to note that the reforestation activities began on May 26th, 2024. Consequently, all months prior to this date are considered part of the pre-project implementation period, while months after are regarded as the post-project implementation period for this analysis.

Between January 2019 and August 2022, average NDVI in the project area remained stable with an overall upward trend, reaching approximately 0.88—indicative of dense and healthy vegetation. A significant decrease occurred in September 2022, likely in response to an extreme rainfall event. Although NDVI recovered in the subsequent months, the average NDVI declined steadily, reaching 0.81 by August 2023. From September 2023 onwards, NDVI values began to recover, increasing to around 0.88 by December 2023 and remaining above 0.85 through early 2024. Following the start of reforestation activities in May 2024, NDVI initially declined slightly, dropping to 0.79 in the same month, possibly reflecting soil disturbance or early growth conditions. However, a modest increase followed, with NDVI reaching 0.85 by May 2025.

Although this short post-project period limits the ability to draw definitive conclusions, the early data suggest signs of positive vegetative response. Notably, throughout the assessment period, NDVI values remained well above 0.5, indicating generally healthy vegetation cover. With continued monitoring and effective project management, further increases in NDVI are anticipated, supporting the goal of establishing dense, lush, and resilient vegetation across the project area.

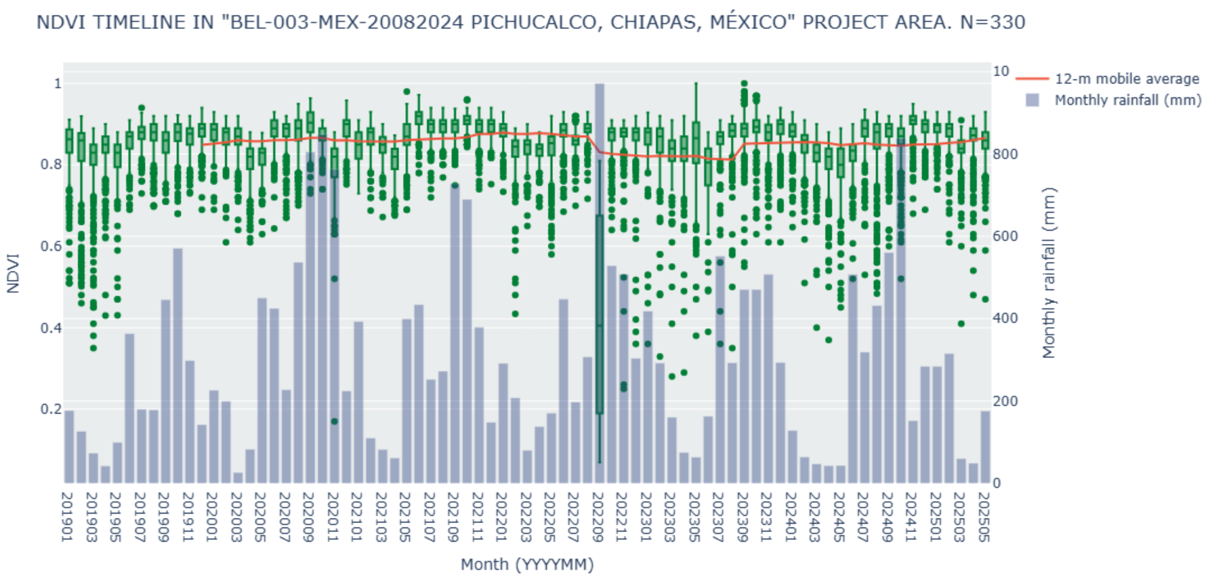


FIGURE 2. NDVI TIME SERIES IN THE AREA OF INTEREST

II.2. IMPACT ON THE LANDSCAPE

The purpose of this project is to address ecological challenges in Pichucalco, Mexico. While the project area already has healthy and dense vegetation cover (Figure 3), the additional reforestation activities seek to combat the loss of wildlife and restore deforested areas through comprehensive forest management practices and biodiversity conservation. Key activities include the reforestation of 15,151 trees and shrubs and other measures such as land clearing, reinforcement of fences, protection against illegal logging, fires, pests, and diseases, and ongoing maintenance to ensure long-term success. The project also integrates fruit production and wildlife conservation into its efforts, enhancing both the ecological value of the area and its productivity. The success of this project will contribute to long-term carbon sequestration and biodiversity enhancement.

2019 2024

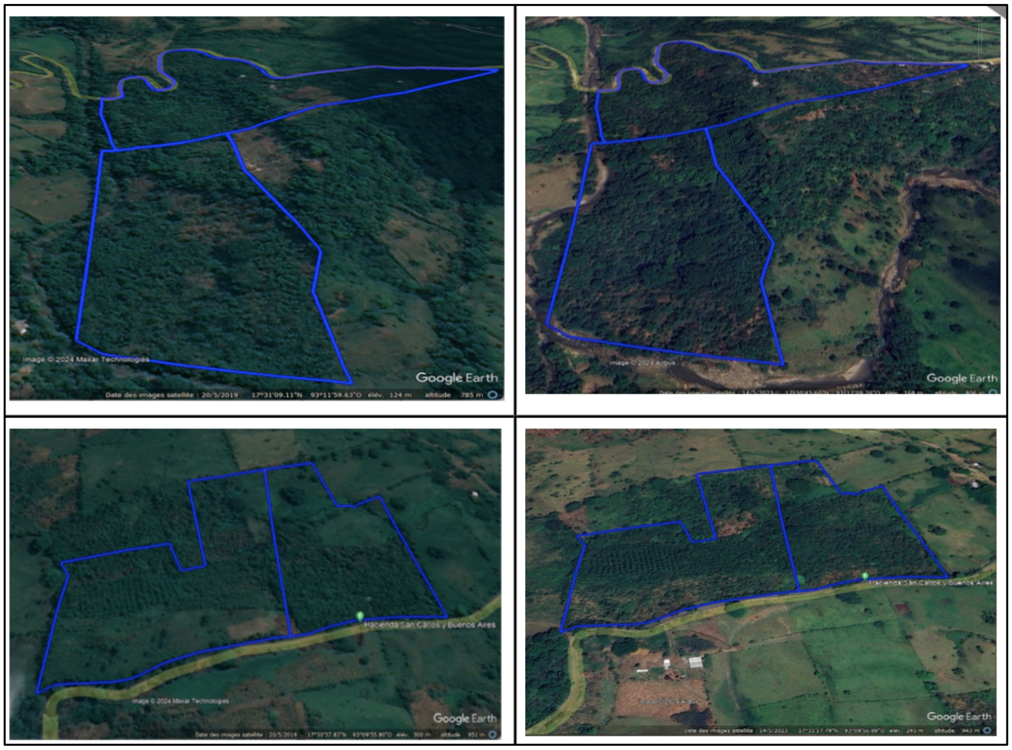


Figure 3. Satellite aerial view of area pre- (2019) and post- (2024) project implementation

III. Technical specifications

III.1. Carbon removal

This section analyzes the carbon sequestration expected by the project from the reforestation.

III.1.1. Reforested area

The project encompasses a plot with a total area measuring 31.8 hectares situated in Pichucalco, Chiapas (Mexico).

III.1.2. Species

The reforestation project successfully planted a total of 15,151 trees, encompassing six different species. The number of individuals of each species is shown in Table 2. The selection of species was based on a preliminary assessment of the region, considering available bibliographic information, as well as the prevailing climatic, vegetative, and meteorological conditions. All species chosen are indigenous to the area and well-suited to the local climate and environmental conditions. Out of the total number of trees planted (15,151), the percentage by species and origin is presented in Table 2.

TABLE 2. NUMBER AND ORIGIN OF TREES BY SPECIES

Species	Number of trees	Percentage (%)	Origin
Theobroma cacao	4,680	30.9	Native
Gliricidia sepium	3,489	23.0	Native
Cordia megalantha	1,997	13.2	Native
Cedrela odorata	2,076	13.7	Native
Alseis yucatanensis	2,151	14.2	Native
Citrus aurantifolia	758	5.0	Introduced
Total	**15,151**	**100%**	

The assessment revealed an average planting density of one tree per 21.1 square meters, equivalent to an average of 477 trees per hectare in the plot. This moderate density approach offers several ecological, environmental, and economic advantages. The moderate tree density, combined with the implementation of various tree species, will foster biodiversity and enhance ecological resilience within the restored ecosystem. Moreover, the density will expedite canopy closure, creating a continuous cover as the tree canopies interlock. This canopy closure plays a crucial role in weed suppression, creating improved microclimates, moisture retention and reducing soil erosion.

It is important to note, however, that high planting densities may lead to competition for resources among trees, which may result in stunted growth, reduced health, and increased mortality of some trees. In addition, the proximity between trees can facilitate the rapid spread of diseases and pests, therefore, controlling and managing these issues can become more complex in densely planted areas.

From this moderate-density with “wide spacing" planting strategy, the reforestation project is well-positioned to maximize carbon sequestration potential, promote wildlife habitat, and provide essential ecosystem services. The management of this densely planted plot will be critical to ensure the continued success and long-term sustainability of the reforestation efforts.

III.1.2.1. Distribution/Origin of the species selected for reforestation

The distribution of plant species is influenced by a variety of abiotic and biotic factors, including:

- Climate
- Soil
- Topography
- Hydrology
- Competition between plants for resources
- Seed dispersal

These factors interact in complex ways to determine the distribution of plant species across a landscape.

Understanding and knowing the distribution of the flora species that have been selected for reforestation is important to ensure the adaptation of the new trees and their survival, to secure the long-term benefits of the project, and to avoid altering the ecosystem balance by introducing non-adapted species.

To achieve this, each species was consulted in the Global Biodiversity Information Facility GBIF (https://www.gbif.org). This database allows you to know the species classified as introduced in each country, their EUNIS habitat, their native range, and observation records.

The Global Register of Introduced and Invasive Species (GRIIS) presents validated lists of introduced (alien) and invasive alien species at the country, territory, and associated island level. The International Union for Conservation of Nature (IUCN) describes an introduced/alien and invasive alien species as follows:

- **Introduced/alien species:** A species, subspecies, or lower taxon occurring outside of its natural range (past or present) and dispersal potential (i.e., outside the area, it could occupy without human intervention) and which has been transported by human activity; this includes any parts, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce.
- **Invasive alien species**: A species that becomes established in natural or semi-natural ecosystems or habitats, is an agent of change, and threatens native biological diversity. This includes widespread species, rapidly expanding, or present in high abundance and that hurt biodiversity.

According to the aOCP's eligibility criteria, species classified as invasive alien species cannot be counted towards the project's benefits.

- *Theobroma cacao*

Recorded as introduced in Mexico	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	Not specified
Georeferenced records	

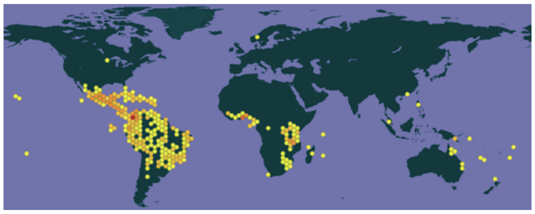
- *Gliricidia Sepium*

Recorded as introduced in Mexico	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	Not specified
Georeferenced records	

- *Cordia megalantha*

Recorded as introduced in Mexico	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	Not specified
Georeferenced records	

- *Cedrela odorata*

Recorded as introduced in Mexico	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	America
Georeferenced records	

- *Alseis yucatanensis*

Recorded as introduced in Mexico	☐ Yes ☒ No
Habitat EUNIS	Not specified
Native range	Not specified
Georeferenced records	

- *Citrus aurantifolia*

Recorded as introduced in Mexico	☒Yes ☐No
Habitat EUNIS	Constructed, industrial and other artificial habitats (J level 1) Regularly or recently cultivated agricultural, horticultural and domestic habitats (I level 1)
Native range	Asia-Tropical Eastern Asia Southern Asia

Georeferenced records	

Citrus aurantifolia is considered an introduced species in Mexico (https://www.gbif.org/species/148739089/verbatim). No negative impact has been reported from the species, therefore, it will be included in any calculations relevant to this project and is considered *noninvasive*.

From the 6 implemented plants species, one species is considered introduced in Mexico, however, no species are considered invasive; therefore, all species can be considered for biodiversity or carbon credit generation for the project.

The technical data sheets providing detailed information about each of the species utilized for the reforestation project are included below, in Table 3. These sheets offer insights into the characteristics, growth patterns, environmental requirements, and other relevant details of the selected plant species. These data sheets serve as valuable references for understanding the specific attributes and suitability of each species for the reforestation efforts.

TABLE 3. TECHNICAL DATA SHEETS FOR SPECIES USED IN REFORESTATION EFFORT

Theobroma cacao

- **Native Habitat**: Theobroma cacao, commonly known as the cacao tree, is native to the tropical rainforests of Central and South America, thriving under warm, humid conditions with consistent rainfall.
- **Primary Use**: Its seeds, commonly called cacao beans, are the primary ingredient in chocolate production, as well as other products like cocoa powder and cocoa butter.
- **Growth Characteristics**: A mature cacao tree typically reaches 4-8 meters in cultivated settings but can grow up to 12 meters in the wild. It prefers shaded environments and is often grown under larger canopy trees.
- **Ecological Role**: The tree is a critical species in agroforestry systems, providing habitat for wildlife and supporting biodiversity in tropical regions.
- **Economic Importance**: Theobroma cacao is a major global crop, supporting the livelihoods of millions of farmers.

Gliricidia sepium

- **Native Range:** Commonly known as quickstick or madre de cacao, it is native to Central America and Mexico.
- **Multi-Purpose Tree:** It is valued for various uses, including as a fodder tree for livestock, green manure to enrich soil, and a source of firewood and shade for crops like cacao.
- **Growth Characteristics:** This fast-growing, medium-sized tree typically reaches a mature height of 10-12 meters and is known for its ability to thrive in poor soils and withstand drought conditions.
- **Nitrogen Fixation:** *Gliricidia sepium* fixes atmospheric nitrogen, improving soil fertility and making it a popular choice for agroforestry systems and intercropping.
- **Ecological & Economic Role:** It supports sustainable farming by reducing the need for chemical fertilizers, providing shade and erosion control, and serving as a habitat for pollinators and other beneficial species.

Cordia megalantha: • **Native Range**: Found in tropical regions, particularly in Central and South America. • **Uses**: Known for its high-quality timber used in furniture and construction; also valued for its ornamental flowers. • **Growth**: Medium-sized tree with a mature height of 10-15 meters. • **Ecological Role**: Supports biodiversity by providing food and habitat for pollinators and birds. • **Resilience**: Adapted to a variety of tropical climates and soil types.	
Cedrela odorata: • **Native Range**: Widely distributed across Central and South America and the Caribbean. • **Uses**: Valued for its durable and aromatic wood, used in furniture, cabinetry, and musical instruments. • **Growth**: A large tree, reaching heights of 20-40 meters when mature. • **Ecological Role**: Provides shade in agroforestry systems and contributes to soil stabilization. • **Threats**: Overharvesting for timber has made it vulnerable in some regions.	

Alseis yucatanensis: • **Native Range**: Endemic to the Yucatan Peninsula and adjacent regions in Central America. • **Uses**: Primarily an ecological species, contributing to forest restoration and habitat enrichment. • **Growth**: Typically grows to 8-15 meters in height, depending on local conditions. • **Ecological Role**: Provides habitat for wildlife and plays a role in forest dynamics. • **Adaptations**: Thrives in limestone-rich soils common to its native range.	
Citrus aurantifolia: • **Native Range**: Originated in Southeast Asia but is widely cultivated in tropical and subtropical regions. • **Uses**: Known for its small, tangy fruits (key limes) used in culinary applications, beverages, and as a source of essential oils. • **Growth**: A small tree or shrub, typically reaching 2-4 meters in height. • **Ecological Role**: Supports pollinators like bees and contributes to diversified cropping systems. • **Cultivation**: Grows well in well-drained soils with abundant sunlight, often found in home gardens and orchards.	

III.1.3. REFORESTATION TECHNIQUE

The reforestation technique implemented is the wide spacing or moderate-density planting technique. Wide spacing or moderate density planting is a reforestation technique where tree seedlings are planted with relatively larger gaps between them. This approach contrasts with high-density planting, where seedlings are placed closer together. The wide spacing technique aims to provide individual trees with more access to essential resources such as sunlight, water, and nutrients, allowing them to grow with reduced competition. The goal of this technique is to optimize the use of available resources, such as sunlight, water, and nutrients by creating a more efficient growing environment as trees have ample room to establish strong root systems and develop healthier canopies, potentially leading to better long-term growth. Additionally, with wider spacing, there's a reduced risk of disease transmission between trees compared to denser plantings.

Nevertheless, it is important to note that the suitability of wide spacing depends on factors like soil type, climate, and water availability. In addition, choosing tree species adaptable to wider spacing is crucial for successful establishment. It is a balance between optimizing individual tree growth and considering the overall ecosystem dynamics.

III.1.3.1. Methodological process

The operational phase is divided into three steps shown in Figure 4.

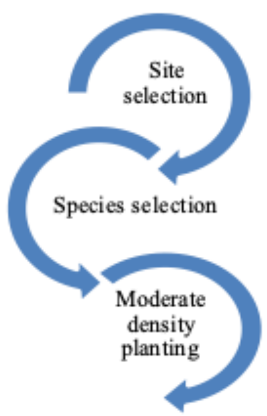


FIGURE 4. METHODOLOGICAL PROCESS

The reforestation process involved a well-defined series of steps. Firstly, a thorough evaluation was conducted to select the most suitable reforestation area, considering restoration needs, climatic and soil feasibility, permit requirements, and cost considerations. It ensured that the chosen location was conducive to successful reforestation. To preserve the ecological integrity of the region, reforestation was not carried out on scarified ground. This approach aimed to leverage the existing ecosystem to facilitate the growth and development of the newly planted trees, promoting biodiversity and increasing the chances of successful reforestation. Local community stakeholders were actively involved in the process, fostering a sense of ownership and sustainability in the reforestation initiative.

III.1.4. PROJECT CAPACITY

This section determines the project's and the area's capacity to absorb CO_2 using Net Primary Productivity (NPP) as a reference parameter. Three approaches are used to arrive to a sound result considering various ecological aspects and data sources:

A. Species-specific allometric equations, survival/mortality defined by tree density according to mean DBH of trees and latitude, according to (Madrigal-González et al., 2023).
B. Species-specific allometric equations, survival/mortality defined by tree density according to regional timber plantation tables,
C. Carbon stocks derived through a machine learning model trained with the Global Forest Aboveground Carbon Stocks and Fluxes from GEDI and icesat-2, a global carbon dataset.

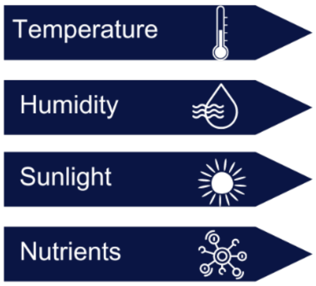
For all three approaches, Net Primary Productivity (NPP) is regarded as the upper limit, representing the maximum achievable carbon sequestration potential based on biophysical considerations.

Using Net Primary Productivity (NPP) as a reference parameter. The amount of CO_2 that can be captured is then estimated with allometric equations considering the age and height of individual species. Subsequently, the estimation of survival rates is derived from tree density projections published in the study by Madrigal-González et al. (2023).

III.1.4.1. Net Primary Productivity (NPP)

Net Primary Productivity (NPP) is the result of organic matter production through the process of photosynthesis. However, primary productivity involves more than photosynthesis; it also encompasses the uptake of inorganic nutrients and the assimilation of diverse organic compounds into protoplasm, which are vital for all photosynthetic organisms. Among various ecosystem processes, NPP is extensively measured due to its ability to reflect carbon accumulation in ecosystems. The calculation of NPP is based on the increase in biomass per unit area over a specified period.

NPP is influenced by several factors, including:



Hence, the net primary productivity (NPP) can be expressed as the difference between the carbon absorbed by vegetation through photosynthesis (referred to as Gross Primary Production or GPP) and the carbon lost through respiration. Temperature and precipitation are key limiting factors for NPP, and it is generally assumed that NPP increases with both temperature and precipitation. However, it is important to note that the NPP cannot exceed the saturation value of 3000 gDM/m^2/year (DM stands for dry matter) in either case.

For the calculation of NPP in the Murcia Ecological Restoration project, present and future NPP were computed to take into consideration ecosystem's vulnerability to climate change and to define the threshold for carbon sequestration. Both were computed on Google Earth Engine using the resources available in the catalog. Present NPP was calculated for 2024 from 2 data sources: a) precipitation data from the "CHIRPS Daily: Climate Hazards Group Infrared Precipitation with Station Data (Version 2.0 Final)" dataset (Funk et al., 2015) and b) temperature data from the MODIS/Terra Land Surface Temperature/Emissivity Daily L3 Global 1km SIN Grid V061 [Dataset] (Wan et al., 2021). Future NPP was computed using precipitation and temperature data for the year 2064, from the NEX-GDDP-CMIP6 dataset (Thrasher et al. 2022). This dataset, comprised of global downscaled climate scenarios derived from the General Circulation Model (GCM), runs conducted under the Coupled Model Intercomparison Project Phase 6; the CMIP6 GCM runs were developed in support of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR6).

This methodology incorporates the following equations to determine NPP:

$$\mathbf{NPP} = \mathbf{min}\ (\mathbf{NPP_T}, \mathbf{NPP_P})$$

Where:

$$NPP_T = 3000(1 + exp(1.315 - 0.119 * T))^{-1}$$

$$NPP_P = 3000(1 - \mathrm{Exp}(-0.000664 * P))$$

Where:

T: average annual temperature

P: accumulated precipitation

Carbon capture capacity was calculated using the conversion factor 0.47 (IPCC, 2006), using the following equation:

$$NPP_c = NPP_{dm} \times 0.47$$

Where:

Npp_c: Net primary productivity, gc m-2 yr-1

Npp_{dm}: Net primary productivity, gdm m-2 yr-1

Then, the equivalence to carbon dioxide was calculated using the conversion factor of 3.67. This factor represents the molar mass ratio of CO_2: C. CO_2 molar mass is 44 and C is 12, therefore, 44/12 = 3.67. The conversion was done using the following equation:

$$CO_2 \text{ capture capacity} = 3.67(npp_c)$$

Finally, the maximal CO_2 capture capacity for the Project area was computed by multiplying the previous result by the Project area surface. The calculation was repeated for each scenario (present with real data, present with CMIP data and future with CMIP data). Real data is privileged over modelled data for the present scenario. To estimate future NPP, the percent change was calculated between present and future estimates done with CMIP6 data. This percent change was then applied to the present estimate done with real data, this way we obtain a future NPP estimate based on present real data.

The results (Table 4) indicate that the project area currently has an NPP of 2,690.68 gDM m^{-2} yr^{-1}, which, due to the climatic conditions, will decrease to 2,473.25 gDM m^{-2} yr^{-1} in 2064. This change, of -52.79 gDM m^{-2} yr^{-1}, represents a decrease of -2.09%. In terms of CO_2, **the Project restoration area (31.8 ha) is currently capable of capturing** 1,485,872.25 **kgCO_2 yr^{-1} and is expected to capture around** 1,454,820.40 **kgCO_2 yr^{-1} by 2064**.

Based on these results, it has been determined that **1,454.82 TCO_2-eq/year** will serve as the base parameter for the estimation of maximum achievable annual CO_2 capture. For the 40 years of the project, it equals **58,192.82 TCO_2-eq.**

TABLE 4. NPP AND BIOMASS POTENTIAL BY ALL PLOTS WITHIN THE PROJECT SITE.

NPP	Present Real Data	Present CMIP	2064 CIMP	CMIP Change	CMIP % Change	2064 Based On Real Data	Real Data Change
$gDM/m^2/yr$	2,690.68	2,526.04	2,473.25	-52.79	-2.09	2,634.45	-56.23
$gCO_2/m^2/yr$	4,641.15	4,357.17	4,266.11	-91.06	-2.09	4,544.16	-96.99
$gC/m^2/yr$	1,264.62	1,187.24	1,162.43	-24.81	-2.09	1,238.19	-26.43
$KgCO_2/plot/yr$	1,485,872.25	1,394,953.33	1,365,801.51	-29,151.82	-2.09	1,454,820.40	-31,051.85

III.1.4.2. Allometric Equations

Allometric equations are mathematical formulas used to estimate the amount of CO_2 that can be captured and stored in certain types of vegetation, such as trees or shrubs, depending on their morphometry. Table 5 shows the allometric equations used for each species planted.

TABLE 5. SPECIES-SPECIFIC ALLOMETRIC EQUATIONS

Species	Allometric Equation CO_2 absorbed (Kg)	Reference
Theobroma cacao	Biomass=0.026*(DBH)^(1.529)*(H)^(1.747)	Araujo, T., Higuchi, N. and Carvalho, J. d. J. 1999. Comparison of Formulae for Biomass Content Determination in a Tropical Rain Forest Site in the State of Para, Brazil. Forest Ecology and Management,(117): 43-52.
Gliricidia sepium	Biomass=0.1245*(DBH)^(2.4163)	Hung, D.N., Son, N.V., Hung, N.P. (2012) Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam - Evergreen broadleaf forests in Quang Binh Province in (Eds) Inoguchi, A., Henry, M. Birigazzi, L. Sola, G. Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam, UN-REDD Programme, Hanoi, Viet Nam
Cordia megalantha	log Biomass=-0.942+2.062*LOG10((DBH))	Segura, M; Kanninen, M; Suarez, D. 2006. Allometric models for estimating aboveground

Species	Allometric Equation CO_2 absorbed (Kg)	Reference
		biomass of shade Trees and coffee bushes grown together. Agroforestry Systems 68(2):143-150.
Cedrela odorata	Biomass=0.1245*(DBH)^(2.4163)	Hung, D.N., Son, N.V., Hung, N.P. (2012) Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam - Evergreen broadleaf forests in Quang Binh Province in (Eds) Inoguchi, A., Henry, M. Birigazzi, L. Sola, G. Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam, UN-REDD Programme, Hanoi, Viet Nam
Alseis yucatanensis	Biomass=(0.0301*((DBH)^2*(H))^1)	Cairns, M., I. Olmsted, J. Granados y J. Argaez. 2003. Composition and aboveground tree biomass of a dry semi-evergreen forest on Mexico's Yucatan Peninsula. Forest Ecology and Management 186:125-132.
Citrus aurantifolia	Biomass=0.1245*(DBH)^(2.4163)	Hung, D.N., Son, N.V., Hung, N.P. (2012) Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam - Evergreen broadleaf forests in Quang Binh Province in (Eds) Inoguchi, A., Henry, M. Birigazzi, L. Sola, G. Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam, UN-REDD Programme, Hanoi, Viet Nam

Carbon stocks in planted trees and shrubs at year 40 was calculated applying these allometric equations to the tree dimensions expected at age 40. The total carbon storage at year 40 for the 15,151 trees and shrubs is estimated to be 7,921.70 Tons CO_2.

Due to natural ecological processes, a fraction of the planted trees and shrubs will die. The survival/mortality percentages were computed with two different approaches, as described in the following subsection.

III.1.5. CO_2 Capture

In reforestations carried out in degraded areas, a planting density of 1 tree every four meters is considered, since distributing the trees in this way allows each tree to have enough space to grow and develop adequately, avoiding excessive competition for resources such as sunlight, water, and soil nutrients. The reference density for this scenario is 16 square meters per tree. At present, the project has achieved a density of 21.1 square meters per tree, which is higher than the targeted reference density.

Planting density can have significant implications for the success of reforestation efforts. By providing adequate space for individual tree growth, the chances of survival and healthy development are increased. Proper management practices will be essential to ensure the optimal utilization of resources, especially as the trees grow and compete for sunlight, water, and nutrients. Maintaining the appropriate balance between tree density and resource availability will be crucial to sustaining the health and productivity of the reforested ecosystem over time.

The avoidance of resource competition promotes optimal access to sunlight for photosynthesis, sufficient water uptake, and efficient nutrient absorption from the soil as defined by the Net Primary Productivity (NPP). These factors are crucial for the establishment of a sustainable and resilient forest ecosystem.

III.1.5.1 Survival rate based on forest tree density.

Tree density as a function of mean DBH and latitude.

One estimation of survival rate is based on the results from Madrigal-González et al. (2023). These authors established the relationship between mean Diameter at Breast Height (DBH) and latitude in determining forests' tree density (Figure 5).

According to this reference, predicted tree density for an area located at latitude 17.5°N, and with a mean tree diameter of 26.34 cm is around 350 trees per hectare. Considering that 15,151 trees and shrubs were planted in the restoration area (31.8 ha), i.e. 477 trees per hectare, a survival of 73.4% would lead to the density of 350 trees ha-1, proposed by Madrigal-González et al. (2023).

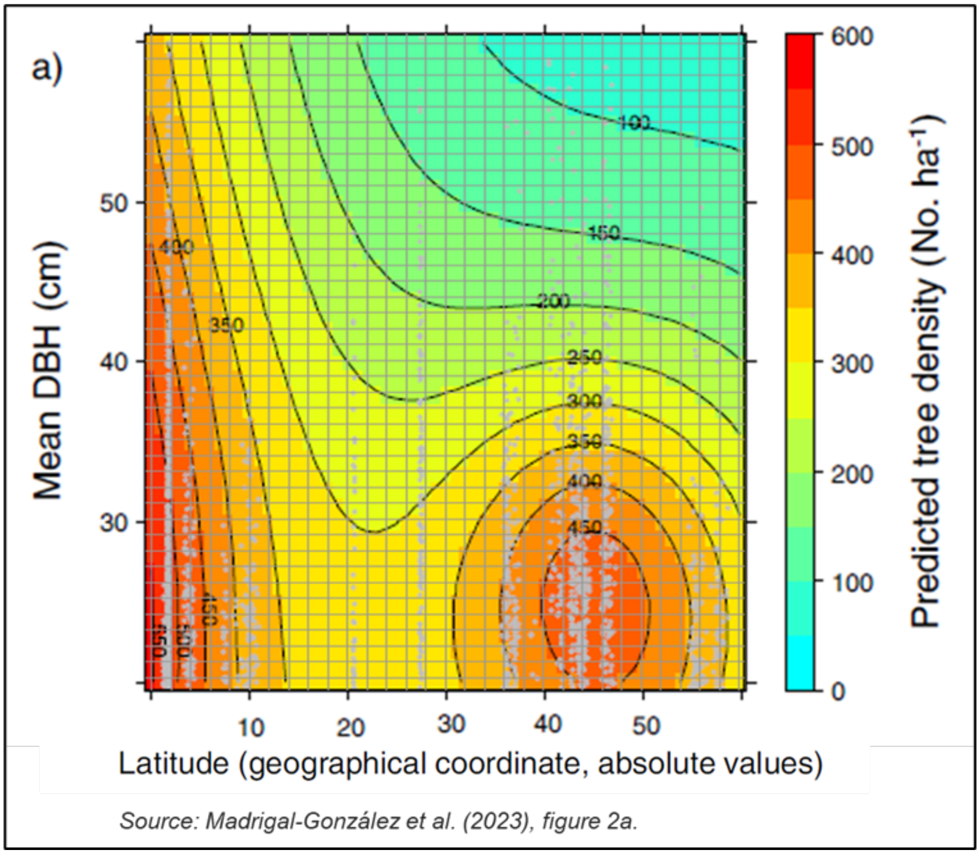


FIGURE 5. PREDICTED TREE DENSITY AS A FUNCTION OF MEAN DBH AND LATITUDE. SOURCE: MADRIGAL-GONZÁLEZ ET AL. (2023).

Tree density according to timber plantation tables.

Cienciala et al. (2022) elaborated a list of estimated survival rate due to tree mortality and management interventions by biogeographic regions and species group types. For Mediterranean conifers and broadleaves, they report a stand density at year 40 from plantation, of 1169 trees per hectare. Since the plantation in the restoration area has a density of 477 trees ha-1, a survival of 245.1% would lead to the final density reported by the authors.

In conclusion, currently the project has a density of 477 trees and shrubs per hectare, which will generate an initial competition for resources. However, due to the expected mortality that occurs in each reforestation project, the planting density will progressively decrease and the trees that manage to adapt and survive will have increasing access to the available resources (water, sunlight, and nutrients), and will be able to continue growing.

Based on the 2 density references, there are 2 scenarios for survival rate of the project at year 40. One, estimates survival at 73.4% and the other at over 100%.

III.1.5.3.2. Carbon capture in vegetation

The carbon removal potential, calculated using the allometric equations, was adjusted to account for survival/mortality, as follows. Survival scenario 1, calculated from tree density predicted by Madrigal-González et al. (2023), results in a survival of 73.4% of planted trees and shrubs. Therefore, 73.4% of the carbon removal potential equals 5,814.53 T CO_2-eq along the 40 years of the project. Survival scenario 2, calculated from tree density predicted by Cienciala et al. (2022), results in a survival of 100% of planted trees and shrubs. Therefore, 100% of the carbon removal potential equals 7,921.70 T CO_2-eq along the 40 years of the project.

Considering these 2 scenarios, the amount or carbon removals the project can generate attributable to the planted trees and shrubs lies between 5,814.53 and 7,921.70 T CO_2-eq. However, it is important to note that this ex-ante estimation excludes carbon removals from vegetation that develops in the project area natural regeneration, triggered by Project activities. As the reforestation matures, it is expected that monitoring campaigns reveal carbon stocks higher than those estimated ex-ante. These estimates were and will continue to be cross-referenced with the maximum carbon removal determined through Net Primary Productivity (NPP), which for this project equals 1,495.16 T CO_2-eq, to ensure adherence to biophysical ecological limits, thus avoiding overestimates.

III.1.5.2. Carbon Credits

According to *aOCP Methodology for estimating carbon removal capacity of projects V2.0,* this ecological restoration project in Pichucalco (Mexico) spanning an area of 31.8 hectares with 15,151 trees and shrubs planted, has the potential to generate between 5,814 and 7,921 Verified Carbon Credits (VCC) from removals. This range considers survival scenarios of 73.4% and 100%, as elaborated above. However, the inclusion of carbon capture calculations conducted by the project developers will further refine these estimates and provide a more comprehensive assessment of the project's environmental impact.

The project developers did not indicate a predicted carbon capture for the project; however, they did state that they expected a 90% survival of the reforested individuals at the completion of the project period. By applying this survival rate to the initially aOCP determined carbon capture, this rate yields 7,129.53 T CO_2-eq. Table 6 presents a summary of the of the considerations.

Therefore, based on the information and considerations outlined above, the estimated carbon capture of this project ranges from 7,129.53 to 7,921.70 TCO_2-eq.

TABLE 6. ESTIMATED CARBON CAPTURE OF ECOLOGICAL RESTORATION PROJECT AT YEAR 40.

Survival Scenarios			Carbon Capture (TCO_2-eq)	Carbon credits (VCC)
aOCP Determined	Total Derived	100%	7,921.70	7,921
	Madrigal-González et al. (2023).	73.4%	5,814.53	5,814
	Survival suggested by aOCP	80%	6,337.36	6,337
	Plantation Tables	100%	7,921.70	7,921
	Project Developer expected survival	90%	7,129.53	7,129

Derived from the survival scenarios presented above, a conservative approach will be maintained for the allocation of carbon credits. This means that VCC will be awarded based on 80% of the survival rate estimated by the aOCP after the project site visit during the audit (6,337 VCC).

It is important to note that carbon credits will be calculated annually in the dynamic baseline. This baseline will be adjusted based on the results of audits, monitoring, and the action plan implemented by the project developer.

As established in section III.1.5 of the *Project Procedures*[2] document**,** version 2.3, for projects classified as Type **"B"** under the Nat5 Scoring, **30%** of the credits generated will be allocated to the buffer pool as a measure to ensure the permanence of the project's benefits. This corresponds to **1,901 VCCs**, resulting in a total of **4,436 Verified Carbon Credits (VCCs)** to be issued as "after project" credits.

[2] https://www.nat5.bio/wp-content/uploads/2025/03/I.3.-aOCP-Project-Procedures-V2.3.pdf

IV. Relevant Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs), established by the United Nations in 2015, are essential in guiding restoration projects toward meaningful and enduring outcomes by addressing the interconnected nature of global challenges such as biodiversity loss, climate change, poverty, and social inequalities (https://sdgs.un.org/goals). Acting as a comprehensive framework, the SDGs enable project activities and their associated restoration and conservation efforts to align environmental, social, and economic objectives, ensuring that projects contribute not only to ecological recovery but also to broader sustainable development. By embedding these principles into restoration efforts, projects contribute not only to ecological recovery but also to the broader pursuit of sustainable development envisioned by the UN. Project initiatives can foster ecosystem resilience, support climate adaptation, enhance community livelihoods, and promote responsible resource use. This holistic approach acknowledges the intricate linkages between healthy ecosystems and human well-being, emphasizing that environmental restoration is also a pathway to achieving social equity and economic stability.

Moreover, aligning restoration projects with specific SDGs facilitates measurable progress, enhances accountability, and ensures the initiatives' relevance within a global context. It also opens pathways to partnerships with stakeholders who share a commitment to these goals, from local communities and governments to international organizations and private entities. By adopting this approach, restoration projects can amplify their impact, making meaningful contributions to global sustainability targets. The following table (Table 7) highlights the SDGs most relevant to the project initiatives, illustrating how each goal serves as a guiding principle in shaping the strategies and ensuring the long-term success of the project.

Table 7. Sustainable Development Goals Applicable to the Project

SDG #	Goal	Positive impact / Indicator
8 DECENT WORK AND ECONOMIC GROWTH	Generation of local green employment and community capacity building	Reforestation, maintenance, monitoring and environmental education activities require local labor and skills transfer.

SDG #	Goal	Positive impact / Indicator
11 SUSTAINABLE CITIES AND COMMUNITIES	Improved natural environment and reduced risk of erosion and landslides	Restoration of 31.8 ha in hillside areas improves landscape stability and local ecosystem services.
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Use of sustainable techniques and selection of adapted native species	The project avoided exotic species and used moderate-density planting to maximize ecological efficiency.
13 CLIMATE ACTION	Significant CO_2 sequestration over the long term	Estimated sequestration of 5,814.53 to 7,921.70 tCO_2e over 40 years contributes to climate change
15 LIFE ON LAND	Increase in biodiversity and habitat	Use of native species, ecological design, improved water infiltration, and new habitat for wildlife contribute to biological connectivity.

This project showcases a nature-based solution to environmental degradation, demonstrating how targeted reforestation can drive climate resilience, biodiversity restoration, and sustainable land use. By sequestering carbon and improving local ecosystems, it supports global sustainability efforts while delivering long-term ecological and community benefits.

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