# EMISSIONS OFFSET PROGRAM
# Conservation of the Galilea-Amé Forest

## Monitoring Report

**May 4, 2018**

**Document prepared by South Pole Carbon Asset Management S.A**

# General description

The program seeks to conserve 29,859 hectares of forest known by the community as the Galilea forests. These forests are part of the priority areas for conservation in the region of the Andes and Piedemonte Amazónico, as they are in the biological corridor that connects the Andean and High Andean Forest with the moorlands of the Sumapaz National Natural Park[1]. In addition, regarding the department, it is the last relict of primary forest in eastern Tolima and contains the source of the Negro River, one of the main tributaries of the Hidro Prado dam[2].

The objectives of the compensation program for the conservation of the Galilea-Amé Forest are as follows:

- Reduction of CO2 emissions by avoiding deforestation of the forest.
- The protection of biodiversity as it is a forest of high floristic and faunistic richness of the High Andean zone of Tolima.
- The security and conservation of natural hydric sources that benefit local communities, agricultural and livestock irrigation systems, and the Prado hydroelectric power generation system for regional and national benefits
- Improving the living conditions of rural communities located in or around the project's expansion area through the implementation of productive activities.

The program starts with 12,701 hectares of forest belonging to the Fundación Amé and the Universidad del Tolima, which constitute the current area of the program. The remaining 17,158 hectares are forest areas with potential to be included in the program in the next monitoring audits[3]. The sum of the current program area and the areas with potential to be included were defined as the program expansion area.

## 1.1 Name of the emission offset program

Conservation of the Galilee-Amé Forest

## 1.2 Program Location and Geographic Boundaries

### 1.2.1 Program expansion area

The program is located in the eastern mountain range of the Colombian Andean zone, its area is mainly within the municipality of Villarrica, although it also includes areas of the municipalities of Cunday, Dolores, Purificación and Prado, all of which belong to the department of Tolima. It is located between the coordinates: 3°40'34.28" - 4°1'21.87" N and 74°30'40.27" - 74°43'58.8" W (Illustration 1). The program expansion area consists of 29,859 ha of forest[4] belonging to the Fundación Amé, Universidad del Tolima, the municipalities of Dolores and Villarica and other private landowners.

[1] Villalba X. (2017). Bosque Galilea: un paraíso tolimense en riesgo por intereses petroleros. El Nuevo Día, el periódico de los tolimenses. Retrieved from:: http://www.elnuevodia.com.co/nuevodia/tolima/regional/403812-bosque-galilea-un-paraiso-tolimense-en-riesgo-por-intereses-petroleros

[2] Information obtained from the Atlas Ambiental del Tolima 2014.

[3] Currently, the program has begun to invest in the consultation of databases that allow to see the property distribution of these areas and their respective owners to determine the areas that can be included in the program and start approaching the owners to sign conservation agreements.

[4] These are the forest areas that meet the definition of eligibility presented in section 3.2.

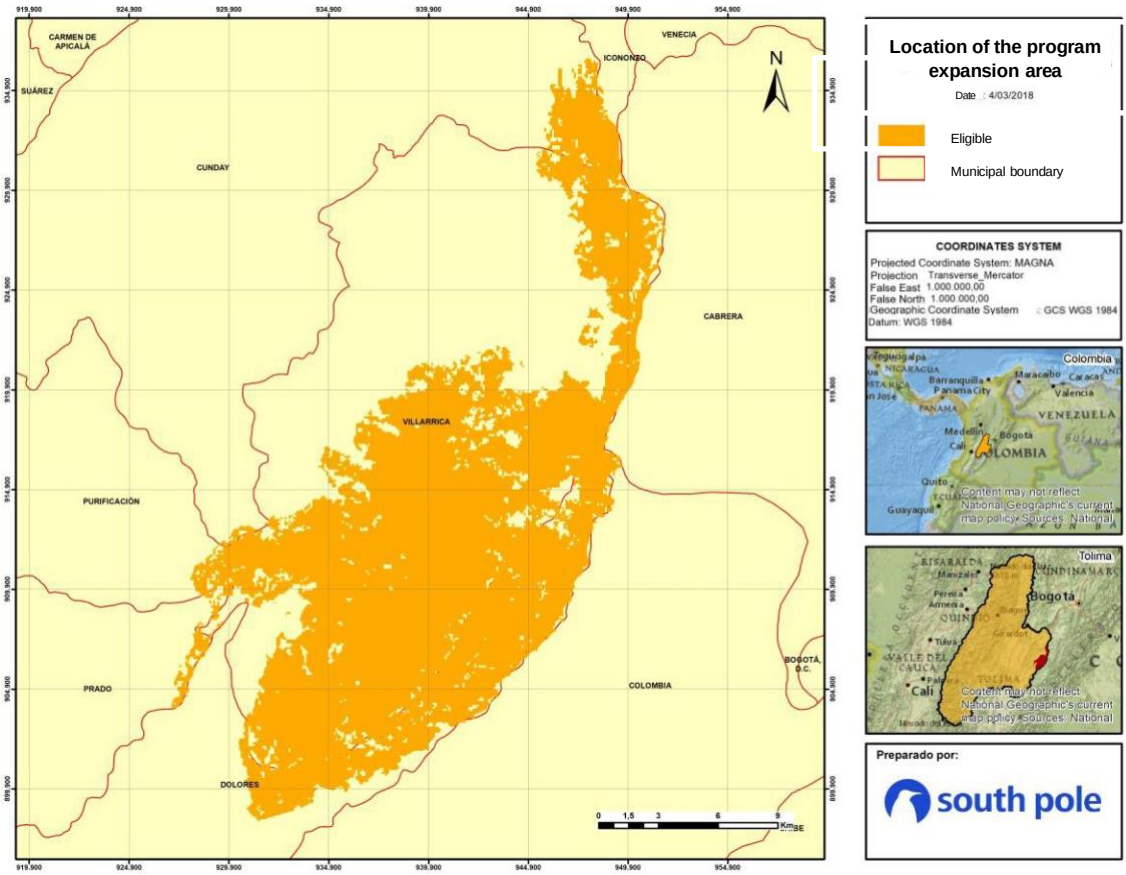


**Illustration 1. Location of the program expansion area.**

### 1.2.2 Current program area

The current program area comprises 12,701 ha of forest[5] (Illustration 2) located in the municipality of Villarrica, which is situated in the eastern part of the department of Tolima at 161 km from Ibagué, the department's capital. It is bordered on the north by the municipalities of Cunday and Icononzo, on the east by the department of Cundinamarca, on the west by the municipalities of Cunday, Purificación and Prado, and on the south by the municipality of Dolores. It has 32 rural districts and three townships, and its economic structure is based on agriculture (coffee, banana, guava, and banana) and cattle raising.[6]

[5] These are the forest areas that meet the definition of eligibility presented in section 3.2.
[6] Plan de desarrollo Villarrica: 2012-2015. Available at: http://www.villarrica-tolima.gov.co/index.shtml?apc=v-xx1-&x=2640611

## 1.3 Activities to reduce deforestation

### 1.3.1 Description of activities

The activities proposed by the program to reduce deforestation are described below:

**Donation program:**

The donation program was described in section 1.4. Although it is an activity that started before the Compensation program, it is an activity that is maintained as a main strategy to carry out conservation activities in the territory in conjunction with the Universidad del Tolima.

**Beekeeping:**

Honey production project[12] that seeks to meet the following objectives:

- Establishment of 350 hives in the current project area and nearby areas where there is interest from the community.
- Extraction of high-quality honey, pollen and propolis.
- Training of local communities in the different stages of the honey chain.
- Positioning of a brand of high-quality honey products.

Production

*Stage I:*

-Project feasibility study.

- Pilot project: establishment of 30 hives in 2017 with the potential to produce 25 kilograms of honey per hive per year.

- Establishment of rules for hive management and bee care.

- Production of crates for the program's hives and sale of crates for external projects.

*Stage II*

- Establishment of 100, 110 and 110 hives in 2018, 2019 and 2020 respectively.

- Hiring of a beekeeping technician to achieve the goals presented above and evaluate the needs of personnel to be hired to obtain the establishment of the 350 hives and their maintenance.

- Inclusion of the nearby community in the project as direct honey producers.

- Technification of honey extraction: this activity will depend on the success of the inclusion of the community as honey producers.

Commercialization

*Stage III*

- Commercialization of honey in the SERATTA gourmet market.

- Processing of the INVIMA registration for the expansion of the market.



**Research**

Conservation through research has been the main activity of the project proponent and will continue throughout the life of the program. The research activities proposed by the program to be executed with the revenues from the sale of carbon bonds are the following:

Creation of the Center for Environmental Biodiversity Research (CIMA by its Spanish acronym):

The main objective of CIMA is *"to obtain results in the knowledge of the forest ecosystems of Galilea, through the constitution of a multidisciplinary and interinstitutional group of researchers at regional, national and international level, which will allow the consequent generation of proposals that achieve the sustainable management of these resources, combining the conservation of biodiversity present in the area and the use of it, for the welfare of local communities, the region,*

*the country and its future generations"*. This research center has not been consolidated due to the lack of resources of the university; therefore, the resources generated by the carbon bonds will constitute the main capital for the creation of this research center.

The steps for the creation of CIMA are:

- Updating the existing research plan[13].
- Presentation of the project to the Headquarters Council.
- Creation of a central research committee that includes the Fundación Amé. This committee will oversee selecting and approving support for projects presented to CIMA, giving priority to those that emphasize species of high conservation value and productive projects that help avoid deforestation.

Support in-kind or with resources to the field practices of the different courses of the Universidad del Tolima:

As with the donation program, this activity was described in section 1.4 and will continue throughout the life of the program.

Support for the publication of a bird book:

Support in the publication of the Tolima bird book being developed by professors Miguel Ángel Quimbayo-Cardona, Hugo Nelson Loaiza-Hernández, Vivian Tatiana Flórez-Delgado and Julián Leal-Villamil. This book will present the main species located throughout the Department of Tolima, dedicating a section (Unit VII) to the birds present in the expansion area of the program.

The book is the result of research projects of the Research Group on Biodiversity and Dynamics of Tropical Ecosystems (GIBDET by its Spanish acronym) of the University of Tolima. The document is based on the experience of its authors in the area of ornithology and geographic information systems and has a compilation of technical and scientific ornithological documents updated to the year 2017[14].

**Conservation agreements**

The objective of signing conservation agreements is to expand the current area of the program. To achieve this, the following actions will be carried out:

- Tenure study of the properties located in the expansion area of the program that were not included in the first follow-up audit.
- Purchase of possession from settlers who approach the foundation with an interest in selling.
- Meetings with the owners of the forest with the objective of increasing the current area of the program.

**Ecotourism**

The ecotourism project seeks to make tourists aware of the importance of caring for the environment through the implementation of ecological tourism packages. This is an activity that must be carried out in stages due to the high costs of establishment and maintenance.

[13] See support document in [Supporting documents/Project activities/Research plan_CIMA].
[14] The executive summary of the book can be found in [Supporting documents/Project activities/Executive summary of the book Avifauna del Tolima Book].

*Stage I*

Identification of the ecotourism activities that can be carried out in the project considering a cost-effectiveness economic study. This study should include an analysis of topographic and access variables to identify the activities with the greatest potential

and the sites where infrastructure should be developed, as well as the identification of areas with the greatest potential for fauna and flora observation.

*Stage II:*

Construction of infrastructure for ecotourism, especially cabins, ecological trails, and bridges.

*Stage III:*

Start of ecotourism activities

**Forest Ranger Program (training with the Universidad del Tolima)**

The objective of this program is to train settlers or other people from the community around the program area to carry out the following activities:

- Control and surveillance tasks in the areas where deforestation is most likely to occur.
- Accompaniment on ecological trails.
- Monitoring of cover with drones.

The training will be done in conjunction with the Tourism Business Administration program at the Universidad del Tolima or with the Servicio Nacional de Aprendizaje (SENA by its Spanish acronym). This activity will be carried out in two stages: i) training and ii) hiring park rangers.[15].

*Control and surveillance work in the areas where deforestation is most likely to occur:*

Through a mobility analysis, the areas with the highest probability of access to the population for deforestation were identified with the objective of determining the places near the current program area that require more attention. The steps to determine the most accessible areas are presented below:

- Performing an accessibility cost raster in which the factors present in Table 4 were considered including their weighted weight:

**Table 4. Variables for the cost matrix**

| Factor | Weighted weight (%) |
|---|---|
| Slope | 30 |
| Distance to populated centers | 30 |
| Distance from tracks | 20 |
| Distance to drainage networks | 20 |

Prior to the creation of the cost raster, the variables used were reclassified on a scale of values ranging from one to seven based on the following criteria: i) risk increases with proximity to population centers, drains and roads; ii) risk increases with decreasing slope.

- Delimitation of a pixel size of 100 x 100 m for all layers.

[15] The rangers will carry out the initial control and surveillance tasks through constant patrols along the different access roads to the forest while they carry out the training.

- Once the cost raster was generated, areas with a cost of less than 3 were classified as higher risk, medium risk areas with a cost of 4 and low risk areas with cost values between 4 and 7 (Illustration 4).

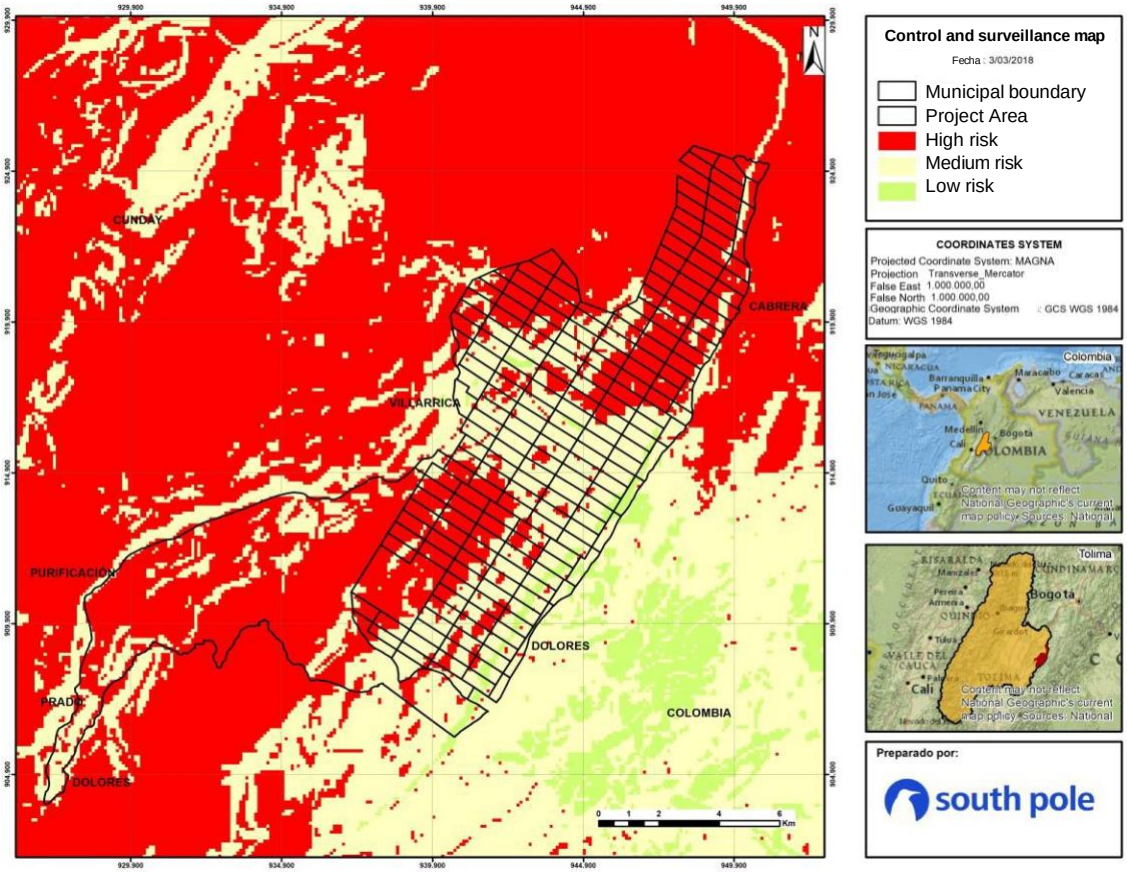


**Illustration 4. Classification of the risk of deforestation according to a mobility analysis considering access restrictions**

*Land cover monitoring with drones*

The main objective of monitoring is to identify changes in specific points of the forest cover subject to degradation and deforestation processes that are only observable from the sky, with remote sensing images of high spatial resolution. Drones also allow the monitoring of forest fires and land invasions, thus enabling better management of natural resources. The drone monitoring activity will be carried out in two stages: i) training forest rangers in the use of drones and ii) implementation of the activity.

**Adequacy of historic Trail**

At the entrance to the current project area, which is located in the La Colonia rural district (municipality of Villarica), there is a stone path built in colonial times that connected the La Colonia rural district with the Galilea rural district. The project proposes the recovery and adaptation of this trail, complemented by a process of reconstruction of the historical memory that will allow guided tours along the trail.

**Establishment of a butterfly farm**

*Stage I*
Use the butterfly thesis by Campos (2008) to carry out a complementary study to identify the species with the greatest potential for a biocommerce project. This analysis will be carried out through an agreement with the institution Zoonatura.

*Stage II*
Processing of legal requirements for the establishment of the butterfly farm.

**Environmental classroom and a museum of memory**

Joint work with the Junta de Acción Comunal of the Galilea rural district and the El Piñal rural district to adapt the facilities of the school located in the current program area with the objective of establishing an environmental training center and a museum of memory.

### 1.3.2 Monitoring, impact, and stakeholders of activities

The monitoring expected impact and stakeholders involved in the project activities are presented in Table 5. In Table 6 and Illustration 5 the prioritization of activities is presented according to the environmental and social impacts expected from the implementation of the activities.

**Table 5. Monitoring, impact and stakeholders of activities**

| Name of the activity | Monitoring | Expected impact | Related actors |
|---|---|---|---|
| Donation program | Area under the ownership of the Universidad del Tolima | Forest conservation through research and governance work in the territory by the Universidad del Tolima. | - Fundación Amé: oversees managing the donor program.<br>-Donors: carry out the entire legal process to deliver the lots to the university.<br>-Universidad del Tolima: reception of the donated lots for conservation actions. |
| Beekeeping | **Production**<br>Record of:<br>-Number of hives collected.<br>-Maintenance activities of the hives.<br>-Number of liters delivered to the Fundación Amé.<br>-Number of people employed on a temporary and permanent basis**.**<br><br>**Commercialization**<br>-Record of the number of liters sold. | - Generation of employment and alternative source of income for the community.<br>-Transfer of knowledge through training for community members.<br>-Awareness of the importance of beehives.<br>-Increase of the bee population, contributing to the conservation of the species pollinated by them. | - Fundación Amé: project management and administration.<br>-Employment generation is aimed at settlers living in the current program area and community members living around the current project area, especially those located in the areas at greatest risk of being deforested. |
| Research | - Publication of the bird book<br>-Creation of CIMA.<br>-Projects approved by CIMA's central research committee with the participation of the Universidad del Tolima and the Fundación Amé.<br>-Undergraduate work. And internships.<br>Scientific reports and publications. | -Support for the knowledge and participation of local communities and scientific communities.<br>-Education and awareness of the need to protect biodiversity and the environment. | - Universidad del Tolima: creation of CIMA and implementation of research actions.<br>-Fundación Amé: support to the Universidad del Tolima in the creation of CIMA, participation in the selection of projects to be financed and support with resources to different initiatives that contribute to the knowledge of the forest. |

| Name of the activity | Monitoring | Expected impact | Related actors |
|---|---|---|---|
| Conservation agreements | Areas included in the program in each follow-up audit. | Expansion of the conservation area. | -Fundación Amé:<br>Coordination of meetings with forest owners for socialization and invitation to participate in the program.<br>Agreements for the purchase of possession to settlers interested in selling.<br>-Settlers: interested in selling the possession to the program proponent, they must accompany the foundation in the necessary actions to deliver the lot.<br>-Universidad del Tolima: inclusion of the areas they receive as donation in the next follow-up audits.<br>-Owners of the expansion area of the project that do not yet belong to the program, Fundación Amé: attend the meetings scheduled by the Fundación Amé and carry out the necessary document management to include the land in the program. |
| Ecotourism | - Study of prioritization of activities.<br><br>- Biannual report of activities carried out. | -Creates awareness and respect for local culture and the environment.<br><br>-Provides positive experiences for all.<br>-Employs and benefits communities.<br><br>-Educates visitors about local political, social, and environmental issues. | -Fundación Amé and Universidad del Tolima: joint work in the identification, prioritization, and implementation of ecotourism activities.<br>-Employment generation will be aimed at settlers living in the current program area and members of the community living in the vicinity of the current project area. |
| | | -Tourists' money is used for the conservation of the area. | |

| Name of the activity | Monitoring | Expected impact | Related actors |
|---|---|---|---|
| | | - Visitors come away with new ideas that influence their own environment. | |
| Forest Ranger Program | Stage I<br>Agreement with the Tourism Business Administration program of the Universidad del Tolima or with SENA.<br>Registration of trainees<br><br>Stage II<br>Semiannual report of activities | -Control of deforestation.<br>-Protection and conservation of the forest.<br>-Training for forest rangers.<br>-Employment and income generation. | -Fundación Amé and Universidad del Tolima: joint work in the training of forest rangers. The foundation will be in charge of hiring.<br>-Employment generation will be aimed at settlers living in the current program area and members of the community living in the area surrounding the current project area. |
| Forest coverage monitoring with drones | Semiannual report with:<br>- Date of flights performed<br>- Description of flight findings<br>- Storage of the images taken<br>-Dissemination of the results on the Fundación AME web page. | -Detailed and accurate information of areas that are difficult to access.<br>- Facilitates the detection and evaluation of adverse factors.<br>-Flights carried out and programmed by community members themselves without the need for advanced training.<br>-Knowledge transfer through training of community members.<br>-Drone images are inexpensive and quickly accessible.<br>-Data under all weather conditions.<br>-Enable generation of field data, better estimates, and forest mapping. | -Fundación Amé and Universidad del Tolima: joint work in the training of forest rangers.<br>-Forest rangers: implementation of the activity. |

| Name of the activity | Monitoring | Expected impact | Related actors |
|---|---|---|---|
| Adequacy of historical trail | - Progress report of activities | -Contribution to the Regional Ecotourism Project.<br>-Generation of employment in the activities of road recovery and later in the accompaniment of guided tours. | -Villarrica Mayor's Office, Universidad del Tolima and Fundación Amé: management of adaptation activities.<br>-The generation of employment will be aimed at the community near the current project area, especially the community located in the La Colonia rural district. |
| Establishment of butterfly farm | Stage I<br>Result of the study of potential species.<br><br>Stage II<br>Partnership with Zoonatura.<br>Registration of activities. | -Employment generation<br>-Transfer of knowledge through training and coaching for mothers who are heads of households. | -Zoonatura, Fundación Amé and Universidad del Tolima: joint work in the creation and administration of the butterfly farm.<br>-Employment generation will be aimed at settlers living in the current program area and members of the community living around the current project area. |
| Environmental classroom and museum of memory | -Partnership with the Secretary of Education of Villarrica and the community.<br>- Record of meetings with stakeholders.<br>- Record of progress in the activity | -Environmental training for youth leaders of the rural communities with influence in this zone. | Universidad del Tolima, Fundación Amé and the community in general |

**Table 6. Prioritization of activities**

| Activity | Priority (***)[16] | Economic & Social Co-benefit (***)[17] | | Environmental Impact (***)[18] |
|---|---|---|---|---|
| | | Communities | OP | |
| Beekeeping | *** | *** | *** | *** |
| Ecotourism | *** | *** | *** | * |
| Drone Monitoring | ** | * | | ** |
| Forest Ranger Program | ** | * | | *** |
| Research | ** | * | | *** |
| Butterfly Farm | * | * | * | * |
| Environmental classroom, museum of memory and adequacy of the historical trail | * | * | | * |

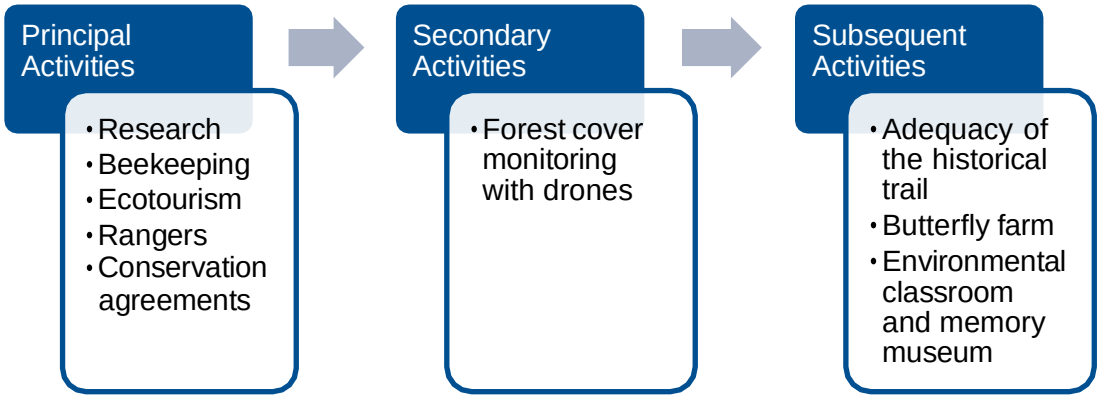


**Illustration 5. Tree of activities according to the results of Table 6.**

[16] Priority attributed to each activity on a scale of (***) depending on the timeframe for implementation, expected co-benefits and impacts, as well as the current need for the activity for the project.
[17] Estimated Economic and Social co-benefits of each activity on a scale of (***) for the parties interested and addressed by the project. If there is no (*), it is considered as a cost or investment. In the case of the communities, the potential of each activity to create welfare, employment and new forms of income was considered. In the case of the OP, the potential of each activity to generate a benefit or the capacity to generate credits was considered, as in the case of a Restoration Project.
[18] Estimation of the expected environmental impact of each activity on a scale of (***) in which aspects related to expected positive externalities were considered. In effect, this scale was based on aspects such as environmental protection, biodiversity protection and forest regeneration, in addition to the education and awareness of both communities and tourists that are expected to result from these activities.

### 1.3.3 Schedule of activities

| Activity | Etapa | Years | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| Donation strategy | I | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Beekeeping | I | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | II | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | III | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Research | I | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conservation agreements | I | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ecotourism | I | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | II | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | III | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Forest Ranger Program | I | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | II | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Butterfly Farm | I | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | II | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# 2 Environmental conditions in the program expansion area

## 2.1 Temperature and precipitation [19]

Based on the precipitation data recorded by the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM by its Spanish acronym) at the Puerto Lleras station in the municipality of Villarrica (number 21160180),[20] it was possible to construct a curve that shows the average annual behavior for the region; this station has a data record that began in 1984. The data in Illustration 6 show a bimodal behavior, characteristic of the Colombian Andean zone, with the highest records between April - May and October - November and a dry season between July - August. The average data show an annual rainfall record of more than 2,400 mm.

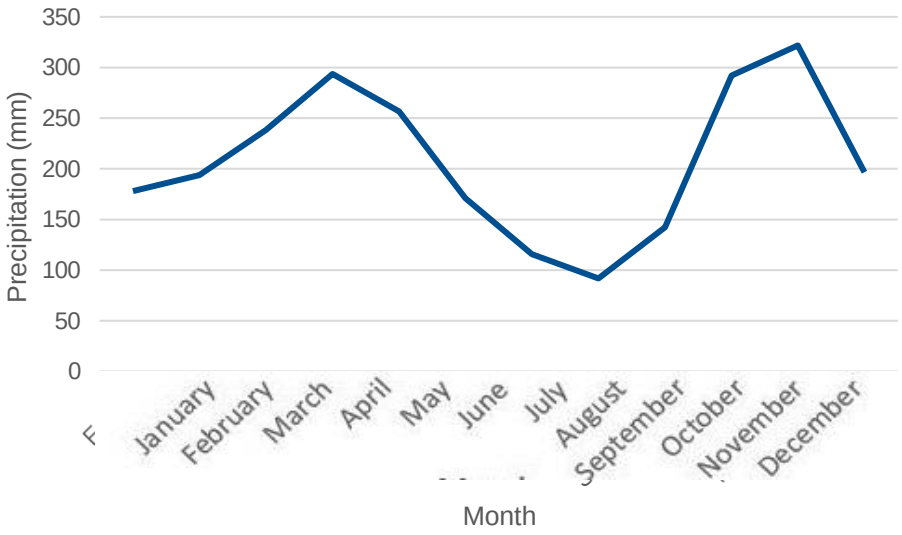


**Illustration 6. Average monthly precipitation, Puerto Lleras station [21]**

Regarding temperature, Villarrica has a varied altitudinal range, from 800 masl to more than 3,000 masl, so the temperature, a variable influenced by altitude, has a similar change. Table 7 shows the average annual temperature and the isotherm in which they are located.

**Table 7. Average annual temperature [22]**

| Station | Average annual temperature (°C) | Isotherm (masl) |
|---|---|---|
| Villarrica | 23,87 | 975 |
| Puerto Lleras | 22,35 | 1.195 |
| Cabrera | 17,49 | 1.900 |
| Núñez | 17,15 | 1.950 |
| El Fique | 23,15 | 1.080 |

[19] Section developed based on data from Villarica because 74% of the program expansion area is located in this municipality and the current program area is located entirely in the municipality of Villarica.
[20] The base information can be found as a support document in: [Climate Data Support].
[21] Data obtained from the Puerto Lleras station (21160180), belonging to IDEAM.
[22] Table obtained from Technical Document I "Climate, hydrology and surface water characterization studies" of the Villarrica Land Use Planning Scheme 2003 - Page 40, Temperature.

## 2.2 Life zones

The life zones were classified according to Holdridge[23], following the guidelines of section 5.5.2.4.1 of the Colombian Technical Standard NTC 6802 *"Mitigation actions in the land use, land use change and forestry sector (USCUSS) at the rural level, incorporating social and biodiversity considerations".* This classification is made according to the average precipitation and temperature parameters in the area. Precipitation and temperature data were obtained from WorldClim[24], a set of global climate layers with a resolution of approximately 1km$^2$. Using geographic information system tools, the downloaded layers were reclassified (see Illustration 7 and Illustration 8). Subsequently, a combination of both layers was made where the resulting layer had the proposed precipitation and temperature intervals, and, finally, according to the combination of intervals present, each pixel was named according to the life zone it belonged to.

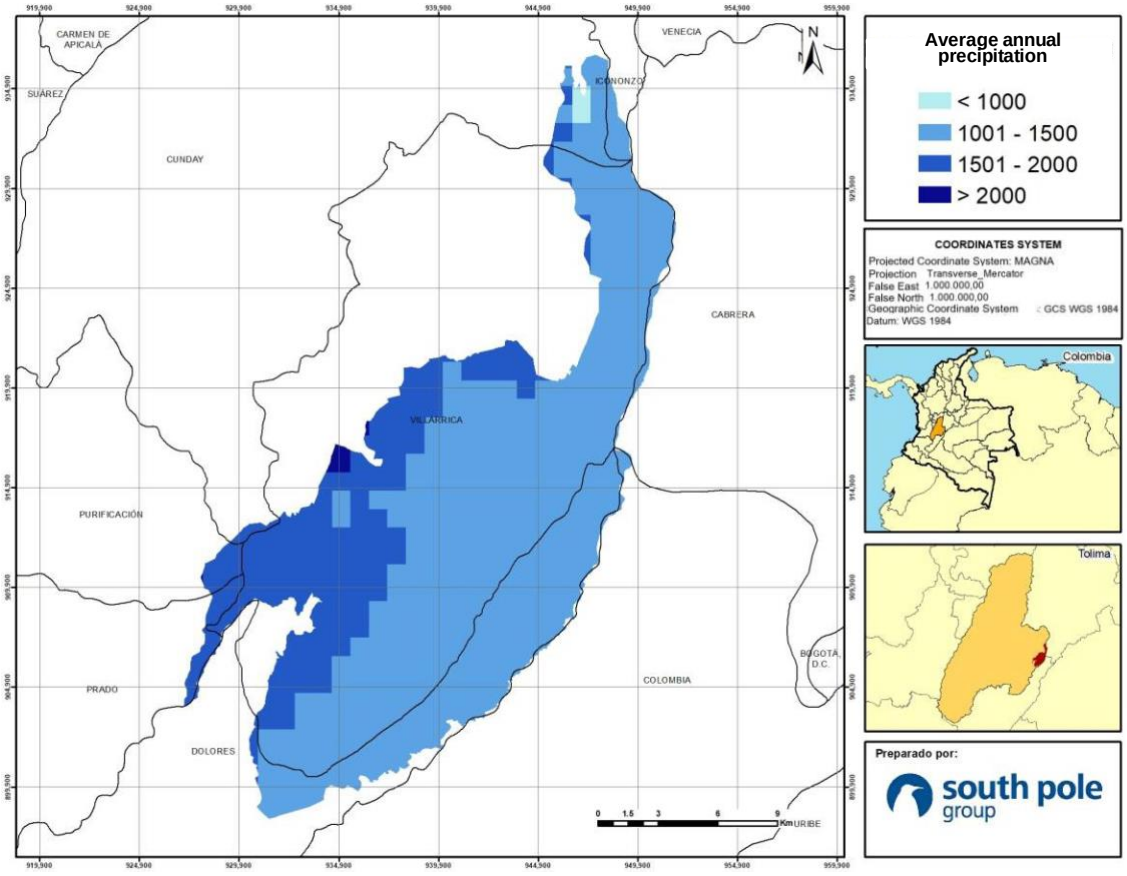


**Illustration 7. Average annual precipitation [mm/year]**

[23] Holdridge, L. R. 1967. «Life Zone Ecology». Tropical Science Center. San José, Costa Rica
[24] http://www.worldclim.org/bioclim

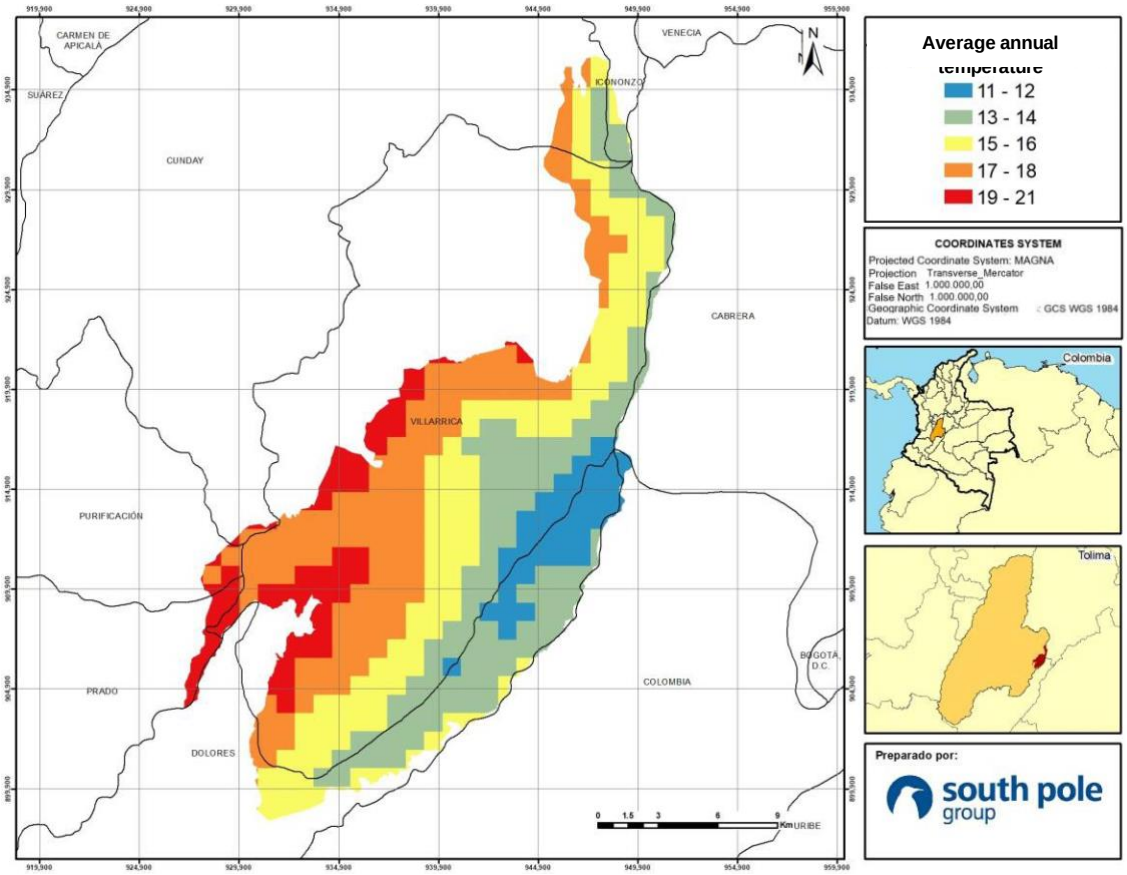


**Illustration 8. Average annual temperature [°C]**

In this process, as shown in Illustration 9, the predominant life zone in the program is the low montane rainforest, which covers a little more than 80% of the total area, followed by the premontane rainforest (more than 10%), very humid montane forest (approximately 8%) and very humid premontane forest (remaining area).

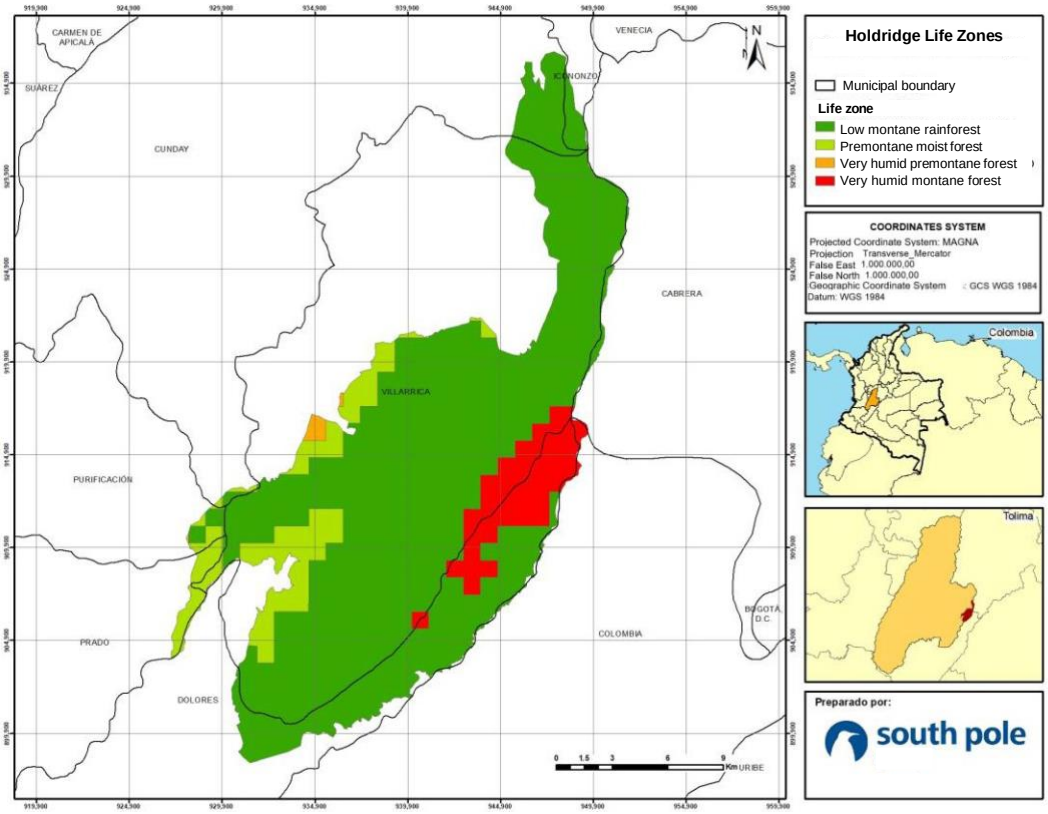


**Illustration 9. Holdridge life zones**

## 2.3 Hydrography

The hydrological network that runs through the municipality of Villarrica belongs to the basins of the Río Cuinde Negro, whose watershed covers more than 50% of the municipality, the Río Negro (35%) and the Río Riachón (10%). The Río Negro River is of special interest for the program and its area of influence, since its waters originate in the upper zone of the current program area, crosses a large part of its territory (Illustration 10) and supplies the Prado reservoir,[25] as well as the Río Negro, the Río Cunday and the Río Prado also drain this reservoir. In Illustration 11, the water network of the program area is presented (those lines marked under classification 1 in the Strahler-Horton order),[26] which shows the supply of water resources in the area.

[25] Information obtained from Technical Document I "Estudios de clima, hidrología y caracterización de aguas superficiales" of the Villarrica Land Use Planning Scheme 2003 - Page 51, Hydrological study.
[26] The Strahler-Horton Order is used in hydrology to represent the hierarchy of drainage networks where values of 1 represent the lowest level (headwaters).

**Illustration 10. Rio Negro riverbed in the area of the program area**

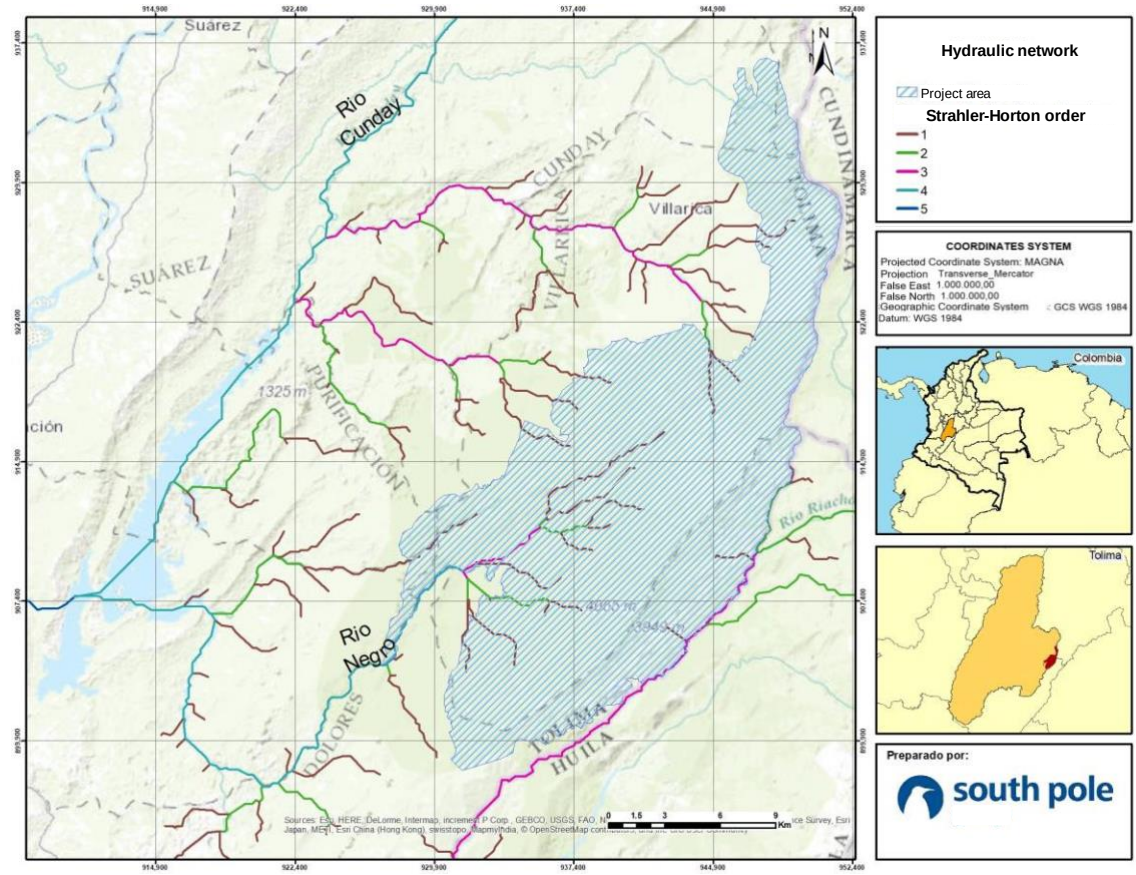


Illustration 11. Hydric network in the program area

## 2.4 Geology, geomorphology, and soils

In the municipality of Villarrica there are sedimentary rocks with ages ranging from the Cretaceous to the Upper Paleogene. Three groups predominate in the geology: Villeta group (Kv) formed by gray shales with limestones and sandstones; Guadalupe group (Ksg) formed by metric strata of quartz-sandstones ranging from fine to thick and gray shales; and the Gualanday group (Tg), a unit formed by clays, sandstones, and conglomerates. There is also a dry formation (TKs) in the

Río Negro and Altamizal synclines, and colluvium deposits (Qco) generally located at the foot of escarpments made up of rock debris and soil.[27]

The predominant landscape in the municipality is mountainous, sometimes accompanied by flat relief. Within this landscape, seven geomorphological units are identified: (i) mountainous and hilly structural-erosional relief, (ii) steep monoclinal ridge reliefs of lydites and quartz sandstones, (iii) ripples in banks of claystones interstratified with quartz sandstone, iv) steep monoclinal spine in quartz sandstones interbedded with claystones, v) slope of a synclinal bowl of mudstones interbedded with quartz sandstones, vi) steep excavated anticline of lydites and quartz sandstones and, vii) removal colluvium derived from lydites and quartz sandstones, viii) removal colluvium derived from lydites and quartz sandstones.[28]

In terms of soils, the study conducted for the 2003 Land Use Planning Scheme identified 19 soil units in an equal number of landscapes, with a variety of depths and characteristics.[29]

## 2.5 Biodiversity

The program area is part of the priority areas for conservation in the region of the Andes and Amazonian foothills, as they are in the biological corridor that connects the Andean and High Andean Forest with the moorlands of the Sumapaz National Natural Park. [30]. The following is a description of the main fauna and flora species reported in the area. Flora

According to Malagón (2008),[31] 108 vascular plant families, 317 genuses and some 594 species are recorded in the program's forests. Most of the individuals are grouped in lower diameter classes, harboring many endemics or locally distributed species. Meanwhile, CORTOLIMA (2012)[32], reports 74 tree species distributed between the life zones of very humid premontane forest and low montane rainforest for this area. Both authors agree that some of the most representative species within the forest are under a certain category of threat, such as the Oak *(Quercus humboldtii)* and the Chaquiro *(Podocarpus oleifolius)*, which are in the vulnerable category (UV); Comino crespo (Aniba perutilis) and Magnolia cf, critically endangered (CR); Truco or Carmensi *(Hyeronima macrocarpa*) and *(Magnolia caricifrangs)* endangered (EN); and Cedar *(Cedrela montana)* near threatened (NT).

Table 8 shows some of the species reported in the reference area by the authors mentioned previously, by Nieto (2006) [33] and by the Colombian Biodiversity Information System (SIB by its Spanish acronym)[34] [35].

**Table 8. List of some of the flora species reported by different sources**

[27] Information obtained from the Esquema de Ordenamiento Territorial de Villarrica 2003 - Page 41, Geology.
[28] Information obtained from the Esquema de Ordenamiento Territorial de Villarrica 2003 - Page 43, Geomorphology.
[29] Information obtained from the Technical Document III "Estudios de suelos, uso y cobertura, I.P.H., flora y fauna" of the Esquema de Ordenamiento Territorial de Villarrica 2003.
[30] Villalba X. (2017). Galilea Forest: a paradise in Tolima at risk by oil interests. El Nuevo Día, the newspaper of the people of Tolima. Retrieved from: http://www.elnuevodia.com.co/nuevodia/tolima/regional/403812-bosque-galilea-un-paraiso-tolimense-en-riesgo-por-intereses-petroleros
[31] Malagón, W. (2008). Floristic composition, structure and diversity of the forests of the Galilea Forest reserve, Tolima (Colombia). Universidad del Tolima. Thesis for the title of Magister.
[32] CORTOLIMA (2012). Plan de Ordenamiento de la Cuenca del río Prado.
[33] Nieto (2006). Structure and floristic composition of forests in the greater Prado River basin, Tolima.
[34] https://www.sibcolombia.net/
[35] The species reported by the SIB that do not have the name of the village where they were recorded have geographic coordinates, which were verified to know their location (see Supports/GIS/Shapes/Biodiversity). The date of the report is presented in the file: (Soportes\Fuentes secundarias\Biodiversidad\Documentos\Info SIB_Coordenadas)

| Scientific name | Family | IUCN Threat Category | Reported by: |
|---|---|---|---|
| *Anthurium spp.* | Araceae | - | SIB |
| *Ardisia guianensis* | Myrsinaceae | - | SIB |
| *Banara guianensis* | Flacourtiaceae | - | SIB |
| *Blakea andreana* | Melastomataceae | - | SIB |
| *Brunellia subsessilis* | Brunelliaceae | - | SIB |
| *Biophytum falcifolium* | Oxalidaceae | - | SIB |
| *Cavendishia angustifolia* | Ericaceae | - | SIB |
| *Cedrela montana* | Meliaceae | - | SIB |
| *Chrysochlamys colombiana* | Clusiaceae | - | SIB |
| *Condaminea corymbosa* | Rubiaceae | NT | SIB |
| *Cuphea buravii* | Lythraceae | - | Nierto (2006) |
| *Cyperus odoratus* | Cyperaceae | - | SIB |
| *Desmodium uncinatum* | Fabaceae | - | SIB |
| *Elaeagia utilis* | Rubiaceae | - | SIB |
| *Ficus sp* | Moraceae | - | Malagón (2008) |
| *Hyeronima macrocarpa* | Phyllanthaceae | - | Malagón (2008) |
| *Inga* | Mimosaceae | - | SIB |
| *Juncus densiflorus* | Juncaceae | - | SIB |
| *Magnolia caricifragans* | Magnoliaceae | - | Malagón (2008) |
| *Magnolia cf* | Magnoliaceae | EN | Malagón (2008) |
| *Meriania longifolia* | Melastomataceae | - | SIB |
| *Miconia acuminifera* | Melastomataceae | - | SIB |
| *Miconia affinis* | Melastomataceae | - | SIB |
| *Miconia argyrophylla* | Melastomataceae | EN | SIB |
| *Miconia barbinervis* | Melastomataceae | CR | SIB |
| *Miconia smaragdina* | Melastomataceae | - | SIB |
| *Miconia velutina* | Melastomataceae | - | SIB |
| *Myrsine coriacea* | Myrsinaceae | - | SIB |
| *Ocotea longifolia* | Lauraceae | - | Malagón (2008) |
| *Olmedia aspera* | Moraceae | - | Nierto (2006) |
| *Palicourea ovalis* | Rubiaceae | - | SIB |
| *Phytolacca rivinoides* | Phytolaccaceae | - | SIB |
| *Piper eriopodon* | Piperaceae | - | SIB |
| *Podocarpus oleifolius* | Podocarpaceae | - | Malagón (2008) |
| *Protium cranipyrenum* | Burseraceae | - | Malagón (2008) |
| *Protium cundinamarcense* | Burseraceae | - | SIB |
| *Psychotria chaponiana* | Rubiaceae | - | SIB |
| *Quercus humboldtii* | Fagaceae | - | Malagón (2008) |
| *Schefflera morototoni* | Araliaceae | - | Nierto (2006) |
| *Solanum* | Solanaceae | - | SIB |
| *Sphyrospermum cordifolium* | Ericaceae | CR | SIB |
| *Sphyrospermum cordifolium* | Ericaceae | - | SIB |
| *Tibouchina ciliaris* | Melastomataceae | - | SIB |
| *Vismia baccifera* | Hypericaceae | - | Nierto (2006) |

| Scientific name | Family | IUCN Threat Category | Reported by: |
|---|---|---|---|
| *Wettinia praemorsa* | Arecaceae | UV | Nierto (2006) |

In addition to the above, the importance of *Quercus humboldtii* within the current program area is highlighted, since this species has a gregarious distribution forming forest associations called Robledales. The oak forests are dominated by fagaceae species that constitute the skeleton of various types of forest ecosystems representative of the mountainous environment, from 750 masl to 3,450 masl[36]. They are considered refuges of other threatened or endemic species with a high conservation value at national, regional and local levels, such as *Aniba perutilis*, *Podocarpus oleifolius, Prumnopitis montana, Sterigmapethalum tachiriensis, Matudaea colombiana*, *Magnolia viroliniensis, Magnolia arcabucoana, Magnolia caricifragans*, laurels (species belonging to genera *Nectandra, Ocotea, and Persea*), holm oaks (species of the genus *Weinmannia)*, cedars (*Cedrela montana, Junglands neotropica*) and palms such as the San Pablo (*Geonoma orbignyana)* and wax palms *(Ceroxylum quinduense, C. vogelianum, C. parvifrons)*, some of which have been reported for the reference area[37] (Table 8, Illustration 12).

**Illustration 12. Oak grove in the current program area**

### 2.5.1 Fauna

#### Mammals

In the forests of Villarrica and La Pepina in the municipality of Cunday, species considered endangered have been reported, such as white-tailed deer *(Odocoileus virginianus),* otter *(Lutra*

[36] Alexander Von Humboldt Institute. Los Robledales. Retrieved from: http://reporte.humboldt.org.co/biodiversidad/2016/cap1/105/index.html#seccion5.

[37] Avella A. M., (2016). Los Bosques de Robles (Fagaceas) in Colombia: floristic composition, structure, diversity and conservation.

*longicaudus)*, *Aotus trivirgatus*, anteater *(Tamandua mexicana)* and ocelot *(Felis tigrina)*[38].

On the other hand, according to the Forest Management Plan of the Department of Tolima (2007), in the Galilea Forests that correspond to the forest management unit VI Icononzo - Villarrica, the greatest diversity of mammals has been recorded, with 30 species in the low montane rainforest and 24 species in the premontane rainforest, out of a total of 39 species reported for the department. The families with the highest relative abundance of species are *Didelphidae*, *Procyonidae and Felidae*.

### Birds

According to the Forestry Management Plan of the Department of Tolima (2007), the avifauna present in the area is made up of 106 bird species, belonging to 35 families and 14 taxonomic orders. The most abundant families recorded are *Trochilidae, Thraupidae, Tyrannidae* and *Emberizidae*. The species *Crypturellus soui (Tinamidae*) is rare according to its true frequency.

Additionally, 13 uncommon species were found: *Aramidaes cajanea* (Rallidae), *Claravis mondetoura, Zenaida auriculata* (Columbidae), *Coccyzus melacorhyphus* (Cuculidae), *Tyto alba (Tytonidae), Otus choliba* (Strigidae), *Piculus rubiginosus* (Picidae), *Eubucco bourcierii* (Ramphastidae), *Thamnophilus multistriatus* (Thamnophilidae), *Elaenia frantzii* (Tyrannidae), Stelgidopteryx *ruficollis* (Hirundinidae), *Cyanocorax affinis and Cyanocorax yncas* (Corvidae).

Thirteen species were found to be vulnerable, of which two (Psarocolius angustifrons and Psarocolius decumanus) have large size and wide distribution range and the remaining *(Chamaepetes goudoti, Aratinga wagleri, Forpus conspicillatus, Pionus chalcopterus, Pionus menstruus, Aulacorhynchus haematopygus, Aulacorhynchus prasinus, Cyanocorax affinis, Cyanocorax yncas, Mimus gylvus and Icterus chrysater)* less so.

### Reptiles

Among the reptile species reported for the municipality of Villarrica, the most abundant are Taya x (Bothrops atrox), hunter (Drymarchon corais), alligators (Mabuya mabouya, Cnemidophorus lemniscatus) and lizards (Anolis latifrons, Anolis antonii); followed by Bejuca Verde (*Leptophis ahaetulla*), Sabanera (*Atractus werneri*) and the Iguana (*Iguana s.p*); the rarest species are Granadilla (*Bothrops schlegelii*), Icotea (*Pseudomus scripta*), Morrocoy (*Geochelonie carbonaria*), Turtle (*Chelonia mydas*), False Coral (*Erythrolamprus bizona*), Candela (*Pseudoboa neuwedii*), Bejuca (*Imaantodes cenchoa c*), Peppertail snake (*Micrurus mipartitus*) and Coral (*Micrurus dumerilii*). and the species considered rare Tatacoa (*Amphisbaene fuliginosa*), Rattlesnake (*Crotalus durissus*).

With terrestrial habits, the species *Anolis latifrons* and *Anolis antonii stand out*. In the case of snakes, there are the Granadilla (*Bothrops schlegelii*) and Sabanera (*Atractus werneri*); with arboreal habits, the species *Leptophis ahaetulla*, and with aquatic habits, Turtle (*Chelonia mydas*), Morrocoy (*Geochelonie denticulata*) and Icotea (*Pseudomus scripta*).

Finally, the SIB reports, for the project area, the fauna species presented in Table 9, of which the presence of *Lagothrix lagothricha lugens a primate species that is not very abundant and is critically endangered, according to IUCN reports, stands out*[39].

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[39] Cunday City Hall (2003). Territorial planning scheme.
[39] International Union for Conservation of Nature (IUCN) Red List. See: http://www.iucnredlist.org/details/39926/0.

**Table 9. Faunal species reported by the SIB (by its acronym in Spanish) in the project area**

| Scientific name | Class | Family |
|---|---|---|
| *Akodon sp.* | Mammalia | Mammalia |
| *Lagothrix lagothricha lugens (CR)*[40] | Mammalia | Atelidae |
| *Marmosa sp.* | Mammalia | Didelphidae |
| *Oligoryzomys sp.* | Mammalia | Muridae |
| *Erythrodiplax* | Insecta | Libellulidae |

Additionally, Illustration 13 shows the location of the fauna species reported by the SIB and the location of the oak groves within the program area.

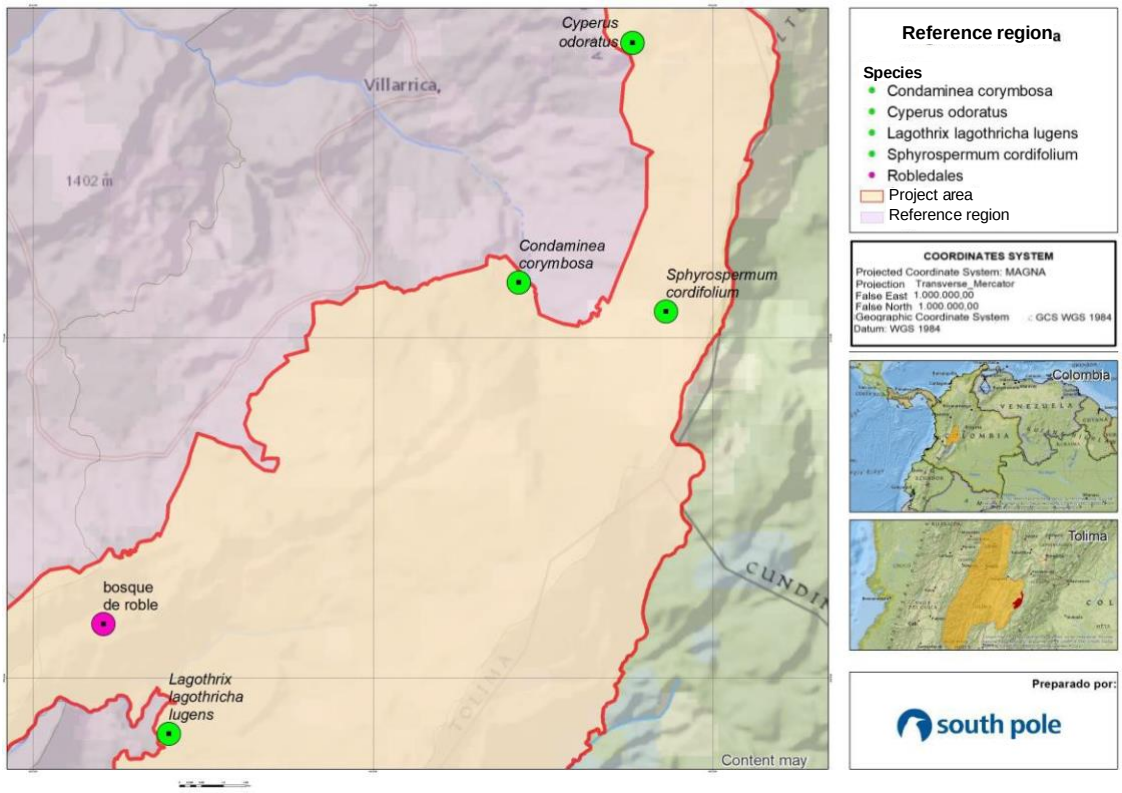



**Illustration 13. Location of fauna species reported by the SIB (by its acronym in Spanish) within the program area[41].**

Finally, Campos (2008)[42] reported the presence of 659 individuals distributed in 101 species of butterflies belonging to the superfamilies Hesperioidea y Papilionoidea, finding that the most diverse subfamilies in the Galilea Forest were Satyrinae, Nymphalinae, Heliconiinae, Ithomiinae y Riodinidae.

[40] Critically endangered species according to the red list of the International Union for Conservation of Nature (IUCN). See: http://www.iucnredlist.org/details/39926/0.
[41] See [Supports/GIS/Biodiversity].
[42] Campos L. R., (2008). Study of the richness and composition of the butterfly community (Hesperioidea: Papilionoidea) in the eastern mountain range, Galilea Forest (Tolima - Colombia). Doctoral thesis. See [Supports/Biodiversity/ Campos (2008)].

# 3 Quantification of removals for the granting audit

## 3.1 Methodology selection

The methodology applied for the estimation of removals is the Colombian Technical Standard NTC (by its Spanish acronym) 6802 *"Mitigation actions in the land use, land use change and forestry sector (USCUSS) at the rural level, incorporating social and biodiversity considerations".* The sections of this methodology that were developed are those that refer to REDD actions:

Section 5.2 Land eligibility

Section 5.3 Reference scenario for REDD+ actions

Section 5.5.2 Removals due to REDD+ actions

Analyses to meet the requirements of NTC 6802 that do not have a detailed methodology were done following the guidelines of the VCS methodology "VM*0015 Avoided Unplanned Deforestation"*[43].

## 3.2 Land eligibility

Section 5.2 of NTC 6802 and section 2 of the "*Protocol for the Certification of Compensation Programs ES-I-CC-002*" establish that the eligible areas for an emission reduction project due to REDD+ activities are the areas covered by forests[44] for at least ten years prior to the start of the program. To meet the eligibility requirement, the following steps were followed:

- Identification of forest areas using the Forest-Non-Forest layers generated by IDEAM for the year 2000 and 2010 [45] (Illustrati). Identification of forest areas using the Forest-Non-Forest layers generated by IDEAM for the year 2000 and 2010 (Illustration 14). The 2010 layer was also improved by using remote sensing (optical and radar) to better categorize the information that in the satellite images was considered lost (no information) due to the presence of clouds. The IDEAM layers in satellite format contain information of all Colombia under the categories "forest", "non-forest" and "without information" (areas with presence of clouds or other factors that prevent their interpretation), the data provided by these layers are obtained mainly using LANDSAT images (TM and ETM+ sensors) with a spatial resolution of 30 m, complemented in some cases with other types of optical and RADAR images of medium resolution.[46]
- Following the recommendations of the IDEAM methodology[47], "no information" areas that occurred during any of the periods are excluded. once the "no information" areas are excluded, using geographic information systems (ArcGIS), the 2000 and 2010 layers are analyzed in order to find those areas that have retained the forest category during these ten years, these are the eligible areas, while those that have gone from "forest" to "non-forest" category (deforested areas), those that have gone from "non-forest" to "forest" (regenerated areas) and those that are retained under the "non-forest" category, are

[44] The delimitation of forest areas eligible for the GHG emissions compensation program was carried out under the definition given by the IDEAM for natural forest: "Set of plant communities dominated by trees with a minimum height of 5 meters, crown density greater than 30% and minimum extension of one hectare" Source: Cabrera E., Vargas D. M., Galindo G., García M. C., and Ordóñez M. F. 2011a. Quantification of the deforestation rate for Colombia, Period 1990-2000 and 2000-2005. Institute of Hydrology, Meteorology and Environmental Studies – IDEAM-. Bogotá, D. C., Colombia. Page.22

[45] Downloaded from the Colombian Environmental Information System (SIAC): http://www.siac.gov.co/catalogo-de-mapas

[46] Information contained in the methodology" Change in the area covered by natural forest (CSBN)". – IDEAM. Available at: http://www.ideam.gov.co/documents/24155/125494/49-4.05_HM_Cambio_bosque_natural_3_FI.pdf/64d68d79-56ce-4ab5-916e-e69dd94bea3c

[47] Information contained in the methodology" Change in the area covered by natural forest (CSBN)" – IDEAM. Available at: http://www.ideam.gov.co/documents/24155/125494/49-4.05_HM_Cambio_bosque_natural_3_FI.pdf/64d68d79-56ce-4ab5-916e-e69dd94bea3c

considered as ineligible. Illustration 15 shows the spatial distribution of forest, non-forest and no information areas within the program boundaries and Table 10 shows the areas in hectares under each category.

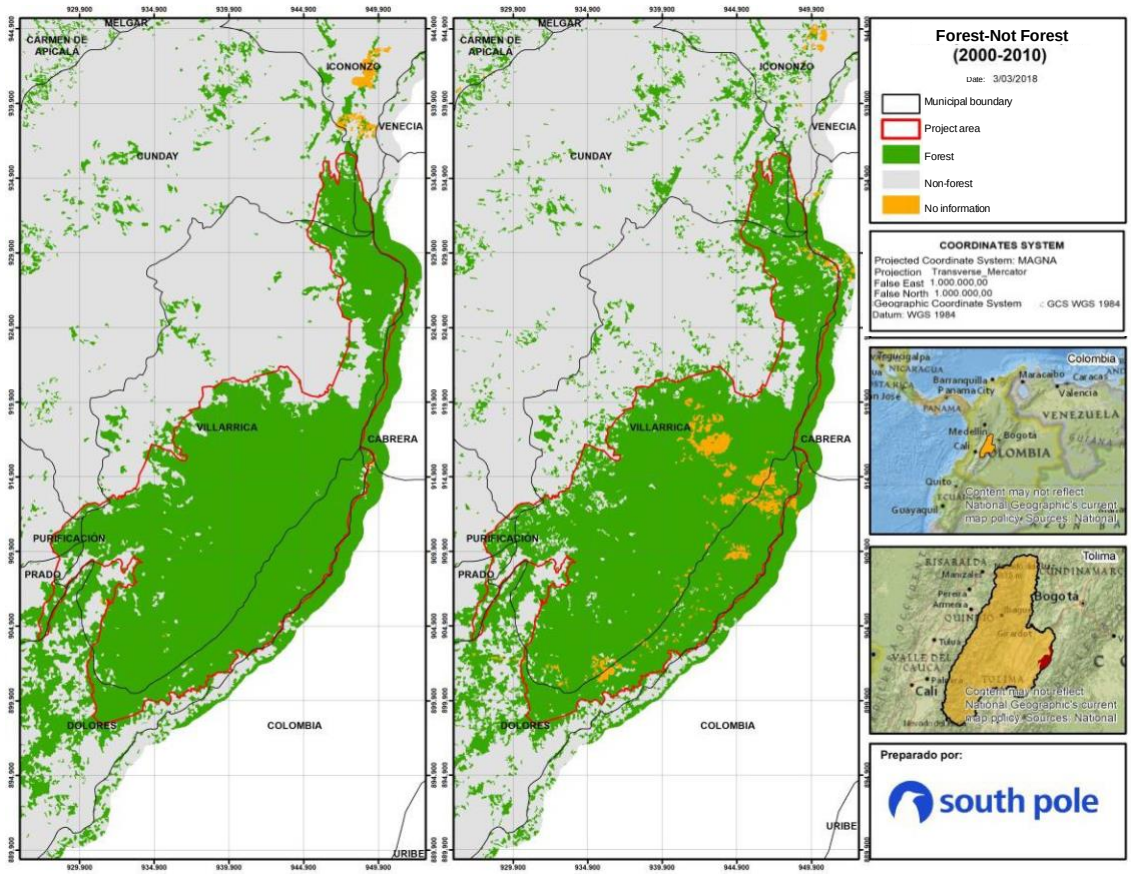



**Illustration 14. Forest-non-forest area of the IDEAM (by its acronym in Spanish) layers in the program expansion area in the years 2000 (left) and 2010 (right).**

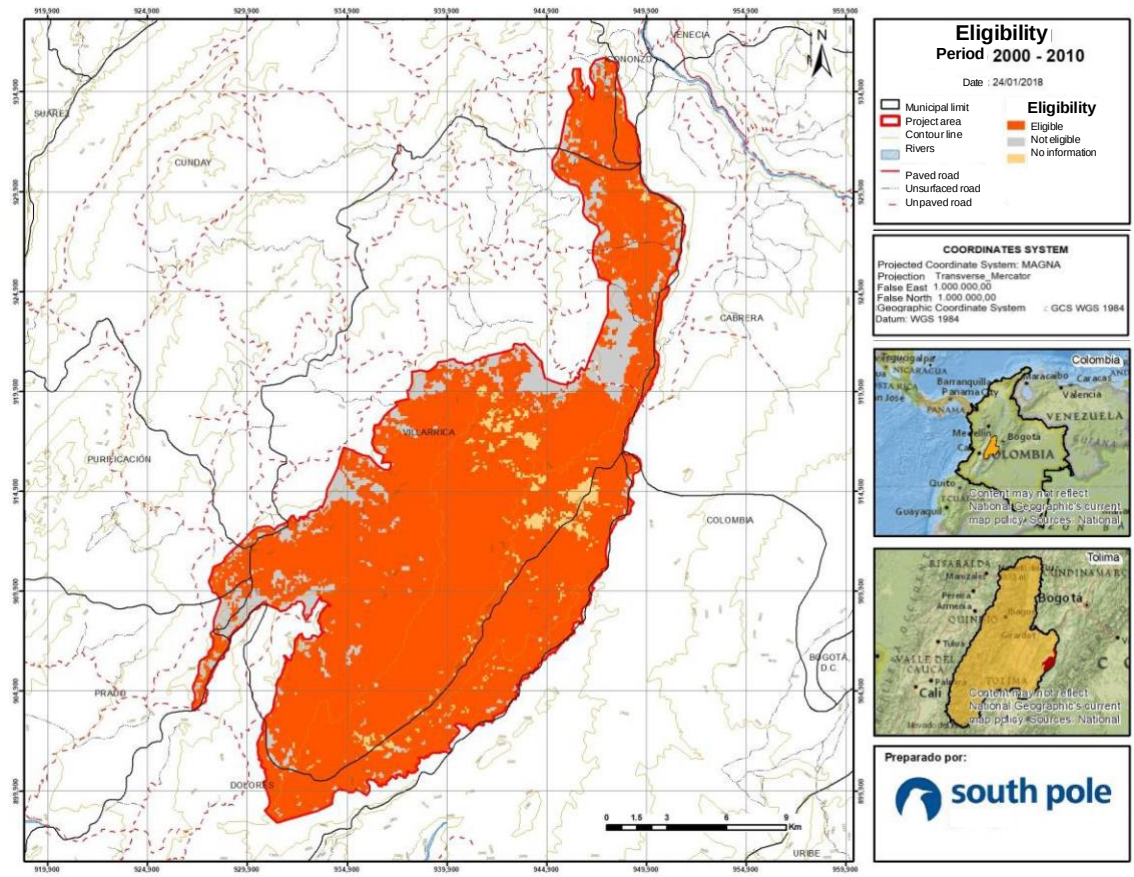



**Illustration 14. Eligibility map of the program expansion area**

**Table 10. Current program areas**

| Eligibility | Area (ha) | Percentage (%) |
|---|---|---|
| Eligible | 12.701 | 82,9 |
| Not Eligible | 2.006 | 13,1 |
| No information | 617 | 4,0 |
| Total | 15.324 | 100 |

## 3.3 Reference scenario for REDD+ actions

The reference region corresponds to the area in which the analysis of deforestation, land use change and analysis of agents and drivers of deforestation is carried out. The selection of the reference region was made considering the guidelines set forth in section "1.1.1 *Reference region*" of the methodology "*VM0015 Avoided Unplanned Deforestation"*[48], which indicates that the reference region adequately represents the program area if it meets three of four landscape criteria: altitude ranges, slope ranges, mean annual precipitation and forest cover type. The selected region includes the municipalities of Alpujarra, Carmen de Apicalá, Cunday, Dolores, Icononzo, Prado, Purificación, Suarez and Villarrica, municipalities of eastern Tolima (Illustration 15), which meet the similarity in the conditions of slope ranges, mean annual precipitation and

forest cover type (Table 11, Table 12, and Table 13).

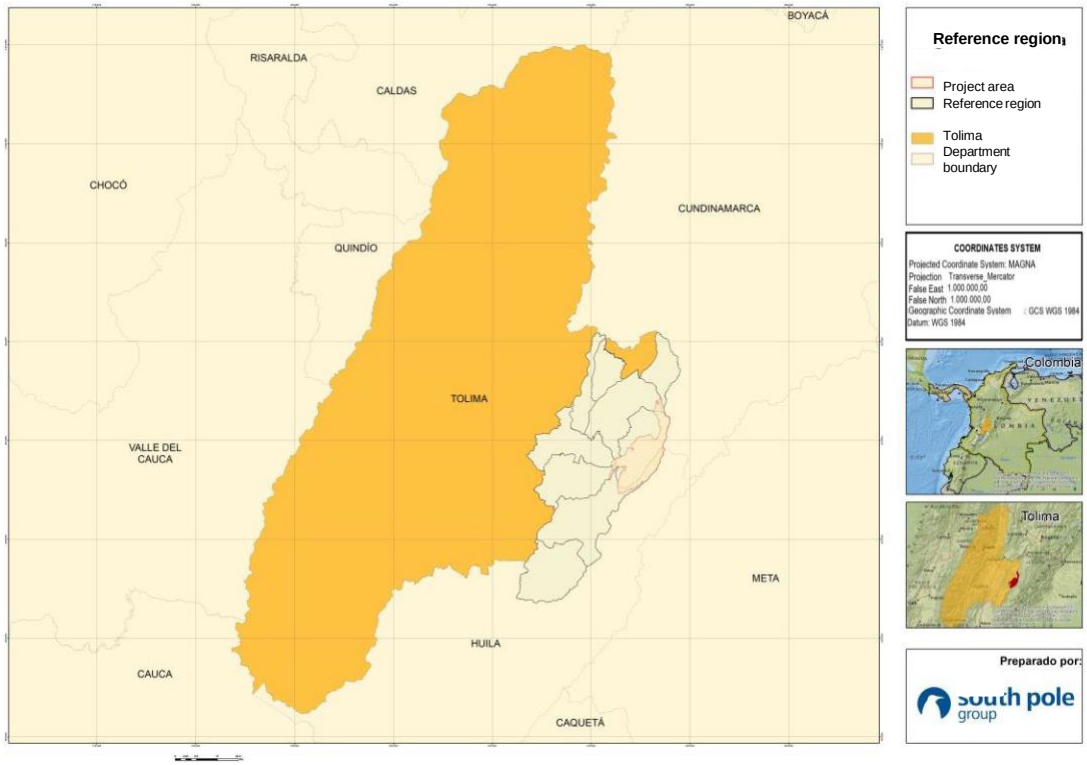



**Illustration 15. Reference region**

**Table 11. Slope ranges**

| Slope ranges (degrees) | Program expansion area (ha) | Reference region (ha) | Cumulative project area (%) | Cumulative reference region (%) |
|---|---|---|---|---|
| 0 - 3 | 931,3 | 55.745,6 | 2,67% | 17,61% |
| 4 - 12 | 19.382,6 | 141.459,0 | 58,34% | 62,28% |
| 13 - 18 | 8.449,1 | 62.790,6 | 82,60% | 82,11% |
| 19 - 27 | 4.124,8 | 40.688,0 | 94,45% | 94,96% |
| 28 - 36 | 1.291,1 | 12.653,3 | 98,15% | 98,96% |
| 37 - 45 | 474,9 | 2640,5 | 99,52% | 99,79% |
| >45 | 168,0 | 663,6 | 100,00% | 100,00% |
| Total | **34.822** | **316.641** | | |

**Table 12. Precipitation ranges**

| Average annual precipitation (mm) | Project area (ha) | Reference region (ha) | Accumulated project area (%) | Cumulative reference region (%) |
|---|---|---|---|---|
| 900-1000 | 159,4 | 11,1 | 0,46% | 0,00% |
| 1000-1100 | 13.703,6 | 4.060,8 | 39,81% | 1,29% |
| 1100-1200 | 6.740,4 | 6.108,9 | 59,17% | 3,22% |
| 1200-1300 | 2.190,2 | 3.902,2 | 65,46% | 4,45% |
| 1300-1400 | 1.605,6 | 4.888,4 | 70,07% | 5,99% |

| | | | | |
|---|---|---|---|---|
| 1400-1500 | 1.258,1 | 11.241,2 | 73,68% | 9,54% |
| 1500-1600 | 1.160,2 | 21.919,3 | 77,01% | 16,46% |
| 1600-1700 | 1.155,9 | 28.308,5 | 80,33% | 25,40% |
| 1700-1800 | 1.981,7 | 36.392,9 | 86,02% | 36,90% |
| 1800-1900 | 2.549,1 | 56.775,3 | 93,34% | 54,83% |
| 1900-2000 | 2.169,8 | 65.283,7 | 99,58% | 75,45% |
| 2000-2100 | 147,9 | 51.730,5 | 100,00% | 91,78% |
| 2100-2200 | 0 | 23.884,9 | 100,00% | 99,33% |
| 2200-2300 | 0 | 2.132,51 | 100,00% | 100,00% |
| Total | 34.822 | 316.640 | | |

**Table 13. Forest cover type**

| Forest classification | Project area (ha) | Reference region (ha) | Cumulative project area (%) | Cumulative reference region (%) |
|---|---|---|---|---|
| Tropical dry forest | 0 | 105.832 | 0,00% | 33,42% |
| Tropical rain forest | 0 | 32.359,1 | 0,00% | 43,64% |
| Premontane rainforest | 3.539,1 | 98.018,5 | 10,16% | 74,60% |
| Very humid premontane forest | 147,9 | 45.815,4 | 10,59% | 89,07% |
| Low montane rain forest | 28.140,4 | 34.615,4 | 91,40% | 100,00% |
| Very humid low montane forest | 2.994,4 | 0 | 100,00% | 100,00% |
| Total | 34.822 | 316.640 | | |

## 3.4 Removals due to REDD+ actions

### 3.4.1 Detection of changes and historical deforestation rates

#### 3.4.1.1 *Analysis of land use land cover changes*

The analysis of changes in land cover was conducted for the period 2000 - 2010 following the guidelines of section 5.5.2.1 of NTC 6208. For this, the information on land cover for Colombia from the IDEAM at a scale of 1:100,000 was used, based on the "*Corine Land Cover*" methodology adapted for Colombia and available in the SIAC (Environmental Information System of Colombia) [49]. To homogenize the information of the land cover layers with the Forest-Non-Forest layers, the layers described in section 3.2 were used. The following is a description of the process for creating the land cover change matrix:

The cover and Forest-Non-Forest layers were cut with the reference area of the program, establishing a buffer of 50 m, to avoid empty spaces when crossing the information. The cover layers that were in vector format were converted to raster format, to make them comparable with

[49] http://www.siac.gov.co/catalogo-de-mapas

the Forest-Non-Forest raster data, and then converted back to polygon.

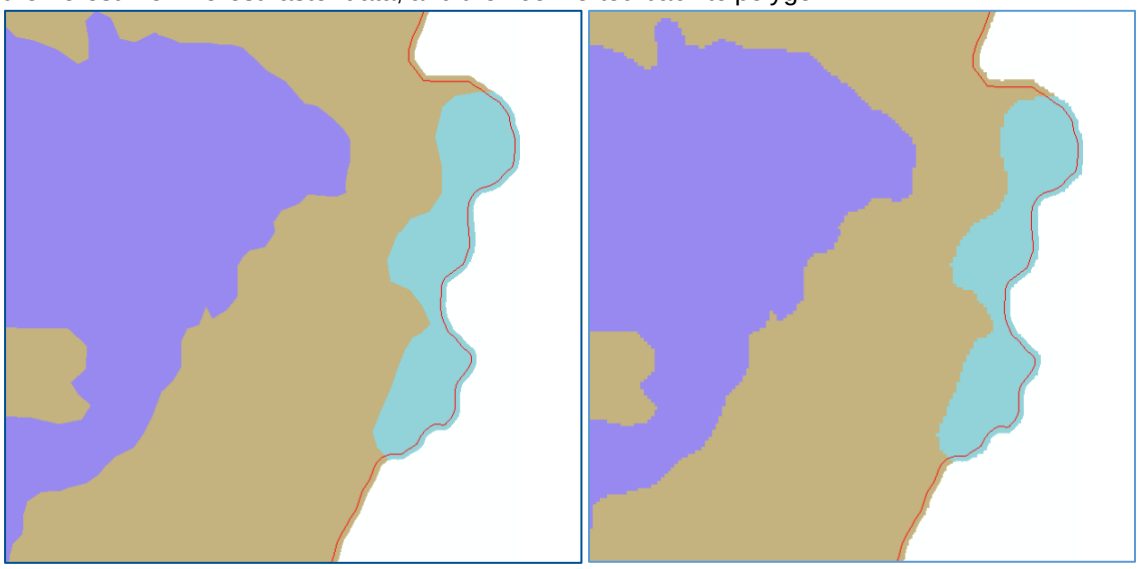


**Illustration 16. Image of smoothed edges compared to the bardes in raster format**

- After having the cover layers converted into *vector*, format, the cloud areas were extracted from both layers and the areas without information from the IDEAM forest layer were merged and defined as areas without information, which are not comparable, as they differ at the temporal and spatial level.
- The land cover categories of the *Corine Land Cover* were homologated to the land cover categories that have aerial biomass values according to the IDEAM emission factors. This homologation was done following Annex A and Table 6 of NTC 6208, generating the classes presented in Illustration 21 and Table 14.

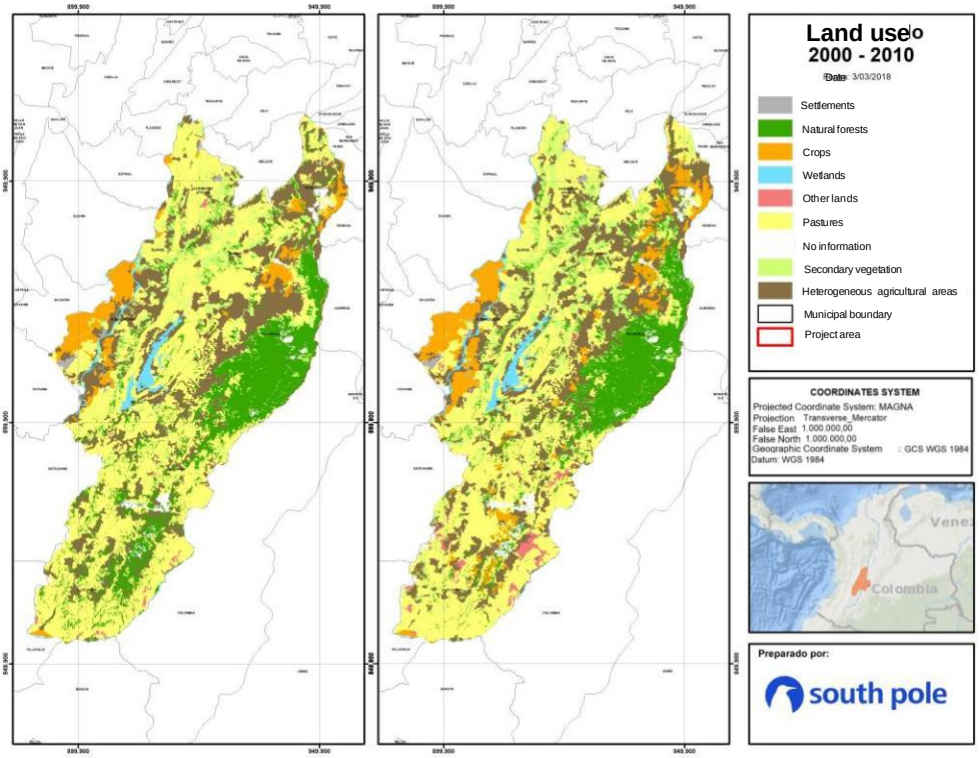



**Illustration 17. Land coverages 2000 and 2010 with equal cloud areas for both layers**

**Table 14. Conversion of Corine Land Cover classes**

| Corine Land Cover | NTC 6208 Coverage (Table 6) |
|---|---|
| 2.4.1. Crop mosaic | Heterogeneous agricultural areas |
| 2.4.2. Mosaic of pastures and crops | |
| 2.4.3. Mosaic of crops, pastures, and natural areas | |
| 2.4.4. Mosaic of pastures with natural spaces | |
| 2.4.5. Mosaic of crops with natural spaces | |
| 1.1.1. Continuous urban fabric | Settlements |
| 1.1.2. Discontinuous urban fabric | |
| 1.2.4. Airports | |
| 1.4.2. Recreational facilities | |
| 3.1.1. Dense forest | Natural Forest |
| 2.1.1. Other transitory crops | Crops |
| 2.1.2. Cereals | |
| 2.1.3. Oilseeds and leguminous plants | |
| 2.2.2. Permanent bush crops | |
| 2.2.3. Permanent tree crops | |
| 5.1.1. Rivers (50 m) | Wetlands |
| 5.1.4. Artificial bodies of water | |
| 3.3.2. Rock outcrops | Other lands |
| 3.3.3. Bare and degraded land | |
| 3.3.4. Burned areas | |
| 2.3.1. Clean pastures | Pastures |
| 2.3.2. Wooded pastures | |
| 2.3.3. Weedy pastures | |
| 3.2.1. Grassland | |
| 3.2.2. Shrubland | |
| 9.9. Clouds | No information |
| 3.2.3. Secondary or transitional vegetation | Secondary vegetation |

Finally, to obtain the land use change matrix required by the methodology (section 5.5.2.1 of NTC 6208) an intercept was performed using the *Analysis Tools/Overlay/Intercept* tool using the layers with the final categories and the respective areas. The land use changes from forest in 2000 to non-forest categories in 2010 are shown in Illustration 19 and the land use change matrix is presented in Table 15.

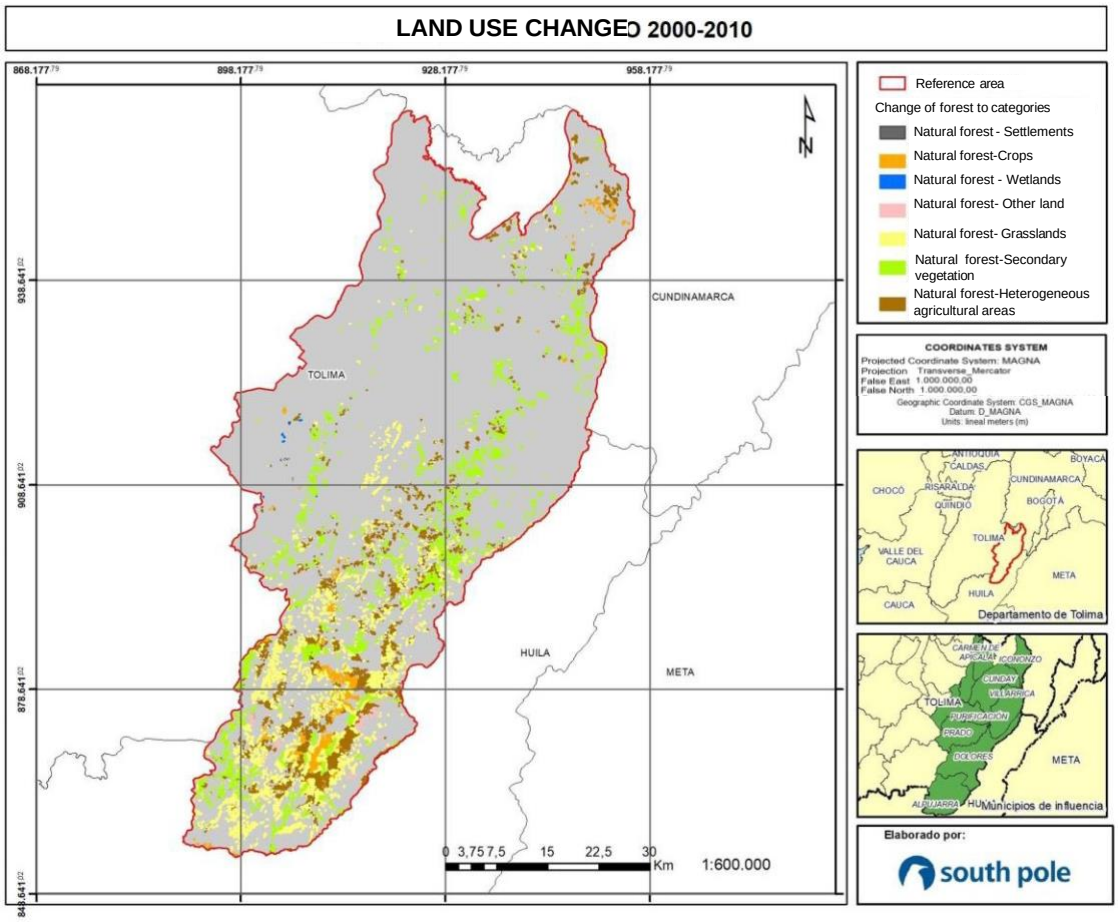



**Illustration 18. Land use change from forest in 2000 to non-forest categories in 2010.**

Table 15. Housing and population in the municipalities of the reference area

| Categories NTC 6208 | Wetlands | Natural Forest | Crops | Heterogeneous agricultural areas | No information | Pastures | Settlement | Other lands | Secondary vegetation | Total 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| Wetlands | 5.520,2 | 3,1 | 159,8 | 440,3 | 0,0 | 167,1 | 0,0 | 0,0 | 51,1 | 6.341,6 |
| Natural Forest | 87,0 | 44.316,6 | 2.341,7 | 5.778,7 | 911,8 | 5.570,6 | 2,2 | 158,3 | 3.869,4 | 63.036,3 |
| Crops | 75,4 | 188,4 | 16.680,4 | 757,9 | 0,0 | 656,7 | 26,0 | 14,0 | 93,7 | 18.492,5 |
| Heterogeneous agricultural areas | 460,1 | 1.468,8 | 8.656,0 | 43.824,0 | 0,0 | 12.783,0 | 22,1 | 389,8 | 7.751,5 | 75.355,2 |
| No information | 0,0 | 178,2 | 0,0 | 0,0 | 4.071,0 | 0,0 | 0,0 | 0,0 | 0,0 | 4.249,2 |
| Pastures | 250,4 | 1.056,7 | 1.844,8 | 20.320,5 | 0,0 | 112.612,1 | 17,6 | 3.116,5 | 12.427,0 | 151.645,6 |
| Settlement | 5,1 | 0,1 | 5,9 | 2,2 | 0,0 | 6,5 | 1.393,0 | 0,0 | 3,3 | 1.416,0 |
| Other lands | 0,0 | 77,9 | 0,0 | 128,8 | 0,0 | 387,5 | 1,8 | 587,4 | 5,1 | 1.188,5 |
| Secondary vegetation | 185,3 | 0 | 396,1 | 4.148,3 | 0,0 | 4.206,8 | 5,7 | 4,8 | 20.660,0 | 29.607,0 |
| Total 2010 | 6.583,6 | 47.289,8 | 30.084,6 | 75.400,7 | 4.982,8 | 136.390,4 | 1.468,3 | 4.270,7 | 42.890,2 | 351.331,9 |

### 3.4.1.2 *Deforestation rate*

The deforestation rate for the quantification of future deforestation was calculated using the formula given by Puyravaud (2003)[50], according to section 5.5.2.2 of NTC 6208. This formula expresses the percentage of forest area decreased per year, with the following equation:

$$r = \left(\frac{1}{(t_2 - t_1)} * \ln\left(\frac{A_2}{A_1}\right)\right) * 100$$

Where, **r** is the annual rate of deforestation, $\mathbf{t_2}$ y $\mathbf{t_1}$ are the period for the analysis, in this case 2010 and 2000 respectively, and $\mathbf{A_2}$ and $\mathbf{A_1}$ are the area of forest at the end and beginning of the analysis period. Replacing the parameters of the equation with the forest data in the reference area for the years 2000 and 2010 described in Table 15 gives an annual rate of 2.87%[51].

### 3.4.1.3 *Analysis of agents and drivers of deforestation*

The following is a description of the analysis of deforestation agents and drivers to comply with section 5.5.2.1 of NTC 6208.

#### 3.4.1.3.1 Deforestation Agents

**Actors' analysis[52]**

The actors in the program's expansion area are grouped as follows: i) public, private, educational or external charitable institutions that are present in the territory, ii) associations formed in the community and iii) local experts (Table 16). Of these, those that are key for their constant presence in the territory were identified at the local, municipal, and departmental levels (Illustration 20).

**Table 16. Social actors in the program area.**

| Institutions | Associations | Community (local experts) |
|---|---|---|
| Universidad del Tolima | Community action boards | Saúl Sosa (Vereda Galilea) |
| Alcaldía de Cunday | Fundación reiniciar | Fidel Tovar |
| CORTOLIMA | Asociación (en proceso de | José Sánchez (Veredas Cuatro |
| Gobernación del Tolima | creación) para la defensa del | Mil - Galilea) |
| Instituciones educativas de las | agua y medio ambiente | José Iván Haya (Vereda Galilea) |
| veredas Alto Puerto Lleras, | Comité de cafeteros | Deogracia (Vereda Galilea) |
| Cuatro Mil y Galilea | Comité de cacaoteros | Luis Briceño (Vereda Galilea) |
| Enertolima | Comité de bananeros | Hermida Briceño (Vereda. |
| | Ganaderos | Galilea) |
| | Comité dinamizador todos por la | Isidro Parra (Veredas. Alto |
| | defensa de la cordillera | Puerto Lleras - Galilea) |
| | Comité de plataneros | Ebristelio Godoy (Vereda |
| | Comité de luleros | Galilea) |
| | Asojuntas Cunday | Aurelio Sánchez (Vereda |
| | Guanabaneros | Galilea) |
| | | Alirio Pinzón (Vereda. Galilea) |

[50] Puyravaud, J.-P., 2003. Standardizing the calculation of the annual rate of deforestation. Forest Ecology and Management, 177: 593-596

[51] Support/Information management/Estimations/180227_Ex-ante_estimates].

[52] Gómez. E. J., Pastrana G. E., (2016). Community conservation strategies as a contribution to the sustainable environmental development of the Galilea Forest, in the east of the department of Tolima. Universidad Nacional del Tolima. Department of Forest Engineering.

DEPARTMENTAL

- CORTOLIMA
- Asociación Unidos por la Cordillera
- Government of Tolima
- Universidad del Tolima

MUNICIPAL

- Cunday City Hall
- Villarrica City Hall
- Producers Committee

LOCAL

- Community
- Educational Institution
- Community Action Boards

**Illustration 19. Territorial reach of the social actors[53].**

In addition, conflicts of interest have been identified among the stakeholders, which include the following:

- The local community of the Galilea Forest is interested in conserving the natural resources of the Alto Torres, Cuatro Mil, Galilea and Puerto Lleras trails. On the other hand, the agricultural producers take advantage of the natural forest in these areas for the establishment of crops.

- The Committee of Coffee Growers and the Committee of Producers seek to orient their productive processes in a way that allows them to conserve the Galilea Forests and at the same time, to use them appropriately. In turn, the small and medium sized producers are interested in accessing the land informally through the establishment of pastures and crops.

**Identification of deforestation agents**

Farmers, breeders, and the local population are the main agents of deforestation, since it is caused by the expansion of the agricultural frontier, for the establishment of crops and pastures, and by the extraction of timber from the forest for land appropriation, local use or trade.[54]

**Socioeconomic characterization of the reference area**

The population of the reference area has a total of 23,242 dwellings, with 71,235 inhabitants in 2005 and 78,258 projected for 2010.[55] Of the total number of municipalities, Purificación, Icononzo and Cunday are the most populated, and Villarrica and Dolores are the least populated (Table 17).

[53] Taken from Gómez & E. J., Pastrana G. E. (2016)

[54] Gómez. E. J., Pastrana G. E., (2016). Community conservation strategies as a contribution to the sustainable environmental development of the Galilea Forest, in the east of the department of Tolima. Universidad Nacional del Tolima. Department of Forest Engineering. In the prospective section, the local community identified for the Puerto Lleras, Alto Puerto Lleras and Galilea villages, the areas where there are currently crops or pastures for livestock, which 20 years ago were natural forest. In addition, he assures that despite the fact that, during a period of time, the population decreased due to the armed conflict, in the last few years it has increased.

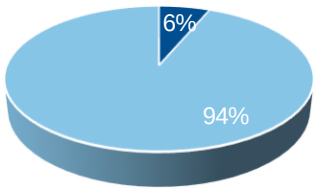
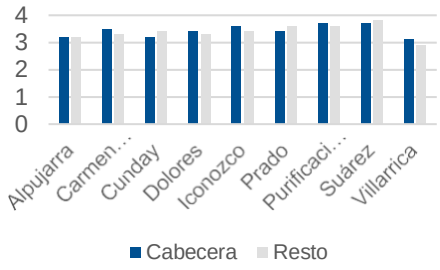
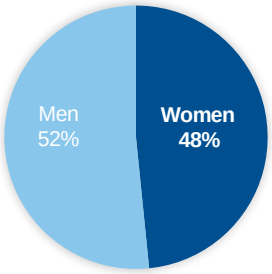
[55] National Population Census 2005. The bulletins for each municipality can be found at: Supports/Deforestation Threats/Bulletin Census 2005. The municipalities of Suarez and Prado do not present this information in their bulletins.

**Table 17. Housing and population in the municipalities of the reference area[56].**

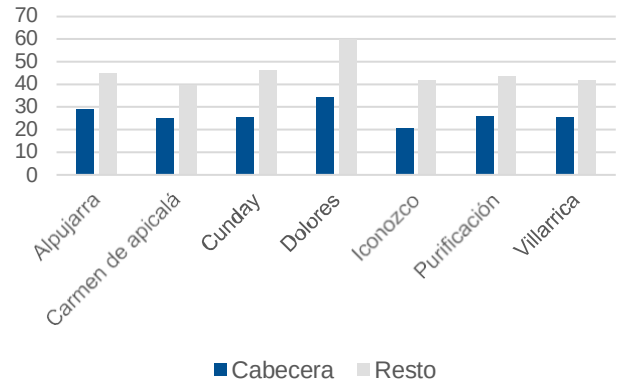
| Municipality | Housing | People 2005 | People 2010 |
|---|---|---|---|
| Alpujarra | 1.868 | 5.098 | 5.092 |
| Carmen de Apicalá | 3.773 | 8.330 | 8.605 |
| Cunday | 3.275 | 8.445 | 10.171 |
| Dolores | 1.914 | 5.636 | 8.600 |
| Icononzo | 3.095 | 10.130 | 11.365 |
| Purificación | 7.288 | 27.586 | 28.601 |
| Villarrica | 2.029 | 6.010 | 5.824 |
| Total | 23.242 | 71.235 | 78.258 |

Table 18 describes the percentage of households with economic activities, the average number of people per household, the proportion of male and female population, and the Unsatisfied Basic Needs Index (UBN).

**Table 18. Population and demographic characteristics of the reference area[57].**

| Variable | Descriptive statistics | Description |
|---|---|---|
| Percentage of households with economic activities |  | Six percent of the households in the reference area have economic activities. |
| Average number of people per household |  | On average, all municipalities have a similar number of people per household, approximately 3 to 4 people, both in the municipal capitals and in rural areas. |
| Female and male population |  | The population of men and women is similar, with slightly more men (52%). |

[56]Taken from DANE (2005)
[57]Taken from the National Population Census (2005).

| Variable | Descriptive statistics | Description |
|---|---|---|
| Index of Unsatisfied Basic Needs (NBI) |  | Of the municipalities for which this variable is reported, Dolores has the highest proportion of people with unsatisfied basic needs. The rest of the municipalities have similar proportions. |

**Socioeconomic characterization of the Villarrica villages where the program expansion area is located.**

Of the total number of villages in the municipality of Villarrica, 4 are within the jurisdiction of the program area. These are: Alto Puerto Lleras with 14 houses and one of them uninhabited, Cuatro Mil with eight houses, Galilea with 26 houses and Puerto Lleras with 11 houses.[58]

According to the National Agricultural Census (2014), the total number of inhabitants in these villages is 42 people, distributed in 13 dwellings, with a total of 8 resident producers, 148 agricultural production units and 19 non-agricultural production units[59].

The area's economy is based mainly on cattle farming and subsistence crop production, which has represented a conflict because the land use is destined for conservation.[60]

According to the Villarrica City Hall (2003), Puerto Lleras is the only one of the four villages in the Galilea forest's jurisdiction that has an active educational institution with 20 students and a health care center. In the other villages, the schools are not active due to the absence of students. Regarding the health posts, they have been destroyed by the armed conflict in Colombia, in the case of the Galilea trail; or they have never existed, in the case of the Alto Puerto Lleras and Cuatro Mil trails.

#### 3.4.1.3.2 Deforestation drivers

Following this, the factors that lead the identified agents (ranchers, farmers, and local population) to make decisions on land use are evaluated, with the objective of recognizing what have been the causes of deforestation.

**Variables explaining area (hectares) deforested**

Key variables

- Expansion of the agricultural and cattle raising frontier
- Logging

Variables description

[58] Gómez E. J. & Pastrana G. E. (2016). Community conservation strategies as a contribution to the sustainable environmental development of the Galilea forest, in the east of the department of Tolima. Universidad del Tolima. Thesis for the degree of Forestry Engineering.

[59] National Administrative Department of Statistics DANE (2014). National Agricultural Census. Taken from: https://www.dane.gov.co/index.php/estadisticas-por-tema/agropecuario/censo-nacional-agropecuario-2014#entrega-de-resultados-del-3er-censo-nacional-agropecuario-preliminar. See: Supports/Deforestation Threats/Agricultural Census information-trails..

[60] Gómez E. J. & Pastrana G. E. (2016). Community conservation strategies as a contribution to the sustainable environmental development of the Galilea forest, in the east of the department of Tolima..

*Expansion of the agricultural and cattle-raising frontier*

The main causes of the expansion of the agricultural frontier are the establishment of crops and pastures for dual-purpose cattle raising. In addition to this, the poor quality of the soils causes producers to expand their production areas to maintain their production. Another aspect that leads to the expansion of the agricultural frontier in riparian zones is the search for water sources to supply the production systems.[61]

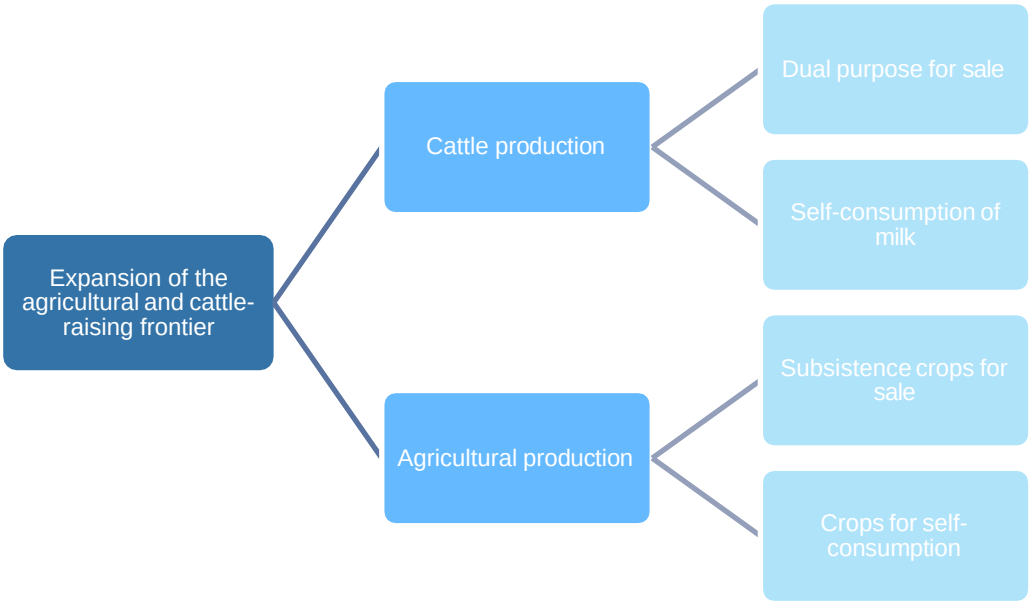



**Illustration 20. Analysis of the drivers of deforestation: expansion of the agricultural frontier**

*Cattle production*

Refers to farmers dedicated to raising, exploiting, and trading dual-purpose cattle. Since there is no information available on the number of people dedicated to cattle raising, the information on the number of head of cattle for the deforestation analysis period (2000 - 2010) was used as a reference value (Illustration 22).

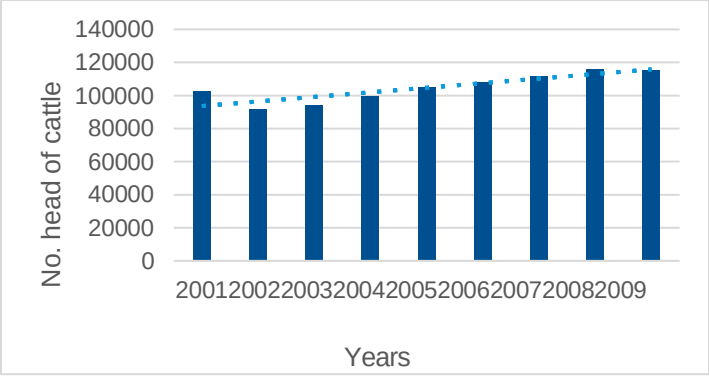



**Illustration 21. Behavior of the cattle inventory in the reference area for the period 2001 to 2009.[62].**

In Villarrica, where the current program area is located, between 2001-2009, the number of head of cattle showed an increasing trend (Figure 23).

[61] CORTOLIMA (2009). Management Plan for the Prado River Basin.
[62] Taken from Fedegan. Bovine inventory by municipality. Sub-management of Animal Welfare and Health, 2016: http://www.fedegan.org.co/estadisticas/inventario-ganadero.

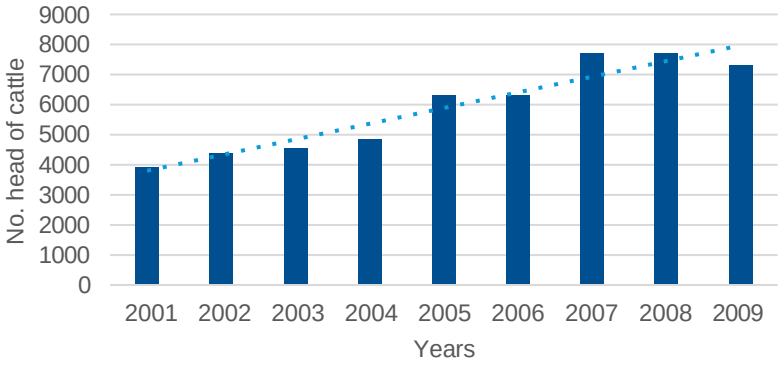



**Figure 22. Behavior of the cattle inventory in Villarrica for the period 2001 to 2009[63].**

*Agricultural production*

According to the municipal agricultural evaluations (EVA by its Spanish acronym),[64] in the municipalities that make up the reference region[65] the crops with the largest planted area between 2006 and 2010 were: coffee and rice with an area greater than 50,000 ha; followed by corn, banana, plantain, cocoa, orange, guava, sugarcane and mango with areas between 1,000 and 10,000 ha; and beans, lemon, banana, cholupa, sorghum, tree tomato, among others, with areas between 0 and 1,000 ha. Illustration 24 shows the trend in the area established with these crops in the reference region.

According to the same source of information, the crop with the largest area planted[66] in Villarrica is coffee and to a lesser extent banana, guava, cacao, sugarcane, soursop, traditional corn, tomato, and banana. Illustration 25 shows the trend in the area planted with these crops in the region, which has been constant since 2008. In the villages where the program's expansion area is located, agriculture is characterized by subsistence crops such as corn, sugarcane, onion, banana, cocoa, coffee, yucca, blackberry, and fruit trees, among which coffee predominates.[67]

[63] Fedegan (2016). Cattle inventory by municipality. Animal Welfare and Health Sub-management.

[64] MinAgricultura (2016). Municipal Agricultural Evaluations. Taken from http://www.agronet.gov.co/_layouts/15/xlviewer.aspx?id=/Lists/Boletin/Attachments/1052/Base%20Agr%C3%ADcola%20EVA%202007-2016%20(P).xlsb&Source=http%3A%2F%2Fwww%2Eagronet%2Egov%2Eco%2FLists%2FBoletin%2FDispForm%2Easpx%3FID%3D1052

[65] Information is included for all the municipalities in the reference region with the exception of the municipality of Suarez due to the fact that no data from this municipality is recorded in the agricultural assessments.

[66] At least 50 ha.

[67] Gomez E. J. & Pastrana G. E. (2016). Community conservation strategies as a contribution to the sustainable environmental development of the Galilea forest, in the east of the department of Tolima.

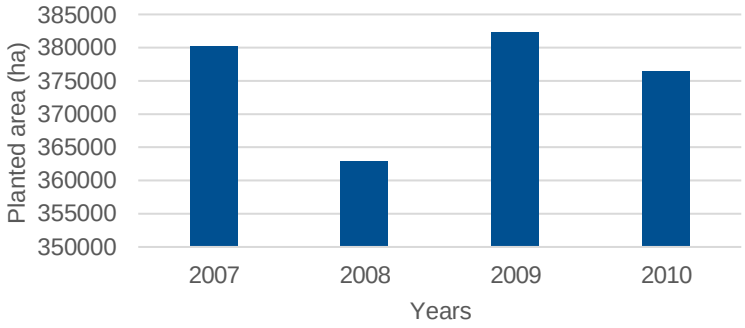



**Illustration 23. Behavior of the area planted in the reference area between 2007 - 2010[68].**

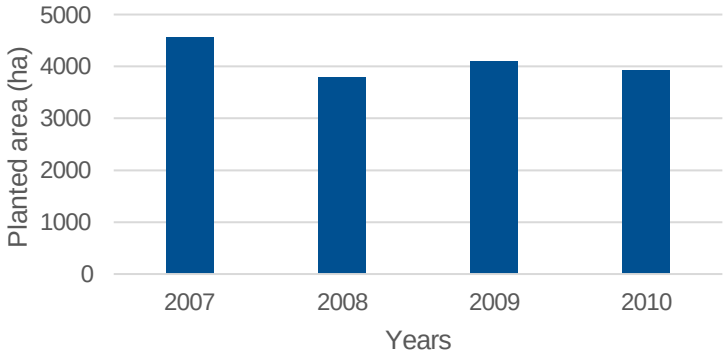



**Illustration 25. Behavior of the area planted in the municipality of Villarrica between 2007 – 2010[69].**

*Timber extraction*

Logging is the second leading cause of deforestation and is carried out for three purposes: i) as a method of appropriating land that the local population considers wasteland,[70] ii) commercialization of timber for different purposes, and iii) local use of the timber. The lack of tools and incentives to undertake conservation projects and land use problems in the region are some of the causes that lead local people to cut down the forest.[71]

The rate for appropriation purposes has historically reached its greatest expression in the concept of "improvements", i.e., stripping the vacant land or settleable land of its original cover or forest, which is a requirement to become an owner.[72]

In the region where the program expansion area is located, logging for timber commercialization has reached such a magnitude that it has significantly reduced the abundance of timber species, including *Tabebuia rosea*, *Juglans neotropica*, *Aniba perutilis, Nectandra spp.*, *Nectandra*

[68] MinAgricultura (2016). Municipal Agricultural Assessments. Taken from: www.agronet.gov.co/_layouts/15/xlviewer.aspx?id=/Lists/Boletin/Attachments/1052/Base%20Agr%C3%ADcola%20EVA%202007

[69] MinAgricultura (2016). Municipal Agricultural Assessments. Taken from: www.agronet.gov.co/_layouts/15/xlviewer.aspx?id=/Lists/Boletin/Attachments/1052/Base%20Agr%C3%ADcola%20EVA%202007-2016%20(P).xlsb&Source=http%3A%2F%2Fwww%2Eagronet%2Egov%2Eco%2FLists%2FBoletin%2FDispForm%2Easpx%3FID%3D1052

[70] Conversations with villagers during field visits to the project..

[71] Gómez E. J. & Pastrana G. E. (2016). Community conservation strategies as a contribution to the sustainable environmental development of the Galilea forest, in the east of the department of Tolima.

[72] CORTOLIMA (2009). Management Plan for the Prado River Basin.

*acutifolia*, *Cedrela sp.* and *Cinchona pubescens*. Additionally, it was identified that these species are used locally for construction, poles, handicrafts, medicinal uses, and firewood.[49]

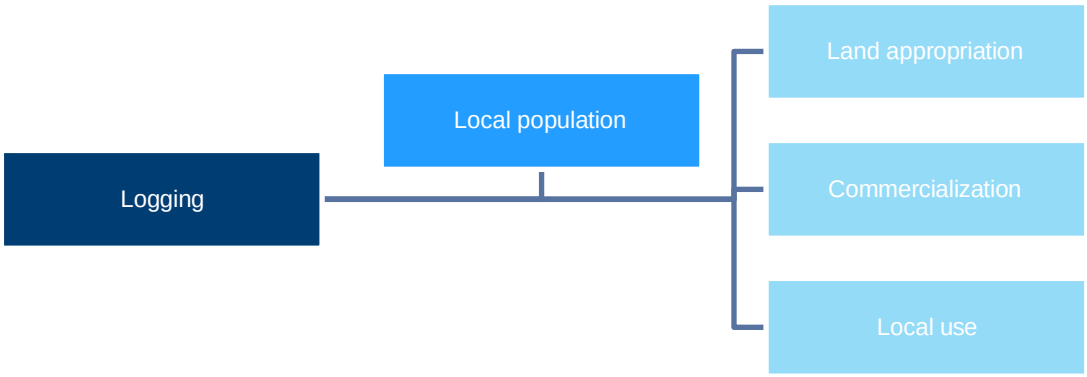



**Illustration 24. Analysis of the drivers of deforestation: logging.**

**Variables explaining the location of deforestation**

Historical deforestation attributable to cattle raising and agriculture

According to the analysis carried out for the change in vegetation cover between 2000 and 2010, it was estimated that 5,570.6 ha in the reference area changed from natural forest in 2000 to pasture. In the case of agriculture, according to the same analysis, it was calculated that 2,341.7 ha of forest were converted to cropland during that period. In addition, 5,778.7 ha of forest became heterogeneous agricultural areas, where both agriculture and cattle raising can be developed (section 3.4.1.1). Considering the above, a total of 13,691 ha were deforested to be transformed into crop and pasture areas, which represents 22% of the total natural forest present in 2000 (63,036.26 ha).

*Correlation analysis of topographic and land use suitability factors.*

The latest version of the Dinamica-EGO software was used to define the correlation between deforestation and the factors that explain it. (Soares-Filho, Rodrigues, & Costa, 2009)[73]. The analysis was developed in two stages: (i) elaboration of maps with the explanatory factors of deforestation: distance to population centers, relief, forest suitability, number of head of cattle and planted area; and (ii) selection of a calibration model by determining the weight of evidence and analyzing the correlations between variables[74].

The results indicate a directly proportional relationship between deforestation and distance to population centers, height above sea level and forest suitability. According to Illustration 27, deforestation increases as forests are located at a distance greater than 2500 m from populated centers. This is attributed to the fact that at less than 2500 m there is no forest to be harvested and the population must travel a greater distance to access them. In the case of altitude above sea level, deforestation increases from approximately 1250 meters above sea level. Finally, the areas with forest suitability between 1 and 2 show greater deforestation, as they tend to be areas with greater accessibility due to the slope, altitude, and possible existence of roads.

[73] Soares-Filho, B., Rodrigues, H., & Follador, M. (2013). A hybrid analytical-heuristic method for calibrating land-use change models. Environmental Modelling & Software, 43, 80–87. https://doi.org/10.1016/j.envsoft.2013.01.010
[74] See calibration model: Supports/Correlation analysis/Procedure.

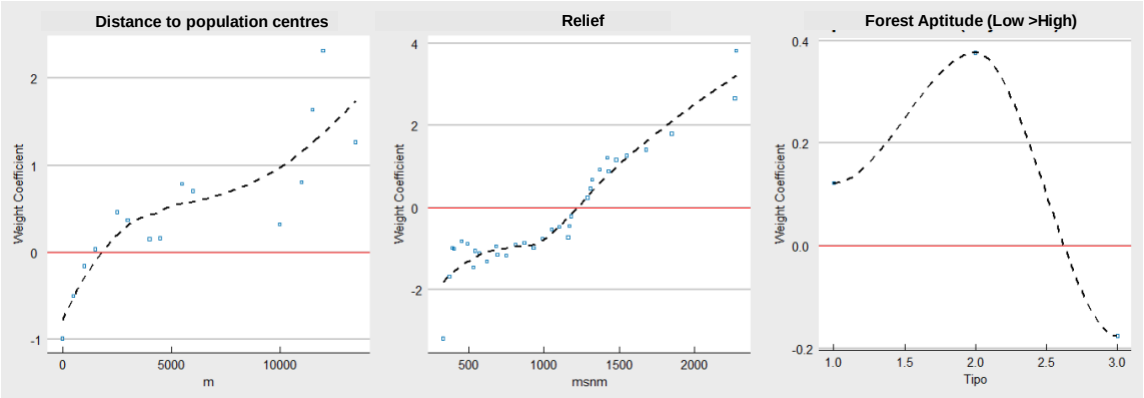



**Illustration 25. Correlation between deforestation and distance to populated centers, relief (m.a.s.l.) and forest suitability.**

### Future drivers of deforestation

Oil exploration in the program area [75]

Based on information from the environmental licenses for hydrocarbon areas granted by the National Environmental Licensing Authority (ANLA by its Spanish acronym), two exploration permits were found: i) exploration license granted to Petrobras Colombia Limited and ii) exploration license granted to Canacol Energy (Illustration 28). Although exploration activities do not yet have a direct impact on the current program area, both companies have permits to open roads and Canacol Energy is currently adapting an existing road near the current program area. Therefore, exploration activities may indirectly affect deforestation in the program area due to improved access to the forest.

[75] See: Supports/GIS/Shapes/Hydrocarbons

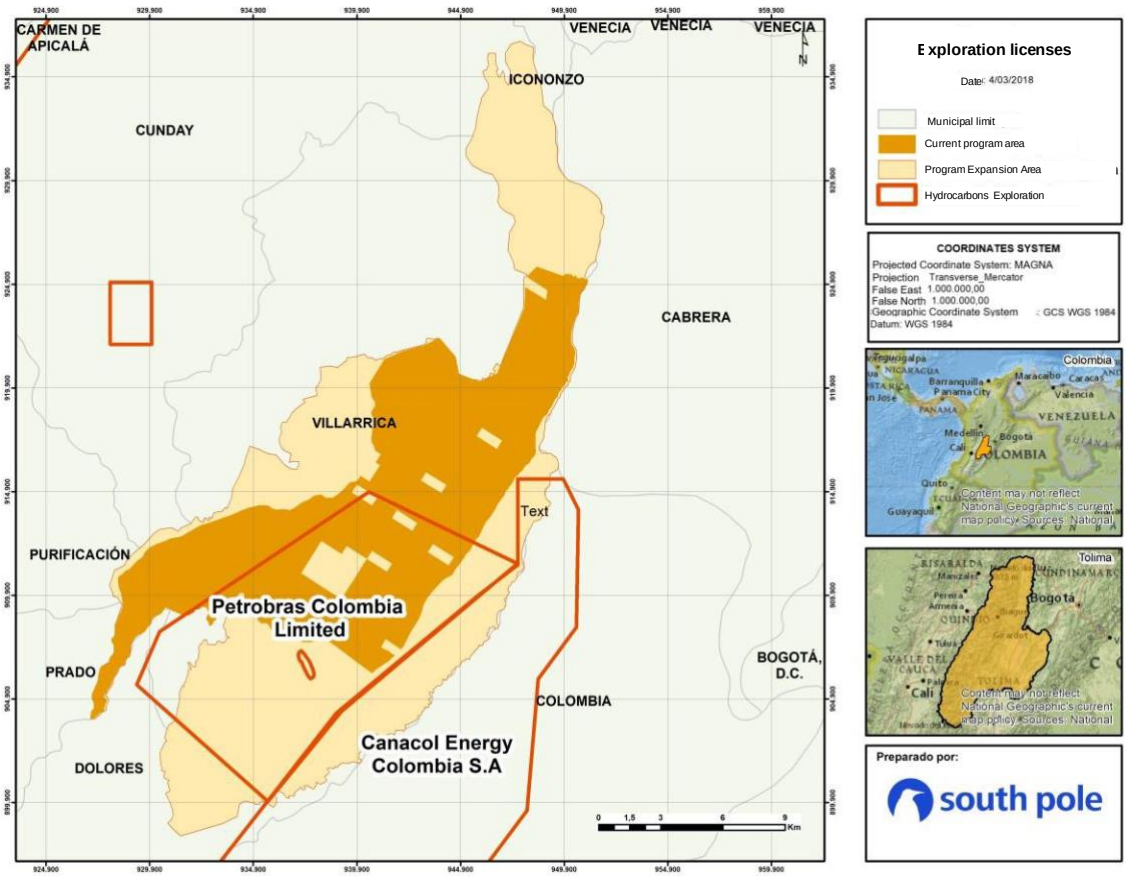



**Illustration 26. Areas granted to hydrocarbons according to ANLA(by its acronym in Spanish) information**

#### 3.4.1.3.3 Underlying Causes of Deforestation

Underlying causes of deforestation are factors related to socioeconomic or biophysical conditions, which influence the direct causes of deforestation and allow us to understand why deforestation occurs. They are determined by structural macroeconomic, policy, technological, cultural, demographic, and biophysical factors.[76]

In the reference area, the main underlying causes of deforestation are, in the biophysical aspect, low soil productivity, accessibility to the forest through roads and the topography of the terrain. On the socioeconomic side, poverty, financing of agricultural activities and land tenure.

**Description of causes**

Biophysical causes

*Soil productivity* [77]

Low soil productivity has been identified as one of the main causes of deforestation, since, being poor soils, the productive cycle is limited and forces the displacement of producers to areas where they can establish their crops again, generating pressure on forests with the expansion of the agricultural frontier.

In the reference area, the soils belonging to the mountain landscape in the cold humid and very humid climate are characterized by being poorly developed on steep slopes and soils with low to medium organic matter content, high stoniness, shallow effective depth, acid reaction and low

[76] Taken from: http://www.marn.gob.gt/Multimedios/4530.pdf.
[77] CORTOLIMA (2009). POMCA Rio Prado Hydrographic Basin

fertility. With respect to medium-humid and very humid climate soils, they are susceptible to severe erosion in areas with slopes greater than 75% and light erosion on slopes between 50 and 75%. As in the cold climate, these are soils with low fertility levels, with acid reaction, low phosphorus levels and moderate to high organic matter content. Their main limitations are stoniness, susceptibility to erosion and high slopes. Finally, soils in warm climates do not differ significantly from the previous ones, because they have the same limitations.

*Roads*

Road density was considered as another determining variable in deforestation for two reasons; first, road construction involves the removal of vegetation cover and second, this opening facilitates access and subsequent extraction of forest resources. In the reference area, roads constitute a total of 574 km, with a road density in each of the municipalities of less than 0.5 km/km2 (Table 19).

**Table 19. Road characterization by municipality**

| Municipality | Area (ha) | Roads (km) | Road density (km/km2) |
|---|---|---|---|
| **Alpujarra** | 50603,75 | 35,05 | 0,07 |
| **Carmen de Apicalá** | 19110,69 | 32 | 0,17 |
| **Cunday** | 50863,09 | 114,6 | 0,23 |
| **Dolores** | 65544,16 | 89,4 | 0,14 |
| **Icononzo** | 21361,75 | 69,9 | 0,33 |
| **Prado** | 41780,73 | 74,6 | 0,18 |
| **Purificación** | 40775,73 | 77,6 | 0,19 |
| **Suárez** | 19208,94 | 26,4 | 0,14 |
| **Villarrica** | 43218,18 | 51,9 | 0,12 |

*Topography*

Topography is considered a variable that can favor deforestation, since the slope of the land may or may not facilitate access to it. In the reference area, most of the area has slopes between 0 and 12% and in the program area, slopes between 4 - 12% (occupying 56% of the area) and 13 - 18% (occupying 24% of the area) predominate (Illustration 28).

Given the characteristics, it is considered that it favors deforestation, since the area is dominated by slopes that allow access to the population. In addition to the above, the slope is not such a strong constraint for the establishment of crops such as coffee or cattle raising since it is

common to observe these systems on steep slopes.

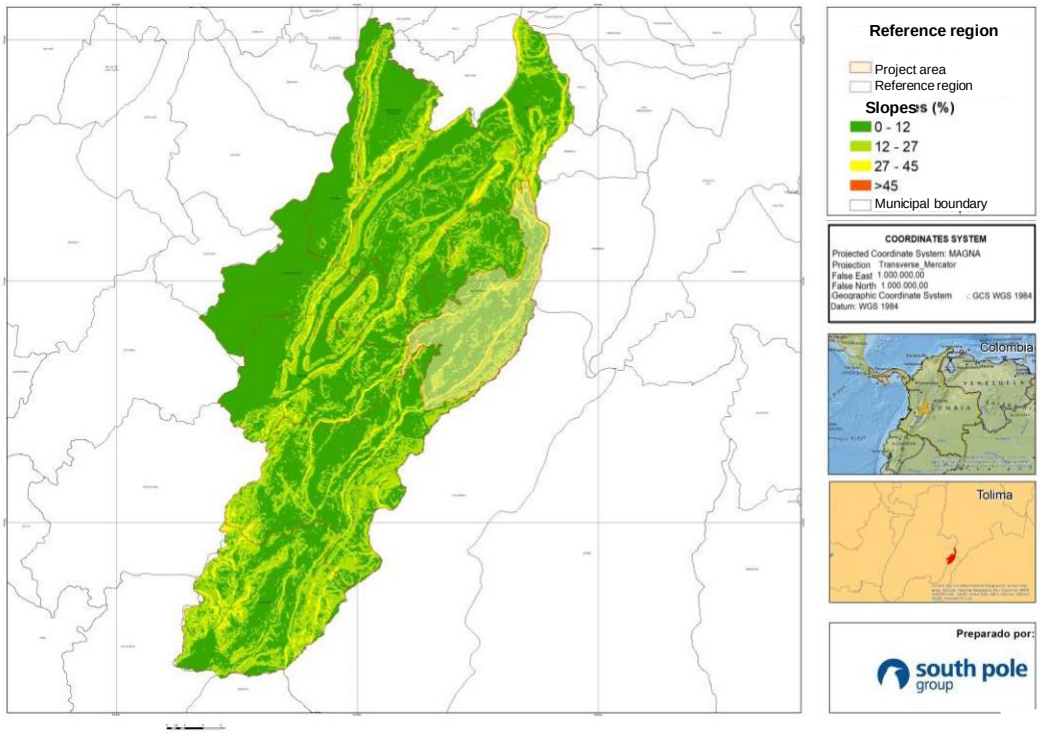



**Illustration 27. Map of slopes of the reference area.**

Socioeconomic causes

*Poverty*

In the reference area, on average, 26.4% of the population located in the municipal capital has unsatisfied basic needs (UBN), a condition that in rural areas reaches 45.3% of the population.[78] The municipalities with the highest population with UBN are Dolores, Cunday and Alpujarra (Table 20).

The inhabitants of the rural zone take advantage of the forest resources to satisfy their needs, and in turn extract products that can be marketed. It is for this reason that the level of poverty in an area influences deforestation, since to the extent that a population is not able to satisfy all its needs through its own resources, it must access the forest to extract a source of resources, either to market and obtain income or to finish supplying its needs.

**Table 20. Unsatisfied Basic Needs (UBN) in the reference area.**

| Municipality | Municipal capita | Rest of the area |
|---|---|---|
| **Alpujarra** | 28,8 | 44,9 |
| **Carmen de Apicalá** | 25,0 | 39,7 |
| **Cunday** | 25,6 | 46,0 |
| **Dolores** | 34,2 | 59,9 |
| **Icononzo** | 20,4 | 41,6 |
| **Purificación** | 25,8 | 43,3 |
| **Villarrica** | 25,3 | 41,6 |

[78] See Supports/Deforestation Threats/Bulletin Census 2005

*Financing of agricultural activities*

Credit to the agricultural sector and the lack of real incentives for forest management are a factor that indirectly favored deforestation. The existence of low-interest loans and other incentives for the agricultural sector, in contrast to the absence of incentives for conservation, favored the advance of the agricultural frontier. Between 2004 and 2010 FINAGRO granted loans to the agricultural sector to large, medium, and small producers (Illustration 30).

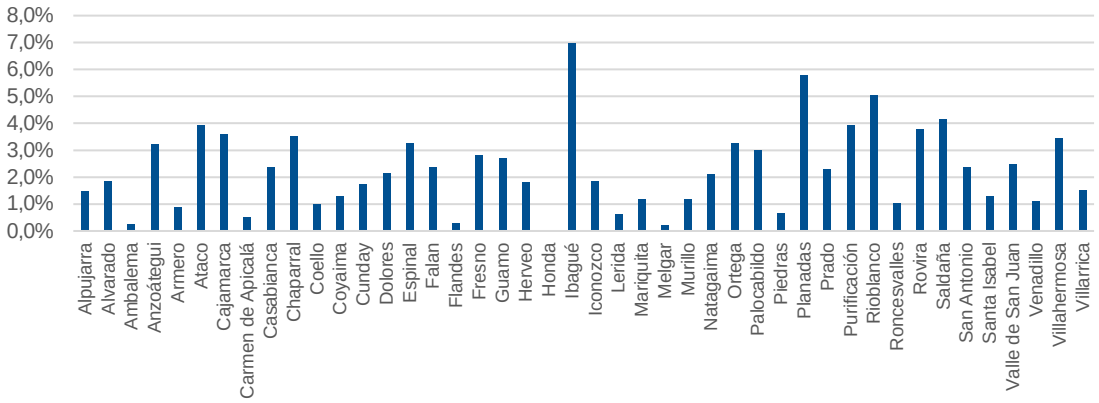



**Illustration 28. Agricultural loans granted between 2004 and 2010**

*Land tenure*

In the reference area, the majority or at least approximately 50% of the total land in the rural area are smallholdings with an area of less than 5 ha (Table 21) and the land with an area greater than 100 ha reaches 2% or less of its area[79]. This situation generates pressure on the forest, because a large part of the population finds the need to expand their productive areas to increase their income and achieve the expected production.[80].

**Table 21. Percentage of smallholdings by municipality [81].**

| Municipality | Properties with area > 100 ha (%) | Properties with an area between 5 and 100 hectares (%) | Properties with area < 5 ha (%) |
|---|---|---|---|
| Cunday | 2 | 54, | 44 |
| Dolores | 2 | 44 | 54 |
| Icononzo | 0 | 25 | 75 |
| Prado | 2 | 41 | 57 |
| Purificación | 1 | 22 | 77 |
| Villarrica | 0 | 62 | 38 |

**Analysis of the chain of events leading to deforestation**

Based on the historical information evaluated, the relationships between the agents, factors and underlying causes of deforestation were analyzed to explain the sequence of events that have led and will lead to deforestation (Illustration 31).

[79] CORTOLIMA (2009). POMCA Hydrographic Basin of the Prado River. Available at: https://www.cortolima.gov.co/contenido/fase-ii-diagnostico-r%C3%ADo-prado
[80] CORTOLIMA (2009). POMCA Hydrographic Basin of the Prado River.
[81] CORTOLIMA (2009).

Deforestation in the reference area is related to socioeconomic factors, and its location depends on geographic and economic variables. In areas where the soil vocation is forestry, farmers cut down the forest to develop agricultural activities or as a method of informal land appropriation, and then commercialize or use the products they extract from the forest locally.

Therefore, the main causes that have led to deforestation in the area are the expansion of the agricultural frontier and the cutting of trees for different purposes, with cattle raisers, farmers and the local population being the agents that make decisions on land use.

The population of the reference area has unsatisfied basic needs, which represents a situation of poverty. The sources of income are derived from the economic activities carried out on their land, which in many cases is less than 5 ha, which is why if they want to increase their income, they must look for additional areas for production. Both cattle raisers and farmers do not have technical assistance that would allow them to develop cleaner production systems, and the soil characteristics do not favor them because they are poor and stony. In addition, there is the road network in the municipalities that make up the reference area and future projects to open roads to facilitate access to the forests.

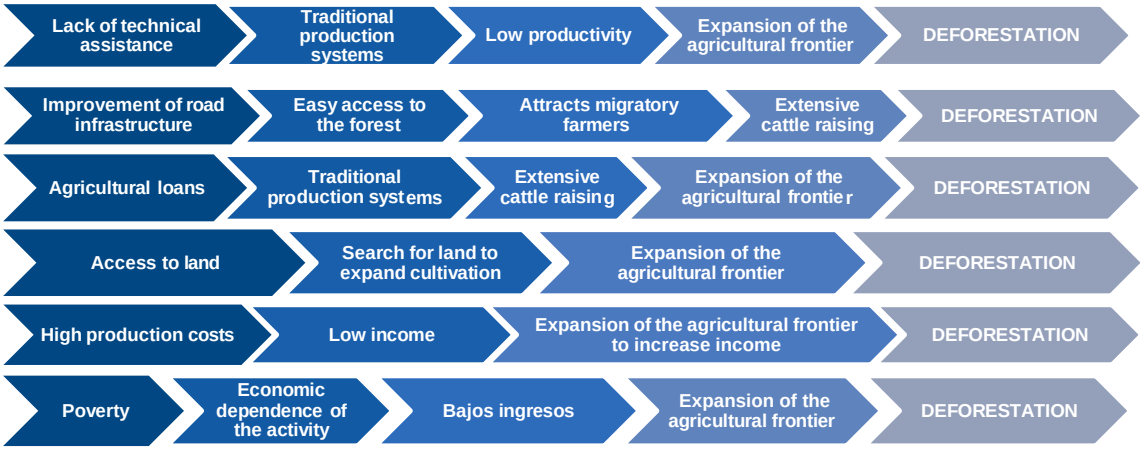



**Illustration 29. Chain of events leading to deforestation in the reference area.**

### 3.4.2 Carbon reservoirs

Section 5.5.2.3 of *NTC 6802* and 6.2.3 of the " *Protocol Certification of Offset Programs ES-I-CC-002*" establish that the reservoirs to be included as a minimum are aboveground biomass and belowground biomass. As a conservative approximation, other carbon reservoirs were not considered for the calculation of removals. The calculation of the value per hectare for each of the reservoirs is described below.

**Carbon in aboveground biomass**

The value of carbon in the aboveground biomass of the current project area was defined according to Yepes (2011)[82], which is presented according to the Holdridge life zone. Considering that the

[82] Yepes, A., Navarrete D.A., Phillips J.F., Duque, A.J., Cabrera, E., Galindo, G., Vargas, D., García, M.C y Ordoñez, M.F. 2011. Estimation of carbon dioxide emissions generated by deforestation during the period 2005-2010. Institute of Hydrology, Meteorology, and Environmental Studies-IDEAM-. Bogotá D.C., Colombia. 32 pp.

current project area has four life zones (section 2.2), to have a value of carbon in aboveground biomass [83] per hectare for the entire project, a weighted average of carbon was made according to the area of the program in each life zone (Table 22), resulting in 132.7 tons of carbon per hectare, equivalent to 486.4 $tCO2e\ ha^{-1}$.

**Table 22. Weighted carbon stored in the program**

| Life zone | Area (ha) | Stored carbon (t/ha) | Carbon by region |
|---|---|---|---|
| Low montane rain forest | 11536 | 147.5 | 1701516 |
| Pre-montane rainforest | 1111 | 57.0 | 63325 |
| Pre-montane very humid forest | 0.03 | 91.5 | 2 |
| Very humid montane forest | 1244 | 62.7 | 78012 |
| Carbon weighted average value (t/ha) | | | **132.7** |

**Carbon in belowground biomass**

The value of belowground biomass was estimated based on Table 4.4 of the IPCC National GHG Inventory Guidelines,[84] which establishes the relationship between aboveground and belowground biomass. The aboveground/underground biomass ratio for the "Tropical Rainforest" ecological zone is 0.37. Therefore, the carbon present in the belowground biomass in the program area is 180.0 $tCO2e\ ha^{-1}$.

**Total carbon**

The total carbon stored by the forests in the project area corresponds to the sum of above and below ground carbon, which is equivalent to 666,43 $tCO_2e$/ha.

### 3.4.3 Calculation of removals

**Deforestation projection**

The deforestation projection was calculated based on a linear estimate of forest loss from the multiplication of the deforestation rate described in section 3.4.1.2 and the current project area in 2010 (Table 23).

**Table 23. Deforestation projection for the period 2010-2039 considering historical deforestation for the period 2000-2010.**

| Year | Area deforested annually | Remaining area |
|---|---|---|
| 2010 | 365,1 | 12.336,2 |
| 2011 | 365,1 | 11.971,2 |
| 2012 | 365,1 | 11.606,1 |
| 2013 | 365,1 | 11.241,1 |
| 2014 | 365,1 | 10.876,0 |
| 2015 | 365,1 | 10.511,0 |
| 2016 | 365,1 | 10.145,9 |
| 2017 | 365,1 | 9.780,9 |
| 2018 | 365,1 | 9.415,8 |

[83] Taken from 0.
[84] IPCC Guidelines for National Greenhouse Gas Inventories Vol 4 - AFOLU - Chapter 4 Forest Land"

| Year | Area deforested annually | Remaining area |
|---|---|---|
| 2019 | 365,1 | 9.050,8 |
| 2020 | 365,1 | 8.685,7 |
| 2021 | 365,1 | 8.320,6 |
| 2022 | 365,1 | 7.955,6 |
| 2023 | 365,1 | 7.590,5 |
| 2024 | 365,1 | 7.225,5 |
| 2025 | 365,1 | 6.860,4 |
| 2026 | 365,1 | 6.495,4 |
| 2027 | 365,1 | 6.130,3 |
| 2028 | 365,1 | 5.765,3 |
| 2029 | 365,1 | 5.400,2 |
| 2030 | 365,1 | 5.035,2 |
| 2031 | 365,1 | 4.670,1 |
| 2032 | 365,1 | 4.305,0 |
| 2033 | 365,1 | 3.940,0 |
| 2034 | 365,1 | 3.574,9 |
| 2035 | 365,1 | 3.209,9 |
| 2036 | 365,1 | 2.844,8 |
| 2037 | 365,1 | 2.479,8 |
| 2038 | 365,1 | 2.114,7 |
| 2039 | 365,1 | 1.749,7 |
| 2040 | 365,1 | 1.384,6 |

**Carbon in the final land use after deforestation:**

The estimation of carbon content in the land use classes of the deforested areas was estimated considering the results of the land use change matrix (Table 15), the carbon values in the aboveground biomass of the non-forest classes specified in Table 6 of NTC 6208 and the aboveground biomass/underground biomass ratio according to IPCC (2006)[85]. As with aboveground forest carbon, a weighted average of aboveground and belowground carbon in relation to the percentage of deforested area in each non-forest category was performed (Table 25).

[85]Intergovernmental Panel on Climate Change (IPCC). 2006. Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use. Chapter 6. Table 6.1.

Table 24. Weighted average carbon.

| Final coverage | Area of final forest cover to post deforestation categories (%) | t C aboveground /ha | t C underground /ha[86] |
|---|---|---|---|
| Secondary vegetation | 0,22 | 19,60 | 8,23 |
| Permanent crops | 0,13 | 28,90 | 17,34 |
| Pastures | 0,31 | 6,40 | 3,84 |
| Heterogeneous agricultural areas | 0,32 | 5,80 | 3,48 |
| Settlements | 0,00 | 0,00 | 0,00 |
| Other lands | 0,01 | 0,00 | 0,00 |
| Wetlands | 0,00 | 0,00 | 0,00 |
| | **Weighted average** | **11,94** | **6,40** |

**Removals when avoiding land use change**

The value of carbon in the final land use is 18.34 tC/ha, which is equivalent to 67.24 tCO2e/ha. The final value of removals per hectare from forest to non-forest is 599.17 tCO2e/ha, which is the result of subtracting the carbon present in the deforested areas from the carbon stored by the forests (section 3.4.2).

To estimate emission removals in the current project area, the avoided carbon content per change of use was multiplied by the area to be deforested annually presented in Table 23. The expected removals from avoided deforestation in the program area include the discount of a 15% non-permanence reserve in accordance with the requirements of section 7.1 of the ES-I-CC-002 protocol[87]. Table 25 presents the removals per year and cumulative removals in accordance with the requirements of Section 5.5.2.4.3.

Table 25. Estimated ex-ante emission reductions

| Year | Annual GHG emissions reduction (tons of CO2e) | Cumulative GHG emissions reduction (tons of CO2e) |
|---|---|---|
| 2010 | 142.209 | 142.209 |
| 2011 | 147.066 | 289.275 |
| 2012 | 151.923 | 441.198 |
| 2013 | 156.780 | 597.978 |
| 2014 | 161.636 | 759.614 |
| 2015 | 166.493 | 926.107 |
| 2016 | 171.350 | 1.097.457 |
| 2017 | 176.207 | 1.273.664 |

[86] The aboveground/ground biomass ratio for secondary vegetation was consulted in: Intergovernmental Panel on Climate Change (IPCC). 2006. Chapter 3: LUCF Sector Good Practice Guidance.
The aboveground/ground biomass ratio for pastures is 0.6 according to: Intergovernmental Panel on Climate Change (IPCC). 2006. Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use. Chapter 6.
As a conservative approximation, the same relationship was used for crops and heterogeneous agricultural areas since according to IPCC the changes in belowground biomass from forest to non-forest are not significant. Source: Intergovernmental Panel on Climate Change (IPCC). 2006. Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use. Chapter 5.

[87] Detailed step-by-step estimates can be found in [Supports/Information management/Allocation estimates/180227_Ex-ante_estimates].

| Year | Annual GHG emissions reduction (tons of CO2e) | Cumulative GHG emissions reduction (tons of CO2e) |
|---|---|---|
| 2018 | 181.063 | 1.454.727 |
| 2019 | 185.920 | 1.640.647 |
| 2020 | 185.920 | 1.826.567 |
| 2021 | 185.920 | 2.012.487 |
| 2022 | 185.920 | 2.198.407 |
| 2023 | 185.920 | 2.384.327 |
| 2024 | 185.920 | 2.570.247 |
| 2025 | 185.920 | 2.756.167 |
| 2026 | 185.920 | 2.942.087 |
| 2027 | 185.920 | 3.128.007 |
| 2028 | 185.920 | 3.313.927 |
| 2029 | 185.920 | 3.499.847 |
| 2030 | 185.920 | 3.685.767 |
| 2031 | 185.920 | 3.871.687 |
| 2032 | 185.920 | 4.057.607 |
| 2033 | 185.920 | 4.243.527 |
| 2034 | 185.920 | 4.429.447 |
| 2035 | 185.920 | 4.615.367 |
| 2036 | 185.920 | 4.801.287 |
| 2037 | 185.920 | 4.987.207 |
| 2038 | 185.920 | 5.173.127 |
| 2039 | 185.920 | 5.359.047 |

## 3.5 Protocol for monitoring removals

### 3.5.1 Change in coverage for the monitoring period

The monitoring process to obtain the certification of the reduction of emissions generated by the activities of the program is based on the methodological proposal "*Protocol for Digital Image Processing for the Quantification of Deforestation in Colombia at National Level*"."[88] The methodological proposal is oriented to the direct detection of changes, in which satellite images from the two monitoring dates are processed and compared simultaneously, identifying changes in the spectral response that may correspond to a loss or gain of forest cover.

**Methodological process**

The methodology is based on the elaboration and analysis of the change in cover using as input the forest-non-forest layers for the years analyzed. The information from remote sensors (Optical-Radar) is processed based on the "Protocol for Digital Image Processing for the Quantification of Deforestation in Colombia at the National Level", proposed by IDEAM.

[88] Work funded by the Fundación Gordon y Betty Moore, project "Consolidation of a Forest and Carbon Monitoring System (SMBYC), as support for environmental policy and management in Colombia. Institute of Hydrology, Meteorology and Environmental Studies (IDEAM), Ministry of Environment and Sustainable Development (MADS).

Protocol that proposes a methodology oriented to the direct detection of changes in forest cover, in which satellite images from the two monitoring dates are processed and compared simultaneously, identifying changes in the spectral response that may correspond to a loss or gain of forest cover.

The protocol also presents the minimum steps to be followed to detect changes in forest area that occurred between two dates and integrates traditional and semi-automated preprocessing and processing tools that reduce random errors caused by inattention and lack of experience of the interpreter and facilitate continuous improvement of the results in a standardized manner (Galindo, Espejo, Rubiano, Vergara, & Cabrera, 2014).

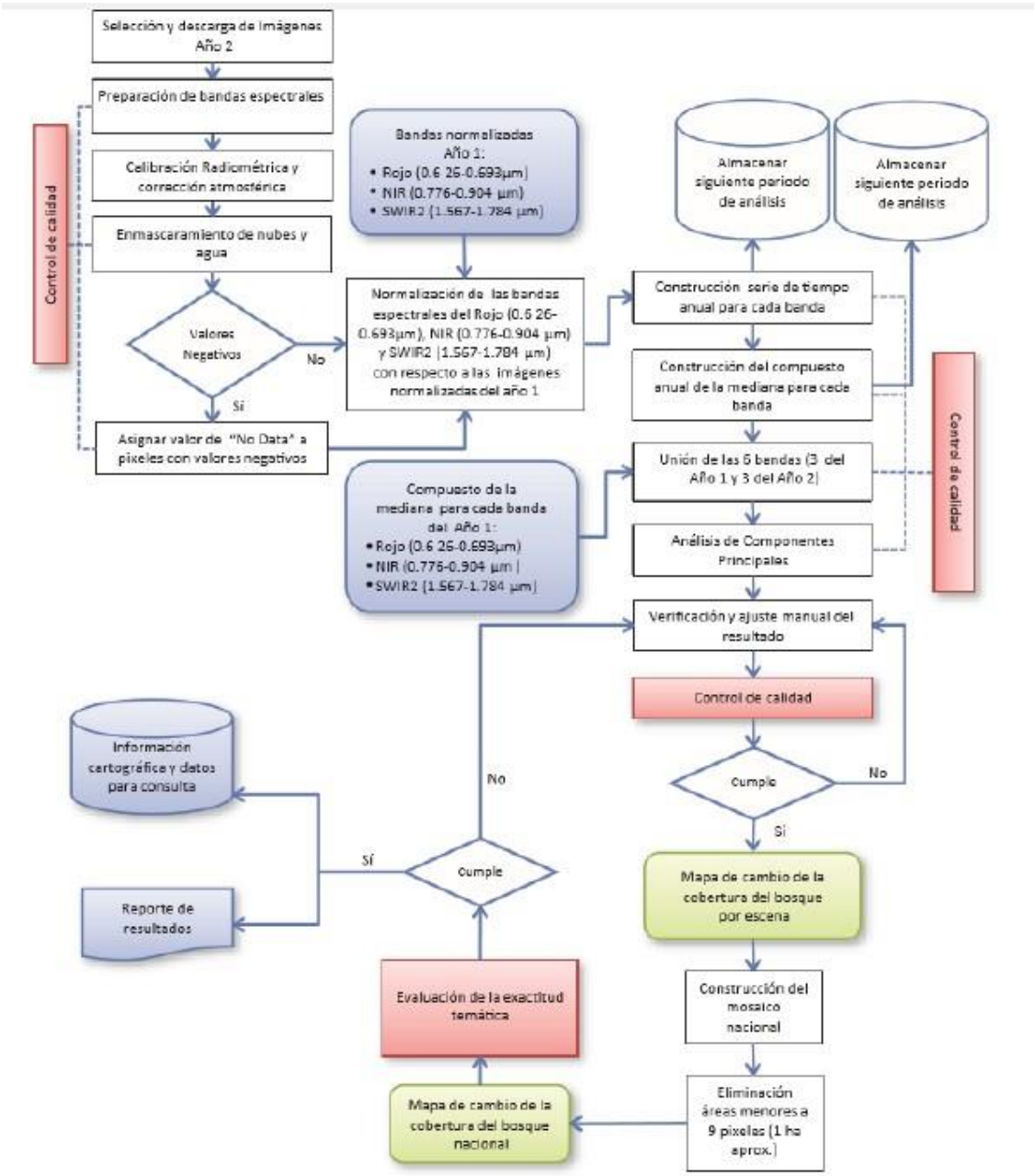



**Illustration 30. Methodological steps for the detection of changes in forest coverage**

A description of the methodological steps is given below:

#### 3.5.1.1 *Image selection and download*

Search and selection of free Landsat images from the *Earth Resources Observation* and *Science Center (EROS)* of the United States *Geological Survey (USGS)*, downloading as many images as possible with cloud-free information available for the generation of each year's composite.

The methodology in the protocol is not for exclusive use of Landsat images, being possible the use of data from other sensors that meet the spatial and temporal resolution appropriate for the scale and application thereof. Most of the methodological steps of the protocol can and should be applied to any type of images from remote sensors (Galindo et al., 2014).

#### 3.5.1.2 *Pre-processing*

The preprocessing tasks indicated are used for the first and last year of the period in which the change is identified. Each of the steps to be followed is described below:

- *Band stacking or compilation:* Once the images have been downloaded, the bands of each image are compiled or joined in order, discarding those that correspond to the thermal infrared wavelength, in the case of Landsat 8 OLI, and the Aerosols and Cirrus layers.
- *Geometric correction*: For the construction of the time series of images and composites it is essential to have an exact pixel-level co-registration between all the images obtained for each Landsat scene. Landsat products supplied by EROS usually have an exact pixel correspondence; however, it is recommended to make a visual review of each image and adjust those that do not meet this condition. The geographic reference system WGS84 UTM Zone 18N of the images is maintained throughout the process, in order to avoid the loss of co-registration between pixels when applying the geometric adjustments of the cartographic reprojection models (Galindo et al., 2014)[89].
- *Data conversion process to reflectance surface:* Landsat image pixel values are in units of digital levels and must be transformed into units of reflected energy, which is known as radiometric calibration (Asner, Tasar, Sousan, & Knapp, 2013)[90]. Also, because radiometric data contain information from both the land surface and the atmosphere, a correction that minimizes atmospheric effects on the values of each pixel must be applied, obtaining a reflectance surface image. This surface has a greater consistency in the radiometric responses within and between images, allowing the application of standard processes and models for all scenes and dates analyzed.
  There are different algorithms and models that can be used for radiometric calibration and atmospheric correction, one of the most used models that is included in several processing tools is the S6 Radiative Transfer model. This model was used in the protocol tests with good results.
- *Masking of water and clouds:* The masking of areas of shadows, clouds, haze, and banding of the reflectance surface images was performed, so that each scene was left with only the pixels containing coverage information.
- *Radiometric normalization process:* Radiometric normalization applied to multitemporal time series images is necessary, since the spectral responses for the same cover, such as forests, vary between different dates, limiting the effectiveness in the classification or detection of changes due to deforestation.

[89] Galindo, G., Espejo, O. ., Rubiano, J. ., Vergara, L. ., & Cabrera, E. (2014). Digital image processing protocol for deforestation quantification in Colombia.
[90] Asner, G., Tasar, E., Sousan, S., & Knapp, D. (2013). CLASlite Forest monitoring technology. Version 3.1 Use Guide.

The aim of normalization is to adjust the radiometric signals of the images used so that they are consistent with each other (Potapov et al., 2012)[91].

The normalization method is applied under the premise that the relationship between the irradiances recorded by the sensor on two different dates is spatially homogeneous and can be approximated by linear functions (Tarantino, n.d.)[92]. The normalization is performed seeking to decrease the variability due to atmospheric differences, illumination, geometric distortions, sensor calibration, in order to make the images comparable and avoid that the detected changes are not due to these types of factors (Olthof, Pouliot, Fernandes, & Latifovic, 2005; Potapov et al., 2012)[93]. The images are fitted by programming codes and models, the mean and standard deviation, each band with the values of the respective band of the reference compound.

#### 3.5.1.3 *Composite image generation*

After performing the normalization process to each image, an annual time series is generated for each of the bands separately (Red, NIR, SWIR2), where all the available annual dates for each band are joined using a Layer Stack function.) The composites are generated for each band, starting from the median and obtaining a single value for each series. Finally, an annual composite is obtained for each of the bands containing the median value of the normalized reflectance values included in the time series.

#### 3.5.1.4 *Detection of changes due to deforestation*

For the detection of changes due to deforestation, a direct detection method such as Principal Component Analysis (PCA) is used, with correlation matrices to the merged data of the two dates of comparison; generally, the components greater than three are the ones that present the changes of interest.

In the result obtained from the components, the range of values or thresholds that will be considered as a change due to deforestation or forest regeneration must be selected. The ranges depend on the selected method, the type of change that occurred (deforestation to cultivation, pasture, etc.), and the present cover of the area under study, so it is not possible to generalize a single value or range for all areas. The selection of the threshold is made visually by comparing the results obtained with the reflectance surface images.

The threshold is reclassified to class or category values as follows: i) Stable Forest, ii) Deforestation, iii) No Information, iv) Regeneration and v) Not Stable Forest.

#### 3.5.1.5 *Visual verification of detected changes by the interpreter*

The verification with the preliminary change map is performed by contrasting the resulting map with the reflectance surface images of the required years. If errors are found, they are reclassified to the corresponding class.

### 3.5.2 Removal calculation

The estimation of emission reductions for the monitoring period is carried out as presented in section 3.4.3.

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[91] Potapov, P. V., Turubanova, S. A., Hansen, M. C., Adusei, B., Broich, M., Altstatt, A., … Justice, C. O. (2012). Quantifying forest cover loss in Democratic Republic of the Congo, 2000–2010, with Landsat ETM + data. Remote Sensing of Environment, 122, 106–116. https://doi.org/10.1016/J.RSE.2011.08.027

[92] Tarantino, E. (n.d.). Radiometric Normalization of Landsat Etm+ data for Multitemporal Analysis. IAPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Retrieved from http://www.academia.edu/3034346/Radiometric_Normalization_of_Landsat_Etm_data_for_Multitemporal_Analysis

[93] Olthof, I., Pouliot, D., Fernandes, R., & Latifovic, R. (2005). Landsat-7 ETM+ radiometric normalization comparison for northern mapping applications. Remote Sensing of Environment, 95(3), 388–398. https://doi.org/10.1016/J.RSE.2004.06.024

# 4 Monitoring

## 4.1 Project Activities[94]

**Research**

- Field practices of the Universidad del Tolima in the current project area.
- Study of community conservation strategies as a contribution to the sustainable environmental development of the Galilea Forest, in the east of the department of Tolima (2016)[95].
- Development of the bird book. The Fundación Amé will publish the bird book. Currently the authors are taking photographs of the endemic species in the project area to include them in Unit VII of the book.
- Support to CORTOLIMA in the studies of flora and fauna in the area.
- Attendance to meetings with CORTOLIMA and the community in general for the search of conservation strategies.

**Donation program:**

The Universidad del Tolima has received the lots presented in Table 3.

**Creation of Fundación Amé:**

- The creation of the Fundación Amé replaces the role of ASOPROBOSQUES as administrator of the forests that do not belong to the Universidad del Tolima. The objective of the creation of the Foundation is to provide on-site support to the university to implement the conservation strategies complementary to the research that has been planned since the beginning of the project.
- Service contract with STRATIK, a company specialized in media production and marketing for the definition of the Foundation's corporate image. The result of this contract was the creation of the Institutional logo, symbol logo, web page, institutional video and thematic videos referring to the importance of the Forest.
- Socialization meeting with the community and the Universidad del Tolima at an informative level for the taking of field images and testimonial actions of community leaders.

**Communication with different stakeholders**

Attendance at workshops and different activities with stakeholders involved in conservation activities:

1. Workshop with members of the Community Action Board of the Galilea rural district, to define concrete actions and joint work activities.
2. Attendance and participation in a meeting called by the Community Action Board of the Galilea rural district and the Fundación Reiniciar to learn about the plans of the Fundación Reiniciar and the Mesa Ambiental del Oriente of the department and identify synergies with these institutions.
3. Inter-institutional work meeting in the Alto de Torres village, convened by the Regional Autonomous Corporation of Tolima - CORTOLIMA to review the management commitments determined by the POMCA of the Río Prado and EOT of the municipality of Villarrica.
4. Creation of a permanent working group to define the route of activities for the Galilea forests. This table is made up of members of CORTOLIMA, the Universidad del Tolima

[94] See [Information Management/Monitoring/ Tracking1/ Activities].
[95] See [Supports/Biodiversity/Fields 2008].

and the Fundación Amé as a representative of the forest owners. So far, the foundation and the Universidad del Tolima have attended three working groups.

5. Meeting with the City Hall of Villarica and Dolores to present the compensation program.

**Investment in studies**

- Support with resources to the University of Tolima for research studies to strengthen the conservation project.
- Studies for the implementation of the GHG removal project.
- Studies of potential activities to be carried out in the current project area.
- Initiation of a tenure study in the expansion area of the project for the inclusion of new landowners to the program.
- Investment study for a beekeeping project.

**Beekeeping**

- Training of two community members in honey production.
- Hiring of a permanent employee for the implementation of the first stage of the project through the establishment of 30 beehives.
- Beginning of honey commercialization.

**Drone coverage monitoring**

- Test drone monitoring activity in the current project area. Photography and quotation for equipment purchase and training.

## 4.2 Quantification of removals first follow-up audit

The quantification of the reduction in removals was carried out considering the steps described in section 3.4.3.

### 4.2.1 Monitoring of forest change for the period 2010-2017

Actual changes in forest cover for the program area for the period 2010-2017 were made according to the methodology described in section 3.5

**Image selection and downloading**

The main problem for the selection of optical images of the area under study is related to weather conditions, since there is a high cloud cover, which makes it difficult to obtain sufficient information with optical images, as shown in Illustration 33. For this reason, the support of Radar images from the SAR sensor was required for the preparation of the maps.

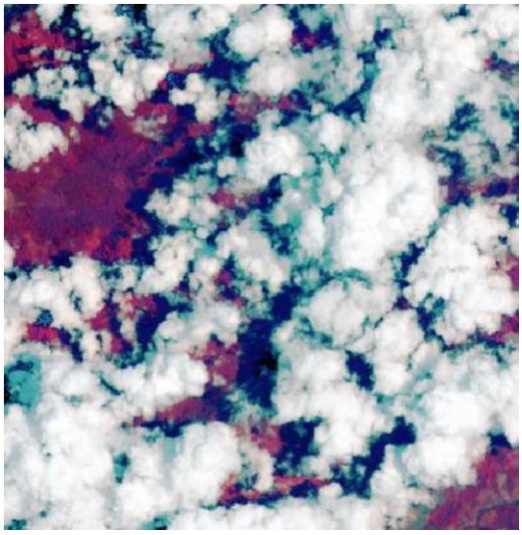

**Illustration 31. 2010 Landsat image with high cloud cover in the study area**

Free radar images acquired for the year 2017 were used. These images present double polarization (VV and VH) and a spatial resolution of 10 m, which allowed obtaining more information and detail on vegetation covers in the program area with respect to Landsat optical images. The information from radar images is complementary to the optical images, since new and important information is obtained to improve the quality of the maps obtained and eliminate the information gaps generated by the high cloud cover in the images.

**Composite image preprocessing and generation**

The step-by-step procedure described in sections 3.5.1.2 - 3.5.1.5 was followed to identify the change in the period 2010-2017 and to obtain an annual composite of the bands for the generation of the forest cover maps for the study area (Illustration 34). The results of combining the Landsat images with radar indicate that of the 617 ha that were categorized in Table 10 as no information, 613 corresponded to forest cover and the remaining to non-forest cover (Table

26).

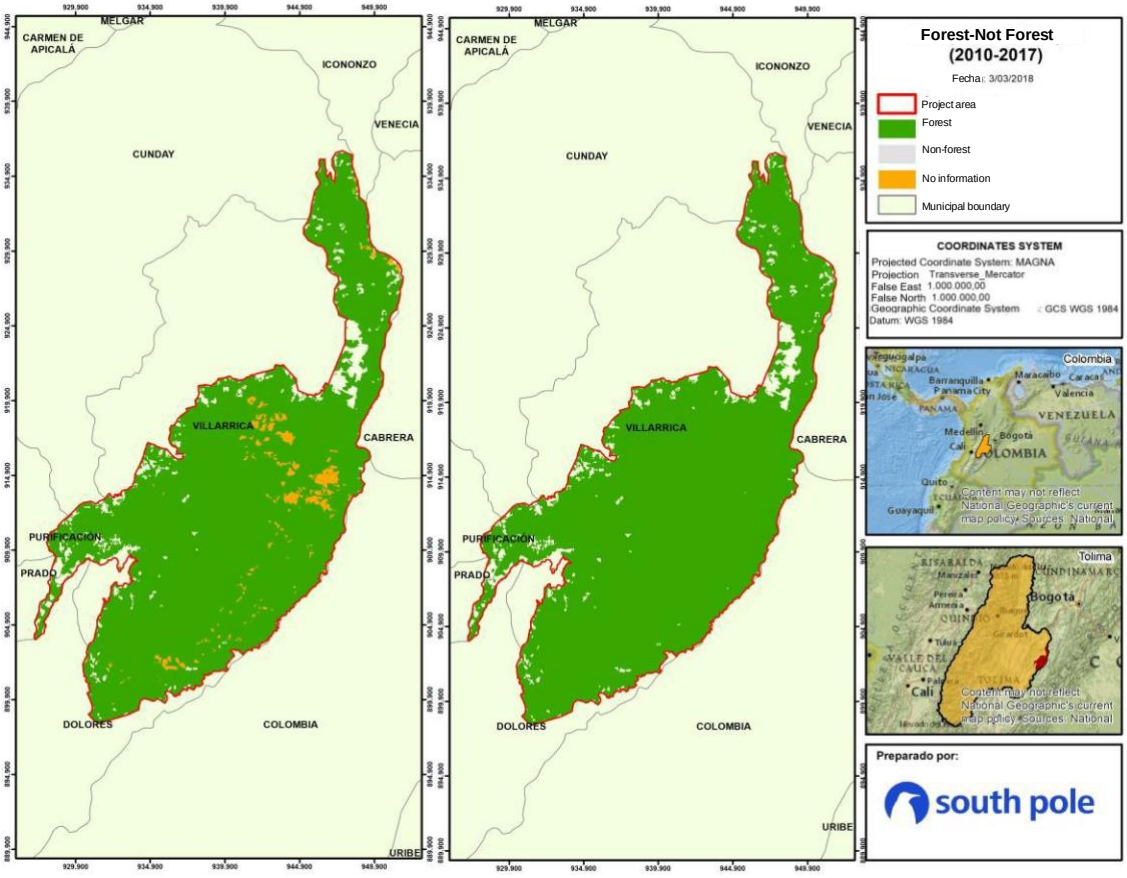


**Illustration 32. Forest-Non-forest layer for the years 2010 (left) and 2017 (right)**

**Table 26. Coverage in the current project area for the period 2010-2017**

| Eligibility 2010 | Monitoring 2017 | Area |
|---|---|---|
| Not Eligible | No forest | 2006 |
| Eligible | Deforestation | 114 |
| Eligible | Forest | 12587 |
| No Information | No forest | 4 |
| No Information | Forest | 613 |

To determine the change in forest cover in the current project area, the layers of forest change for the project expansion area were intersected with the current project area (Illustration 33). The total area deforested in the period 2010-2017 is 114 ha, which corresponds to an annual loss of 16.4 ha.

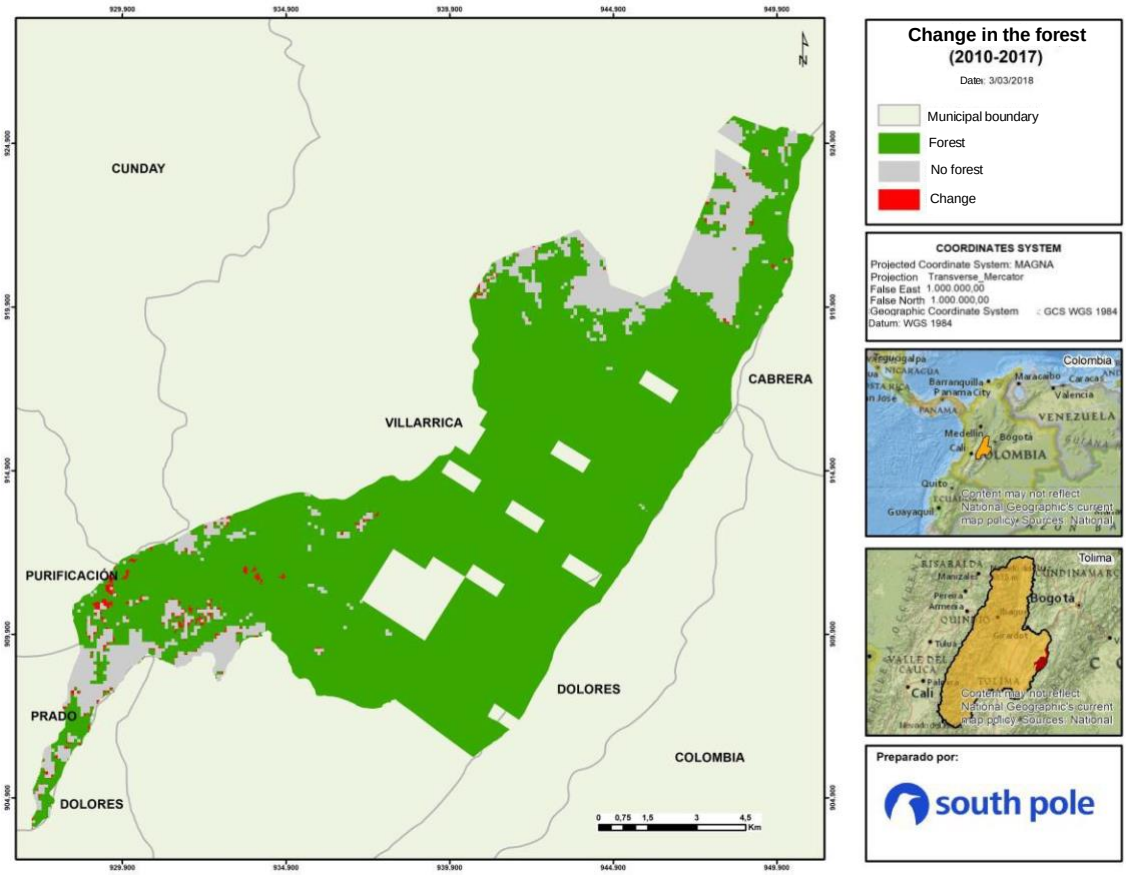


**Illustration 33. Forest change for the 2010 - 2017 period**

### 4.2.2 Calculation of removals

The estimation of emissions removals by the program due to avoided deforestation was performed as presented in section **¡Error! No se encuentra el origen de la referencia.**, changing the deforested area by the monitored value (16.4 ha/year). Table 27 presents the results of removals according to the results of the cover monitoring for the years 2010-2017, discounting a reserve of 15% of the non-permanence bonuses according to the requirements of section 7.1 of protocol ES-I-CC-002[96].

**Table 27. Estimated removals due to avoided deforestation in the period 2010 - 2017.**

| Year | Annual GHG emissions reduction (tons of CO2e) | Cumulative GHG emissions reduction (tons of CO2e) |
|---|---|---|
| 2010 | 142.693 | 142.693 |
| 2011 | 147.566 | 290.259 |
| 2012 | 152.439 | 442.698 |
| 2013 | 157.312 | 600.010 |
| 2014 | 162.186 | 762.196 |
| 2015 | 167.059 | 929.255 |

[96] Detailed step-by-step estimates can be found in Supports/ Information Management/ Estimates Granting\180227_ Monitoring_ Estimates]

| Year | Annual GHG emissions reduction (tons of CO2e) | Cumulative GHG emissions reduction (tons of CO2e) |
|---|---|---|
| 2016 | 171.932 | 1.101.187 |
| 2017 | 176.805 | 1.277.992 |

# 5 Management of legal requirements

The development of this program is framed under compliance with environmental legislation in Colombia. The main laws and decrees that regulate the issue of environmental conservation in Colombia are presented in Table 28. So far, the activities carried out in the current program area during the period 2010-2017 comply with the legal requirements for environmental conservation activities.

The development of productive activities will include consultation of the environmental legislation that must be complied with and in each follow-up audit a report will be presented on the identification of said requirements and compliance with them, such as: (i) labor conditions for temporary workers; (ii) butterfly collection license to conduct research base for the development of the butterfly farm; (iii) licenses that must be processed to technify honey extraction in the project area; (iv) licenses required to conduct ecotourism in the project area including domestic use for the construction of infrastructure and identification of the carrying capacity of the ecotourism project and (v) any other requirements defined by CORTOLIMA for the program area.

**Table 28. Colombian environmental regulations related to forest and biodiversity conservation**

| Regulation | Date | Description | Program Compliance |
|---|---|---|---|
| Decree 2811 | 1974 | Whereby the National Code of Natural Resources is created. Book II, Part VIII, regulates forests, forest reserve areas, forest harvesting and reforestation. It also defines measures for the protection, conservation, and use of forests. | Currently, the area is not under a protection category.<br>In the 2010-2017 period, no forest harvesting was carried out. Instead, activities were focused on research and conservation of the forest. |
| Decree 622 | 1977 | The areas with exceptional values established in the National Code of Natural Resources are called "System of National Natural Parks" and everything related to these areas is regulated. | Currently, the area is not under a protection category of the National Natural Park System. |
| Political Constitution | 1991 | About 80 articles related to sustainable environmental management were included. | In the 2010-2017 period, no forest harvesting was carried out. Instead, activities were focused on forest conservation research. |
| Law 99 | 1993 | The Ministry of the Environment, the National System of Protected Areas (SINAP by its Spanish acronym), among others, are created. It establishes a new forest harvesting regime, expands and creates new protected areas, and creates a special administrative unit of the National Natural Parks System. | Currently, the area is not under a SINAP protection category.<br><br>In the 2010-2017 period, no forest harvesting was carried out. Instead, activities were focused on research and conservation of the forest. |

| Regulation | Date | Description | Program Compliance |
|---|---|---|---|
| Conpes No. 2834 | 1996 | Approving the "Forestry Policy", which seeks to achieve the sustainable use of forests, to conserve them, consolidate the incorporation of the forestry sector in the national economy and contribute to the improvement of the quality of life of the population. | In the 2010-2017 period, no forest harvesting was carried out. Instead, the activities were focused on forest conservation research. When productive activities that require logging permits are developed, these will be processed with the responsible entities and an update of this table will be presented at each follow-up audit. |
| Decree 900 | 1997 | Whereby the Forest Incentive Certificate for Conservation is regulated. | This certificate is not currently in effect. In the event that it is approved in the future, ICONTEC will be consulted to see if it is possible for the areas to apply for any additional benefits in relation to carbon bonds. |
| Law 165 | 1994 | Approving the convention on biological diversity and recognizing the ecological, social, genetic, educational, and cultural values of biological diversity. | The activities of the 2010-2017 period focused on forest research and conservation, which is in line with the provisions of Law 165 of 1994. |
| Conpes No. 3582 | 2009 | It considers biodiversity as a strategic area and recognizes the need to advance in the knowledge and sustainable use of biodiversity. | The activities of the 2010-2017 period focused on forest research and conservation, which is in line with the provisions of Conpes No. 3582 of 2009. |
| Decree 1076 | 2015 | Sole regulatory decree of the environment and sustainable development sector. It gathers all the environmental regulations in Colombia. | Due to the reasons stated above, the program activities developed during the period 2010-2017 comply with the provisions of Decree 1076 of 2015. |
| Conpes No. 3850 | 2015 | The Fondo Colombia en Paz is conceived as an instrument to contribute to materialize the economic, social, and environmental dividends of peace, associated with interventions in sustainable rural development, biodiversity conservation and the fight against climate change within a framework of strengthening the rule of law in the post-conflict period. | The program is not a beneficiary of the Fondo Colombia en Paz. However, the alignment of the program's activities with the activities carried out in the area by this fund will be sought. |
| Resolution 2028 | 2016 | Through which the Bosques de Paz National Program was created, whose objective is to create sustainable management models that seek to | The program is not a beneficiary of the National Forests of Peace Program. However, the alignment of the program's activities with the activities carried out in |

| Regulation | Date | Description | Program Compliance |
|---|---|---|---|
| | | integrate conservation for the benefit of communities settled in forested areas, strengthening their organization and environmental education, constituting them as guardians of peace and the environment. | the area by this program will be sought. |
| Decree 1655 | 2017 | Whereby the organization and operation of the National Forest Monitoring System, the National Forest Inventory and the Forest and Carbon Monitoring System, which are part of the Environmental Information System for Colombia, are established and other provisions are issued. | The program will be aware of the results of the Environmental Information System for Colombia to make changes to carbon values and the deforestation baseline if necessary. Prior to each follow-up audit, the portals of the different programs of the Environmental Information System will be consulted to make the necessary adjustments. |

# 6 Information management

## 6.1 Database

As established in the protocol, the organization responsible for the program must have a database that includes the information presented in Table 29.

**Table 29. Data management**

| Required information | Location in the database |
|---|---|
| Area with forestry activities. | Supports/ Information management/ Current program area |
| Geographical coordinates. | Supports/ Information management/ Land tenure/ Centroides_lotes |
| Vegetation cover at the beginning of forestry activities. | Support/ Information Management/ Initial Coverage |
| Information on tenure and land use rights. | Support/Information management/ Land tenure/Fundame_UT_agreement |
| Species | Not applicable - Conservation program |
| Provenance and production of plant material. | Not applicable - Conservation program |
| Objective of the forestry activity (e.g., conservation, recovery, production, etc.). | Conservation |
| Management cycle of the species and length of forestry activities. | Not applicable - Conservation program |
| Date of start of forestry activities. | Section 1.4 of the Program Document<br>Supports/ Information Management /Start Date |
| Silvicultural management. | Not applicable - Conservation program |
| Annual growth in biomass if periodic measurements are taken. | Not applicable - Monitoring will be without measurement of plots. |
| Parameters related to the conservation of biomass to carbon variation according to the selected methodology. | Not applicable - Conservation program |
| Results of the quantification of removals. | Supports/Information Management/Estimates Granting |
| Disturbance events (if any) | If submitted, they will be collected and stored in the following folder: Support/ Information Management. |
| Monitoring | Support/ Information management/ Monitoring |

In addition to the information presented in the previous Table, the organization will have within the database a folder called *Compensation_Report* to track the removals assigned or sold as compensation, to ensure that there is no double counting. In this folder a folder per year will be created to store each of the sales made.

For this, in the folder of the corresponding year, the file *"Compensations_Report"*[97] will be saved with the information of each sale made. The name of the file must contain the date of delivery, the name of the buyer and the number of vouchers assigned as follows: ddmmaa_comprador_bonos.

## 6.2 Information quality management and document control

All information in the database will be reviewed periodically to ensure compliance with the proposed goals and that the information is accurate. Likewise, if errors or omissions are found in the reviews, these will be dealt with by generating a report of the finding, after which a respective adjustment must be made, and the appropriate person must be notified. Having the documentary information database makes it possible to generate an adequate document control, including those corresponding to removals and compensation issued for such removals.

[97] The file that must be filled out is located in [Support/Information Management/ "Compensations sold"/ Compensation Report].

# 7 Disruptive events prior to reaching compensation

As specified in the ICONTEC protocol, in the event of an incident that prevents the achievement of the compensation already sold, the program will be responsible for informing the client of the situation and the actions that will be taken.

The following events have been identified as threats to the scope of the offset:

- Loss of forest cover due to natural events: the area is located in a territory with a low threat of natural fires; however, there is a risk of fires from anthropogenic sources, due to the slash-and-burn process carried out by some farmers to establish pastures or crops. In addition, the area has a medium and high risk of landslides and floods.[98]
- If the activities proposed by the program are not adequately developed in terms of the successful inclusion of the communities near the program area or the settlers living in the program area, it is possible that the deforestation control that took place in the 2010-2017 period will be reduced.

In the case of fires, meetings will be held with the community to make them aware of the risks of burning for land preparation and to identify an efficient communication system. Likewise, control and surveillance activities will be increased through the implementation of forest rangers. Regarding natural hazards, by maintaining forest cover, the risk of landslides in areas with steeper slopes is expected to be low. However, in the event of any of the described disturbances, the affected area will be estimated and the tCO2e emitted will be deducted from the total estimated amount.

For the period 2010-2017, no type of disturbance occurred.

[98] CORTOLIMA (2009). POMCA Hydrographic Basin of the Río Prado.