MORE FORESTS FOR MEDELLIN

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2 PROJECT DETAILS

2.1 Summary Description of the Project

The proposed Forestry *"More Forests for Medellin" ("Mas Bosques para Medellín")*, is based in the establishment of forest plantations, agroforestry systems, silvopastoral systems, assisted models for natural regeneration and forest enrichment in areas of stubble; taking into account socioeconomic and cultural traditions of population in the area of influence of the Project. The implementation of these types of projects under the Verified Carbon Standard (VCS) scheme, promotes the sustainable development to the Region, brings benefits to the communities and protects the existent natural resources. To do so, the Project looks forward to get international funds by mean of trading and selling of carbon credits under the VCS mechanism. The proposal Project was proposed in the year 2007 and started in year 2009 for the Municipality of Medellin and it was accepted by the Environmental Authorities: Metropolitan Area of Valle de Aburrá, and the Environment Secretary (Secretaría del Medio Ambiente, agreement 287 of 2007). Financing Institutions are: Municipality of Medellin through its Environment Secretary and the Metropolitan area of the Valle de Aburrá. In the course of its formulation and design, the Project took into account with the technical assistance of the next institutions: Corporación Autónoma Regional del río Negro – Nare (CORNARE), Corporación para el Manejo Sostenible MASBOSQUES and the Corporación Centro de investigación en Ecosistemas y Cambio Global – Carbono y Bosques (C&B). The jointed entities of the structural organization of the Project are described next:

Municipality of Medellin – Secretaría del Medio Ambiente, is developing an integrated management over the strategic ecosystems, watersheds (hydrographical basins) and urban areas of environmental importance. Some of the developed projects are formulation and implementation of micro-basins management plans; property acquisitions of micro-basins for water supply according to the Colombian Act 99 of 1993; the consolidation of urban and rural ecological nets; Agricultural technical assistance to the municipality farmers; development of scientific and technical knowledge around protected areas. This entity will finance the formulation, development and performance of the project in the first years.

In this order of ideas, the main objective of the Project is the achievement of economic benefits by the service of carbon capture by forestry to support the Global Warming mitigation, as a social and environmental and economic viable alternative aimed to the contribution of the sustainable development of the region. Additionally, the secondary objectives are: *1)*. Generate appropriated land use alternatives to the rural areas to promote the recovery of slopes, hills and strategic ecosystems of the Municipality of Medellin which are affected by urban pressure and inadequate land use; *2)*. Generate productive alternatives in the rural area to reduce the pressure of the forest relicts and contribute to the stability of Flow Rates in rivers, to the soil conservation and biodiversity, among others environmental benefits; *3)*. Encourage the establishment of forest systems through comprehensive mechanisms to contribute to the regional environmental sustainability. *4)*. Supply alternative funds to the rural communities of the Municipality.

The influence area of the Project is featured by being settled in the boundaries of the urban area of the city of Medellin and includes the natural landscapes (green areas) which belong to the tutelary hills located within the urban area. The hills and the rural green areas are of great interest to natural restoration and to conservation. At the same time, these actions will promote opportunities of development, and alternatives for economic activities to benefit the community. Rural areas also are of very important as areas for strategic ecosystems, as a result of the presence of hydrographical basins in the region, which are the main water suppliers to important streams that cross the city, and include relicts of natural forests which should be protected. The establishment of the project seeks alternatives for an adequate land use, in order to decrease: human pressure in the relicts of natural forest; develop of an adequate land use; and contribute with the balance of flow streams of rivers. The Project activities involve: reforestation with models of commercial forest plantation of commercial species; silvopastoral and agroforestry systems; forest restoration by Assisted Natural Reforestation (ANR); and the establishment of a Forest Enrichment (FE). Commercial species taken into account are: *Pinus patula* Schltdl. & Cham.*, Pinus tecunumanii* Eguiluz & J.P. Perry.*, Eucalyptus grandis* W. Hill ex Maiden., and *Cordia alliodora* (Ruiz & Pav. Cham.= Species from the same features of nearby natural forest fragments that will be used for the ANR are: (*e.g*. *Croton magdalenensis* Müll. Arg.*, Clethra fagifolia* Kunth.*, Brunellia subsessilis* Killip & Cuatrec.*, Godoya antioquiensis* Planch.*, Quercus humboldtii* Bonpl.*, Juglans neotropica* Diels.*, Eschweilera antioquensis* Dugand & Daniel., among others) and finally, considered species to the FE modelling are: *Nectandra reticulata*, *Cedrela montana*, *Daphnosis bogotensis*, Citaraexylum subflavescens, Nageia rospigliosii, *Guarea* sp, *Ocotea* sp, *Persea caerulea*, *Alnus acuminata*, *Callophylum* sp, *Juglans neotropica*, *Quercus humboldtii* and *Panopsis yolombo*.

Social aspects include: increment of people incomes by employment generation; encourage the creation of social organizations; and improvements for food security of impacted communities. This will impact positively in: welfare, conservation, and the environmental development of the local communities, as well as the sustainable use of resources. Our country has great opportunities as a consequence of the implementation of international markets of Emission Reductions of Green House Gases (GHG). This motivated the development of a feasibility assessment which established the project eligibility and the technical and economic viability of the project. As a result of it, it was established the *Project Design Document (PDD)* for the implementation of a Forest Project under the VCS guidelines. The results obtained in the present PDD document of the Project will illustrate, in one hand, the different and viable market scenarios for the VCS Forest Project in the Municipality of Medellin, and in the other hand the PDD formulation. This will assist to begin the validation and verification process under VCS.

2.2 Sectoral Scope and Project Type

More Forest is an Afforestation, Reforestation and Revegetation (ARR), project that gets into the Agriculture, Forestry and Other Land Use (AFOLU) projects.

2.3 Project Proponent

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2.4 Other Entities Involved in the Project

The participants of the Project “More Forests for Medellin” (“Mas Bosques para Medellín”) (Figure 1), are: the Área Metropolitana del Valle de Aburrá (AMVA) [Metropolitan Area of the Valley of Aburrá]; the Municipality of Medellin; and the association Agremiación de Propietarios [Land Owners Association].

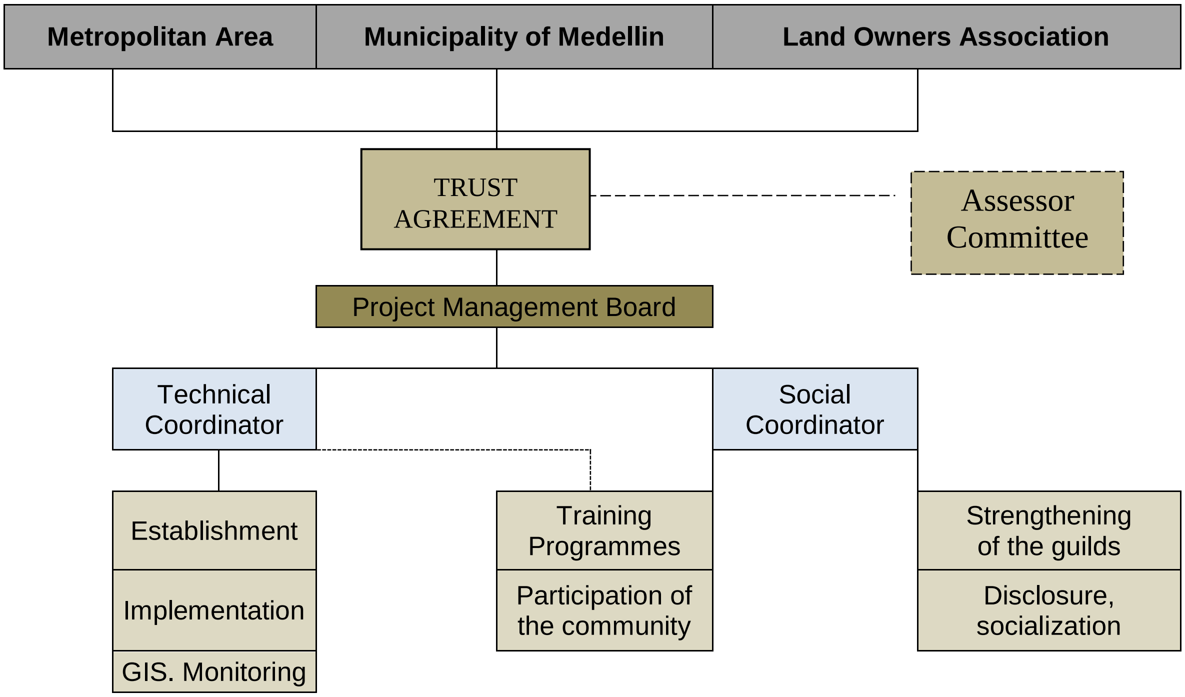


Figure 1 Organizational (hierarchical) Structure of the Project: “Mas Bosques para Medellín”

Each of the participants will follow the next functions:
The Municipality of Medellin and AMVA will establish a long-term agreement, and afterwards, the Land Owners Association will adhere to the agreement by a non-profit association.
As owner and partner of the Project, the Municipality of Medellin must:
-Ensure the implementation and development of the agreement, under the guidelines established in the PDD and PSA in a long-term. (30 years)
-Provide financial resources as the cash flow Project
-Participate in the Project Manager Board activities
-Manage the Project till the Land Owners Association participation begins.

The AMVA as partner of the Project must:
-Provide financial resources as the cash flow of project
-Participate in the Project Manager Board activities

The Land Owners Association as a partner and owner of the project must:
-Associate through a non-profit association
-Perform the project in a medium-term
-Participate in the Project Manager Board activities
-Manage the project in during a medium-term

Trusteeship:
Funds and contributions will be administrated by the Manager Board through a TRUST AGREEMENT. Contributions come as well from all the partners and other entities interested in participating. The

TRUST AGREEMENT will be responsible for carrying out the contracts that include each owner into the project during the entire duration of the project.

Assessor Committee
-Lead and escort the execution of the project.
-It will be the forum for consultation and decision making.
-Approve the investment plans proposed by management.

Management:
-It is the administrative entity of the Project.
-Responsible for implementing the guidelines of the Advisory Committee
-Positioning and negotiations of the Project.
-Logistical support (technical secretariat) to the assessor committee
-Execution of the Project through operative and investment plans

Technical and Social development:
Responsible of the well development of the activities of the Project and, it will be the executor component of the Project according to the management guidelines, and eventually, it could participate in the assessor committee at the request of its members.

2.5 Project Start Date

February 01 2010. The Project starts by establishing protection parcels in the township of Palmitas

2.6 Project Crediting Period

Start date of crediting period: June 2009

Length of credting period: 30 years

Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	x
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2009	-5.719,40
2010	-1.478,01
2011	-155,07
2012	294,24
2013	-6.651,17
2014	-22.829,45
2015	12.705,48
2016	16.927,94
2017	19.991,38
2018	23.626,32

2019	10.548,15
2020	9.580,31
2021	21.445,83
2022	1.970,19
2023	3.421,14
2024	14.782,61
2025	10.325,59
2026	14.638,77
2027	11.984,11
2028	12.275,99
2029	10.085,44
2030	-36.405,10
2031	-41.906,83
2032	3.826,80
2033	-6.058,62
2034	10.751,06
2035	13.345,98
2036	12.330,64
2037	-2.274,44
2038	4.992,71
Total estimated ERs	116.372,57
Total number of crediting years	30
Average annual ERs	3.879,09

2.7 Description of the Project Activity

Four Stand models are present in the project (Figure 2):

- Commercial
- Silvopastoral
- Natural Assisted Regeneration (NAR)
- Forest Enrichment (FE)

Commercial, Silvopastoral stand models use four commercial forest species: *Pinus patula, Pinus tecunimanii, Eucaliptus grandis* and *Cordia alliodora*. Although, *P. patula* and *E. grandis* are exotic species, they have been successfully incorporated to diverse programs of commercial reforestation in Colombia aimed to supply the demands of timber for pulp and sawn timber (Table 1). Environmental entities of Colombia have considered that commercial forest plantations established with these forest species in lands on process of degradation cause positive environmental impacts (Ministerio del Medio Ambiente 1999). In the case of Natural Assisted Regeneration (NAR) and Forest Enrichment (FE) models, native species will be used. Table bellow presents a brief description of some of the species used.

Figure 2 Commercial systems: silvopastoral, agro-forestry, and Assisted Natural Regeneration/ Forest Enrichment. Systems to be implemented in the Forest Project "More Forests for Medellin".

Tabla 1 General description of species to be incorporated in the commercial stand models: silvopastoral and agro-forestry. This description is related from consulted general literature (see note at the bottom).

Family	Specie	Stand model	T (°C)	Altitude (m.a.s.l)	Precipitation (mm)	Soil	Observations
Boraginaceae	*Cordia alliodora*	Agro-forestry	18-25	0-1900	1000-4000	Better in soils with rich organic matter; deep soil and good drainage. Can tolerate alkaline soils, neutral and slightly acids. (pH, between 4.5 to 6.5).	Is a native species; planted as well as wild plant. Broad ecological conditions for growth. It grows in hills, slopes, gullies, bank streams, deep lands (swamps) and coastal flood plains.[1, 2]
Myrtaceae	*Eucalyptus grandis*	Silvopastoral	15-22	0-2100	800-4000	Requires deep soils, good drainage, wet soils, and high and medium fertility. Can tolerate pH slightly acid to neutral.	Exotic species. Timber is used for heavy construction, manufacture of timber-beams, flooring, furniture, etc. It is planted for commercial purposes and for soil conservation. [2]
Pinaceae	*Pinus patula*	Commercial Silvopastoral	12-18	1400-3300	750-2000	Better in deep soils, wet soils, fertile, good drainage, neutral pH and acid.	Although it has a very restricted natural distribution, Patula pine has been successful in industrial plantations throughout the tropics and subtropics. Particularly by its form, rapid growth and big size. [1, 2]
Pinaceae	*Pinus maximinoi*	Commercial	14-22	450-2400	1000-2400	Well developed in fertile soils, deep soils with good drainage. Well adapted to different soil varieties. pH between 4.5-5.5.	It is a remarkable species with excellent phenotypic and silvicultural conditions; rapid growth and probably the best stern form of tropical pines, which gives it great potential as a reforestation species in tropical and subtropical regions. [1, 2]
Lauraceae	*Persea caerulea*	RNA	-	1.000-2.000	-	-	-
Betulaceae	*Alnus acuminata*	RNA	4-27	1.500-2.800	1.000-3.000	silty alluvial or volcanic, deep, well drained	The genus *Alnus* can be found on steep hillsides with dry conditions. It thrives on the banks of rivers and wet slopes. It develops in areas of cloudiness, with frequent foge
Clusiaceae	*Callophylum* sp	RNA	-	1.700-2.300	-	-	In Antioquia the tree reaches heights between 11 and 22 m high and up to 70 cm in diameter. This species has potential as an ornamental for its beautiful foliage. It is important for bird life. The wood is used for making furniture, cabinets and general carpentry. His latex has medicinal properties.
Juglandaceae	*Juglans neotropica*	RNA		1.600-2.800	800-2.000	It is susceptible to high winds and does not	These trees cannot stand intense cold or frost. The large amount of tannin content in

Family	Specie	Stand model	T (°C)	Altitude (m.a.s.l)	Precipitation (mm)	Soil	Observations
						tolerate calcareous soils, heavy or poorly drained.	leaves is an impediment to grow vegetation around.
Fagaceae	*Quercus humboldtii*	RNA	-	1500-3200	-		The seeds can be seriously attacked by larvae, which penetrate the seeds in juvenile age.
Podocarpaceae	*Nageia rospigliossi*	RNA	10-19	1400-2500	1500-2500	Deep soils and good drainage. Exigent in fertility and moisture. Developed in hills and deep river valleys. pH acid.	It is a native species of Colombia and is recommended for enrichment in secondary forest or over-exploited primary forest. Slow-growing species in the first years; afterwards increase positively. [2]
Verbenaceae	*Cytharexylum subflavens*	RNA	14-22	1800-2800	-	Tolerate clay soils.	It is a melifera species used by bees for feeding. Timber is used for tool accessories, posts and firewood. Is used to environmental reforestation.[2]
Meliaceae	*Cedrela montana*	RNA	12	1600-2800	500-2000	Better in deep soils, good drainage, ph from neutral to alkaline and very fertile lands.	Slow-growing species, reaching 25-30 m tall and diameter up to 30 cm.[2, 3]

[1] www.conabio.gob.mx/conocimiento/info_especies/arboles
[2] Trujillo (2007)
[3] www.rngr.net/Publications/ttsm/Folder.2003-07-11.4726/PDF.2003-12-08.1553/file
[4] Álvarez (2006)

Assisted Natural Regeneration (ANR) will use typical species of near fragments of natural forest which occasionally constitute the boundaries of the project . Twenty eight (28) species will be used overall. They were classified by ecological groups (Table 2) and taking into account eco-physiology characteristics and present succession theories (Martínez-Ramos 1985, Lamprecht 1990).

Tabla 2 Species Used in the Assisted Natural Regeneration model.

Ecological group	Family	Scientific Name	Common name
Pioneer Species	Melastomataceae	*Miconia caudata*	Niguito
		Miconia lehmanii	Niguito
		Miconia theazans	Niguito
	Cecropiaceae	*Cecropia angustifolia*	Yarumo
	Euphorbiaceae	*Croton magdalenensis*	Drago
	Clethraceae	*Clethra fagifolia*	Chiiriguaco
	Ulmaceae	*Trema micrantha*	Surrumbo
	Clusaceae	*Vismia baccifera*	Carate
	Solanaceae	*Solanum psycophanta*	Tachuelo
	Cunoniaceae	*Weinmannia pubescens*	Encenillo
Secondary Species	Euphorbiaceae	*Alchornea grandiflora*	-
	Araliaceae	*Oreopanax floribundum*	Mano de oso
	Verbenaceae	*Citharexylum subflavescens*	Quimulá
	Mimosaceae	*Inga sierrae*	Guamo
	Brunelliaceae	*Brunellia subssesilis*	Cedrillo
	Aquifoliaceae	*Ilex caliana*	Cardenal
	Lauraceae	*Beilschmedia pendula*	Aguacatillo
	Cunoniaceae	*Weinmannia balbisiana*	Encenillo
	Ochnaceae	*Godoya antioquensis*	Caunce
	Euphorbiaceae	*Hieronyma antioquensis*	Candelo
Tolerant Species	Podocarpaceae	*Nageia rospigliosii*	Pino romeron
	Meliaceae	*Cedrela montana*	Cedro de montaña
	Clusiaceae	*Calophyllum sp.*	Barcino
	Fagaceae	*Quercus humboltii*	Roble
	Juglandaceae	*Juglans neotropica*	Cedro cebollo
	Lecythidaceae	*Eschweilera antioquensis*	Olla de mono
	Meliaceae	*Guarea kunthiana*	Cedro macho
	Bombacaceae	*Spirotheca rhodostyla*	Ceiba de tierra fría

Technology to be employed by the proposed A/R VCS project activity:

Establishment plantation practices, weed control, fertilization, and pruning regimes to be used, are detailed in the document: "*Plan general de establecimiento y manejo de Sistemas silvopastoriles (SSP), plantación comercial (PC)"*. Next, we present a brief description of these activities.

1. Commercial Stand model

Commercial model will be established in current abandoned degraded pastures and cattle-grazing pastures for milk production. In these conditions, and the necessity of connect pastures with relicts of natural forest, the proposal idea is to develop commercial plantations with *Pinus patula* and *Pinus maximinoi*

Land preparation

This activity will be developed with hand-tool practices (machete). To highlight, remnant trees in lots will not be removed neither burning of material resulting from land preparation.

(Delineation/outlining)

After land preparation, ground delineation/outlining is developed in square lines at 3 meters distance between plants and 3 meters between paths, in order to obtain 1,111 trees per hectare. In any case, distance shall be adjusted according to the slope of the ground.

Clearing and digging

Weeds will be removed with a hoe around the planting site of trees, in a radius of 50 cm. Next practice afterwards will be to dig a hole of 20 cm in diameter and 30 cm deep using a vertical shovel. Soil extracted will be spread and mixed in order to defragment compaction and reduce difficult penetration of roots, which is a cause of a bad development of the plants.

Fertilization

Fertilization depends on soil analysis. 2 fertilization sessions are proposed during the period of plantation. First fertilization will be implemented 30 days after the trees establishment with 50 N-P-K grams (10-30-10) per tree. Second fertilization will be six (6) months after the trees establishment by applying 50 grams of chemical fertilizer 10-30-10.

Replanting

It is recommended to carry out an inventory of survival or mortality population of trees up to 90 days after planting session. It is estimated a 10% of mortality of the initial amount of trees.

Fire protection

Consist of a continuous and preventive vigilance in strong-dry seasons in order to avoid damages caused by spontaneous or induced fires in the plantation. In some cases by defining trails and cleaning firebreaks lines inside or around the planted lots, strategically located (width between 5-8 meters).

Brush Control

Manual cleaning of weeds will be carried out, by depending aggressiveness of weeds, in order to prevent roots damages of trees, which are still quite shallow. Clearing plates of a diameter of 100 centimetres must be carried out per each tree. Three clearing sessions will be developed, during the first and second year; and two sessions in the third and fourth year of plantation.

Pruning

Pruning program on the private areas will be carried out during the first five year of plantation by cutting approximately 40% of the foliage. Will be three pruning sessions, first in the year 3, second in the year 4 and third session will be in the year 5 of plantation (Table 3).

Tabla 3 Pruning programme for the species P. patula and P. maximinoi.

Pruning Session	Year approx.	Average height of trees (m)	Intensity of pruning	Height of pruning (m)
1	3	6	40%	2,4
2	4	8	50 %	4
3	5	10	60%	6

Thinning and final cut

Two thinning sessions are proposed during plantation (Table 4, Table 5). First session is in the year 7, with an intensity of 40%. Second thinning, also low, will be done in the year 12, with an intensity of 50% and considering a mortality of 3% of tree remnant from the first thinning. Final cut is undertaken at age 20 and considers 100% of the remnants. This activity will be developed during three rotation periods (60 years).

Tabla 4 Thinning Programme for the species P. patula.

Thinning	Extraction (%)	Year	Tree Number	Trees to extract	Remnants
1	40	7	1111	444	667
		Mortality (3%)		30	647
2	50	10	647	323	323
		Mortality (3%)		10	314
Last turn	100	20	314	314	0

Tabla 5 Distribution of areas for planting by species in the Commercial Stand model.

Model	Species	2009	2010	2011	2012	2013	2014	2015	Total
Commercial	*P. patula*	57	114	114	-	-	-	-	285
	P. tecunumanii	38	76	76	-	-	-	-	190
	Subtotal	**95**	**190**	**190**	**-**	**-**	**-**	**-**	**475**

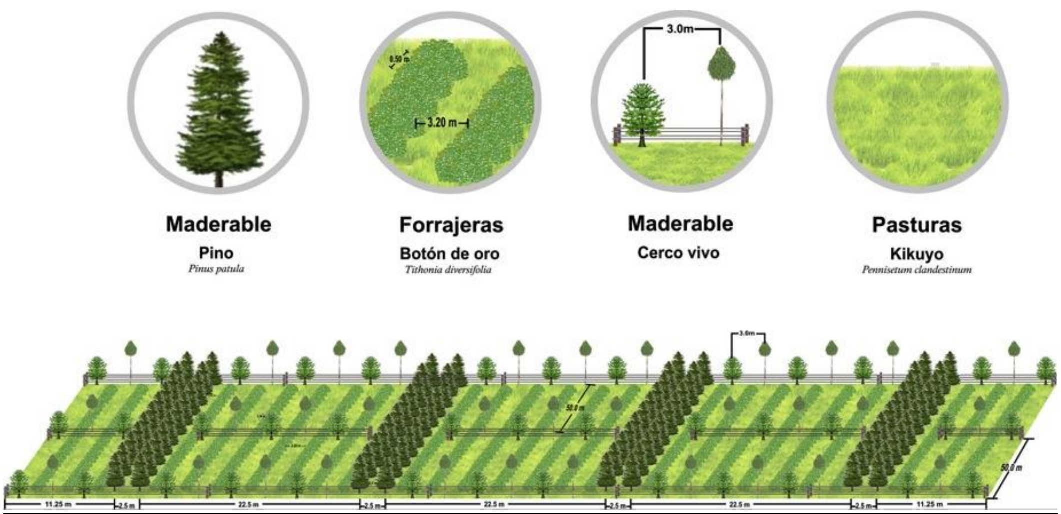
2. Silvopastoral Stand Model

This model (Figure 3) is established to areas with current pastures coverage, used to livestock or as unproductive lands. The model includes livestock activities with the addition of forest species for timber (*Pinus patula* or *Eucalyptus grandis* - 268 trees/hectare) and others forest species considered as forage species (*e.g. Tithonia diversifolia* 5,400 shrubs/hectare). Besides, it is proposed to associate with living fence commercial timber and rapidly growing species like *E. grandis* and native species of high ecological value (90 trees / hectare). The purpose of the fence is help to increase tree cover and environmental benefits). In order to not shift livestock activities, the entry of cattle for feeding will be held in forage banks previously established.

Timber species (*Eucalyptus grandis* or *Pinus patula*.) will be established in four fringes. Each fringe is composed of 2 furrows of trees (width 2.5 meters), planted in square distance (2.5 meters between furrows per 3 meters between plants), obtaining 67 trees/fringe. Distance between fringes is 22.5 meters where species of forage type will be distributed. This density will produce 268 trees per hectare.

Area between fringes of timber species are seven hedge of *T. diversifolia* (3.2 meters between furrows per 0.5 meters between plants) obtaining 4.200 shrubs/hectare. Another two (2) hedges are distributed in both sides of the fringes of the timber trees planted and the boundary of the unit of area. Each area has a length of 11.25 meters. Each hedge is made up of three (3) furrows in the same distribution. Width of hedge is 1.6 meters. Every hedge has a population of 600 seedlings for a total of 1200 seedlings. Total amount of fodder shrubs per hectare is 5400 plants.

The living fence is located perpendicular to the fringes of timber and fodder shrubs. The planting distance between each line of living fence is 50 m; thus, there is a centre line of trees and two (2) lines on each end of the design. The planting distance between trees is 3 m, it can be only *E. grandis* or interspersed with native species of high value timber. Planting density is 90 trees / hectare. Each line is protected with electric fence at a distance of 1 m on both sides.



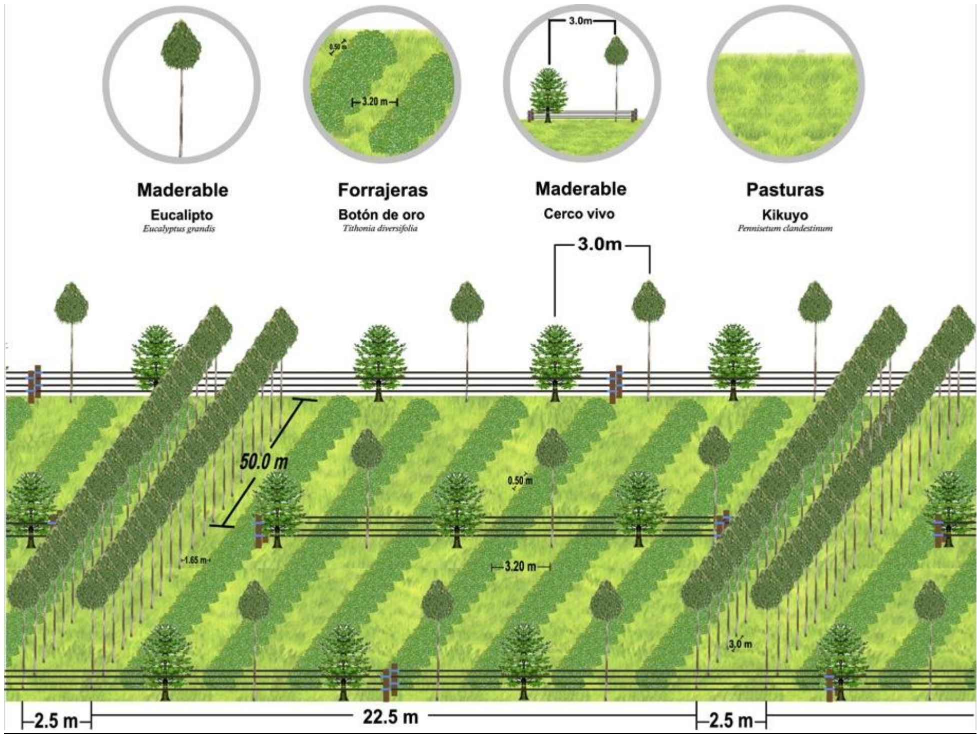


Figure 3 Spatial distribution in the Silvopastoral system for Eucaplytus grandis and Pinus patula

Cleaning and soil preparation will be developed by machetes and chemical application. In the areas for forage vegetation to be intervened shall be required manual labour with mattock and hoe in the slope direction in order to maintain a loose and aerated soil. Before the beginning of planting is necessary to carry out the establishment of paths in the area if is necessary, to manage different supplies for planting practices, a higher efficiency of land use, a better distribution of transport supplies in field, and a good transit for workers in the maintenance activities. Tillage practices for soil conservation are applicable in all cases; therefore, they should be well performed.

Hole-digging practices (and ground chipping).

For the timber species, a hole of 20 cm of diameter and 30 cm of deep will be developed, using a short shovel. The excavated soil will break down and remove to defragment any hard layer that may obstruct root penetration and thus affect its development. For forager species is necessary to use a hoe to get a loose and aerated soil (ground chipping). Re-chipping is to obtain and ensure fewer lumps in the soil that may affect the development of the sprouts of planted vegetation. Chipping the ground and re-chipping shall be carried out at a depth and width of 20 cm.

Planting practices

Planting depends on trails developed for each species. Timber species will be transplanted in field. In the case of forage species, Stakes must be similar of bezels to prevent moisture accumulation. Stakes will be planted 1.3 meters long horizontally (steady flow planting) with 10 cm overlap in each end.

Fertilization

Fertilization depends on soil analysis testing which it will be developed in the lots. For timber species, 2 fertilization practices must be carried out during plantation activities. First fertilization will be during tree planting in field by applying the necessary supplies of fertilization depending of soil testing. For forage species, poultry manure as compost and balanced fertilization. Fertilizer applications is made on the groove at the same time of digging practices with a hoe with the purpose of incorporate the fertilizer to the soil and ensure a good performance at the moment of planting *T. diversifolia.* Normally, application use is N-P-K (50g/tree).

Electric fence

Basic equipment (driver, lighting diverter, rod pole to ground) must be installed by an electrician to ensure a good performance of operation. For the location of the driver, an easy access to electricity lines is recommended, but protected of water and sinister (being stolen).

Lamp posts installations and cables will be built according to pre-design established for rotations and management of cattle grazing in the system. The electric line must be settled in two lines. Each post must have electric insulators to separate direct contact between wire and wood to avoid less energy flow. Electric lines must have terminal insulators and clamps.

Livestock water supply network

Installation of hoses/pipes and accessories will be according to the design established for rotations and management of cattle grazing in the Silvopastoral system.

Ground pruning and plate recovery

Not only for trees, but also forages and pastures, a brush control will be carried out by machete (hand) on woody species and high aspect. For timber species, according to the aggressiveness of the weed will be hand-cleaning practices in order to obtain less damages of tree roots. Plate recovery-cleaning of each tree shall be done in a diameter of 80 – 100 cm. These activities will be developed in four maintenance practices of the plantation.

Re-planting

A maximum of 10% of re-planting will be performed in areas where the trees planted are dead. A hole must be carried out, of 20 cm of diameter and 30 cm of depth by using a shovel. To forage species, 10% of re-planting activities will be developed (maximum). Ground-chipping and re-chipping will be of 20 cm of depth and width. Stacks can be obtained in the area, from the pruned material of planted trees in the system after grazing.

Pruning for forage species

The "botón de oro" *(T. diversifolia),* must be pruned 20 cm height, in order to develop a better outbrake (more number of regrowth) and at the same time, maintaining the ideal height for grazing of cattle. Three pruning sessions will be programmed for the species used. For *Pinus patula,* first pruning will be in year 3; second pruning in the year 4 and third in year 5 of the plantation. For *Eucalyptus grandis*, pruning will take place from year 2. Table 6 shows pruning sessions listed by implemented species.

Tabla 6 Pruning Programme by species.

Pinus patula				
Pruning number	**Year**	**Height average of trees (m)**	**Pruning intensity %**	**Pruning height**
1	3	6	40%	2,4
2	4	8	50 %	4
3	5	10	60%	6
Eucalyptus grandis.				
Pruning number	**Year**	**Height average of trees (m)**	**Pruning intensity %**	**Pruning height**
1	2	4	40%	1,6
2	3	6	50 %	3
3	4	8	60%	4

Thinning

For the species *Eucalyptus grandis,* 2 thinning practices are proposed during plantation (Table 7). The first thinning will take place during year 3, by removing 20% of sick individuals and malformed (thinning at low), about 396 trees. The second thinning, also at low, will take place in year 7 with an intensity of 40% and considering a 3% of mortality of trees remaining from the first thinning; 123 trees will be removed. The wood product extraction can be used for pulp (80%) and stakes (20%). The final harvest will take place in year 12, should be approximately 179 trees / ha, which is used for sawing-timber (60%) and pulp (40%).

Tabla 7 Thinning programme for E. grandis.

Thinning sessions	Extraction (%)	Year	Tree numbers	Tree number to extract	Remnants
1	20%	4	358	79	317
		3%[1]		10	307
2	40%	7	307	123	184
		3%[1]		6	179
Last session	100%	12	179	179	0

[1] 3% of mortality is considered.

3. Assisted Natural Regeneration Stand Model (ANR)

At this time, most of the area of municipality of Medellin is becoming urbanized and relicts of native ecosystems have been displaced towards the upper areas of the surrounded hills of the valley. Most of these reduced fragments of native vegetation located in this area are still threatened by human intervention with the establishment of seasonal crops, pastures, buildings, roads and infrastructure, which deteriorates physically and chemically the soils, modifies the hydric balance and destabilizes the basins. Also, these activities fragment and reduce the habitat as a consequence of loss of biodiversity, as well as the extinction and genetic variation of flora and fauna population (Corantioquia 2006). In this panorama, the implementation of Assisted Natural Regeneration will improve ecological conditions, promote connectivity between forest fragments and restore the landscape conditions in some areas of the Municipality.

This system will be implemented in the upper areas of Municipality of Medellin, specifically in areas with the feature of Low-Mountain Rain Forest (bh-MB). These areas present highly-degraded soils because of cattle-grazing activities and extracting (*e.g*. mining, extraction of forest products, etc…) traditionally developed in the region. It is expected with the implementation of this program: improvements of landscape conditions, generation of connecting micro-corridors between isolated forests, protection of water sources, prevention of soil erosion, and favorable conditions to subsequent establishment of native vegetation. To develop the model will depend of the availability of seeds/seedlings of selected plants. Selected plants will correspond to the same characteristics of existent forest in the Municipality. Vegetal material will be supplied by the Secretaria del Medio Ambiente (Environment Secretary of Municipality), through the Red Community Nursery Network.

Stand Model features

Native species will be selected because is the most appropriated method to achieve the basic objectives of the ecological restoration; which is the establishment of a protective vegetal layer composed by these kind of species[1]. In total, twenty eight species will be selected (Table 9), which belong to three important ecological groups (Martínez-Ramos 1985) and have the following characteristics:

- Importance in the area in terms of abundance, dominance and frequency.
- Some of these are critical species because they have been exploited or because they are not able to reproduce easily due to unfavorable environmental conditions of intervention.
- The propagation systems are known and the vegetal material is available.

Tabla 8 Ecological group of species to be used in the Assisted Natural Regeneration Stand Model.

Pioneers	Secondary	Tolerants
Very fast growth (height 1 to 4 m/yr, and 2 to 5 cm/year in diameter), need high-light conditions; shade-intolerant, very light wood. Regeneration occurs through a seed bank which remains latent during long periods of time. Seed dispersion by wind-spread or by a broad diversity of animals. Small seeds with induced dormancy due to light or temperature conditions. 1 to 5 years for first early reproduction. Low dependence of specific pollinators and low longevity (15-30 years). They are considered short-lived species and work as substrate for non-pioneer species. Growth in any	These are species with a high capacity of adaptation to different lighting conditions. They can be light-demanding or shade-tolerant. Respond to different factors of dispersion (wind, animals, mechanical). Long to medium cycle of life. The plasticity of these species makes them the most abundant and diverse in the forest. They have a great potential to be managed as sustainable plantations as wood products, medicinal, industrial, among others.	These species are mainly featured by a wide tolerance to shades; They are rare species with a low distribution of tree per hectare. Highly selective in its niche, with a slow growth. Hard and heavy Wood, regenerated by seedling Banks, with a large seed dispersion due to animals and by gravity for its fruits. Big and heavy seeds. They have a slow reproduction (later ages of reproduction), high dependence on specific pollinators and very long cycle of life. In some cases over 100 years.

[1] Despite soil disturbances experimented for this species, they have evolved under local environmental conditions.

Pioneers	Secondary	Tolerants
kind of soils.		

Spatial design for plantation

Pioneer species and secondary species will be planted interspersed at a distance of 4 meters between lines and 2 meters between trees. Between the lines of 4 meters, tolerant species will be planted, with distances of 5 meters between trees. Stocking density is 1750 trees per hectare; of which 36% must be pioneer species (625 individuals); 36% (625 individuals) for secondary species; and 29% (500 individuals) for tolerant species (Figure 4, Table 10).

Figure 4 Spatial design for the Assisted Natural Regeneration Stand Model.

Tabla 9 Population proportion by species for the Assisted Natural Regeneration Stand Model.

Ecological Group	No.	Family	Population per species	Total
Pioneer Species	1	*Miconia caudata*	80	625
	2	*Miconia lehmanii*	70	
	3	*Miconia theazans*	80	

	4	*Cecropia angustifolia*	80	
	5	*Croton magdalenensis*	63	
	6	*Clethra fagifolia*	63	
	7	*Trema micrantha*	54	
	8	*Vismia baccifera*	45	
	9	*Solanum psycophanta*	36	
	10	*Weinmannia pubescens*	54	
Secondary Species	11	*Alchornea grandiflora*	65	625
	12	*Oreopanax floribundum*	52	
	13	*Citharexylum subflavescens*	65	
	14	*Inga sierra*	78	
	15	*Brunellia subssesilis*	78	
	16	*Ilex caliana*	65	
	17	*Beilschmiedia pendula*	52	
	18	*Weinmannia balbisiana*	65	
	19	*Godoya antioquensis*	40	
	20	*Hieronyma antioquensis*	65	
Tolerant Species	21	*Nageia rospigliosii*	73	500
	22	*Cedrela montana*	63	
	23	*Calophyllum sp.*	63	
	24	*Quercus humboltii*	75	
	25	*Juglans neotropica*	38	
	26	*Eschweilera antioquensis*	63	
	27	*Guarea kunthiana*	50	
	28	*Spirotheca rhodostyla*	75	

4. Forest Enrichment (FE) Stand Model

This proposal is the introduction of advanced succession typical species in areas where natural regeneration process of the vegetation has begun, particularly in low stubble predominantly pioneer tree and shrub species that can generate the conditions necessary for the proper development of the species they are entered. This model will prioritize the planting of secondary species and shade tolerant. Since some pioneer species are already in coverage, these will be introduced exclusively in gaps or patches where there are barriers to the growth of woody vegetation such as ferns or grasses aggressive.

The proposed establishment of plantations with native tree species based on the model of forest will enrichment take place in areas that have the following characteristics: a). Present lands coverage with shrubs; and b). Regulated use of Protector (P) model; c). Positive intentionality of landowners. It was proposed to develop a mixed plantation based by thirteen species of trees; nine species with harvest 20 years: *Nectandra reticulata*, *Cedrela montana*, *Daphnosis bogotensis*, *Citaraexylum subflavescens, Nageia rospigliossi*, *Guarea* sp, *Ocotea* sp, *Persea caerulea* and *Alnus acuminata*. And four species with harvest 25 years: *Callophylum* sp, *Juglans neotropica*, *Quercus humboldtii* and *Panopsis yolombo.* This species shows climatic characteristics such as non-tolerance of high light exposure in early stages and slow growth rates. This system is expected to harvest 250 trees per hectare.

Model Features

After prepared the ground for plantation as indicated previously, the layout will be held at a distance of 4 meters between seedlings and 5 meters between paths (in square distribution) for a total density of 500 trees per hectare.

(Delineation/outlining)

Weeds are removed with hoes around the site of planting trees in a radius of 50 centimeters. Then dig a hole chipping of 30 cm diameter and 30 cm deep using a palin. The excavated soil will be broken and removed to defragment any hard layer that may hinder root penetration and thus affect its development, the bottom of the hole shall be removed with the bar or palin to facilitate the penetration of roots

Fertilization

First fertilization will be implemented 30 days after the trees establishment with 50 N-P-K grams (10-30-10) and 20 minor elements (agrimin) grams per tree.

Due to soil acidity conditions shown in the analysis, apply 100 g of triple amendment 30 or dolomite lime on the walls of the hole ringing. This application must be forwarded with the organic matter in the settlement RNA.

Planting

the bag or container in which content comes the pylon of the seedling, will be remove in order to avoid differences in the root system, this activity will be made with a cutting to avoid damage to the pylon. The pylon of the tree planted should be full, preventing it from falling apart, centered in the hole, also the root collar should be flush with the surrounding land should not be above the ground or buried, because it can affect the gas exchange and therefore the proper setting of the tree. After seeding should be performed to remove tread compaction chambers of air and ensure that the tree will not tip. The resulting bags of seed should be collected and packaged for subsequent transportation and disposal somewhere certified by the relevant environmental authority.

2.8 Project Location

The project is located in the Municipality of Medellin in the Department of Antioquia at the riverbank of Medellin River (6° 13´ 55.098" N and 75° 34´ 05.752" O) with a total area of 382km^2 (Figure 5). Urban area is 27.1%; urban expansion area is 1.1%; and rural area is 71.8% of the total area Alcaldía de Medellín 2003, POT-Diagnóstico 2007). The topography of the territory is featured by a valley with high mountains surrounding the east and west; these mountain ranges correspond to the two divisions of the Central Cordillera of the Andes in Antioquia. Additionally, into the urban area of Medellin is located seven tutelary hills named: El Volador; Nutibara; Pan de Azúcar; El Picacho; Santo Domingo; La Asomadera and El Salvador. These hills provide to the inhabitants numerous environmental goods and services among others (Alcaldía de Medellín 2003, POT-Diagnóstico 2007). Currently, Medellin population is 2,499,080 inhabitants. From these, 63% are located in the urban area (DANE 2005, POT-Diagnóstico 2007). Rural area of the municipality is surrounded by five villages; these are: Altavista, San Antonio de Prado, San Cristóbal, Santa Elena and San Sebastián de Palmitas.

Altavista *is* located in the southeast of Medellin with altitudes between 1600 and 2400 m.a.s.l, and a total area of 2,827.7 ha; is bounded on the north by the village of San Antonio de Prado; on the south by the Itagüí municipality; and on the east by the urban area of Medellin. This is one of the closest villages to the urban area of Medellin without natural limits between them. In addition, this village is a supplier of sand, gravel and clay for house building, construction and general infrastructure to Medellin urban area. These resources derive from the mountains near the Barcino formation. These resources are associated with the basins of the streams (springs): La Picacha - Aguas Frías and la Altavista (Alcaldía de Medellín 2006b). It has weather from warm to cold, annual temperatures of 15 to 20°C. Life zones are featured by: low-mountain Rain Forest (bh-MB) and pre-mountain Rain Forest (bh-PM).

San Antonio de Prado is located in the southwest area of Municipality. The village is bounded on the east by the village of Altavista; on the north with the villages of San Sebastian de Palmitas and San Cristobal; on the south by the Itagüí and La Estrella Municipalities; and on the west by the Heliconia and Angelópolis Municipalities. The village is relatively isolated from the city perimeter of Medellin due to the natural barriers: Barcino formation, the Padre Amaya hill and the Cuchilla del Romeral. These three geographical barriers help as boundary limits and constitute a biological corridor of great importance. This includes areas from foothills to tops of hills and the village of San Antonio de Prado. It has altitudes between 1900 to 2500 m.a.s.l.; annual temperatures from 20 to 24°C.; and ecosystems features of: low-mountain Rain Forest (bh-MB) and pre-mountain Rain Forest (bh-PM). The area presents a heterogenic land use and presence of native forest, forest plantations, extensive and semi-extensive cattle grazing, agricultural areas, and human settlements (Alcaldía de Medellín 2006b).

San Cristóbal is located northwest of the urban area of Medellin and bounded on the north by the Municipality of Bello; on the south by Altavista and San Antonio del Prado villages; and west by the San Sebastian de Palmitas village. It has an area of 5,380.9 ha with altitudes from 1900 to 3000 m.a.s.l. (Alcaldía de Medellín 2006a). Annual temperatures are from 12 to 20°C. Some top-hills are presence of frequent fog events. There are three ecosystems: low-mountain Rain Forest (bh-MB), low-mountain very wet Rain Forest (bmh-MB), and pre-mountain Rain Forest (bh-PM) (Alcaldía de Medellín 2006b).

Santa Elena has a total area of 7,413.1 ha; is located on the east area of Municipality of Medellin, and it has part of the Arví Regional Park. It is bounded on the north by the Municipalities of Copacabana and Bello; on the east by Guarne and Rionegro Municipalities; on the west by the rural area of the Municipality of Medellin; and the south with Envigado. Village weather is cold with temperature averages from 13 and 15°C.; and an altitud average of 2500 m.a.s.l. Life zones are featured by: low-mountain Rain Forest (bh-MB) and low-mountain very wet Rain Forest (bmh-MB). Some of the main streams of this village district are: Piedras Blancas, Santa Elena, El Rosario, Las Palmas and El Espíritu Santo (Alcaldía de Medellín 2006b).

San Sebastián de Palmitas is located on the north-west of the city, and has a total area of 5,783.9 ha; altitudes between 1400 and 3100 m.a.s.l. Located specifically to the east side of the basin of the Cauca River. It is bounded on the north by the municipalities of San Geronimo and Bello; on the east by San Cristobal village; on the south by San Antonio de Prado and on the west with the Municipality of Ebéjico (Alcaldía de Medellín 2006a). Weather corresponds to warm and cold areas, with temperature variation depending of the altitude. Life zones features present in the area are: low-mountain very wet Rain Forest (bmh-MB) with temperatures of 12 to 18°C; and pre-mountain very wet Rain Forest (bmh-PM) with temperatures from 18 to 24°C (Alcaldía de Medellín 2006b).

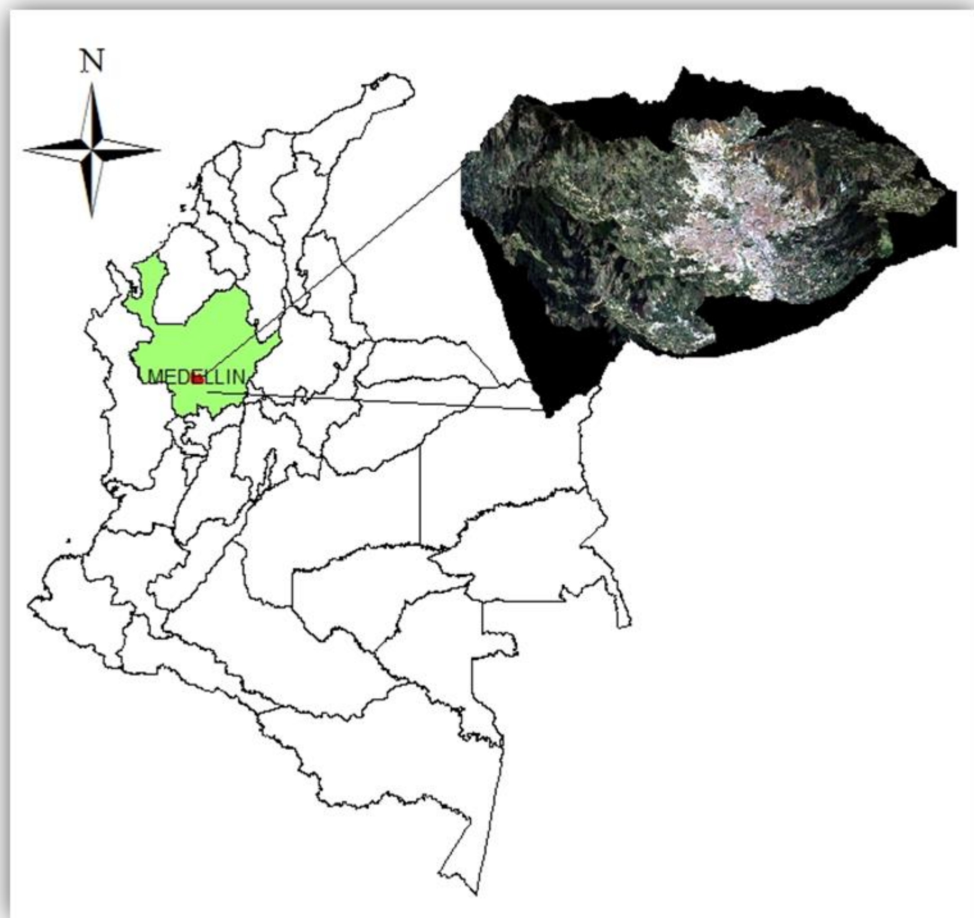


Figure 5 Geographical Division of the municipality of Medellin, for the Forest Project: "More Forests for Medellin" ("Mas Bosques para Medellín")

2.9 Conditions Prior to Project Initiation

Description of the environmental conditions of the Project correspond to the environmental conditions of Medellin and some particularities are mentioned by village districts

Climate:

Because of its tropical equatorial region location, Medellin´s weather shows an isothermal character. Temperature range moves between 16 and 28°C, and average of 24°C. The highest temperatures are between 27 and 28.6°C with an absolute highest of 32°C, and the lowest ones around 16°C with an absolute minimum of 10°C. The average annual rainfall is 1571 mm, with dry season in the early months and mid-year. Rainfalls are not uniformly distributed along the valley, whereby southern areas are rainier than northern ones (Table 11). Elevation on sea level is 1460m in the junction of La Iguana, Santa Elena streams and Medellin River, and 3100m at Cerro del Padre Amaya hill, Altos del Romeral and Las Baldías to the west. Winds regime is soft, determined by the Alisios Winds from the northeast and the warm air which come up from the low valleys of the Magdalena and Cauca Rivers, with predominant movement at the northern part of the Valle de Aburrá, which originates a north-south movement (Mayor of Medellin, 2003, POT-Diagnóstico 2007). Hydric balance for Medellin does not show water deficiency, so there is equilibrium between the rainfalls and the used water by vegetation (Moreno *et al*. 1997).

Tabla 10 Weather characteristics of the municipality of Medellin.

Temperature (°C)												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Minimum - average	16.1	16.3	16.7	17	17	16.6	16.1	16.3	16.2	16.3	16.4	16.3
Average	22	22.3	22.3	22	21.9	22.3	22.5	22.5	21.9	21.2	21.2	21.5
Maximum - avegae	28.1	28.5	28.5	27.9	27.8	28.1	28.6	28.5	28	27.2	27.3	27.6

Rainfall, solar brightness and relative humidity												
Mes	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average rainfall (mm)	55	77	114	179	191	153	108	154	178	218	150	79
Rainy days	11	12	16	21	23	18	16	19	21	24	21	14
Relative humidity (%)	66	66	67	70	71	68	63	64	68	72	73	70
Solar brightness hours/month	177	148	154	128	142	170	204	192	150	135	140	156

Measured data at Olaya Herrera airport (IDEAM)	Anual average	**Temperature (°C)**			**rainfall**			**Solar brightness (hours)**
		Min.	**Ave.**	**Max.**	**Total (mm)**	**Rain (días)**	**Humidity (%)**	
		16.4	22	28	1656	215	68	158

Hydrology:

The Medellin or Aburrá River is the main flow in the valley and runs from south to north, dividing the city in two parts. Santa Elena, La Iguana and Doña Maria streams are the most important because of their length and caudal, are the most important in the municipal territory. These rivers and streams constitute the main environmental connection lines between the rural area (from the protection zones located at the high parts of the mountain chains) and the urban area, which in turn, have generated communication possibilities between both zones (POT_Formulation 2007)

Geology and soils

According to Botero (1963), Medellin´s geology is formed by a group of metamorphic rocks with different ages, which are known as Ayura-Montebello group, from the pre-cretaceous, probably Paleozoic. However, some other authors (Restrepo and Toussaint, 1982) proposed to denominate this same unity as polimetamorphic complex of the mountains of the Central Cordillera of Colombia (Central Chain), with Precambrian to cretaceous ages (Moreno *et al*. 1997). According to the Colombia´s soils map (1:8.000.000), the city of Medellin presents mountain landscape soils, common at warm weather places, humid and very humid, sometimes with volcanic materials influence; this soils belong to Inceptisols and Andisols orders. The first ones, are characterized for being incipient soils with a low evolution grade, so the horizon differentiation is difficult; while the Andisols, are more developed soils from a wide range of volcanic ash deposits, fundamentally consist of a A-type soil, brown color horizon, with organic matter content up to 30% (IGAC 1995, Jaramillo 2000). For the particular case of the Medellin River watershed, its geographic location has serious implications on its geological factors, such as the regional tectonic, regional and local faults, which at the same time condition the geomorphologic processes like valley formations and escarpments. In general, metamorphic and igneous rocks are present which vary chronologically from geological ages like Paleozoic to Cretaceous and, recent deposits from different alluvial origins (POMCA 2007). Geological faults are common and associated to tectonic activity, frequent in the western Colombian regions; the most representative faults are those ones which make part of the Romeral fault system, located at the southern area of the Medellin River watershed.

Geomorphology

Within the Medellin River basin (watershed), were identified five big geomorphologic unities, within which minor unities are also distinguished. The unities are: Main scarp, edges and hills, soft slopes in deposits, alluvial surfaces and alluvial terraces (Table 12)

Tabla 11 Geomorphologic unities description present in the municipality of Medellin, Colombia (Source POMCA 2007).

Cartographic unity	Minor unities	Location	Description
Main scarp (MS)	Main scarp unity (Ep), Isolated hills unity and Picachos (Cr), Low edges unity (Fb), Secondary scarp unity (Ex), Hills unity (Cr).	At the limit between the erosion surfaces or plateau and the	Strong inclination surfaces, 45° or higher. This scarp defines a hills system developed from saprolitic materials
Edges and hills (Fa, Fm, Fb, Ca, Cm, Cb)	High edeges unity (Fa), Low edges unity (Fb), Medium edges unity (Fm), High hills unity (Ca), medium (Cm), low (Cb) and very low (Cmb), Cuchillas unity (Ch), Hills unity (Cr), step unity (Pe), Unidad de Cuchilla de Ancón Norte (Ch), La Meseta step unity (P).	Bottom of the valley as it occurs with the Nutibara and El Volador hills, and at the médium slopes such as the Pan de Azucar.	Developed from saprolitic materials as a result of the deposits dissection of slopes and alluvials, predominating the narrow edges, Sharp tops, slightly convex and outstretched mainly on perpendicular direction to the river.
Soft slopes in deposits(Vsd)	Soft slopes in deposits unity (Vsd), Alluvial unity (Al), Low hills unity (Cb),	Among the geomorphologic scarp unities, edges and	Soft inclination surfaces molded by slope deposits. Straight and

Cartographic unity	Minor unities	Location	Description
	medium (Cm), Low edges unity (Fb). Low hills and hilly slopes (Cb-Vc). Plateau unity (Alp), Hilly plateau unity (Alpc), Plateau with isolated hills unity (Alpca).	alluvial deposits.	steep surfaces slightly concave. Light to moderate dissection degree.
Alluvial surfaces (Al)	Alluvial unity (Al)	Among all Aburra valley segments	Surface formed by alluvial deposits from the Medellin River and its main tributaries
Alluvial terraces (T)	Terraces unity (T), Alluvial unity (Al)	Mainly at the northern part of the municipality	Related to elevations formations between 10 and 15m over the alluvial surface.

Life zones

The latitude and altitude of the city result in a sub-tropical weather sub-humid under the Martonne classification system (Eslava 1993). This system describes the life zones: low pre-mountain rainforest (bh-PM), very humid pre-mountain rainforest (bmh-PM), low-mountain rainforest (bh-MB), very humid low-mountain rainforest (bh-MB) and pluvial mountain rainforest (bp-M) according to the Holdridge classification system (1978), this life zones show the following characteristics.

Pre-mountain Rainforest (bh-PM): it is located between the 1000 and 2000 m over the sea level. Average temperatures are between 17 and 24°C and rainfalls of 1000 to 2000 mm (Holdridge 1978). Vegetation on its majority is evergreen forest, from 20 to 30 m high, with moderate epiphytism (mayor of Medellin 2006). Among the species present in the area of the study we can find*: Albizia carbonaria* (Pisquin), *Brownea ariza* (palocruz), *Bauhinia varigata* (casco de vaca), *Calliandria medellinensis* (carbonero), *Caesalpinia pulcherrima* (Clavellina), *Crecopia sp*. (yarumo), *Cedrela angustifolia* (cedro), *Cupressus lusitanica* (cipres), *Pinus patula* (pino*), Crescentia cujete* (totumo*), Genipa Americana* (jagua), *Hura crepitans* (tronador), *Eugenia uniflora, Hymenaea courbaril* (algarrobo), *Inga sp.* (guamo*), jacaranda mimosifolia* (gualanday*), Spathodea campanulata* (tulipán africano), *Ochroma pyramidale* (balso*), Tabebuia chrysantha* (guayacan amarillo), among others (Espinal 1992). However, natural vegetation has been historically destroyed for the establishment of urban settlements, coffee farms and leisure properties.

Very humid pre-mountain rainforest (bmh-PM): This life zone is located between 1000 and 2000 m and has climate limits an approximate biotemperature average between 18 and 24°C and an annual rainfall between 2000 and 4000 mm (Espinal 1992). Vegetation of this life zone is widespread in the coffee regions, where is common species such as: *Cordia alliodora* (vara de humo), *Adenaria floribunda* (chaparral), *Aiphanes caryotifolia* (corozo), *Albizia carbonaria* (pisquín), *Cassia spectabilis* (velero), *Cupania* sp., *Erythrina edulis* (chachafruto), *Heliocarpus popayanensis* (balso blanco), *Inga edulis* (guamo), *Tabebuia chrysantha* (guayacán amarillo) and *Trema micrantha* (surrumbo) (Espinal 1992).

Low-mountain rainforest (bh-MB): distributed between 2000 and 3000 m, this life zone has average temperatures of 12 and 18°C and, an annual rainfall average of 1000 to 2000 mm. the bh-MB dominates in the western part of Medellin, specifically by the Alto de Boquerón and towards the San Pedro zone (Espinal 1992), and in some other places in Santa Elena township. Some places are plenty of the species Quercus humboldtii (roble de tierra fria) (Mayor of Medellin 2006b)

Very humid low-mountain rainforest*:* Temperatures in this life zone oscillate between 12 and 17°C, with rainfalls of 2000 to 4000 mm. The bmh-MB is found at heights from 2000 to 3000m (Holdridge 1978). Common species at this life zone, are among others: *Abatia parviflora* (chirlobirlo), *Alchornea bogotensis* (montefrío), *Alnus jorulensis* (aliso), *Befaria glauca* (carbonero), *Cavendishia pubescens* (uvito), *Cecropia teleincana* (yarumo), *Cinchona pubescens* (quina), *Clethra fagifolia* (chirihuaco), *Cordia archeri* (brazo de tigre), *Croton magdalenensis* (drago), *Drimys winteri* (canelo de páramo), *Scheweilera antioquensis* (olla de mono), *Freziera reticulata* (cerezo), *Cupressus lusitanica* and *Pinus patula* (Espinal 1992).

Pluvial mountain rainforest (bp-M): it is located between 3000 and 4000 m, with average temperatures of 6 and 12°C and annual rainfalls over 2000 mm. this region is commonly called "paramo" or "subparamo", in some places it starts at 2800-2900m this life zone is present in the Padre Amaya hill and Alto del Boqueron (Los Baldios), where mosses are abundant over the trees, lichens, orchids and species like: *Drimys wintery* (canelo de páramo), *Hediosmum* sp. (silbo-silbo), *Brunelia boqueronensis*, *Miconia rudis*, *Weinmannia articulata* (encenillo) and *Persea ferruginea* (aguacatillo) (Espinal 1992).

It is important to clarify that in the area of study the dominant life zones are the humid pre-mountain rainforest (bh-PM) and the low mountain rainforest (bh-MB), for this reason the proposed species by forestry models, are species which eco-physiologically adapt themselves to the climate characteristics of each life zone.

In the municipality of Medellin, has a high diversity of landscapes (Figure 6), which have immersed ecosystems with high ecologic importance, because they have native vegetation and wild life with conservation priorities, or either because of the goods and services offered by eco-tourism, hydrologic caudal regulation and their cultural meaning for the population. Others, although are visibly impaired are key for the landscapes connectivity and maintenance of the biodiversity. Below there is a brief description some important ecosystems for the municipality. A detailed description can be found in technical documents like Plans of watersheds management, the POT-Diagnostic (2007) and the POMCA (2007) of the municipality of Medellin. Next is presented in a succinct way the main ecosystems in each one of the villages:

Altavista: In this village still exists native forest and high stubbles which protect the existent micro-basins (e.g Aguas Frias, La Buga, Altavista streams among others). Additionally, the formation of the Barcino which determines the limit between Itagüí and Altavista, is an important ecosystem of this township (mayor of Medellin 2006b)

San Antonio del Prado: in the formation of Barcino exist considerable forest areas, particularly above heights of 2,200m. These native forests have huge esthetic and environmental value as they provide goods and services (water for rural aqueducts, local habitat for important species, etc.). Water of basin discharges in the Doña Maria stream and in the Medellin river (Alcaldía de Medellin 2006b).

San Cristobal: The main natural ecosystem of this township is the Padre Amaya-Las Baldias formation with its ramifications in the sectors of La Culebra and the Alto del Boqueron. In this ecosystem is born one of the main Medellin River´s tributaries: La Iguana stream. Additionally, on the top of this orographic formations exists native forest moderately intervened. (Alcaldia de Medellin 2006b)

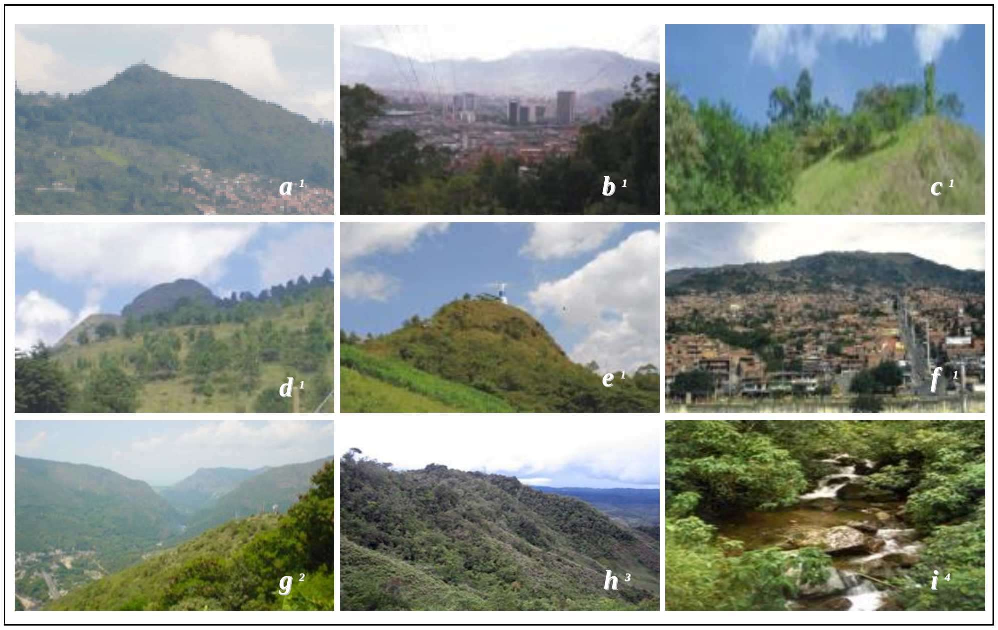


Figure 6 Some ecosystems of the municipality of Medellin a) El Volador hill b)La Asomadera hill c) Nutibara hill d)Pan de Azucar hill e)Picacho hill f)Santo Domingo hill g)panoramic view from Alto del Boqueron h)native forest intervened and i)Santa Elena stream (high part).Source: 1www.medellin.gov.co, 2www.inco.gov.co (alto boquerón), 3www.corantioquia.gov.co (bosques), 4 www.fluidos.eia.edu.co.

Santa Elena: The regional park Arvi which this township makes part is a reserve which hosts vegetable communities where numerous species live, being the "cold soil oak" (*Quercus humboldtii*) the most notorious. There are also species of ecological importance like: the canelo (*Hyeronima antioquensis*), silbo-silbo (*Hedyosmum bonplandianum*), arrayán (*Myrcia popayanensis*), encenillo (*Weinmannia pubescens*), sauco de monte (*Viburnum anabaptista*) and the cordoncillo (*Piper cabellense*). Regarding to the wild life, Santa Elena area have reported around 150 species of birds and 18 of mammals (Corantioquia 2008, Parques Nacionales 2008).

San Sebastian de Palmitas: This village has high hydrologic wealth. Although the main activity is agricultural, still survive important forest relicts which must be conserved, especially the areas belonging to the influence area of the streams (Alcaldía de Medellin 2006b)

Some other municipality areas deserve to be recovered and/or conserved to rehab the landscape structure and the bio-geographic viability of the ecosystems which belong to the area. According to POMCA (2007), the geographic zone which extends from the Alto de Las Baldias, passing by Padre Amaya hill, Alto del Barcino, connecting with the Ana Diaz and La Picacha streams, to finish in the south side of the Altavista sub watershed in the Montes del Encanto, which creates a conservation unity and conforms an important ecologic corridor. This corridor is made up by surfaces from 2200m (bh-MB) to 3150m (bp-M), so it contains wide ecologic variability and habitats. Furthermore, it is a strategic Andean ecosystem, with great relevance for the regional hydrologic system.

Soil coverage in the rural area

During the first 30 years of the 20^{th} century, Medellin had a considerable growth on its population (Figure 7), from 59,815 inhabitants in 1905 to 358,189 in 1951. This happens as a result of the trade and industrial attractiveness offered by the new city. Gold extraction and trade, was one of the first activities of the municipality's economy. However, the coffee aptitude of the region and the bonanza on the prices in the international market, were the activities that allowed to broad the purchasing capacity of the population, due to the required work force. During these days, the boom of the coffee and the industrial development through the textile sector present in the city, led to the development of communication infrastructure which expanded the agricultural boundaries and the regional economy (Public Improvements Society 1975, Restrepo 1981). Nowadays, Medellin is the second city in Colombia and is characterized by its high economic, industrial and cultural development when compared to other cities of the country.

(a) (b)

Figure 7 Urban growth of the municipality of Medellin a) Panoramic view of the city from El Volador hill in 1970 and b) Panoramic view of the city from El Volador hill in 2000. Source: www. Panoramio.com/photos/.

According to the map of vegetable coverage and current use of the land from IGAC (1995), Medellin shows lands in agriculture: Miscellaneous, with occupied areas mainly in temporary crops, perennial and semi-perennial crops which are mixed with grass, stubbles and forest relicts. This agrees with the report from the mayor of Medellin (2006a) and the POT of Medellin (2007), where specifically for the rural area of the municipality, in the year 2004, the vegetable coverage correspond to 27,466.7 ha approximately, and are dominated mainly by, high stubble (32.10%), natural grass (20.02%), planted forest (15.25%) and managed grass (12.67%). High stubbles dominate in all villages, and correspond to forest relicts and successive state lands located in the highest zones, which protect the branches of the streams (Figure 8). Natural grass is used for the extensive bovine production and without productive use, and it is found in big extensions, mainly, at the slopes which limit with the urban zone of Medellin: Townships of San Sebastian de Palmitas and Santa Elena. The planted forest (15.25%) is located in the townships of Santa Elena and San Antonio de Prado, and a part of it corresponds to commercial plantations; the rest of the area, (12.67%) is managed grass in big extensions in the townships of San Antonio de Prado and San Cristobal, where the intensive bovine technical production has more importance.

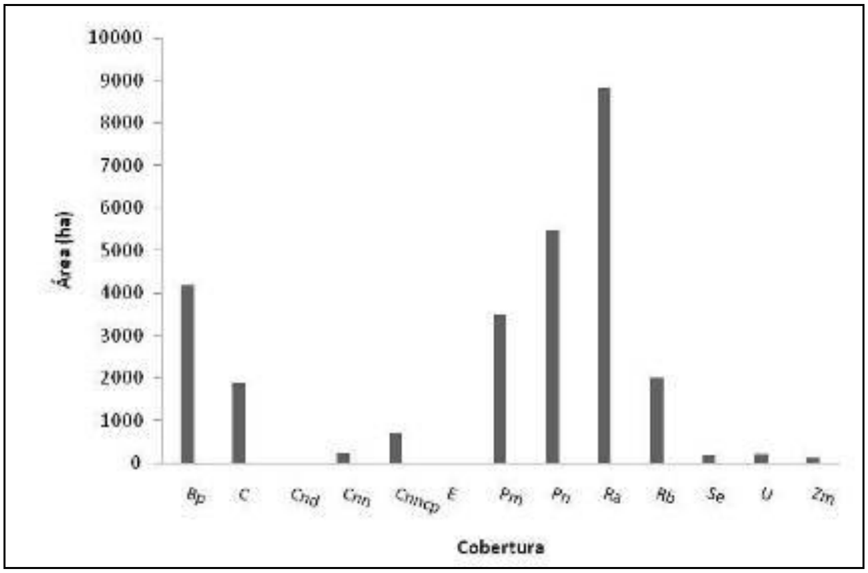


Figure 8 Land cover types for the rural zone of the municipality of Medellin. Bp: Planted forest, C:farming, Cnd: disperse constructions, Cnn: Centered constructions (nucleated constructions) Cnncp: populated centers, E:Dams, Pm: Managed grass, Pn: Natural grass, Ra: High stubbles, Rb: Low stubbles, Se: eroded soil, U: Urban and Zm: Mining zone. (It is highlighted the lack of description of coverage of the natural forest in the study).

In general, the land use in the rural zone of the municipality of Medellin is adequated according to the uses defined by the POT of Medellin, and only an area corresponding to 29.40% presents inadequate soil management. On the other hand, 3.25% of the territory, did not present information about the use of the lands defined by the POT, due to this areas were declared zones with the faculty for the urban development, so they are part of the expansion lands of the municipality. In terms of conflict, the rural area of the municipality, has a 67.35% of its extension without conflict on the use defined by the POT, 25.89% present severe conflict, because the current use of this coverage belongs to the forbidden use category and, the most severe conflict, is present in natural grass coverages and managed grass which in the majority of cases are forest competence according to the POT, only 3.51 of the coverages in the rural area of the municipality, are located where the use of the land is restricted, particularly, in the case of crops and natural grass, where the use of the land should be for forest protection or urban-rural use (Table 13) (Alcaldía de Medellin 2006a).

Tabla 12 land cover in rural areas of the municipality of Medellin in 2004. Source: Alcaldia de Medellin 2006a.

Type of coverage	Code	Township (area in ha)					Total (ha)
		Alta vista	San Antonio de Prado	San Cristóbal	Santa Elena	San Sebastián de Palmitas	
Planted forest	Bp	222.80	1,535.50	57.50	2,232.30	141.80	4,189.90
Crop	C	134.50	169.40	606.00	124.40	875.90	1,910.2

Type of coverage	Code	Township (area in ha)					Total (ha)
		Alta vista	San Antonio de Prado	San Cristóbal	Santa Elena	San Sebastián de Palmitas	
							0
Disperse constructions	Cnd	0.00	26.50	0.00	2.10	0.00	28,60
Centred constructions	Cnn	4.00	0.00	125.60	66.90	41.50	238.00
Populated centers	Cnncp	90.30	36.60	49.10	543.30	0.00	719.30
Dams	E	0.00	0.00	0.00	17.00	0.00	17.00
Managed grass	Pm	40.20	1,493.90	1,466.90	294.60	185.20	3,480.80
Natural grass	Pn	724.10	625.90	1,077.70	1,436.50	1,634.00	5,498.20
High stubbles	Ra	788.60	1,630.40	1,556.50	2,400.00	2,441.60	8,817.10
Low stubbles	Rb	644.80	300.40	374.80	283.00	418.90	2,021.90
Eroded soil	Se	63.30	18.00	59.90	13.00	45.00	199.20
Urban	U	0.00	224.50	0.00	0.00	0.00	224.50
Minning zone	Zm	115.30	0.00	6.90	0.00	0.00	122.20
Total		**2,827.90**	**6,061.10**	**5,380.90**	**7,413.10**	**5,783.90**	**27,466.90**

Presence, if any, of rare or endangered species and their habitats:

According to Corantioquia (2000) the most important environmental services which are offered by the vegetable coverage in the metropolitan area (Which includes the municipality of Medellin) are the carbon fixing, and the contribution to the feeding security of the inhabitants. However, the expansion of the urban areas generates different levels of pressure on the natural resources, which are reflected on the environmental equilibrium and the ecologic sustainability of the existent ecosystems and the wild life surviving in the area (POMCA 2007). In general terms, the isolation of some parts of the natural forest in the municipality of Medellin, has disabled the dispersion of seeds, restricted the genetic variability and limited the succession processes in the surrounding areas which have been degraded due to the substitution of the forest coverage by grass, agricultural systems and urban settlements. As a consequence, some vegetable coverage does not present high diversity on species, and some decrease on wild life and plants population has been detected. According to the POMCA (2007), although in basins like the Medellin River basin persist ecosystems which contain stable populations of high ecologic value species, the structure of the landscape appears as a very fragmented matrix which endangers the survival viability of very delicate wild life populations. This is why according the same study (POMCA 2007), for the conservation of the biologic diversity and the preservation of services (genetic resource banks, hydrologic and climate regulation) and potentialities of some zones "*it is necessary to manage and recover zones of high and low stubbles, connecting them to each other, and with the fragments of the intervened forests and riparian vegetation of the drainage net".*

In general, among the endemic vegetable species for Colombia, located in the assessment area and with a restricted distribution are these: *Brunellia subsessilis and Licania cabrerae*. At the same time, these species as well as: *Wettinia hirsuta* (macana), *Quercus humboldtii* (oak of cold lands), *Dugandiodendron guatepense* (Magnoliaceae) and wild species of bromeliads, orchids, heliconias and zarros or arboreal ferns are within the categories of threat, vulnerability or at risk of extinction (POMCA 2007, Corantioquia 2008: 10194 of 10 of April of 2008). For wildlife, *"because to the fragility of many species and their demand for undisturbed ecological [environments] and of considerable size, it is likely that most of them could disappear together, as a result of the destruction of previously existed forests"* (POMCA 2007). That is why, existing native fauna, is represented by only few species that have been adapted to new habitat conditions and those whose were able to establish again. Wildlife present in the Municipality of Medellin, species of ecological interest are: *Icterus* sp. (turpial), *Turdus* sp. (blackbird), *Eira Barbara* (taira), *Potos flavus* (wild dog – ferret), *Aotus lemurinus* (night monkey), *Agouti paca* (guagua), *Cerdocyon thous* (fox) and the linnet bird founded in the fragments of moderately disturbed native forest (Figura 9) (Jardín Botánico y Asinter 1997).

Given this brief overview, the protection of forest fragments and the reforestation of degraded areas are very important measures for: soil conservation; regulation of natural flow regimes of streams; and the conservation/establishment of the existing flora and fauna of the region. Additionally, according to a report by Corantionquia (2000), there is no balance between the greenhouse gas (GHG) emissions that occur in the metropolitan area and the existing forest cover. Therefore, the capture rate of gases like carbon dioxide (CO_2) from the atmosphere is inadequate and brings environmental pollution problems as a result. This brings serious impacts on health and quality of life of the population (POMCA 2007). In the context, the Project *"Forestry Project of carbon capture to valuation, recovery and management on the hills, slopes and strategic ecosystems in the municipality of Medellin (Colombia)"* is not a threat for rare species or species at risk of extinction at the moment of being implemented and without presence of species of high ecological importance. Instead of it, reforestation for these areas is a benefit for conservation of rare species which are outside the boundaries of the project; it will enhance connectivity between forest fragments which is one of the recurring suggestions for most of the Integral Plans for Land Use and Micro-basins Management of the municipality of Medellin (PIOMES), and additionally, it will contribute to the mitigation of global climate change through the fixing of greenhouse gases such as CO_2.

Figure 9 Some species found in the Municipality of Medellin.

[1]www.wikimedia.org., [2]www.corantioquia.gov.co, [3]www.davesgarden.com, [4]www.elcolombiano.com, [5]www.medellin.go.co, [6]www.mascotasymascotas.com, [7]images.easyart.com, [8]www. flickr.com, [9]www.biologia.eia.edu.co/ecologia.

2.10 Compliance with Laws, Statutes and Other Regulatory Frameworks

One of the benefits identified for this project activity is to promote the Knowledge of the national forest law and the benefits and incentives obtained by working with the project. According to this, there have been many laws and regulations related to the forestry sector, mostly oriented to conservation, but which have not been sufficient to encourage commercial forestry on a large scale.

Colombian forestry legislation provides incentives to commercial reforestation through the Forestry Incentive Certificate (CIF) under Law 139 of 1994. However, the impact of this incentive has not been significant and effective in its aim to promote reforestation, due to high transaction costs and fact that the effectiveness of the incentive depends mainly on the availability of budgetary resources. When national fiscal resources become scarce, the CIF is often not funded due to other priorities.

The project is according of development plans of Municipality of Medellín and Antioquias department that are looking for the achievement of economic benefits by the service of carbon capture by forestry to support the Global Warming mitigation, as a social and environmental and economic viable alternative aimed to the contribution of the sustainable development of the region.

In addition to this, considering the laws of contract, each person has its individual employment contract where as contractor has the duty of paying its own social security against the risks of sickness and accident, in addition to financial compensation for the work performed by the worker.

Every worker has the right to receive job training and it must be provided by the employer in order to raise the standard of living and productivity, according to the programs formulated by mutual agreement between the employee and the employer.

2.11 Ownership and Other Programs

2.11.1 Right of Use

To group the owners of the areas eligible Forestry Project, there were several approaches with them. These approaches consisted of individual visits and socialization on the project. Following these approaches, owners interested in the project, voluntarily signed a letter of intent to participate in the project.

Later, after summarizing each owner with the technical and stand models to establish for each property, the office of Environment of Medellin made the drafting of the contract. By contract, the owners agree to maintain the forestry model during the crediting period . Additionally, a copy of title to land is attached to the contract, as a guarantee that the land is legal and no subsequent conflicts related to ownership of it.

2.11.2 Emissions Trading Programs and Other Binding Limits

There are no other emissions trading programs or binding limits

2.11.3 Other Forms of Environmental Credit

There are no other forms of environmental credits under which the project is planning to be eligible to participate.

2.11.4 Participation under Other GHG Programs

Project is not considering to be validated under other GHG program

2.11.5 Projects Rejected by Other GHG Programs

The project has not been rejected by other GHG program.

2.12 Additional Information Relevant to the Project

Eligibility Criteria

According to the CDM Methodology Booklet November (2012 (up to EB 69)) has been considered that:

• *Vegetation cover on the land eligible for project activities must have been below the forest threshold[2] on 31 December 1989. This needs to be proven (e.g. using satellite image or participatory rural appraisal (PRA));*

For the coverage analysis within the Project limits, were identifies those areas which will not apply for the definition of forest considering the current regulation for Colombia through its designated national authority (Environment minister and rural development)[3] (OCMCC), according to which the forests are characterized by: 30% tree crown coverage, areas with minimum extensions of a hectare and minimum heights of (5 m)[4]. The analysis, allowed identifying that some areas within the municipality of Medellin were not eligible as they did not match all criteria requirements for the definition of forest approved by the designated national authority. In this way, such areas were discarded to be included in the project limits and were considered as potentially eligible, those areas covered by grass, crops and low stubble in the current uses and from 1986. Analysis also concluded that the current uses of the lands are not temporary and are results of cultural, economic and social processes present in the region.

• *No tree vegetation is expected to emerge without human intervention to form a forest on the project land;*

Based on the analyzed information, we can conclude that since 1986 there was not forest coverage in the areas where the project will be implemented and apart from the existent coverage, they do not comply with the established parameters for the definition of forest according to the designated national authority.

- *In absence of the project activity, carbon stocks of the carbon pools not considered in the project activity are expected to decrease or increase less relative to the project scenario.*

The use of the lands within the limits of the project by 1986 was grass, crops and low stubble; they remain in the areas where the project will be implemented.

Leakage Management

[2] The host country determines the forest definition which lies within the following thresholds: A single minimum tree crown cover value between 10 and 30%; and a single minimum land area value between 0.05 and 1 hectare; and a single minimum tree height value between 2 and 5 metres

[3] http://cdm.unfccc.int/DNA/index.html

[4] http://cdm.unfccc.int/DNA/ARDNA.html?CID=49

According to the A/R Large-scale Methodology AR-ACM0003(Version 01.0.0) equation 4 leakage is considered as zero.

Baseline scenario was described as abandoned pastures areas and meadows for cattle grazing activities for milk production. With the implementation of the project, it is expected landowners could integrate silvopastoral stand model in their economic activity. To this, each owner will schedule cattle activities according to the plantation establishment schedule, by intensifying grazing in some areas of the project, while first established plantations reach the appropriate age and size to tolerate animals in a given time. This is for the silvopastoral stand model.

Furthermore, most of the wood used in a domestic way by the owners is not extracted from eligible areas within properties, due to the existing low supply of wood. Therefore, the establishment of stand models will not raise wood collection activities outside the scope of the project, instead of it; wood pressure collection will decrease in nearby areas, due to the supply of wood wastes generated by medium term of stand models.

Finally, the establishment of stand models will not raise the use of wood posts, because most of the properties that define the scope of the project are divided by previously established fences. Additionally, if it´s necessary to establish new fences for some areas protection, wood from the model, inscribed within the project boundary, will be used.

Commercially Sensitive Information

There is not commercially sensitive information about the project already identified.

Further Information

Between the years 1998 and 2005, it was established a reforestation initiative in the zone, with not very successful outcomes (Plan Ladera), due to lack of accompaniment in the process. The Plan Ladera project is a referent for forest projects for the rural communities of the municipality of Medellin, on which were established *Pinus patula* plantations and *Eucalyptus.* In general, the perception of this project has not been favorable, especially in the townships of San Sebastian and San Cristobal because of the poor maintenance, technical support and contracts non-compliance. In Altavista, however, this project has a wide acceptation and has contributed to minimize the pressure on the access to lands for illegal housing, the plantations have been like a barrier for the urban expansion, leading to conservation of micro-watersheds and improving the landscape component

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Methodology applied*: AR-ACM0003. Afforestation and reforestation of lands except wetlands. Version 01.0.0*[5]

3.2 Applicability of Methodology

[5] https://cdm.unfccc.int/methodologies/DB/WB63WYT7LKF8N6V0A3YXXXI8GCP2J3

This methodology is applicable under the following conditions:

(a) The land subject to the project activity does not fall in wetland category;

The areas of the Project present current use coverage: *Natural grass, Managed grass, Mining zones and eroded soils.* Although the agricultural crops are also eligible, it was decided to center the plantations in degraded soils and grasses. The areas which in the eligibility process presented high and low stubbles coverage were discarded, due to the uncertainty generated in these coverage respects to the forest definition parameters.

According to the study done by the Mayor of Medellin 2006 and the POT of Medellin (2007), the grass areas in the zone are used for extensive type bovine production or do not have productive use. These conditions of unproductive lands and low load capacity in the grazing areas reflect the degradation stage and loss of soils. Referent to the carbon content in the baseline scenarios were estimated values between 1,8 and 22 t C ha^{-1} (Carbono & Bosques, 2008[8])

Simultaneously, verification is being done in eligible properties field greater than 3 ha confirming the status of soils degradation in the grazing areas and the low productivity of the crops present in the eligible areas.

(b) Soil disturbance attributable to the afforestation and reforestation (A/R) VCS project activity does not cover more than 10 per cent of area in each of the following types of land, when these lands are included within the project boundary:

(i) Land containing organic soils;

(ii) Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 to this methodology.

Preparation of soils does not lead to a significant reduction on the carbon content in the soils in the long term or a relevant increase on the emission of gasses different to CO_2 from soil. Preparation activities will be done following the *"Management plans for the plantations of the Forestal Project More Forests for Medellin".* According to these, the brush will be eliminated and trees already present in the properties will not be removed

The processes of transformation and changes in the use of land prove the expansion tendency of the agricultural boundaries and vegetal coverage elimination; with the purpose of generate grazing areas. Additionally, grazing activities prevent the starting of natural regeneration process and in the case of a project suspension; the degradation conditions of the soil do not allow a vegetal regeneration in a natural way.

According to Mahecha (2002), incorporation of tree component in the bovine systems, helps to reduce the erosion processes, due to the reduction on the impact of the rain on the soil, the increase of the infiltration, the permanence of the organic matter on the surface and the aggregate effect of the soil particles. Additionally, the soil fertility is increased and its structure improved by better nutrients recycling, deepening of the trees´ roots and more activity of the macro and micro wild life/fauna.

It is estimated that in the farming of the tropical forest soils is reduced the content of carbon in 40%, in grass the reduction is nearly 20%. This decrease on the content of organic carbon from the soil, drives to fertility loss and increase on the emission of greenhouse gases (Mahecha, 2002). The introduction of forest coverage will increase the carbon content in the planted areas, due to the generation of sotobosque conditions, litter and detritus accumulation around the trees.

In Latin America, between the years 1850 and 1985 the change on the use of land generated a net carbon release of around 30 Pg. C (Houghton et al. 1991). This emission was related mainly to the pasture areas growth (Ibrahim *et al*. 1999).

According to the previous statements, it is expected that the implementation of the Project *"More forest for Medellin"*, raises the content of carbon in the soils of the Project and improves its physical capabilities, while in the baseline scenario, it will decrease or in the best of the cases will remain constant.

In addition to this according to the *documents "Plans for plantations management of the Forest Project More Forests for Medellin"* in the management of the stand models there will not be flood irrigation.

No considerable alterations to the soil will be done. In the plate clearing and hole digging practices: the litter will be eliminated with hoe around the trees sowing place in a radius of 50-60 cm. then a hole will be excavated with a 30 cm diameter and 30 cm deep, through the use of a shovel. The extracted soil will be broken and removed to defragment any hard layer which could make difficult the roots penetration and adequate development.

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3.3 Project Boundary

According to the Methodology the "project boundary" geographically delineates the afforestation or reforestation project activity under the control of the project participants (PPs).The VCS project activity may contain more than one discrete area of land. Please refer to section 1.2 Table 1 for further details on coordinates of compartments selected as part of the project area.

Project areas are only eligible if the area had not been a forest for 10 years prior to the project start or since the 1st of January 1990. This criterion must be proven by ground-truthing, satellite images, aerial photographs, official maps or land-use records.

To determine the current vegetable coverage map, the reference information was work of *Coberturas vegetales,current use of lands and use of the land conflict determination based on the rural zone POT of the municipality of Medellin* (mayor of Medellin 2006a) Plan de Ordenación y Manejo de la Cuenca del Río Aburrá –POMCA[6]-, el Sistema Regional de Áreas Protegidas – Parque Central de Antioquia SIRAP-PCA[7] y el Sistema Metropolitano de Áreas Protegidas –SIMAP-[8] and, to establish de coverage map in a date before the 31st December of 1989, the digital processing was done from the image Imagen *LandSat (Path 9) (Row 56)from* 1986, available at http://www.landcover.org/data/landsat/.

Current land coverage

The coverage maps obtained from the mayor of Medellin (2006) (Figure 10), determine the following categories on their inscription, for current use of the land in the rural sector of the municipality, at 1:5000 scale.

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[6] Mapa Base Plan de Ordenación y Manejo de la Cuenca Río Aburrá, 2006.

[7] Corporación Autónoma Regional del Centro de Antioquia Corantioquia, 2008. Delimitación, Zonificación y Formulación del Plan Operativo, para el Desarrollo del Plan Estratégico del SIRAP - PCA. Gobernación de Antioquia Coberturas Terrestres "Corine Land Cover" IGAC, 2007

[8] Universidad de Antioquia - Corporación Académica Ambiental, Medellín, 2007. Soporte Conceptual y Metodológico del Sistema Metropolitano de Áreas Protegidas para avanzar en su Promoción y Desarrollo. Resultado de la homologación de las convenciones de las diversas fuentes, se obtuvo una clasificación de la cobertura de acuerdo con lo planteado por Corantioquia (2002).

i. Planted forest (BP)
ii. High stubbles (Ra)
iii. Low Stubbles (Rb)
iv. Natural grass (Pn)
v. Managed grass (Pm)
vi. Crops (C)
vii. Dams (E)
viii. Disperse constructions (Cnd)
ix. Populated centers (Cnnp)
x. Constructions (Cnn)
xi. Eroded soils (Se)
xii. Mining zones (Z)
xiii. Urban (U)

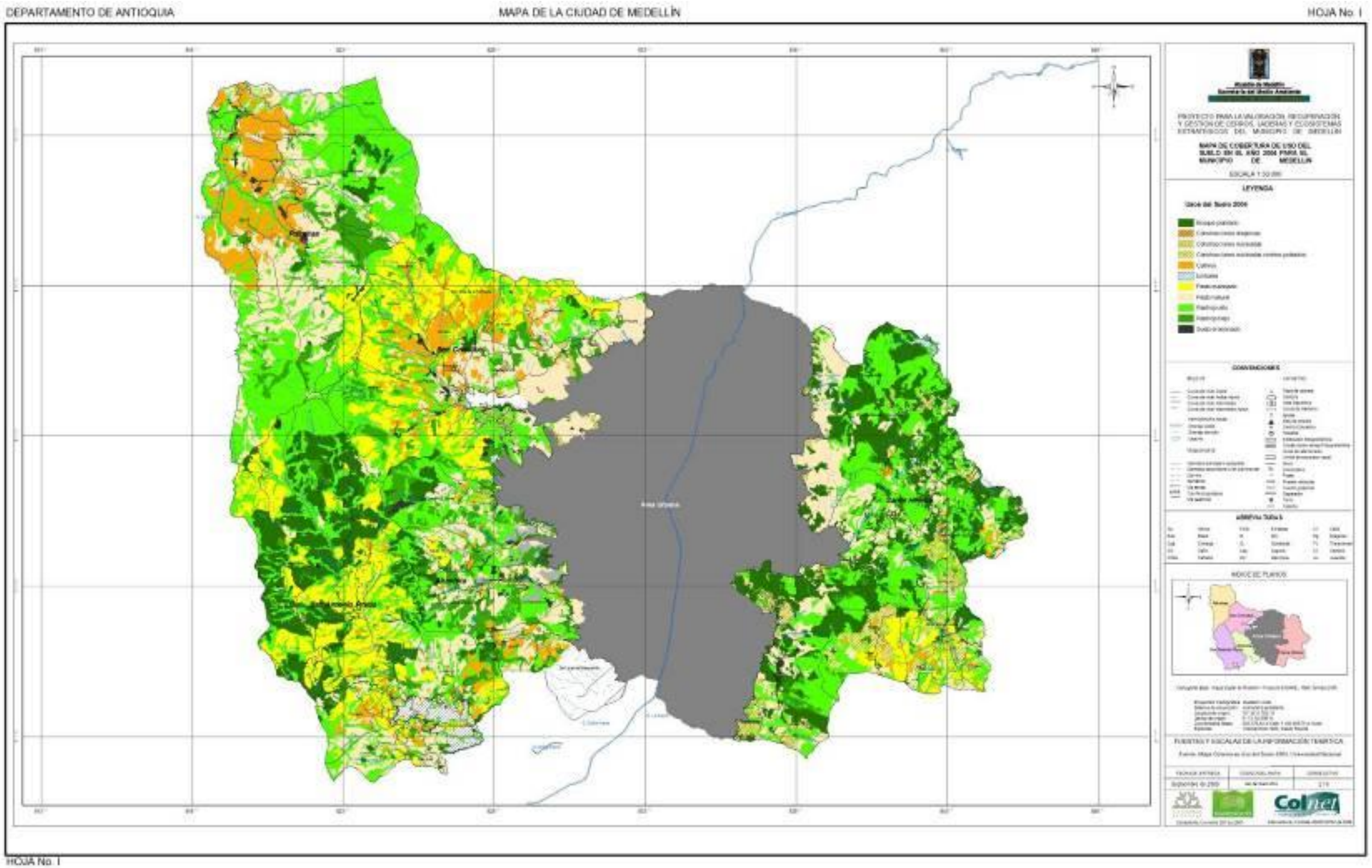


Figure 10 Land use in the rural zone of the municipality of Medellin in year 2004

After considering the forest definitions of the UNFCCC and the OCMCC, it was determined that those areas which possessed coverage of planted forest, high stubbles, constructions, populated centers, disperse constructions, urban and dams in the present, would not be considered as potentially eligible areas.

As potentially eligible areas are then considered, only those surfaces which present current use coverage: *Natural grass, managed grass, crops, low stubbles, mining zones and eroded soil* (Table 14).

Tabla 13 Potentially eligible areas for a forest Project under the VCS in rural areas of the municipality of Medellin for the year 2004

Coverage	Reclasification	Total (ha)	Percentage (%)
Natural grass	Grass	8.969	62,72
Managed grass			
Low stubbles	Low stubbles	3.101	21,69
Crops	Crops	1.908	13,34
Eroded soil	Eroded soil	199	1,39
Mining zones	Mining zones	122	0,85
TOTAL		**14.299**	**100**

The described areas in the above table, add a total of 14.299 ha considered as eligible for today

Land coverage previous to 31st of December of 1989

The determination of the use of the land for dates before the 31st of December of 1989 (Table 15), indispensable requirement for the presentation of the forest project under the VCS, was carried out by the digital processing of the LandSat image (Path 9) (Row 56) from 1986 (Figure 11).

A search through the USGS Global Visualization Viewer-Glovis international catalog was made, disclosing and transferring remote sensing images managed by NASA and allowing searching, viewing, selecting and downloading images from Landsat 7 ETM+, Landsat 4/5 TM, LANDSAT1-5 MSS, EO-1 Hyperion, MRLC, Aster TIR, Aster VNIR remote sensing devices, and MODIS products. The download is done directly through the image or by ordering on the following link (http://glovis.usgs.gov/).

The main criteria for the selection of the images were:

• Cloud cover percentage less than 20%. Value assigned by USGS to the image area percentage occupied by cloud cover or cloud shadows that varies between 0 and 100%.

• Image quality equal to 9. Refers to a technical quality indicator of the data (presence of radiometric errors, adverse effects, etc.) assigned by USGS that varies between 0 and 9, in which 9 is the highest rating, having less image errors.

It was used a panchromatic SPOT5 image with a 5m spatial resolution, from May, 2005, wich was orthorectified as the basis for the geographical correction of the LANDSAT images with a 30m spatial resolution.

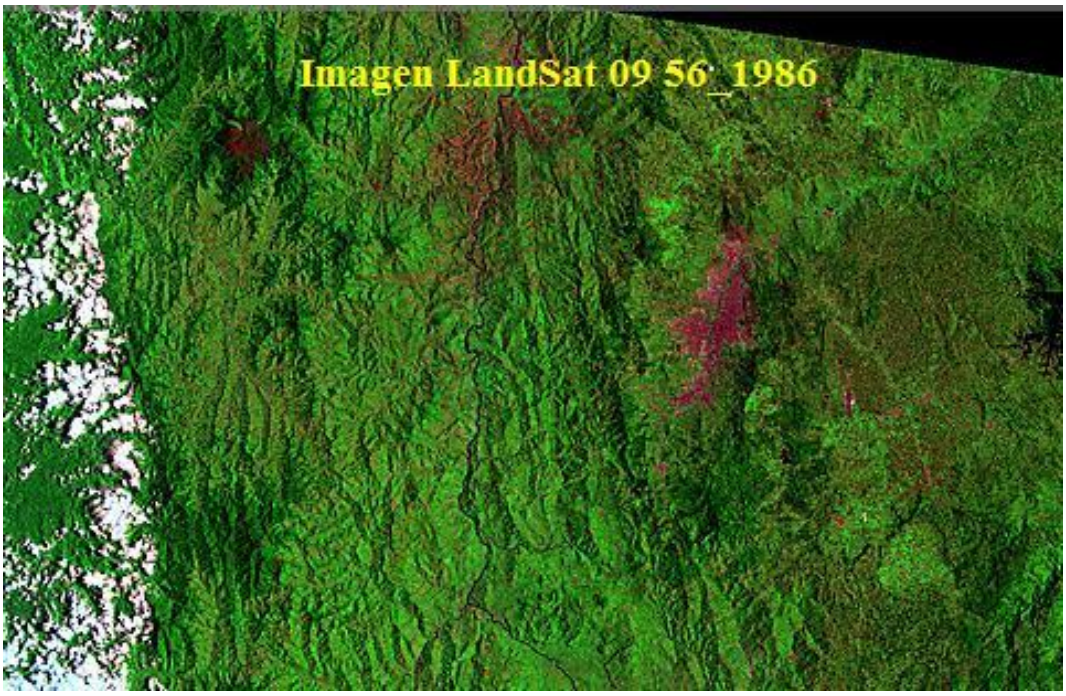


Figure 11 Satellite image LandSat.After considering the definitions of forest of the UNFCCC and the OCMCC, it was determined that those areas which possessed coverage of forest, high Stubbles, Urban Zones, Shadows, Clouds and Water for 1986, would not be considered as eligible.

Tabla 14 Potentially eligible areas for a forest Project under the MDL in areas of the municipality of Medellin for the year 1986.

Coverage	Total (ha)	Percentage (%)
Forest	14463,8	49,03
Non Forest	13909,3	47,17
Others	1125,5	3,8
TOTAL	27808,67	100

To the date prior to December 31, 1989 eligible areas (non forest) totalling 27.808,6 hectares

Eligible areas

Due to the difference in the scale of information (current coverage 1:5.000, previous coverage 1:25000), a generalization of the information on current coverage was done, through the union of polygons with the same category of use and using as minimum spatial unit of measure, polygons of 625 m2. The spatial analysis was performed for a 1:25000 scale.

After establishing the coverage considered as potentially eligible in each one of the moments of time, we proceeded to do the information crossing to determine the areas which comply the eligibility criteria. In this way, areas with size under 1 hectare and in any of the considered moments were in forest coverage, high stubbles, water, shadow or clouds were discarded. Later on were eliminated the areas which were determined as eligible, but only those ones spatially located in defined areas by the POT of the municipality, as urban expansion areas.

All processing was performed using ENVI 4.7 and ArcGis 10.1 programs.

The result of this process of validation and recognition in the field, was the identification of **11.268,68** ha eligible (Table, 16, Figure 11)

Tabla 15 Eligible areas for a forestry Project under the MDL in areas of the municipality of Medellin

Villages	Eligible area (ha)	Percentage (%)
Altavista	1.677,5	14,88
San Antonio de Prado	2.702,8	23,98
San Cristóbal	3.290,5	29,20
San Sebastián de Palmitas	2.724,18	24,17
Santa Elena	874,2	7,77
TOTAL	**11.268,68**	**100**

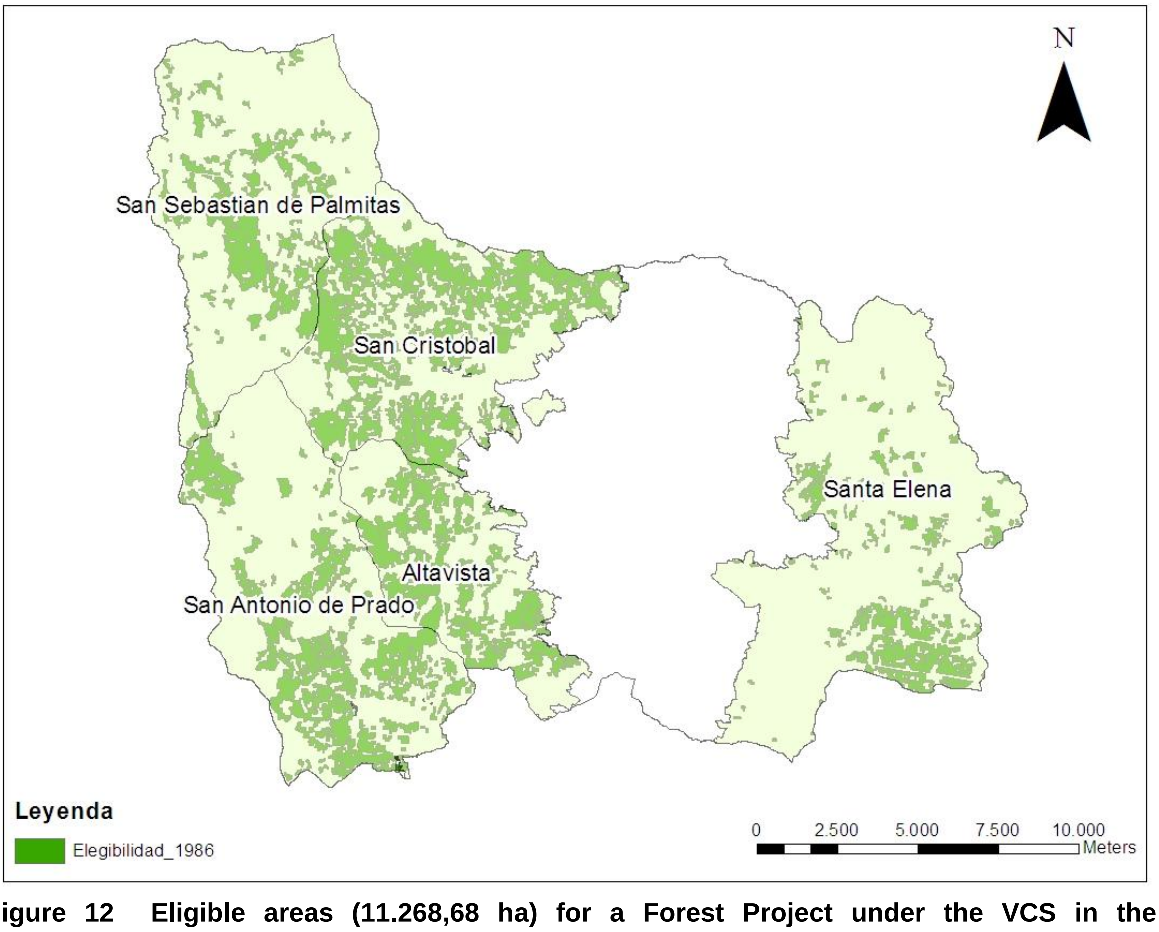


Figure 12 Eligible areas (11.268,68 ha) for a Forest Project under the VCS in the municipality of Medellin

Once a new area is identified its boundaries will be checked with information provided by cadastre official database. In this case each project boundary will be analysed in terms of physical and legal characteristics. For each instance the eligibility information will be filtered bearing in mind the Property Relation and DS Relation attributes, of the cadastre base, which describe the type of relation of the property under 4 categories:

- without defining,
- improvement,
- possession and

- Real.

Only those properties which have at least a relation-type Real owner **and possession** were considered to be evaluated as a part of project area. The final decision to make an area part of the project area was the letter of intention from the project owner as an enforceable and irrevocable agreement that certifies his intention to guarantee the GHG emission reductions during the project crediting period.

Considering this specific eligibility criteria project area corresponds with 685,8 hectares (Table 17, Figure 13)

Tabla 16 Eligible areas with letter of intention from the project owner

Villages	Eligible area WITH LETTER OF INTENTION (ha)	Percentage (%)
San Antonio de Prado	112.8	17
San Cristóbal	468.5	68
San Sebastián de Palmitas	104.5	15
TOTAL	**685.8**	**100**

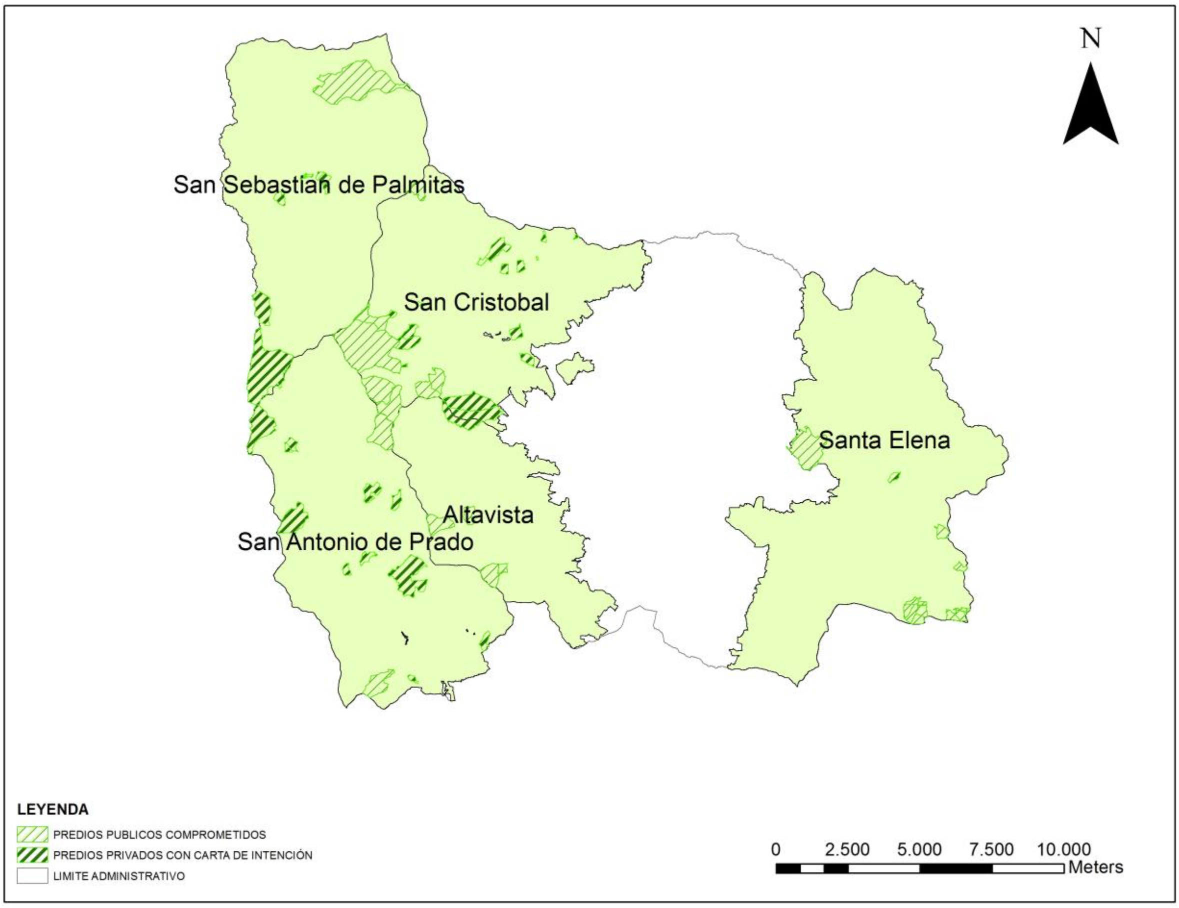


Figure 13 Elegible areas with intention letter from the project owner in the municipality of Medellin

2.4 Baseline Scenario

The baseline scenario will be developed according to the Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities;" V 1.0 and will be described in section 2.5

2.5 Additionality

The additionality analysis will be developed according to the Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities;"

Step 0. *Preliminary survey according to the forestry VCS start date.*

Forestry Project *"More forests to Medellin". ("Mas Bosques para Medellín"),* proposed in 2007 for the Municipality of Medellin and accepted by the Environmental Authorities: Área Metropolitana del Valle de Aburrá and Secretaría del Medio Ambiente, under Convey 287 of 2007, was created with the aim of promoting sustainable development of the Region, by benefiting the communities and protecting natural resources through the establishment of Commercial Forest Stand plantations, Agroforestry systems, Silvopastoral systems, Assisted Natural Regeneration Stand models and Forest Enrichment model. First tree was on February 01 of 2010
.

Background, the project has received technical assistance from institutions with experience in the formulation, design and implementation of forestry projects under the MDL and VCS model, these institutions are Corporacion Autonoma Regional Río Negro – Nare (CORNARE), Corporación para el Manejo Sostenible MASBOSQUES y la Corporación Centro de Investigación en Ecosistemas y Cambio Global – Carbono y Bosques (C&B). In 2008 and 2009, during the formulation process of the project have been some socialization sessions, lectures, and forums, among others, with public and informative purposes. In these spaces, owners have been informed properly about the implementation process of the VCS component. Also about the implications, commitments, liabilities, social-economic-environmental benefits, and possible risks that this component bring to the forestry project.

Step1. *Identification of alternative land use scenarios for the proposed AR VCS Project activity*
Sub-step 1.a. identification of credible alternative land use scenarios for the proposed AR VCS project activity.

In the specific areas where the project will focus, the without project productive alternative is the *cattle-grazing.* This is due to agricultural activities are not attractive activities to the owners.

Cattle-grazing.

About alternatives of economic land uses in the area of influence, it is remarkable that population is disappointed of agricultural production. That is why they historically have chosen to use their land for **cattle-grazing**. Community expressed a disagreement in relation to productive processes that traditionally have been carried out in the rural area, as a result of affected agricultural production due to maintenance, commercialization, marketing, pricing of products, and supplies difficulties. Intermediary and traders of cropped products get most of the profit, which generates to farmers disappointment, devaluation and un-knowledge of the value and importance of their work.

Although many owners are not attempting to develop programs or projects that jeopardize the daily subsistence, they recognize the importance of the water sources protection and to begin activities for reforestation processes to soil recovering and prevent landslides. In this regard, they consider to use the plantation of forest species with commercial and silvopastoral systems in which they can obtain a short-time income.

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

Cattle grazing can be implemented in areas without restrictions of use (Unrestricted category (SR)). In these sense, alternative activity identified is consistent with the regulation and laws over the eligible areas.

Step2. *Barrier analysis*

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

Investment barrier

In the country there is not any incentive of "forest loan", with the exception of two Banco Agrario´s programs: "Plantation and maintenance" and "forest exploitation" (Secretary of Agriculture and Rural Development 2005). In contrast, there is an agricultural structure of loans, with a vision of productive chain and policies that give more and better stimulus for farming and livestock activities than the forest activity. The forest activity is framed within loan structures designed for the agricultural sector; occasionally can be used for forest activities (Acosta 2006). However, it is necessary to consider the forest sector as atypical compared to the agricultural sector, due to the high investments it demands, maturity deadlines, biological cycles, maintenance demands, etc. (Secretary of Agriculture and Rural Development 2005).

This lack of interest from public and private banking is because forest sector is considered as a high risk investment, with long term returns (Acosta 2006) besides:

- Among the forest business characteristics there is the existence of long unproductive periods, between the three (3) and twenty five (25) years.
- Between long unproductive periods, some thinning activities are performed, which can generate some partial income, but this does not happen more than twice in long periods of wood duration.
- Forestry business demands a very important initial investment in the first years of the project, when plantation and early maintenance. As mentioned above, these are followed by extended unproductive periods. Afterwards, is difficult to conciliate a proper cash flow with the acquired financial obligations in terms of payments, different to the very well-known standards for agricultural projects.
- Given the special circumstances, the financial exercises require special profitability calculations in order to cover periods not very common on the traditional schemes. This exercise has not been done for the forestry business and is mandatory to obtain understanding of how this type of projects work, aiming for a better group of conditions, interest rates, deadlines, amortizations, etc. more suitable with forestry reality.
- In the field of the obtained guarantees from the national banking, there are obstacles related to properties acceptation and wood itself. It is necessary for the financial sector to get to know the forestry activity, in order to understand land and wood as assets, which can be used as guarantee. This despite the existence of FAG (Agricultural Funding of Guarantees) which supports loans for the activity.

In comparison, ample lines of credit and financing sources exist for coffee growing and cattle farming (Banco Agrario) because of lower perceived risks, proven experience, and a steady cash flow. Cattle farming require a minimal investment (basically the purchase of cattle). This investment comes from the income earned with the sale of adult cattle. Additionally, this activity requires a very limited labor force, which is supplied by regional inhabitants who have worked for many years in the ranching sector. Given that this is an extensive activity, the region's ecological conditions permit the supply of grass required for production. Lastly, this activity requires little infrastructure given that the management system consists of herding cattle (to handling centers) across pastures that feed them until they reach a marketable weight[9]. There are also tax exemptions oriented to promote the agricultural sector[10].

Barriers as that the lack of knowledge that financial intermediaries have about forest sector, their perception about forest business as a risk in terms of investment and the legal vacuum created through the rejection of Forestry law in 2008[11] have stimulated the banks unwillingness to create flexible credit lines for forestry projects.

About 90% of commercial reforestations are supported by incentives and tax benefits given by the government. These incentives are not enough to stimulate the reforestation adequately[12]. For example, the government created a risk capital in the Fund for Agricultural Financing- Finagro (with more than 30.000 millions COP) to invest directly in the commercial forestry sector, however only 514 millions COP[13] were used for forestry projects (0,99%)[14].

In the case of the areas that belong to the Municipality of Medellin, is clear that there are not enough economical resources to guarantee the establishment of the plantation and its maintenance during the project lifetime. There is a necessity to find more economical resources to guarantee the successful development of the project during its lifetime.

In the case of land owners the Certificado de Incentivo Forestal (CIF) has been created to support A/R activities. According to the Sectorial Forest Monitoring made in 2011 by Banco Agrario of Colombia, in 2008 the total resources received by forestry sector trough government amounted to 51.281 Millions COP[15]. The biggest resources were used trough the CIF (35.000 million COP). It corresponds to 67.57% of resources available. Nevertheless this money is not constant and high transactions costs of obtaining the incentive make it difficult to use. The policies and procedures related to effectively obtaining this incentive are confusing and constantly changing. The delivery of CIF is highly uncertain because it becomes unavailable when the national government accounts go into deficit or when the government changes during the election period (avoidance of corruption). [16]

Further, the level of the incentive is relatively low in terms of the positive externalities generated by reforestation and the high opportunity cost associated with other uses of the land. Second, government deficits often abort the supply of the incentive, even when projects have been approved to receive it.[17].Some projects have waited for more than three years for approval[18]. There is no appropriate information to identify the effectiveness of incentives and it is not possible to determine the real impacts over investors. If you receive the CIF you lost the right to get more incentives or tax exemptions that law gives for forestry sector[19]

[9] de la Hoz, J.V. 2009. Geografía Económica de la Orinoquia. Documento de trabajo sobre economía regional. http://www.banrep.gov.co/documentos/publicaciones/regional/documentos/DTSER-113.pdf
[10] article 31 of the law 812 of 2003 and article 18 of the law 788 of 2002
[11] Ibid
[12] Villar, C.M. 2010. Financiación forestal, estímulos y exenciones. http://www.revista-mm.com/ediciones/rev67/forestal_financiacion.pdf
[13] About 293.714 USD
[14] Ibid
[15] About 29.303.428 M USD
[16] http://www.minagricultura.gov.co/02componentes/06com_03d_cif.aspx
[17] See footnote42 and http://www.minagricultura.gov.co/02componentes/06com_03d_cif.aspx;
[18] Villar, C.M. 2010. Financiación forestal, estímulos y exenciones. http://www.revista-mm.com/ediciones/rev67/forestal_financiacion.pdf
[19] Villar, C.M. 2010. Financiación forestal, estímulos y exenciones. http://www.revista-mm.com/ediciones/rev67/forestal_financiacion.pdf

The subsidies program Agroingreso Seguro (AIS), was proposed inPresident Alvaro Uribe's government and had the goal of reducing the inequalities in rural areas. However, most of the money becoming for this program and that intended to encourage the agricultural crops and long term monocultures didn't have the results that were expected [20]*.*

In general, most of the government monetary resources mentioned before are mainly oriented to the setting of forestry species that the Ministry of Agriculture and Rural Development (MADR for its name in Spanish) promote as more suitable for Colombian regions. In the case of Vichada state the MADR only promotes to plant *Eucaliptus pellita* and *Pino caribea var Houndurensis*.

Institutional barriers

Due to the globalized market conditions for agricultural products in Antioquia, it is predictable to suppose that for many of them; the small volumes are hardly competitive, indicating the need for an institutional infrastructure apart for the physical conditions. These are the relatively successful cases of the coffee and milk in Antioquia, which promote the producers association and cooperation, being one of the essential conditions to achieve a competitive status for the forestry activity (Valencia *et al*, 2006). The development of a national forestry industry has stalled leaving space for wood and wood derivate products imports. This characteristic reflects the lack of initiatives, of strategic alliances between government programs and private possibilities, also the very little tradition for horizontal and vertical integration between the big forestry industries and the small and medium producers (Acosta 2006)

Nowadays there are weaknesses in the official institutions to implement a sustainable forest management, and are originated in the lack of professional staff, specialized in the subject, scarce budgeting and lack of organic structure to respond to the forestry sector responsibilities, leading to restrictions to the exploitation of commercial plantations, meaning excessive regulation or wrong interpretation by the own regional authorities (Acosta 2006).

Technological barriers

The best technologies and modernization of forest productive processes are indispensable conditions for forestry sector to insert itself in the international markets. The scarce knowledge of technological development for the prevention of phytosanitary risks in plantations with more implications in the case of native species, leads to the empiric use of agro-chemicals, generating grave economic and environmental consequences. For the case of Antioquia, there is some descent information respect to the biology, habits and the most common defoliator's population dynamics, but, many insect are still unidentified, as their natural enemies. About phytosanitary problems related to mushrooms, bacteria and viruses, there is very limited research or information which allows a proper management in the case of an epidemic scenario. For this reason, the preventive management of seed and germination techniques is absolutely important (Secretary of Agriculture and Rural Development 2005).

Related to the academy, In Colombia is notorious the lack of programs in sustainable forestal management at different levels and the very few professionals formed at master and PHD levels. It is significant the narrow production of knowledge derived from the basic and applied forest research, and as consequence the new technologies transfer is minimum. The certification on natural forest management is still remote (Acosta 2006).

In the other side, the majority of forest plantations in Antioquia are done with vegetable material produced by the same reforestations in tree nurseries established temporary near to the seeding zones. The 53 tree nurseries identified in Antioquia also contribute with vegetable material. The

[20] http://www.noticiascaracol.com/nacion/video-225269-estallo-el-escandalo-de-agro-ingreso-seguro

majority of these tree nurseries are not specialized for the production of forest type material and the main problem has its roots in the produced material, which in the most of cases, does not come from qualified sources or genetic improvement, which would be ideal to guarantee the proper development of the plantations, in terms of performance and quality (Secretary of Agriculture and rural Development 2005).

Other difficulties identified in the forestry sector in Antioquia in the sanitary area are (Secretary of Agriculture and Rural Development 2005):

- Lack of training of technicians in the diagnose, management and pest control and forest diseases.
- Ignorance of biology, ecology and etiology of harmful agents in forestry plantations
- There is not professional level formation in the specific area of forestry health.
- Little technological development in the knowledge of etiologic control strategies, as the specific pheromones synthesis of species of insects, harmful for forest crops.
- Lack of a monitoring net *in situ* of plagues and exotic diseases which let the detection on time the introduction of potentially harmful organisms for the commercial reforestation in the country.
- Lack of research and studies divulgation by the different bodies from the forestry sector in the phytosanitary subject.
- Lack of preventive campaigns to sensitize and inform the reforestation workers about the potentially harmful organisms for the planted species.
- Lack of monitoring and surveillance in borders and ports, of wood shipments which could bring foreign organisms, potentially dangerous for commercial reforestation in the country.

Barriers related to the local tradition:

Exploitation and commercialization of Forestry products in Colombia has been marked by the informality and presence of intermediaries, making the profitability range to reduce considerably in function of the volume of extracted wood. Commercialization of wood from plantations is done by companies or particular reforestations workers directly with the industries, through intermediaries or as elaborated product to distributors or final customer. There is also an informal trade of natural forest products, dominated by the intermediaries, who contact the local farmers, buy the wood at low prices and then commercialize it in Medellin or other municipalities. In this case, the one who obtains the lowest profit is the local farmer (Secretary of Agriculture and Rural Development 2005). The prices of the wood growing stock, low in excess have been an incentive for the absence of a sustainable forest management, stimulating the change of use of the land facing the low value the forest provides (Acosta 2006).

Barriers due to predominant practices

It has been perceived distrust from the majority of the inhabitants of the county of San Sebastian de Palmitas and San Cristobal about projects executed by the mayor of Medellin, especially in the forestry sector, after previous experiences. In the other side, the forestry activity for the owner of eligible areas is a slow return activity in terms of economical benefits and it does not suit the self-subsistence economies and small scale commercialization, which people are used to, where income is expected in short periods of time.

Barriers due to social conditions

In the forest sector and forest industry could be more vulnerable from illegalities and corruption then other sectors. It seems to happen at least in many tropical countries, where forest ecosystems are more complex, the access is difficult and the detection of illegal operations is poor because of the insufficient surveillance systems and communication media. Not only the people, but also the groups and institutions are able to do illegal activities and place an obstacle in the organization of the forestry sector. The illegal practices can adopt very different forms and they do not only appear in forests, but they also extend to the fields of transport, elaboration and trade of forest products. (Secretary of Agriculture and Rural Development 2005)

As a consequence, the level of uncertainty and risk increases for the international investors who could be interested in the sector due to the social conflicts of the country (Acosta 2006).

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

Forest plantations of native or mixed species (without being registered as a carbon project) is prevented by at least one of the barriers listed in sub-step 2a

Project alternative	Barrier faced
cattle-grazing	No barriers faced

Sub-step 2c. *Determination of baseline scenario*

Applying the decision tree presented in the "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project V.1.0 in the outcome of sub-step 2b is concluded that cattle-grazing is the baseline scenario.

Step 4. Analysis of common practices

Reforestation for commercial or conservation and agroforestry systems are not commonly practiced in the project area. In a national level, reforestation began in the 1940's at a very low scale and has never played a major role in the land use sector. Even though government plans and programs have promoted reforestation, this activity only manages to provide 12,4% of wood supply for the forest industry (84,1% still comes from natural forests and 3,5% from imports)[21]. Forest plantations for industrial purposes (over 500 ha) are usually located in the areas where the industrial activities of pulp, particleboard and immunization occur. These are in the departments of Cauca, Valle, Quindío, Risaralda, Caldas, Tolima, Antioquia, Cundinamarca, Boyacá, Bolivar and Magdalena[22]

In the case of the municipality of Medellin, from the territorial ordering plan (1999-2009), have looked for solutions to the wrong and growing pressure from urbanization, through the *Plan Laderas*, which was established with the objective of generate a belt of trees, as a barrier for the urban expansion, and a biologic corridor, easing the lack of green space, balancing the high density of construction and improving the micro-climate of the city (Zuluaga 2000). The plantations were established approximately in the year 2000 and the planted species are *Pinus patula* and *Eucalyptus*. In general the perception of this project has not been favorable and has generated prevention, because of the plantations lack technical management and tracing, and the contract with the owners have not complied. In Altavista, however, this project has a wide acceptation and is evaluated as favorable, because it has contributed with to minimize the pressure for the access to land dedicated to illegal housing and has become a barrier for the urban expansion, keeping safe the watersheds, improving the landscape component and offering income by touristic activities boosted by the communal action board.

[21] Plan de Acción para la reforestación Comercial. 2011. Ministerio de Agricultura y Desarrollo Rural. Available in http://fedemaderas.org.co/wp-content/uploads/2012/04/Plan-de-Accion-Reforestacion-Comercial.pdf

[22] (Ministry of Agriculture 2005, p. 16).

The proposal of the Project is a different alternative to the previously established reforestation initiatives, because it includes several forest systems, like commercial, agricultural, silvopastoral, natural assisted and mixed regeneration, which will be established according to the objectives and specific needs of the owners. It is expected the active involvement from landlords, grouped in an umbrella project which secures the continuity of the project, success of the plantations and carbon sequestration.

3.4 Methodology Deviations

There are not methodology deviations in the current project description.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The carbon pools included in or excluded from the project boundary are shown in Table 18.

Tabla 17 Selection and justification of carbon pools

Carbon pool	Whether selected	Justification/Explanation
Above-ground biomass	Yes	This is the major carbon pool subjected to project activity
Below-ground biomass	Yes	Carbon stock in this pool is expected to increase due to the implementation of the project activity
Dead wood Litter and Soil organic carbon	yes	Carbon stock in these pools may increase due to implementation of the project activity

Changes in carbón stock of above-ground and below-ground biomass of non-tree vegetation may be conservatively assumed to be zero in the baseline scenario, also it is expected that the baseline dead wood and litter carbon pools will not show a permanent net increase. It is therefore conservative to assume that the sum of the changes in the carbon stocks of dead wood and litter carbon pools is zero in the baseline scenario. Moreover, since carbon stock in SOC is unlikely to increase in the baseline, thechange in carbon stock in SOC may be conservatively assumed to be zero.

As it is demonstrated, baseline is the continuation of extensive grazing (previous activity). The entire area within the project boundaries were and would have been covered by pastures. Thus, it is not applicable to account for tree and shrubs baseline biomass.

Historically cattle grazing have been the main land use in the Project área and selected as the baseline scenario. According to this and in agreement with IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (2003) that the net GHG removals by sinks in the baseline equals zero.

First instance, for GHG removals determination in the baseline scenario, stock carbon present in existing biomas was estimated in the area of the project. By following Equations: 5 6, 7, and 8, of the methodological tool AR-Tool 14 (Version 03.0.0): (ii)"Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities;" (*Method 1, Stock change method*). In this way, we conduct a random drawing of sampling points and were determined: diameter at breast high (*DBH)/ (DAP, in Spanish)* and average of individuals per hectare (*N)* of trees scattered in the pastures scenario (Baseline Assessment). Subsequently, using the equation suggested by Brown (1997), basal diameter is used as a predictive variable (Equation 1). Where, *B* is aboveground biomass (kg per tree) and *DBH* (cm) is the basal diameter.

$$B = Exp(-2,289+2,649 \times \ln DAP - 0,021 \times \ln DAP^2) \quad (1)$$

Additionally, we calculated the values of the Standard Deviation (SD)/ (*DE in Spanish*) for the estimated variables. Subsequent calculations were performed using the average of measurements over the SD, in order to estimate the highest contents of biomass that could be present in the baseline scenario. After obtaining the aboveground biomass of individuals, total CO2 content is calculated by multiplying the number of individuals (*N*); the root expansion factor (*Rj*), the fraction of carbon (*Cf*) and the conversion factor of carbon to CO2 (*CO2f*) (Table 19).

Tabla 18 Parameters considered. DBH: diameter at breast height average (cm), N: average number of individuals per hectare; b: aboveground biomass per tree (kg), Ba: aboveground biomass per hectare (t ha-1), Rj: underground biomass ratio: aboveground biomass; Cf: carbon fraction; CO2f: CO2 conversion factor, N and DAP (DBH) (average values of DE (or SD)) were obtained through field sampling in the baseline scenario. B was calculated using Brown Equation (1997). Rj, Cf and CO2f are default values (IPCC 1996).

Baseline Scenario	(Forest / Non-forest) Component	*DBH*	*N*	*b*	B_a	*Rj*	*Cf*	CO_2f
Pastures	Scattered trees	30.44	39.96	674.85	26.97	0.83	0.50	3.67
	Pastures	-		1.32		3.68	0.50	3.67

Baseline scenario shows an aboveground biomass of 28.29 tha^{-1} and 27.24 tha^{-1} underground. A total of 55.53 tha^{-1}. These values are equivalent to 101.81 tCO_2ha^{-1}. (Table 20)

Tabla 19 Biomass and carbon values in the baseline scenario; Ba: Aboveground biomass per ha (t ha-1); Bb: underground biomass per ha (t ha-1); Bt: Total biomass per ha (t ha-1); Ct: Total carbon per ha (t ha-1); CO2t: Total CO2 per hectare (t ha-1).

Baseline scenario	B_a	B_b	B_t	C_t	CO_2t
Scattered trees	26.97	22.38	49.35	24.68	90.48
Pastures	1.32	4.86	6.18	3.09	11.33
TOTAL	**28.29**	**27.24**	**55.53**	**27.77**	**101.81**

Existing trees in the baseline scenario will be kept within the stand models without being impacted or affected by the project activities. Consistently, scattered trees excluded of the project activities will be properly identified, coded and labeled (with paint and / or permanent registration plates) during activities of plantation establishment, and will be monitored within the monitoring plots. However, these individuals will not be counted in the GHG removals of the project.

4.2 Project Emissions

The emission sources and associated GHGs selected for accounting are shown in Table21

Tabla 20 justification of the project emissions

Sources	Gas	Whether Selected	Justification/Explanation
Burning of woody biomass	CO_2	No	CO_2 emissions due to burning of biomass are accounted as a change in carbon stock
	CH_4	Yes	Burning of woody biomass for the purpose of site preparation, or as part of forest management, is allowed under this methodology
	N_2O	Yes	Burning of woody biomass for the purpose of site preparation, or as part of forest management, is allowed under this methodology

However considering the methodology applied to the project, GHG emissions resulting from removal of herbaceous vegetation, combustion of fossil fuel, fertilizer application, use of wood, decomposition of litter and fine roots of N-fixing trees, construction of access roads within the project boundary, and transportation attributable to the project activity shall be considered insignificant and therefore accounted as zero.

4.3 Leakage

According to the equation 4 of the methodology AR-ACM0003, version 01, the leakage that could occur as a result of the project would be the displacement of cattle ranching from the plots where the plantations would be developed.

The application of the tool “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity” led to the conclusion that this source can be neglected. The application of the “Guidelines on conditions under which increase in GHG emissions related to displacement of pre-project grazing activities in A/R CDM project activity is insignificant”, which is one of the applicability conditions of the tool. In this case project will not cause any displacement of the activity occurring before project implementation.

Baseline scenario was described as abandoned pastures areas and meadows for cattle grazing activities for milk production. With the implementation of the project, it is expected landowners could integrate silvopastoral stand model in their economic activity. To this, each owner will schedule cattle activities according to the plantation establishment schedule, by intensifying grazing in some areas of the project, while first established plantations reach the appropriate age and size to tolerate animals in a given time. This is for the silvopastoral stand model.

Furthermore, most of the wood used in a domestic way by the owners is not extracted from eligible areas within properties, due to the existing low supply of wood. Therefore, the establishment of stand models will not raise wood collection activities outside the scope of the project, instead of it; wood pressure collection will decrease in nearby areas, due to the supply of wood wastes generated by medium term of stand models.

Finally, the establishment of stand models will not raise the use of wood posts, because most of the properties that define the scope of the project are divided by previously established fences. Additionally, if it´s necessary to establish new fences for some areas protection, wood from the model, inscribed within the project boundary, will be used

4.4 Net GHG Emission Reductions and Removals

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

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$ Equation (1)

Where:

$\Delta C_{AR-CDM,t}$	=	Net anthropogenic GHG removals by sinks, in year *t*; t CO_2-e
$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks, in year *t*; t CO_2-e
$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks, in year *t*; t CO_2-e
LK_t	=	GHG emissions due to leakage, in year *t*; t CO_2-e

Baseline net GHG removals and total GHG emissions due to leakage are zero, thus ex-ante estimation of C AR equals ΔC ACTUAL. The period over which the long-term average GHG benefit is calculated is 35 years.

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

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

Where:

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

Change in the carbon stocks in project, occurring in the selected carbon pools in year t shall be calculated as follows:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta C_{LI\_PROJ,t} + \Delta SOC_{AL,t}$$

Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year t; t CO2-e
$\Delta C_{TREE\_PROJ,t}$	=	Change in carbon stock in tree biomass in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO2-e
$\Delta C_{SHRUB\_PROJ,t}$	=	Change in carbon stock in shrub biomass in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO2-e
$\Delta C_{DW\_PROJ,t}$	=	Change in carbon stock in dead wood in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; t CO2-e

$\Delta C_{LI\_PROJ,t}$ = Change in carbon stock in litter in project in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; t CO2-e

$\Delta SOC_{AL,t}$ = Change in carbon stock in SOC in project, in year t, in areas of land meeting the applicability conditions of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities", as estimated in the same tool; t CO2-e

Stratification in the baseline scenario:

Biomass content in the eligible areas coverage of the project, differ in a considerable way. In the case of wooded pastures the biomass content is 6.2 t.d.m.ha^{-1}, while the low stubbles coverage has a content of 15 t.d.m.ha^{-1}. Likewise, the vegetal composition of both scenarios is very different (Annex 3). These differences in the dynamic of the vegetation in the coverage, generates two baseline scenarios:

- Wooded pastures
- Low stubbles

Stratification according to the planned project activity (AR CDM):

The stand models and the selection of species were based on the topographic conditions and biophysical conditions of the areas were plantations would be established. In general, the establishment of the stand models will follow the categories of allowed uses according to the POT of the municipality of Medellin. Particularly, in protection areas only will be established ANR systems, and in the low stubbles scenario, enrichment activities will be performed based on Forest Enrichment or ANR. In the wooded pastures areas, there will be commercial systems (commercial, silvopastoral and agroforestry), as protection (Mixed, ANR), according to the uses allowed by the POT.

Therefore, were defined 5 strata according to forest activities and finality of the established systems. Timber products commercialization and restoration of areas in an anthropogenic way. On one hand, the commercial plantations will have the conventional management and interventions common in this type of activities (fertilization, pruning, thinning and harvest); the ANR and FE systems will only have some maintenance in the first years, and the Forest Enrichment systems, will have some selective exploitation. Finally, these entire factors make the accumulation dynamic projected for the forest systems differs considerably from each other.

So, the defined project models are:

- Commercial model
- Silvopastoral model
- Forest Enrichment
- Assisted natural regeneration model (ANR)

Change in carbon stock in tree biomass in project in year *t*

To estimante the Change in carbon stock in tree biomass in project in year t the Methodological tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities AR-TOOL14 Version 03.0.0 vas employed. According to this the option b) Estimation of tree biomass using the Biomass expansion factor (BEF) technique (equation 1 of the tool) was used. Then this equation was multiplied for the carbon fraction CF to get the change in carbon C in tree in the proyect in year t as follows:

$$B_{TREE,j,p,i,t} = V_{TREE,j,p,i,t} \times D_j \times BEF_{2,j} \times (1 + R_j)$$ Equation (1)

Where:

$B_{TREE,j,p,i,t}$	=	Biomass of trees of species *j* in sample plot *p* of stratum *i* at a point of time in year *t*; t dry matter (d.m.)
$V_{TREE,j,p,i,t}$	=	Stem volume of trees of species *j* in sample plot *p* of stratum *i* at a point of time in year *t*, estimated by using the tree dimension(s) as entry data into a volume table or volume equation; m^3
D_j	=	Density (overbark) of tree species *j*; t d.m. m^{-3}
$BEF_{2,j}$	=	Biomass expansion factor for conversion of stem biomass to above-ground tree biomass, for tree species *j*; dimensionless
R_j	=	Root-shoot ratio for tree species *j*; dimensionless
j	=	*1, 2, 3, …* tree species in plot *p*
p	=	*1, 2, 3, …* sample plots in stratum *i*
i	=	*1, 2, 3, …* tree biomass estimation strata within the project boundary
t	=	*1, 2, 3, …* years counted from the start of the A/R CDM project activity

To the proposed stand models, equations were built from carbon accumulation of information in the scientific literature, giving priority to the information reported for Colombia. Most of the species involved in the model are native species from which no data is available, was necessary to adjust by using the Bertalanffy type equations, using the poor information available. Species, carbon accumulation equations, parameters, and the consulted sources, are presented in Table bellow. It is important to note that the volume of each species was obtained using expansion factors as explained before (Table 22).

Tabla 21 Proposed equations to determine carbón storage and volumen for forest species considered in the Project. A, B, and C are the model parameters.

Species	Model	A	B	C	Source
Pinus patula	*Car = A (1-exp(-b t)^c)*	135.28	0.198	3	CONIF (*s.f.*); Trujillo (2007)
Pinus tecunumanii		192.69	0.113	3	CATIE (2006); Trujillo (2007)
Eucalyptus grandis		113.84	0.323	3	Trujillo (2007); Ministerio de Agricultura (2006)
Montanoa quadrangularis		98.87	0.323	3	Álvarez (2006)
Nageia rospigliossi		119.56	0.059	3	Datos CORNARE; Datos Orrego *et al.* (2003)
Cedrela montana		78.57	0.146	3	Empleando IMAs en volumen suministrados por CORNARE
Cytharexylum subflavecens		92.15	0.223	3	del Valle (1985); Trujillo (2007); información de CORNARE
RNA		58.18	0.121	3	Orrego & del Valle (2003)
Cordia alliodora	*H* = {*S* / *Exp* [(*A* + *B* · *S*) · 10 –*C*]} *Exp* [(*A*+ *B* · *S*) *t* –*K*]	-3.496	0.073	0.025	Alder & Montenegro (1999)
	V = *A* · *H B* · *N C*	0.00004	3.152	0.889	Alder & Montenegro (1999)

For each stand model, we generated a representative volume curve by life zone. Volume curves were obtained by adding the volumes of each fraction weighted basis of participation in a given area and tree density Commercial stand models, silvopastoral will have thinning activities, depending on the management plans for each of the species involved. An example of stand for each model is presented (Figue 14, Figure 15, Figure 16). Subsequently, most of the trees will be harvested after 30 years, during the same time the plantations will be restored, unless a decision to leave the trees standing to continue sequestering carbon.

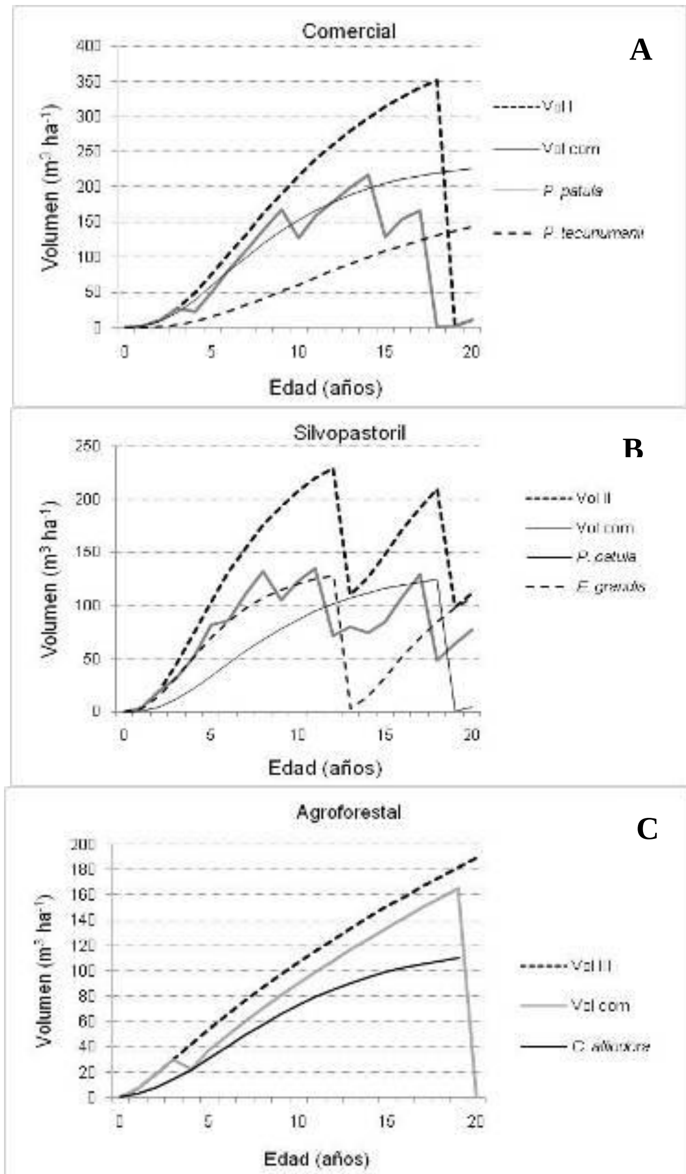
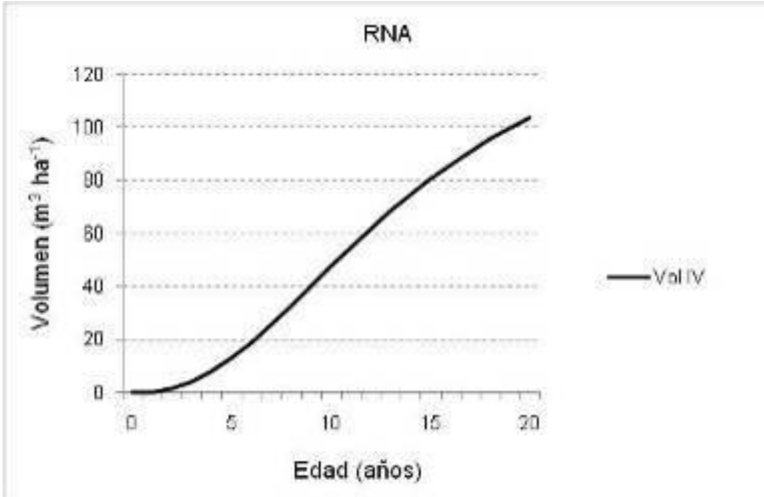


Figure 14 Volume curves for the proposed stand models. a) Commercial; b) Silvopastoral; and c) Agroforestry. The black dashed curve corresponds to the volume modeled, and the gray continuous curve to the commercial volume after thinning. We also present the curves of the species involved in each model according to their percentage of participation in the model and the density of trees.



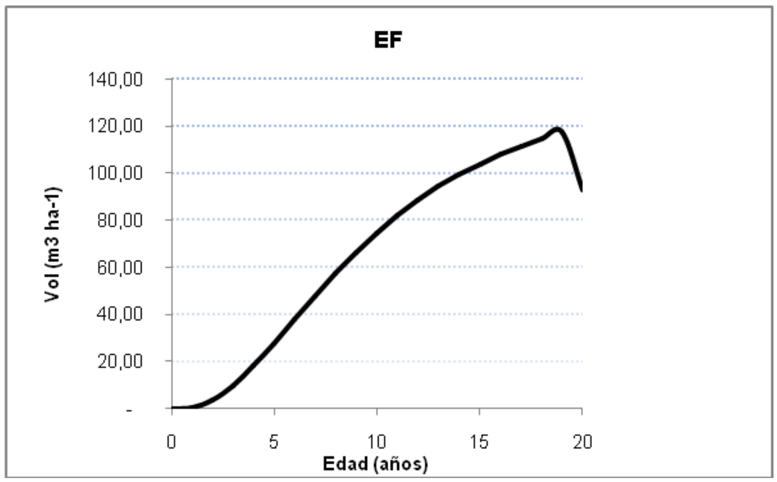


Figure 15 Volume curves for Life Zone for the Model of Assisted Natural Regeneration (ANR) and Mixed Forest Protector.

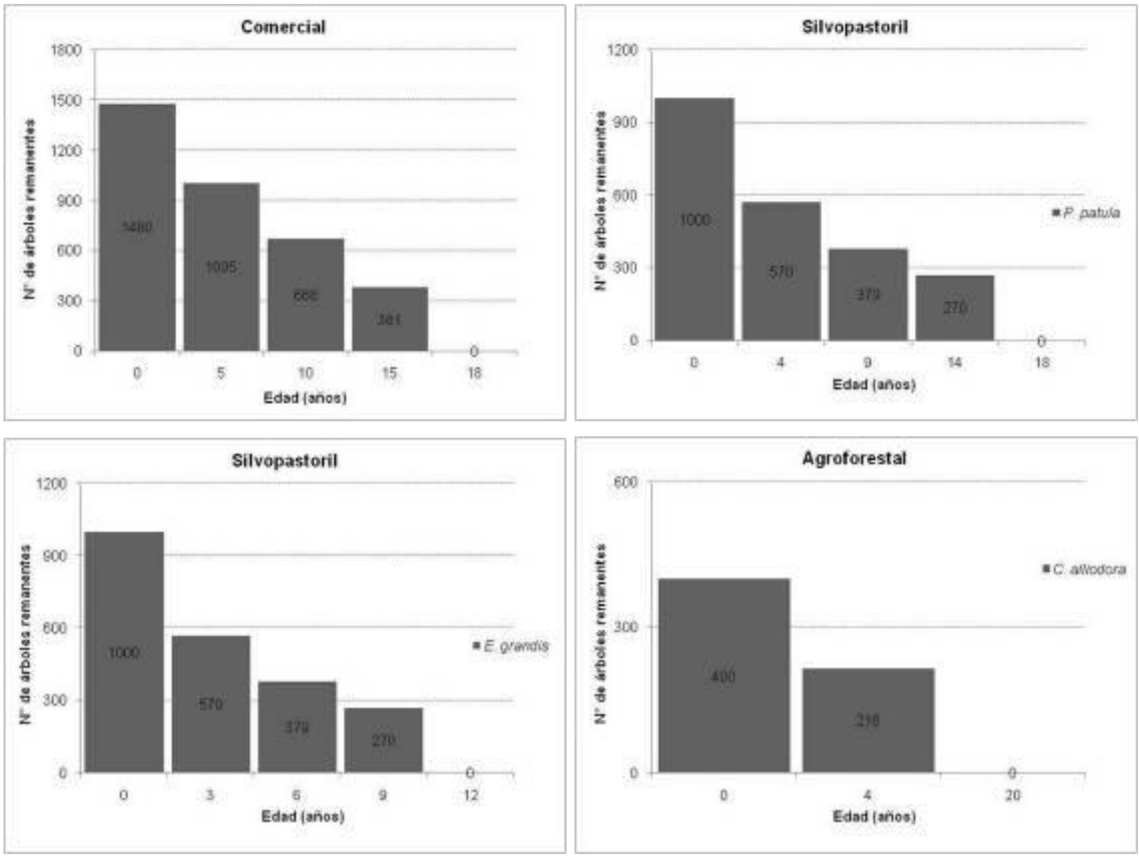


Figure 16 Thinning patterns for commercial, silvopastoral, and agroforestry stand models

The expansion factors correspond to factors suggested by the IPCC (2003). The basic wood density was consulted in the scientific literature for each species. The carbon fraction variables (CF_j), wood density (D_j), expansion factor of biomass (BEF_{2j}), and root growth factor (R_j), all of them were weighted by PP (Participation Rate). PP was determined according to the participation by area of the species in the respective stand model (Table 23).

Tabla 22 Values of Wood density, expansion biomass factors (*BEF*), and expansion root factors (*Rj*), adjusted for PP (percentage of participation of species in the stand model).CF_j is the carbon fraction contained in biomass and *Dj* is the wood density for each species weighted by PP.

Model	Species	*CFj*	PP	*Dj*	BEF_{j-2}	R_{j-1}	R_{j-2}	R_{j-3}
Stand I	*P. patula*	0.50	60.0	0.26	0.78	0.13	0.14	0.07
	P. maximinoi	0.50	40.0	0.20	0.52	0.08	0.10	0.05
Value	**-**	**0.50**	**-**	**0.45**	**1.30**	**0.21**	**0.24**	**0.12**
Stand II	*P. patula*	0.50	37.5	0.16	0.49	0.08	0.09	0.05
	E. grandis	0.50	62.5	0.35	0.88	0.13	0.15	0.08
Value	**-**	**0.50**	**-**	**0.51**	**1.36**	**0.21**	**0.24**	**0.12**
Stand III	*C. alliodora*	0.50	100.0	0.47	1.40	0.21	0.24	0.12

Model	Species	*CFj*	PP	*Dj*	*BEFj-2*	*Rj-1*	*Rj-2*	*Rj-3*
Value	**-**	**0.50**	**-**	**0.47**	**1.40**	**0.21**	**0.24**	**0.12**
Stand IV	*Various species*	0.50	100.0	0.50	1.60	0.21	0.24	0.12
Value	**-**	**0.50**	**-**	**0.50**	**1.60**	**0.21**	**0.24**	**0.12**
Stand V	*FE*	0.50	100.0	0.58	1.40	0.21	0.24	0.12
Value		**0.50**		**0.58**	**1.40**	**0.21**	**0.24**	**0.12**

Soil organic Carbon

Estimations of soil organic carbon (SOC) stocks were done in accordance to the “ Tool for the estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activity”. As suggested by the tool, it is assumed that the implementation of the project activity increases the SOC content of the lands from the pre-project level to the level that is equal to the steady-state SOC content under native vegetation. The increase in SOC content in the project scenario takes place at a constant rate over a period of 20 years from the year of planting. The project meets the applicability conditions of this tool in the area:

The areas of land to which the tool is applied do not fall into wetland category, do not contain organic soils and are not subject to any of the land management practices and application of inputs listed in Tables 1 and 2 of the tool.

Since the land use prior to project start was grassland, only Table 2 applies. For the Tropical, moist climate region corresponding to the project activity, none of the three combinations included in Table 24 are applicable; litter remains on site and is not removed and soil disturbance is in accordance withappropriate conservation practices, limited to site preparation and not repeated more than 20 years.

Tabla 23 Parameters used for the the estimation of the soil organic carbon (SOC)

Parameter	**Symbol**	**Value**	**Source (SOC estimation tool, V01.1.0)**
Reference SOC (tC/ha)	SOCREF,i	47	Table 3 LAC soils, Tropical, moist
Land use factor	fLU ,i	1	Table 6 All permanent grassland
Management factor	f MG,i	0.70 (Tropical)	Table 6 Lands are identified as degraded lands using the “Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities
Input factor	fIN,i	1.11	Grasslands with direct application of fertilizers - organic or

			inorganic

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20\ years} \quad \text{for } t_{PREP,i} < t \leq t_{PREP,i} + 20$$

where:

$dSOC_{t,i}$ — The rate of change in SOC stock in stratum *i* of the areas of land, in year *t*; t C ha^{-1} yr^{-1}

$t_{PREP,i}$ — The year in which first soil disturbance takes place in stratum *i* of the areas of land

$SOC_{LOSS,i}$ — Loss of SOC caused by soil disturbance attributable the A/R CDM project activity, in stratum *i* of the areas of land; t C ha^{-1}

$SOC_{REF,i}$ — Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation – normally forest) by climate region and soil type applicable to stratum *i* of the areas of land; t C ha^{-1}

$SOC_{INITIAL,i}$ — SOC stock at the beginning of the A/R CDM project activity in stratum *i* of the areas of land; t C ha^{-1}

i — *1, 2, 3,* … strata of areas of land; dimensionless

t — *1, 2, 3,* … years elapsed since the start of the A/R CDM project activity

Where

$$SOC_{INITIAL,i} = SOC_{REF,i} * f_{LU,i} * f_{MG,i} * f_{IN,i} \quad \textbf{(1)}$$

where:

$SOC_{INITIAL,i}$ — SOC stock at the beginning of the A/R CDM project activity in stratum *i* of the areas of land; t C ha^{-1}

$SOC_{REF,i}$ — Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation – normally forest) by climate region and soil type applicable to stratum *i* of the areas of land; t C ha^{-1}

$f_{LU,i}$ — Relative stock change factor for baseline land-use in stratum *i* of the areas of land; dimensionless

$f_{MG,i}$ — Relative stock change factor for baseline management regime in stratum *i* of the areas of land; dimensionless

$f_{IN,i}$	Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in stratum *i* of the areas of land; dimensionless
i	*1, 2, 3, …* strata of areas of land; dimensionless

In the case of the soil disturbance attributable to project activity and for which the total area disturbed, over and above the area in the is less than 10% of the area of the stratum. Then the carbón loss is assumed as zero.

The application of these equations results in an estimated increase of 0.71 t C/ha/year in soil organic carbon

Considering Table 24 $SOC_{INITIAL,i}$ = 32.9 t C ha^{-1}

Then, The rate of change in SOC stock in project scenario until the steady-state is reached is estimated as follows

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20\ years} \quad \text{for } t_{PREP,i} < t \leq t_{PREP,i} + 20$$

where:

$dSOC_{t,i}$	The rate of change in SOC stock in stratum *i* of the areas of land, in year *t*; t C ha^{-1} yr^{-1}
$t_{PREP,i}$	The year in which first soil disturbance takes place in stratum *i* of the areas of land
$SOC_{LOSS,i}$	Loss of SOC caused by soil disturbance attributable the A/R CDM project activity, in stratum *i* of the areas of land; t C ha^{-1}

$SOC_{REF,i}$	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation – normally forest) by climate region and soil type applicable to stratum *i* of the areas of land; t C ha^{-1}
$SOC_{INITIAL,i}$	SOC stock at the beginning of the A/R CDM project activity in stratum *i* of the areas of land; t C ha^{-1}
i	*1, 2, 3, …* strata of areas of land; dimensionless
t	*1, 2, 3, …* years elapsed since the start of the A/R CDM project activity

The application of these equations results in an estimated rate of 0.71 t C ha yr^{-1} in soil organic carbon.

The change in SOC stock for all the strata of the areas of land, in year t, is calculated as indicated in equation 8 of the tool.

$$\Delta SOC_{AL,t} = \frac{44}{12} * \sum_i A_i * dSOC_{t,i} * 1year \qquad \textbf{(8)}$$

where:

$\Delta SOC_{AL,t}$	Change in SOC stock in areas of land meeting the applicability conditions of this tool, in year *t*; t CO_2-e
A_i	The area of stratum *i* of the areas of land; ha
$dSOC_{t,i}$	The rate of change in SOC stocks in stratum *i* of the areas of land; t C ha^{-1} yr^{-1}
i	*1, 2, 3, …* strata of areas of land; dimensionless

Then $\Delta SOC_{AL,t}$ in year 30 = 46.418 tCO_2-e

Dead Wood and Litter

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

Dead wood

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

Project proponent won't make sampling based measurements for estimation of C stock in dead wood for all strata to which this default method is applied, the carbon stock in dead wood was estimated as is indicated in equation 9 of the tool:

$$C_{DW,i,t} = C_{TREE,i,t} * DF_{DW} \qquad \textbf{(9)}$$

where:

$C_{DW,i,t}$	Carbon stock in dead wood in stratum *i* at a given point of time in year *t*; tCO_2e
$C_{TREE,i,t}$	Carbon stock in trees biomass in stratum *i* at a point of time in year *t*, as calculated in tool "Estimation of carbon stocks and change in carbon stock of trees and shrubs in A/R CDM project activities"; tCO_2e
DF_{DW}	Conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass; percent
i	*1, 2, 3, …* biomass estimation strata within the project boundary
t	*1, 2, 3, …* years elapsed since the start of the A/R CDM project activity

Value of the conservative default factor expressing carbon stock in dead wood as a percentage of carbon stock in tree biomass (DFDW) was selected according to the guidance provided in the relevant table in Section III of the tool

The rate of change of dead wood biomass over a period of time was calculated assuming a linear change). Therefore, the rate of change in carbon stock in dead wood over a period of time was calculated as is indicated in equation 10 of the tool:

$$dC_{DW,(t_1,t_2)} = \frac{C_{DW,t_2} - C_{DW,t_1}}{T} \qquad \textbf{(10)}$$

where:

$dC_{DW,(t_1,t_2)}$	Rate of change in carbon stock in dead wood within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; $tCO_2e\ yr^{-1}$
C_{DW,t_2}	Carbon stock in dead wood within the project boundary at a point of time in year t_2; tCO_2e
C_{DW,t_1}	Carbon stock in dead wood within the project boundary at a point of time in year t_1; tCO_2e
T	Time elapsed between two successive estimations ($T=t_2 - t_1$); yr

Then, change in carbon stock in dead wood within the project boundary in year $t\ (t_1 \le t \le t_2)$ is given by equation 11 of the tool:

$$\Delta C_{DW,t} = dC_{DW,(t_1,t_2)} * 1 year \ \text{ for } t_1 \le t \le t_2 \qquad \textbf{(11)}$$

where:

$\Delta C_{DW,t}$	Change in carbon stock in dead wood within the project boundary in year t; $t\ CO_2\text{-}e$
$dC_{DW,(t_1,t_2)}$	Rate of change in carbon stock in dead wood within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; $t\ CO_2\text{-}e\ yr^{-1}$

Litter

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

If the PPs will not to make sampling based measurements for estimation of C stock in they will use the default method described in tool. For all strata to which this default method is applied, the carbon stock in litter will be estimated as is indicated in equation 15 of the tool:

$$C_{LI,i,t} = C_{TREE,i,t} * DF_{LI} \quad \textbf{(15)}$$

where:

$C_{LI,i,t}$	Carbon stock in litter in stratum *i* at a given point of time in year *t*; tCO_2e
$C_{TREE,i,t}$	Carbon stock in trees biomass in stratum *i* at a point of time in year *t*, as calculated in tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; tCO_2e
DF_{LI}	Conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass; percent
i	*1, 2, 3, …* biomass estimation strata within the project boundary
t	*1, 2, 3, ...* years elapsed since the start of the A/R CDM project activity

Value of the conservative default factor expressing carbon stock in litter as a percentage of carbon stock in tree biomass (DF) has been selected according to the guidance provided in the tool.

The rate of change of litter biomass over a period of time was calculated assuming a linear change Therefore, the rate of change in carbon stock in litter over a period of time is calculated as is indicated in equation 16 of the tool:

$$dC_{LI,(t_1,t_2)} = \frac{C_{LI,t_2} - C_{LI,t_1}}{T} \quad \textbf{(16)}$$

where:

$dC_{LI,(t_1,t_2)}$	Rate of change in carbon stock in litter within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; $tCO_2e\ yr^{-1}$
C_{LI,t_2}	Carbon stock in litter within the project boundary at a point of time in year t_2; tCO_2e
C_{LI,t_1}	Carbon stock in litter within the project boundary at a point of time in year t_1; tCO_2e
T	Time elapsed between two successive estimations ($T=t_2 - t_1$); yr

Then, change in carbon stock in litter within the project boundary in year $t\ (t_1 \le t \le t_2)$ is given by

$$\Delta C_{LI,t} = dC_{LI,(t_1,t_2)} * 1 year \ \text{ for } t_1 \le t \le t_2 \quad \textbf{(17)}$$

where:

$\Delta C_{LI,t}$	Change in carbon stock in litter within the project boundary in year *t*; tCO_2e
$dC_{LI,(t_1,t_2)}$	Rate of change in carbon stock in litter within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; $tCO_2e\ yr^{-1}$

Table 25 summarizes the conservative default factors expressing carbon stock in dead wood and litter

Tabla 24 Conservative default factor expressing carbon stock in dead wood and litter

Parameter	Description	Value (%)	Comments
DFDW	Conservative default factor expressing carbon stock in dead wood as a DW percentage of carbon stock in tree biomass	6	Biome: tropical Elevation: <2000m Precipitation >1600 mmyr-1
DFLI	Default factor for the relationship between carbon stock in litter and carbon stock in living trees	1	Biome: tropical Elevation: <2000m Precipitation >1600 mmyr-1

Carbons stock in dead wood and litter in stratum i at a given point of time in year t; (tCO_2e) were estimated according to equation 9 and 15 of the methodological tool respectively.

The period over which the long-term average GHG benefit is calculated is 40 years. The total GHG benefit, calculated as the sum of stock changes along the 40-year period, is 4,287,428 t CO2e (Table 23).

Non-CO2 GHG emissions within the project boundary

Increase in non-CO2 GHG emissions within the project boundary as a result of the implementation of the A/R VCS project activity, in year t, as estimated in the tool “Estimation of non-CO2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity”; t CO2-e. Considering equation 1 of this tool:

$$GHG_{E,t} = GHG_{SPF,t} + GHG_{FMF,t} + GHG_{FF,t} \quad \textbf{(1)}$$

where:

$GHG_{E,t}$	Emission of non-CO_2 GHGs resulting from burning of biomass and forest fires withi the project boundary in year *t*; t CO_2-e
$GHG_{SPF,t}$	Emission of non-CO_2 GHGs resulting from use of fire in site preparation in year *t*; t CO_2-e
$GHG_{FMF,t}$	Emission of non-CO_2 GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land or other forest management, in year *t*; t CO_2-e
$GHG_{FF,t}$	Emission of non-CO_2 GHGs resulting from fire in year *t*; t CO_2-e
t	*1, 2, 3, ...* years counted from the start of the A/R CDM project activity

Slash-and-burn is a common practice in the baseline, and fire has been used in the area at least once during the period of ten years preceding the start of the A/R CDM project activity. In this case

$$GHG_{SPF,t} = 0$$

Project lifetime will not consider activities of harvesting or preparation or burning of harvest residue (defined from this point forward as forest fire). Considering this , GHGs resulting from use of fire to clear the land of harvest residue prior to replanting of the land or other forest management, in year t ($GHG_{FMF,t}$)and Emission of non-CO GHGs resulting from fire in year t ($GHG_{FF,t}$) are considered as zero

Finally The net anthropogenic GHG removals by sinks is the actual net GHG removals by sinks minus the baseline net GHG removals by sinks minus leakage, therefore, the following general formula can be used to calculate the net anthropogenic GHG removals by sinks of an A/R CDM project activity (*CAR-CDM*), in t CO2-e.

$$C_{AR-CDM} = \Delta C_{ACTUAL} - \Delta C_{BSL} - LK$$

Where,

C_{AR-CDM} = Net anthropogenic greenhouse gas removals by sinks; t CO2-e

ΔC_{ACTUAL} = Real GHG removals in the project (t CO2-e)

ΔC_{BSL} = Baseline net greenhouse gas removals by sinks; t CO2-e

LK = Total GHG emissions due to leakage; t CO2-e

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
2009		-5,719.40	0	-5.719,40
2010		-1,478.01	0	-1.478,01
2011		-155.07	0	-155,07
2012		294.24	0	294,24
2013		-6,651.17	0	-6.651,17
2014		-22,829.45	0	-22.829,45
2015		12,705.48	0	12.705,48
2016		16,927.94	0	16.927,94
2017		19,991.38	0	19.991,38
2018		23,626.32	0	23.626,32
2019		10,548.15	0	10.548,15
2020		9,580.31	0	9.580,31
2021		21,445.83	0	21.445,83

2022		1,970.19	0	1.970,19
2023		3,421.14	0	3.421,14
2024		14,782.61	0	14.782,61
2025		10,325.59	0	10.325,59
2026		14,638.77	0	14.638,77
2027		11,984.11	0	11.984,11
2028		12,275.99	0	12.275,99
2029		10,085.44	0	10.085,44
2030		-36,405.10	0	-36.405,10
2031		-41,906.83	0	-41.906,83
2032		3,826.80	0	3.826,80
2033		-6,058.62	0	-6.058,62
2034		10,751.06	0	10.751,06
2035		13,345.98	0	13.345,98
2036		12,330.64	0	12.330,64
2037		-2,274.44	0	-2.274,44
2038		4,992.71	0	4.992,71
Total		116,372.57	0	116.372,57

5 MONITORING

5.1 Data and Parameters Available at Validation

Data Unit / Parameter:	BEF1, j
Data unit:	Dimensionless
Description:	Biomass expansion factor for conversion of annual net increment (including bark) in stem biomass to total above-ground tree biomass increment forspecies j
Source of data:	The source of data shall be any of the following: (a) Existing local and species-specific or group of species-specific; (b) National and species-specific or group of species-specific (e.g., from national GHG inventory); (c) Species-specific or group of species-specific from neighbouring countries with similar conditions; (d) Globally species-specific or group of species-specific (e.g., IPCC literature: Table 3A.1.107 of the GPG-LULUCF (IPCC 2003), and Table 4.58 of

	the AFOLU Guidelines (IPCC 2006).)
Value applied:	
Justification of choice of data or description of measurement methods and procedures applied:	/ Data is used for project emission calculation
Any comment:	BEFs in IPCC literature and national inventory data are usually applicable to closed canopy forest. If applied to individual trees growing in open field it is recommended that the selected BEF be increased by a further 30%

Data Unit / Parameter:	Ai
Data unit:	ha
Description:	Area of stratum i
Source of data:	Monitoring of strata and stand boundaries is done using a Geographical Information System (GIS) which allows for integrating data from different sources (including GPS coordinates and Remote Sensing data)
Value applied:	
Justification of choice of data or description of measurement methods and procedures applied:	/ Data is used for project emission calculation
Any comment:	

Data Unit / Parameter:	CF j
Data unit:	t C t -1 d.m.
Description:	Carbon fraction of dry matter for species of type j
Source of data:	The source of data shall be any of the following: (a) National and species-specific or group of species-specific (e.g., from national GHG inventory); (b) Species-specific or group of species-specific from neighbouring countries with similar conditions; (c) Globally species-specific or group of species-specific (e.g., IPCC GPG-LULUCF 2003);
Value applied:	The default IPCC value 0.5 t C t-1 d.m.
Justification of choice of data or description of measurement methods and procedures applied:	/ Data is used for project emission calculation
Any comment:	Carbon fraction of dry matter for dominant species DS when j=DS

Data Unit / Parameter:	D j
Data unit:	t d.m. m^{-1}
Description:	Basic wood density for species j
Source of data:	The source of data shall be any of the following: (a) National and species-specific or group of

	species-specific (e.g., from national GHG inventory); (b) Species-specific or group of species-specific from neighboring countries with similar conditions; (c) Globally species-specific or group of species-specific (e.g., IPCC GPG-LULUCF 2003
Value applied:	
Justification of choice of data or description of measurement methods and procedures applied:	Data is used for project emission calculation
Any comment:	Basic wood density for dominant species DS when j=DS

Data Unit / Parameter:	f j (DBH, H)
Data unit:	t d.m.
Description:	Allometric equation for species j linking diameter at breast height (DBH) and possibly tree height (H) to above-ground biomass of a living tree
Source of data:	Whenever available, use allometric equations that are species-specific or group of species-specific, provided the equations have been derived using a wide range of diameters and heights, based on datasets that comprise at least 20 trees. Otherwise, default equations from IPCC literature, national inventory reports or published peer-reviewed studies may be used—such as those provided in Tables 4.A.1 to 4.A.3 of the GPG-LULUCF (IPCC 2003)
Value applied:	na
Justification of choice of data or description of measurement methods and procedures applied:	Data is used for project emission calculation
Any comment:	

Data Unit / Parameter:	CO_2e
Data unit:	The factor of 3.667 (44/12) is applied to convert the tree carbon sequestered to tree CO2-e sequestered
Description:	The factor of 3.667 (44/12) is applied to convert the tree carbon sequestered to tree CO_2e sequestered
Source of data:	IPCC default value
Value applied:	3.667 (44/12)
Justification of choice of data or description of measurement methods and procedures applied:	Data is used for project emission calculation
Any comment:	Any comment: If default allometric equations are available for conditions that are similar to the project (same vegetation genus; same climate zone; similar forest type), then the equation may be used and considered conservative. Otherwise, it is necessary either to use conservatively assessed values, or to verify the applicability of the equation if mean predicted values are to be used. Allometric equations can be verified by:

	• Selecting at least 5 trees covering the range of DBH existing in the project area, and felling and weighing the above-ground biomass to determine the total (wet) weight of the stem and branch components; • Extracting and immediately weighing 9 sub-samples from each of the wet stem and branch components,10 followed by oven drying at 70ºC to determine dry biomass; • Determining the total dry weight of each tree from the wet weights and the averaged ratios of wet and dry weights of the stem and branch components. If the biomass of the harvested trees is within about ±10% of the mean values predicted by the selected default allometric equation, and is not biased—or if biased is wrong on the conservative side (i.e., use of the equation results in an underestimate rather than overestimate of project net anthropogenic removals by sinks)—then mean values from the default equation may be used

Data Unit / Parameter:	R j
Data unit:	kg d.m.yr -1 (kg d.m.yr -1) -1
Description:	Root-shoot ratio appropriate for biomass stock, for species j
Source of data:	The source of data shall be any of the following: (a) National and species-specific or group of species-specific (e.g., from national GHG inventory); (b) Species-specific or group of species-specific from neighbouring countries with similar conditions; (c) Species-specific or group of species-specific from global studies
Value applied:	See coments below
Justification of choice of data or description of measurement methods and procedures applied:	Data is used for project emission calculation
Any comment:	Conservative choice of default values: 1. If in the sources of data mentioned above, default data are available for conditions that are similar to the project (same vegetation genus, same climate zone, similar forest type), then mean values of default data may be used and are considered conservative; 2. Global values may be selected from Table 3A.1.8 of the GPG-LULUCF (IPCC 2003), or equivalently from Table 4.4 of the AFOLU Guidelines (IPCC 2006), by choosing a climatic zone and species that most closely matches the project circumstances; 3. Alternatively, given that many datasets of root-shoot ratios are relatively small because of the difficulty of determining this parameter, conservative selection of a value from the global

	study by Cairns et al. (1997) is likely to provide a reliable default value. For the purpose of estimating baseline removals by sinks, a conservative value is about one standard deviation (circa 0.04) above the mean (0.26); i.e., a value of 0.3 kg d.m. kg -1 d.m. For the purpose of estimating the project removals by sinks, use a value about one standard deviation below the mean; i.e., 0.22 kg d.m. kg -1 d.m

Data Unit / Parameter:	fN,i
Data unit:	Dimensionless
Description:	Relative stock change factor for baseline input regime (e.g. crop residue returns, manure) in stratum i of the areas of land
Source of data:	Tables 6 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project" activities
Value applied:	1
Justification of choice of data or description of measurement methods and procedures applied:	*NA*
Any comment:	NA

Data Unit / Parameter:	fMG,i
Data unit:	Dimensionless
Description:	Relative stock change factor for baseline management regime in stratum i of the areas of land; dimensionless
Source of data:	Table 6 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project" activities.
Value applied:	0.97
Justification of choice of data or description of measurement methods and procedures applied:	*NA*
Any comment:	NA

Data Unit / Parameter:	SOCREF
Data unit:	t C ha-1
Description:	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation, normally forest) by climate region and soil type applicable to stratum i of the areas of land
Source of data:	Table 3 of "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project" activities.
Value applied:	47
Justification of choice of data or description of measurement methods and procedures applied:	*NA*
Any comment:	NA

Data Unit / Parameter:	fLU,i
Data unit:	Dimensionless

Description:	Relative stock change factor for baseline land use in stratum i of the areas of land
Source of data:	Tables 6 of “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM Project” activities
Value applied:	1
Justification of choice of data or description of measurement methods and procedures applied:	*NA*
Any comment:	NA

5.2 Data and Parameters Monitored

Data / Parameter	A
Data unit	ha.
Description	Total area of project, in accordance with the GIS database of the project.
Source of data	Survey databases of each polygon that is part of the project and is under control of project participants.
Description of measurement methods and procedures to be applied	Global Position System(GPS).
Frequency of monitoring/recording	Continuously, during the beginning of site preparation activities and final establishment.
Value applied:	*Provide an estimated value for the data/parameter*
Monitoring equipment	It GPS has an internal antenna and power source, and a high-performance 12-channelGPS receiver. Its precision varies with meteorological conditions and can range between 1and 5 m.
QA/QC procedures to be applied	Protocol of project boundary control with the addition of new areas under control.
Purpose of data	Project boundary.
Calculation method	*Where relevant, provide the calculation method, including any equations, used to establish the data/parameter.*
Comments	*Provide any additional comments*

Data / Parameter	Ai
Data unit	ha.
Description	Area of each stratum.

Source of data	Databases of all polygons that are part of the project and under the control or potential area of project participants.
Description of measurement methods and procedures to be applied	Global Position System(GPS).
Frequency of monitoring/recording	Continuously, during the beginning of site preparation activities and final establishment.
Value applied:	*Provide an estimated value for the data/parameter*
Monitoring equipment	It GPS has an internal antenna and power source, and a high-performance 12-channelGPS receiver. Its precision varies with meteorological conditions and can range between 1and 5 m.
QA/QC procedures to be applied	Protocol of project boundary control with the addition of new areas under control.
Purpose of data	Project boundary.
Calculation method	*Where relevant, provide the calculation method, including any equations, used to establish the data/parameter.*
Comments	*Provide any additional comments*

Data / Parameter	AP
Data unit	m2
Description	Sample plot area
Source of data	Field measurement
Description of measurement methods and procedures to be applied	na
Frequency of monitoring/recording	Monitoring and measurement plots in the field.
Value applied:	500 m2
Monitoring equipment	Metric tape of 30 m. Precision of 2 mm.
QA/QC procedures to be applied	Monitoring and measurement plots.
Purpose of data	Area of each monitoring plots
Calculation method	*Where relevant, provide the calculation method, including any equations, used to establish the data/parameter.*
Comments	*Provide any additional comments*

Data / Parameter	DBH
Data unit	cm
Description	Diameter at breast height
Source of data	All trees within sample plots.
Description of measurement methods and procedures to be applied	Global Position System(GPS).
Frequency of monitoring/recording	Continuously, during the beginning of site preparation activities and final establishment.
Value applied:	*Provide an estimated value for the data/parameter*
Monitoring equipment	Diametric or metric tape. Precision of1 mm
QA/QC procedures to be applied	Protocol for taking tree measurement variables
Purpose of data	Applied in the allometric equation, for each specie.
Calculation method	*Where relevant, provide the calculation method, including any equations, used to establish the data/parameter.*
Comments	*Provide any additional comments*

Data / Parameter	H
Data unit	m
Description	Total height tree
Source of data	At least 50% of trees within sample plots.
Description of measurement methods and procedures to be applied	na
Frequency of monitoring/recording	Monitoring and measurement plots in the field.
Value applied:	
Monitoring equipment	Measured with hypsometer or clinometer
QA/QC procedures to be applied	Protocol for taking tree measurement variables
Purpose of data	Applied in the allometric equation, for each specie.
Calculation method	
Comments	

Data / Parameter	lat/long
Data unit	Plot location
Description	Localization each sampling plots
Source of data	Data field sampling.
Description of	Measured with GPS

measurement methods and procedures to be applied	
Frequency of monitoring/recording	Monitoring and measurement plots in the field.
Value applied:	*NA*
Monitoring equipment	*GPS*
QA/QC procedures to be applied	Protocol for establishing plot
Purpose of data	Plot location in the field.
Calculation method	
Comments	

Data / Parameter	CACTUAL
Data unit	t CO2-e.
Description	Actual net greenhouse gas removals by sinks;
Source of data	From monitoring plots, and biomass stocks.
Description of measurement methods and procedures to be applied	NA
Frequency of monitoring/recording	In each monitoring. Each five years.
Value applied:	
Monitoring equipment	
QA/QC procedures to be applied	Protocol for establishment and measurement of plots.
Purpose of data	*NA*
Calculation method	
Comments	

5.3 Monitoring Plan

Stratification

Stratification procedures will be under AR-ACM0003 (version 1.0) Methodology. It is possible that some changes of number and stratum/strata categories vary during the Project execution, according to identified differences in some areas due to existing natural factors, such as: physical and chemical soil conditions, topography, weather, hydrology, land use history, existing vegetation categories, among others. In such cases, it would be necessary to develop a second stratification. Another important factor in the differentiation of the strata is the ability of carbon sequestration for rodal/stand models. In this regard, when capture differences are identified in same strata, it will be able to cause new strata, according to the differences found. Similarly, in case of observing a similar behaviour between two or more different strata, these can be joined to form a single stratum.

After the first sampling session, second stratification can be performed, according to biomass accumulation results, planting dates, and silvicultural treatments performed and/or achieved productivity by the different existing forest systems in the project. The information required for the stratification process will be determined by: the forest inventories; evidences on changes in vegetation cover by using aerial photography or by using information from other source, always trying to present the less number of possible strata to facilitate the total assessment of the scope of the project.

Sampling Structuring

It is considered the establishment of permanent sample plots for monitoring. The amount of plots will depend on the number of existing strata in the scope of the project, by obeying cost-effectiveness criteria. Such plots will allow monitoring changes in carbon content of aboveground and belowground biomass, in different periods. Monitoring will assess biomass evolution in rodals/stands or layers enclosed by the project and those that have been subjected to various silvicultural activities (i.e. soil preparation, fertilization, thinning, harvesting, enrichment). All parcels shall be properly numbered, geo-referenced, and located within a coverage/layer map present in the Project scope.

Sample size determination

The amount of plots will be determined by the number of species, number of identified strata, accuracy, and monitoring intervals; Determination will be under an adequate cost-effectiveness concept. Sample size (n) is estimated with fixed precision levels, assuming no differences in costs between the stratum and sub-stratum. *B*ased on assessments made in stands with similar characteristics, or based on existent literature information, for I stratum, the number of plots is given by the following steps:

Step 1) Parameters required for the estimate:

A = total project area; ha
i = stratum, adimensional
A_i = size of each stratum i; ha
AP = sample plot area, (constant for all strata); ha
st_i = standard deviation for stratum i

Then:

$$N = \frac{A}{AP}\,;\quad N_i = \frac{A_i}{AP}\,,$$

Where:

N = maximum possible number of sample units, in the project area
N_i = maximum number of sample units for stratum i

Step 2)

The parameters required in this step are:

Q_1 = approximate average value of the estimated quantity Q, (aboveground biomass, vol, etc); t ha^{-1}, m^3 ha^{-1}.
p = desired level of precision (*e.g.* 10%); dimensionless

Then:

$$E_1 = Q_1 * p$$

Where:

E_1 = allowable error ($\pm$10% of mean)
$z_{\alpha/2}$ = value of statistical z, for α = 0.05 (indicating a 95% confidence level), $z_{\alpha/2}$ = 1.9599

Supposing that the cost of establishing a lot is unknown, the Equation 5 from the tool is used.

$$n = \frac{\left(\sum_{i=1}^{m_{PS}} N_i \cdot st_i\right)^2}{\left(N \cdot \frac{E}{z_{\alpha/2}}\right) + \left(\sum_{i=1}^{m_{PS}} N_i \cdot (st_i)^2\right)}$$

And the sample number by stratum

$$n_i = \frac{\sum_{h=1}^{m_{PS}} N_i \cdot st_i}{\left(N \cdot \frac{E}{z_{\alpha/2}}\right)^2 + \left(\sum_{i=1}^{m_{PS}} N_i \cdot (st_i)^2\right)} \cdot N_i \cdot st_i$$

Where:

st_i = standard deviation for each stratum i; dimensionless
I = 1, 2, 3, … L project strata
A = 1-α is the probability that the estimate of the mean is within the error bound E
$z_{\alpha/2}$ = value of the statistic z (embedded in Excel as: inverse of standard normal probability cumulative distribution), for *e.g*. 1-α = 0.05 (implying a 95% confidence level) $z_{\alpha/2}$ =1.9599

Parcels/Plots size or sampling units

In principle, the size of the monitoring plots will be determined by the type of forest system to evaluate, and the planting density. We recommend a plot setting of 100 m^2 in stands with a planting high density, and up to 1,000 m^2 to more open stands. In this case, it will be established in all forest systems: rectangular plots with an area of 500 m^2 (1/20 hectares). Inside plots, all trees with a diameter equal to or greater than 10 cm will be measured. If necessary, the parcels/plots size may range between 250 and 1000 m2. This size range is considered cost-effective under the model of A/R selected. This decision will be determined by factors such as: stratum, species, planting system, or even, changes in the stand models of the project.

Location of plots in field.

Following the recommendations of the tool for calculating the sample size, the establishment of sampling units is conducted systematically, with a starting point selected randomly. Subjective location of parcels/plots must be avoided (centre of the plots; points of reference of plots; or movement of the centre of the plot to a more "convenient" point), following the principle of randomness. If plots of each strata/layer are separated, it should try to do a uniform distribution of the plots, according to the size of the lots (as recommended in the sample calculation tool). For location and geo-reference activities in field, it will make use of GPS, allowing an easy access, location, and monitoring over the time. The sample plots will be identified with a series of alphanumeric codes and the geographic position information (GPS coordinates), the location of the sampling unit and strata will be recorded and archived.

Monitoring frequency.

Time intervals between monitoring sessions depend largely on the variation of the content of carbon in sinks. However, to reduce implementation costs, it provides a monitoring frequency consistent with the years of verification,

Measurement and estimation of carbon content changes.

It is only considered the increase of aboveground and underground biomass of trees established in the project. Increases in biomass of existing scattered trees are not counted, because these individuals are part of the baseline Therefore, only monitor individual growth of each tree in the plots. This value shall be estimated from the increase in the determined stem in each monitoring. The changes of carbon content in other components of the biomass (branches and leaves) and underground (roots) of trees of each plot, will be estimated by the Method of Biomass Expansion Factors (*Biomass Expansion Factor Method-BEF*). This procedure is accepted by the IPCC[23].

Deadwood, litter and carbon stock will be calculated according to the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities", The conservative default approach might be selected

Standard operating procedure SOP:

SOP Establishment of Plots" will be used to establish all plots. The plots will be systematically located with a random start in each stratum to avoid subjective choice of plot locations (plot centers, plot reference points, movement of plot centers to more "convenient" positions). The plot locations will be identified with the help of a GPS device in the field. For each plot the geographic position (GPS coordinate), administrative location and compartment series number will be recorded and archived. **The PSPs will be established before the first monitoring takes place and measured for each monitoring event. In the case of special circumstances (e.g., forest fires, uneven growth) additional PSPs may be laid out.**

Data Collection

Each pool will be measured following the methodology procedures and IPCC Good Practice Guidance for LULUCF (2003), Carbon stocks in above and below ground biomass of trees are estimated by

[23]The Intergovernmental Panel on Climate Change (IPCC) 2003.IPCC Good Practice Guidance for LULUCF.

applying the BEF method, Stem volume, will be calculated applying a manual of procedures developed for local conditions, based on DBH and height measurement in each plot, Stem volume of trees is converted to above-ground and below-ground tree biomass using basic wood density (D), biomass expansion factor (BEF) and root-to-shoot ratio (R), Default carbon fraction (CF) value will be used in order to estimate the carbon stock.

Deadwood, litter and carbon stock will be calculated according to the tool “Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities”, The conservative default approach might be selected.

Prior to the start of the inventory, all equipment used during the fieldwork shall be checked and calibrated. The project will manage the sampling uncertainties evaluating and trying to reduce the type of errors.

Quality Assurance and Quality Control (QA/QC)

The implementing organization will be responsible for the centralized documentation of all project planning and implementation. QA/QC procedures will be implemented and the use of these procedures monitored to ensure that net anthropogenic GHG removals by sinks are measured and monitored precisely, credibly, verifiably, and transparently. Profesionales de Bolsa will coordinate QA/QC activities and is responsible for implementing and documenting these QA/QC procedures. Profesionales de Bolsa ensures that the QA/QC plan is developed and implemented. For this purpose Profesionales de Bolsa will designate a QA/QC coordinator.

The project will follow the IPCC GPG of using two types of procedures in order to ensure that the inventory estimates and their contributing data are of high quality: [24] [25] [26] Quality assurance (QA) and Quality control (QC). Since a QA/QC plan is fundamental to create credibility, one will be developed that outlines QA/QC activities with a scheduled time frame from preparation to final reporting. The plan will describe specific QC procedures in addition to special QA review procedures. The QA/QC plan is an internal document to organize, plan, and implement QA/QC activities and will be represented here only in reduced from. Abstract of QA/QC plan features: [27] [28]

a) Standard Operating Procedures (SOP) that will be established for all procedures such as: GIS analysis; field measurements; data entry; data documentation, and data storage.
b) Training courses will be held for all relevant personnel on all data collection and analysis procedures.
c) Steps will be taken to control for errors in the sampling and data analysis to develop a credible plan for measuring and monitoring carbon stock change in the project context. The same procedures shall be used during the project life to ensure continuity.

Field data collection

d) The personnel involved in the measurement of carbon pools will be fully trained in field data collection and analysis. SOPs will be developed for each step of the field measurements and followed so that measurements are comparable over time. If different interpretations of the SOPs exist among the field teams, they will be jointly revised to ensure clearer guidance. This procedure will be repeated during the field data collection.

[24] IPCC GPG for LULUCF; Chapter 5.5 Quality assurance and quality control
[25] IPCC GPG and Uncertainty management in National GHG Inventories; Ch. 8 QA and QC
[26] IPCC GPG for LULUCF; Chapter 3.2 Forest land
[27] IPCC GPG for LULUCF; Chapter 5.5 Quality assurance and quality control
[28] IPCC GPG and Uncertainty management in National GHG Inventories; Ch. 8 QA and QC

e) To verify that plots have been installed and the measurements taken correctly:
A minimum of 10% of randomly selected plots will be re-measured by a supervisor with a team not involved in the initial measurement sampling.

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

g) *Measurment t*

$$Error(\%) = \frac{(Estimate1 - Estimate2)}{Estimate2} * 100$$

h) The proper entry of data into the data analyses spreadsheets is required to produce reliable carbon estimates. All data sheets will include a “Data recorded by” field. Communication between all personnel involved in measuring and analyzing data will be used to resolve any apparent anomalies before final analysis of the monitoring data can be completed. If there are any problems with the monitoring plot data that cannot be resolved, the plot will not be used in the analysis. Expert judgment and comparison with independent data will be used to ensure data results are in line with expectations. Additionally, field data will be reviewed by a senior member of the monitoring team further ensuring that the data and analysis are realistic.

i) Due to the long length of the project and the speed at which technology changes data archiving will be an essential component. Data will be archived in several forms and copies of all data will be provided to each project participant.

j) Original copies of the field measurement (data sheets and electronic files) and laboratory data will be stored in a secure location.

k) Copies will be stored in a dedicated and safe place (preferably offsite) of all data analysis and models, the final estimate of the amount of carbon sequestered, any GIS products, and the measuring and monitoring reports.

l) Electronic copies of all data and reports will be updated periodically and converted to any new format required by future software or hardware. A project participant involved in the field measurements will be assigned to implement this updating.

m) The data collected shall be archived for a period of at least two years after the end of the last crediting period of the project activity.

Verification and checklist considered to guarantee the quality of the information gathered and its management.

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

QC activity	Procedures
used.	• Check that temporal and spatial adjustment factors are used correctly.
Check the integrity of database files.	• Confirm that the appropriate data processing steps are correctly represented in the database. • Confirm that data relationships are correctly represented in the database. • Ensure that data fields are properly labeled and have the correct design specifications. • Ensure that adequate documentation of database and model structure and operation are archived.
Check for consistency in data between categories.	• Identify parameters (e.g., activity data, and constants) that are common to multiple categories of sources and sinks, and confirm that there is consistency in the values used for these parameters in the emissions calculations.
Check that the movement of inventory data among processing steps is correct	• Check that emission and removal data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. • Check that emission and removal data are correctly transcribed between different intermediate products.
Check that uncertainties in emissions and removals are estimated or calculated correctly.	• Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. • Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. • If necessary, duplicate error calculations on a small sample of the probability distributions used by Monte Carlo analyses.
Undertake review of internal documentation	• Check that there is detailed internal documentation to support the estimates and enable reproduction of the emission and removal and uncertainty estimates. • Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. • Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation.
Check time series consistency.	• Check for temporal consistency in time series input data for each category of sources and sinks. • Check for consistency in the algorithm/method used for calculations throughout the time series.
Undertake completeness checks	• Confirm that estimates are reported for all categories of sources and sinks and for all years. • Check that known data gaps that may result in incomplete emissions estimates are documented and treated in a conservative way.
Compare estimates to previous estimates.	• For each category, current inventory estimates should be compared to previous estimates, if available. If there are significant changes or departures from expected trends, re-check estimates and explain the difference.

Description of the operational and management structure(s) that the project operator will implement in order to monitor the proposed A/R VCS project activity

Profesionales de Bolsa implements the proposed A/R project activity utilizing the locally available and experienced staff. The A/R VCS project is implemented under the authorization and supervision of the technical manager. The technical manager organizes technical training and consultation, and is responsible for the organization and coordination of measuring and monitoring the actual GHG removals by sinks. Any activity related to monitoring and measuring data will be reported to and archived under RIA/Municipality of Medellin. in both electronic and paper formats.

Under the proposed A/R project activity the project entity will provide technical instruction on reforestation and forest management, conduct the specific supervision of the implementation of the proposed A/R project activity, collect specific activity data at routine basis, be responsible for measuring and monitoring of the actual GHG removals by sinks, establish an expert team when necessary (e.g., to address any technical issues), conduct checks, and verify the accuracy of measured and monitored data.

Uncertainty assessment

The project follows the methods from IPCC GPG for LULUCF, GPG 2003, and the modalities and procedures for A/R project activities to estimate baseline net GHG removal by sinks, leakage, actual net GHG removal by sinks, and net anthropogenic removal by sinks. In the context of this methodology, the major sources of uncertainties related to changes in carbon stock in the living biomass pool include: natural factors such as fire and pest outbreaks; stand variables such as variation in the yield tables, allometric equation, biomass expansion factor (BEF), wood density, carbon fraction; and the errors contributed by the measurement. Estimates of uncertainty will be developed for all land-use categories involved in the inventory part of the monitoring.

Other elements of monitoring plan

The baseline will be the continuation of economic activities that take place today; which are due to historical use of the soil, and is unlikely they will have a change. Additionally, it is considered that the changes in the removal of carbon in the baseline scenario are equal to zero.

However, if in the course of the project is decided to renew the Accreditation Period of this, it must necessary an upgrade of the baseline to determine whether the baseline approach used is still valid or if the conditions have changed due to changes in regulations and sector policies, technical factors, environmental or market.

6 ENVIRONMENTAL IMPACT

Environmental impact is defined as: *"the change of a environmental parameter, in a determined period and area, as a result of a given activity, compared to the situation if such activity had not occurred"* (Wathern, 1988). In this context, environmental impact of the activity of the proposed Project is determined by the environmental conditions of the scenario of pastures/grasses, which corresponds to the project's baseline scenario. As mentioned before, these areas are degraded areas with low ecological capacity to start regeneration processes in a natural way. Therefore, recovery of the soil physical conditions requires mankind intervention and a proper technical management.

Recovery of degraded areas

Ecosystems damage and deforestation is one of the causes of biodiversity loss, quality decreasing, lower quantity in hydric resources, and soil loss in Colombia (Ministery of Environment 1998). As a consequence, these physical processes generate a series of repercussions which affect direct or indirectly population welfare and country's economy. Traditionally, it has been considered reforestation as the main ecological restoration instrument, however, currently is required to use more integral concepts at ecosystem level, in order to achieve ecologic processes restoration, by the recovery of vegetable coverage. This is why among the country's development aspects, starting from the land ordering, it is identified the tree and bush vegetation as fundamental part in the hydrologic cycle running, and the productive silvicultural systems as important contributors to the renewable energy generation, raw materials suppliers and essential ecological processes maintenance. In that sense, use of land categories are proposed, different from the conventional, which include agro-forestal uses, sylvopastoral uses, vegetal succession and ecologic restoration. Additionally, aiming to boost the forest sector and ease the pressure on natural forests, profitable reforestation with commercial use is promoted in areas with economic and environmental fitness (Ministery of Environment, 1998)

Biodiversity

The fast transformation process of habitats and natural ecosystems due to land use, colonization processes and expansion of agricultural borders, construction of infrastructure, grazing zones, Wood exploitation and wildfires, reduce or fragment the ecosystems (Republic of Colombia, 1996). Produced alterations can be temporary if the environment has the capacity to return to its natural state. However, affectation levels in the Project areas are higher than the response capacity of the ecosystem, and also, these are used as productive lands by the owners, who depend economically from their use. Vegetal and forest component in Stand models proposed in the Project, will mitigate the effects of animal and vegetable loss in the region. In the sylvopastoral systems, which density of trees per aerial unity is lower than traditional commercial plantations, it has been observed an increase in fauna and birds, compared to grass areas (Mahecha, 2002)

Soils

One of the main characteristics of the areas of the Project is the size of the farms, with an average between 1 and 3 hectares. The practice of farming on these lands and hillside produces inevitably an erosion process, plus the lack of knowledge of brush control techniques, fertilizers, plague control and diseases, determine low profit production with high social and ecologic costs. Additionally, traditional grazing practices generate environmental impact, as well as the intensive livestock in steep zones, erosion and soil compaction. From the other side, livestock without presence of trees to protect the animals towards temperature oscillations increases the consumption of energy of these animals, which is traduced as: weight loss, and a lower quality of pastures/grasses due to the lack of shade. Agroforestry and sylvopastoral systems can help to improve the problems related to the use of land at productive functions level and services (Ministry of Environment, 1998). Additionally, physical soil conditions improve considerably when forest component is incorporated (Mahecha, 2002):

- Nutrient recycling. Grass management with trees and/or bushes, allows a representative fraction of the nutrients extracted from the soil solution to be returned through deposition, in the soil surface, and from grazing leftovers and pruning. This higher deposition of organic matter, contributes to modify the physical characteristics of the soil like its structure.
- Roots depth. The extended and deep root system of trees, increases the available are to capture water and nutrients
- Action of micro and macro wild life. The bigger presence of organic matter in the soil and micro climate (humidity and temperature) created by the presence of trees, it favours the biological activity of the micro and macro wild life, which results in a higher mineralization and N availability in the soil. Furthermore, organic matter which is incorporated to the soil by the in fauna action, contributes to improve the soil stability and water infiltration capacity
- Erosion control. Trees in sylvopastoral systems perform ecological functions of soil protection from sun direct effects, water and wind.

Water

The presence of trees affects the water dynamics in several ways: as a barrier, controlling runoff, as coverage, by reducing the *drop* impact, and as soil improvers, by increasing the infiltration and water retention (Mahecha, 2002)

The function of trees of regulating the hydrological cycle, through the interception of rain, helping with infiltration and keeping a higher relative humidity than uncovered terrains. The hydric balance in reforested hydrographic basins is not very different from zones with natural forest coverage. About the water availability, the consumption of this resource is related to the species growth pace. In this sense, in the eucalyptus plantations there is a higher consumption compared to other species with slower growth, however, this acceleration acts as a regulator of the hydric resource of the basin. Actually has been determined the usefulness of the trees in the agricultural systems related to the protection against erosion and dangers of drought by wind action, reduction of control costs, livestock protection and a better use of inputs as fertilizers due to nutrients recycling (Martinez *et al*, 2006).

Positive effects on the environment

In order to make an objective assessment of the impacts and benefits of the forest plantations on an ecosystem, we must perform a comparison between the line base activity (grass/pastures) and the project's proposal activity. Studies done by the National Research Corporation and Industrial Promotion (stands for CONIF in Spanish), assessing the impacts that forest plantation activities in the Andean zone of Colombia, show that the benefits of these forest areas are bigger than in pastures (Leon et al. 2007[29]). The results of the ecological impact comparative analysis, show clearly, a positive balance for plantations (+11) and a negative score for prairies with grass (-42), referred to a maximum score of 100.

The environmental benefits of the reforestation activities focused on the restoration of degraded areas are numerous. Then, the assisted natural regeneration model, which aims to take to similar forest conditions to those previously existent in the project's area, will contribute to improve the environmental conditions in the region, increasing the wild life and vegetable diversity and protecting basins from their origin. However, less complex models like commercial reforestation or sylvopastoral, do not contribute in the same way.

In an illustrative way the Table D.2, shows a matrix which identifies the effects on the diverse native components of wild life and plants caused by the execution of sylvopastoral and stand forest commercial models activities. These are focused on the performed activities on the main forest use introduced species in Colombia, like Eucalyptus and Pine (Leon et al. 2009[30]). It is important to highlight that even lower environmental effects occur when forest systems are developed by mixing native species, which is why by being conservative; a bigger impact on the ecosystem is caused.

Activities like hole-digging and planting seedlings do not make any evident effect on the wild life. From the other side, if we consider that activity is developed in soils with presence of grasses, the impact on the native plants would not happen, because it is not present due to livestock activity. So, if we consider that the gaps in the holes for planting are between 2.7 x 2.7 m and 3 x 3 m. we can establish that light is not blocked on its path to the surface in the starting stages, promoting the presence of native plants which was not present when grass dominated the project's area. Other activities like fertilizations are used jointly by plantations and woodland undergrowth wild life and brush growing inside the plantation.

However, the activities that generate the biggest impact on the environment in the forest sector are thinning and forest harvesting. Nevertheless, these are temporary effects, because the activities are rotative, and many times, the stand forest is again established. Additionally, these interventions can be minimized, when low impact activities are implemented.

In the forestry plantations, some effects on the minor vegetation are distinguished like herbaceous and vines. However, these elements were not before starting the activity (Table D.2)

29

30 León, T; Pinilla, G; y Torres, J. 2000. Impacto Ambiental de Plantaciones Forestales: Síntesis de resultados 1996-2000. Corporación Nacional de Investigación y Fomento Forestal –CONIF-. Serie técnica No 47, Bogotá. 148pg.

According to the results, birds are the most benefited group by the establishment of stands forest, because of the offer of food, shelter and nurturing. Some mammal species relatively big (rabbits and armadillos) have the possibility to occupy and move safer within the plantations compared to grass (Table D.2). The synthesis of the analysis shows that positive effects are bigger compared to the baseline activities.

Finally, considering that forest activity with long term species allows native wild life and plants to keep natural patterns, fostering a higher level of biological diversity, recovering the soils structural conditions for a future establishment of native forest coverage when forest activities are abandoned.

A.1. Analysis of socio-economic impacts

Documentation to identification and analysis on the possible socio-economic impacts that the Carbon Capture Forestry Project under *VCS "More forests for Medellin"*, is supported by the socio-economic characterization document done within the feasibility study framework for the VCS implementation, as a forestry activity, and, in the proposal of social work for the involved community of the FRAGUA Project. On this documents, the baseline conditions of the local communities is described in terms of population, land ownership, local employment and food production

The influence area of the Project is found in the rural zones of the municipality of Medellin, which is conformed by the townships of San Sebastián de Palmitas, San Cristobal, Altavista, San Antonio de Prado and Santa Elena, which are border spaces between the rural and urban, making them places where identities, uses of land, habitats and consumption ways are constantly redefined, creating new social dynamiques (Zuluaga, 2005).

Local communities living in these territories traditionally have been countryside people with socio-economic practices supported by the agricultural production, in medium and small farms, normally no bigger than 1 hectare, being used basically for auto consumption, and very few market producers, such as: Onion, flowers, blackberry, sugar cane, grass and milk.

In the last years, the effects of the urban expansion and pressure on the natural resources have lead to a high fractioning of the property, visible in the disperse urbanization, specially second residence places for the wealthier section of the society, causing a higher degree of boos-worker relation with the local residents. At the same time, a mixed economy has emerged; this combines farming and other live hood economical activities. That is why is very common to find local people working as butlers, gardeners, builders or in the street informal commerce or any other domestic activity. (Zuluaga, 2005)

The economic situation of the local communities in the potentially eligible areas of the Project is characterized by the informal employment, unemployment and scarce income, finding among the farmers Little owners of low productivity lands, who sell their products under disadvantage conditions, people who have lost their agricultural vocation and obtain their living by trading products with local business (shops, restaurants or tourist focused activities), and try their luck working in diverse jobs in the city, as drivers, merchants, cleaning and domestic tasks.

Given the social conditions currently observed in the eligible areas, it is expected that the impacts on the communities are moderated or positive, mainly by the increasing of the job opportunities during the establishment stage.

The Project will attract sources to boost the local economy, encouraging the generation of stable workplaces and fairly paid for the families incorporated as owners or as workforce for the establishment of the forest core; in this way, it is expected to contribute with the reduction of unemployment by generating direct vacancies in the plantations, offering stability, and project's sustainability, and additionally coaching activities to transfer forest management knowledge, in order to guarantee continuity and long term wellbeing, as well as incorporation of qualified workforce, capable of multiply the experience.

The areas where the Project is implemented are under grass coverage. Project's participants are landlords (medium properties) dedicated to extensive livestock, without another agricultural activity and many times not used at its potential. These landlords are betting for a change on the use of land and the traditional production ways, looking for a diversification on their income and technifying the livestock activity currently performed. This improvement, will allow doing some other complementary activities, different from grazing ones.

In this context, all alternatives meet in a single objective: to improve the productivity of the farms by using the resource in a sustainable way, through MDL. The proposed forest models contribute with environmental and social benefits, and reactivate the lands' productivity too.

The establishment of the Project searches for correct land use alternatives, in order to decrease the human pressure on the natural forests, and contribute with regulation of the hydric resource, contributing with at least the same good and services identified in the interest areas. This means that baseline economic activity will not be interrupted, and then the owners' income must be at least as high as they were at the beginning of the Project.

An alternative for sustainability of the current bovine production in the project's zone is the establishment of systems where positive relationships are generated, between soil, grass and animals under an integral management system. For example, the sylvopastoral system proposed can provide the owners with extra income. Apart from obtaining Wood, fruits, and some others, it delivers better conditions for wild life and enhances the landscape. In the same way, these can reduce the speed of wind, helping to reduce the effects of environmental temperatures on the animals, lowering the stress generated and the energy used to feed. Pastures under the trees have better nutritional quality, because they contain more proteins and less fiber content.

Stand models proposed include technical components to modify deeply the production way based on an efficient agro-ecologic model. It looks for turning these small farms into profitable companies thanks to an efficient corporative model.

Furthermore, these systems permit to maintain the production while the critical period of the dry seasons, which affect considerably the fodder production, and as a consequence, the whole chain including animals, their reproduction and general health conditions. Additionally, some practices are applied to rehab the productive potential of one of the most affected soils by the overgrazing, exaggerated exploitation and agrochemicals use. The proposed management systems are characterized by the good profitability, high biological efficiency, generation of diverse high value products and nutritional quality (milk, meat, and Wood) increasing the natural capital, contributing with employment and environmentally friendly.

As a goal to change the use of land from degraded pastures (dominant in livestock of small producers) to sylvopastoral and Wood production systems, the animal loads increase per area unit, and some more space is set free to diversify production and establish the stand models of the project

Another expected impacts

- Reactivation and improvement of local economies by investment and project's establishment
- Integration with local commercial network, as well as at national and international level by offering forest products, sale of carbon credits and environmental services
- Employment beyond the establishment time of the plantations, in activities like ranger and environment educators who can replicate the experience in the local communities and adapt it to other communities outside the project's boundaries
- Strengthening of the institutional capacity to achieve self-management for the communal organizations, and participation in activities derived from the project's operation

- Integral development and participative in the land use planning and new practices to implement

- Knowledge of the national forest law and the benefits and incentives obtained by working with the project

- Training and coaching to local communities in the implementation and forest management, in activities headed to soil conservation and transformation and proper forest products exploitation

- Assistance to breeders and farmers to improve grasses and crops, in order to implement successfully the agroforest and sylvopastoral systems proposed on the project

- Strengthening of the cultural identity of the local inhabitants, recognizing practices and traditional knowledge in the management and soil use, assessing and fostering the joint creation of new knowledge, to apply it to the Project.

- Implementations of agroforest and sylvopastoral systems, proposed in the Project are alternatives which allow a gradual change in the land use, minimizing the impacts of the traditional production culture.

- Income from generation of CERs improves the cash flow and return rates for landlords. In absence of regular income, like the ones generated by MDL, these would not be able to compromise their productive lands and generate alternative income sources for long periods, due to the financial return in traditional forest projects normally comes in the long term.

- Curve the need to migrate to cities, because some possibilities of employment are derived from the Project. In the current situation, the abandonment of lands would be one of the few options the local people had.

Economic impact

With the exception of the Natural Assisted Regeneration System (RN), the stand models (MR) exposed in the Project *"More forests for Medellin"* consider different thinning and interventions along the accreditation period, as well as the carbon market participation, aiming to take advantage of the wood resources, similar to the conventional forest systems.

To evaluate the financial aspect provided by MDL to the Project, for each MR (except RN and FE) a cash flow where all establishment costs, plantation management and transactional costs MDL are included, as well as the total income received from both components (Wood sale and carbon credits). None of them included the cost of land.

In order to typify the uncertainty related to the market conditions and the CERs negotiation Price, four scenarios were considered, under three discount rates to evaluate NPV for each MR.

- MR*n* (Wood): scenario of forest activity with Wood harvest and sale
- MR*n* (CER US3): scenario of forest activity with Wood harvest, sale and CER commercialization at US 3.
- MR*n* (CER US7): scenario of forest activity with Wood harvest, sale and CER commercialization at US 7.
- MR*n* (CER US10): scenario of forest activity with Wood harvest, sale and CER commercialization at US 10.

In the next Figures is shown the increase in the profitability values in the implementation scenarios of MDL for the models: commercial, sylvopastoral and agroforest, respectively.

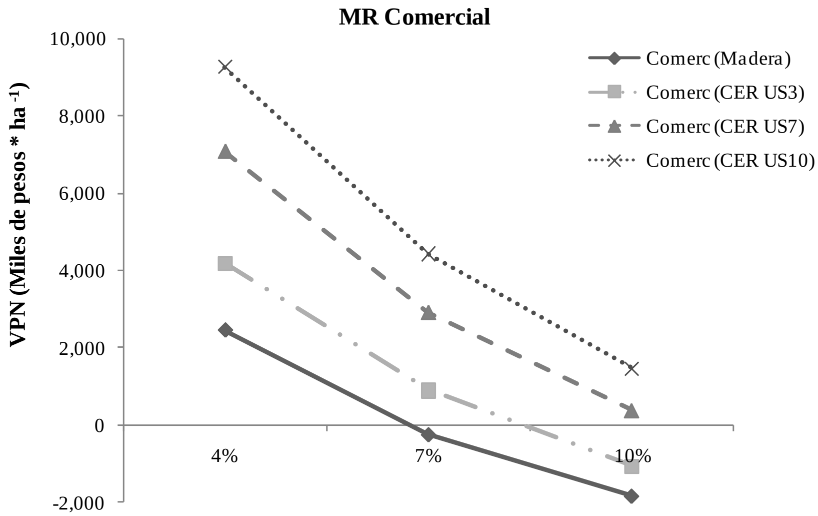


Figure 17 Net present value per ha (NPV - $*ha-1) for the commercial MR, evaluated under three discount rates (4,7 and 10%) Comerc (Wood):scenario of forest activity with Wood harvest, sale and commercialization. Comerc (CER US3): scenario of forest activity with Wood harvest, sale and commercialization at CER Price of US 3. Comerc (CER US7): scenario of forest activity with Wood harvest, sale and commercialization at CER Price of US 7. Comerc (CER US10): scenario of forest activity with Wood harvest, sale and commercialization at CER Price of US 10. Exchange rate used: 2.363 Colombian pesos/US (average value between 1st of January and 1st of June of 2009).

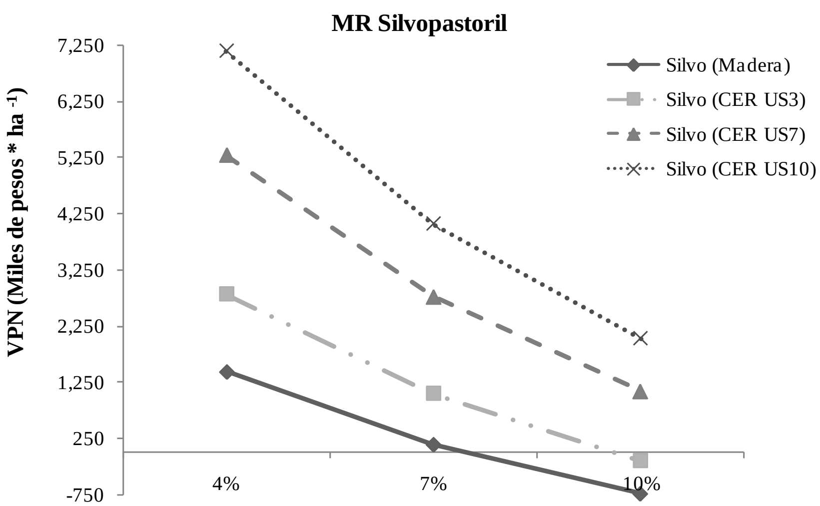


Figure 18 Net present value per ha (NPV - $*ha-1) for the sylvopastorall MR, evaluated under three discount rates (4,7 and 10%) Sylvo (Wood):scenario of sylvopastoral activity with Wood harvest, sale and commercialization. Comerc (CER US3): scenario of fsylvopastoral activity with Wood harvest, sale and commercialization at CER Price of US 3. Comerc (CER US7): scenario of sylvopastoral activity with Wood harvest, sale and commercialization at CER Price of US 7. Comerc (CER US10): scenario of sylvopastoral activity with Wood harvest, sale and commercialization at CER Price of US 10. Exchange rate used: 2.363 Colombian pesos/US(average value between 1st of January and 1st of June of 2009).

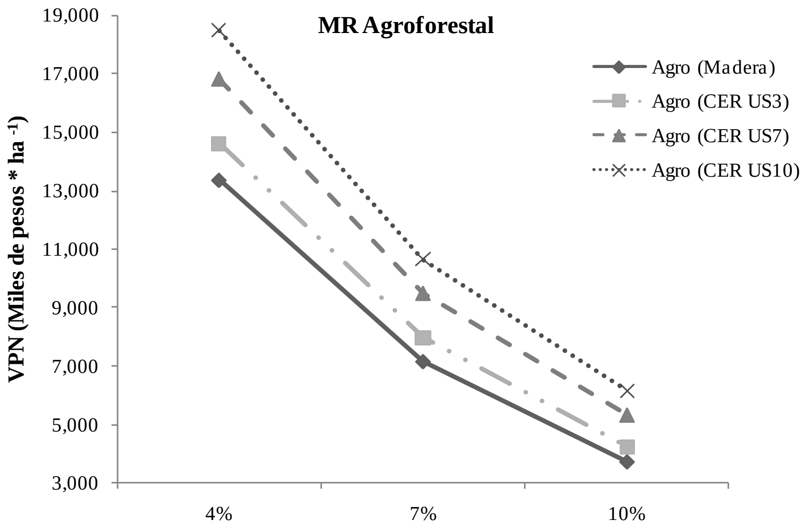


Figure 19 Net present value per ha (NPV - $*ha-1) for the Agroforest MR, evaluated under three discount rates (4,7 and 10%) Agro (Wood): scenario of agroforest activity with Wood harvest, sale and commercialization. Agro (CER US3): scenario of agroforest activity with Wood harvest, sale and commercialization at CER Price of US 3. Comerc (CER US7): scenario of agroforest activity with Wood harvest, sale and commercialization at CER Price of US 7. Comerc (CER US10): scenario of agroforest activity with Wood harvest, sale and commercialization at CER Price of US 10. Exchange rate used: 2.363 Colombian pesos/US (average value between 1st of January and 1st of June of 2009).

Finally, it is expected that for owners, the income do not only come from CERs, but also from improved productive activities which complement as part of the proposal (Table E.1)

Tabla 25 Results of the NPV per hectare ($/ha) under discount rate of 7%, for the livestock activity in baseline compared to the joint activity, where stand models are implemented and livestock is intensified.

Productive systems		Commercial	Agroforest	Sylvopastoral
Baseline (livestock)		$ 9.856.554	$ 9.856.554	$ 9.856.554
Reforestation + Baseline	tCER 3	$10.331.554	$10.906.554	$13.856.554
	tCER 7	$11.306.554	$12.606.554	$14.581.554
Increase	tCER 3	**$ 475.000**	**$ 1.050.000**	**$ 4.000.000**
	tCER 7	**$1.450.000**	**$ 2.750.000**	**$ 4.725.000**

7 STAKEHOLDER COMMENTS

Compilation of opinions and comments from social actors who are involved in the Project *“More forests for Medellin”* was a product from the socialization process developed by meetings done in each one of the townships and a training conference with different governmental institutions, social organizations, leaders, local community and landlords within the potentially eligible areas of the Project.

In total, 10 socialization workshops were done, with the participation of 150 people among the communal action boards representatives, environmental tables and official authorities; the meetings were the scenario to expose the Project explaining its scope and goals, as well as the potential areas for the establishment and general information about operation and communities and official bodies' involvement. As a result, in each meeting was done the relatory task and questionnaires systematization elaborated as an open questions format, also questions, comments, expectancies and doubts from participants were collected, as well as he participants list, leaving written proof of the people present at the meeting.

Socialization workshops were directed by at least a forest professional, companied by a social professional, being dominated by forest projects under the MDL, with technical and administrative conditions of the Project.

In the socialization program framework was done a training conference which had as target public the institutions, local communities, companies and landlords, the subjects studied were climate change, ecologic restoration, reforestation as a natural process and clean development tools (MDL). The seminary called for reflection on climate change and its effects, as well as the government's responsibility and individuals to contribute to conservation and environmental restoration.

It was also collected valuable information to compile comments and perceptions about the Project through surveys performed in the potentially eligible properties, these surveys were complemented by observation and informal conversations with the people, community leaders and representative people from official organizations like UMATA and territorial technicians, where they mentioned the project's perception, the economic and social conditions they live in, and the identification with their immediate needs.

Proposal of social approach for the community involved in the Project performed by FRAGUA

Activities call was made in the following way:
Universal simple: 520 properties
Representative simple: 52 properties (10% of the universal simple)

Tabla 26 Activities call done by FRAGUA Corporation

Distribution poper townships	
San Antonio de Prado	8 (16%)
San Cristóbal	28 (55%)
Altavista	5 (10%)
San Sebastián de Palmitas	10 (19%)

This distribution of participants by township to perform the surveys obeys, basically, to the number of eligible properties of 1 to 3 hectares to intervene in the Project. Additionally, it reflected the last term of interest that the same townships and their participants have shown in the selection processes.

Summary of the comments received
>>
Social agents: local communities, landlords, investors, see the Project as an environmental initiative for conservation and restoration, which contributes to improve the current quality of life, by generating economic alternatives that not only favours the work generations, but also a change in the use of land from which it is possible to obtain additional benefits to the CERs. *"it is to take care of the environment and receive at the same time an income as incentives and better quality of life, we see it as something*

concrete for the payment of environmental services"(meeting in the Environmental Table of the township of San Sebastian de Palmitas).

Local communities highlight the importance of agreement and involvement in the decision-making processes related to the land they live in, ratifying the importance of the communal organizations as facilitators and promoters for the projects' execution.

In the socialization meetings, people contributed to the joint construction of the Project endorsing the incorporation of the proposed stand models (sylvopastoral, agroforestal, and assisted regeneration) pointing that *"in the township people are interested in sowing species able to combine with their crops. People see viable this Project but only if native and easy grow species are proposed to implement, we would also like to saw living fences in the boundaries of the livestock properties".* (Meeting in the environmental tables is San Sebastian de Palmitas) that is *why "it is mandatory to sow trees in the streams but with authority's intervention in order to respect the streams and forbid the access of people who cut down the trees"* (meeting in the environmental table in San Sebastian de Palmitas)

Next, some answers are shown to the questions formulated in the meetings framework done in the townships.

For the local communities the *Project "More trees for Medellin"* raises the following expectancies:

Tabla 27 Communities' expectancies in the Project township

Township	Comments
San Antonio de Prado	To be able to articulate the food production with environmental sovereignty among the inhabitants to improve the quality of life at every level, social, economic, ecologic and cultural"
San Cristóbal	"I think that is feasible, because the western tunnel road has splitted farmer's life and displaced all his lands and costumes" "education for tree sowing in the streams shores and also to sow fruit trees"
Altavista	"it is important to protect the environment and reforestation is the best option in a township where there is so much pollution with brick factories and combustion"
San Sebastián de Palmitas	"It is a very important Project, because it not only conserves the environment, but also it is a sustainable economic way for the owners' families who enjoy the benefits."
Santa Elena	"Reforestation as key factor to create life in dead zones. Carbon capture as economic way"

Viability for project's implementation was discussed with the participants, finding scenarios where local communities respond positively to the project's proposal (Table F.3).

Tabla 28 Comments on the project's viability, from the community.

¿Do you consider viable, feasible, the Project being formulated in your territory	
Township	**Comments**
San Antonio de Prado	"yes, some terrains are very extense and do not have a proper use"

San Cristóbal	"The Project is viable only if it is more environmental aimed than economic (with a conservationist spirit) and while it is integrated with some other benefits such as: tax reduction, cheaper public services."
Altavista	"very feasible as long as soil and species condition are analyzed according to the community's convenience"
San Sebastián de Palmitas	"I think it is viable due to the high part of the township has been destined to conservation, and it counts with a big quantity of lands without use"
Santa Elena	"I find it feasible as long as the most benefited group is the local farmers"

Project's perception from participants (FRAGUA Corporation)

Perception of the project's possible impact

Bellow it is shown the reported perception on whether the zone will experience benefits or not on three axis: social, economic and ecologic-environmental. Next, an analysis is presented with some observations for each axis.

Tabla 29 (Corporación FRAGUA).Project's perception from participants (FRAGUA Corporation)

Social scope	
yes	46 (88%)
No	6 (12%)
Economic scope	
yes	45 (87%)
No	7 (13%)
Ecologic-environmental scope	
yes	49 (94%)
No	3 (6%)

General perception participants have respect to the project's possible impact on its three dimensions, is distributed in a very homogeneous way. However, out of the three, the surveyed people have a higher tendency to the conscience aspect and the importance of the Project on the environmental impact and its improvement (Table F.4), with a 94%, what is presumably the central reason of the Project itself. At this point the majority of the participants say that the Project will have a direct influence on:

- Capture and reduction of CO_2 in the atmosphere, due to they are aware of the climate change and the damage done on their lands
- It was also mentioned the incidence on the lands condition and the protection provided for the new trees against erosion
- The importance of the reforestation and with it, the grass.
- It is also important for them the substantial improvement in the water quality.
- Finally, it was mentioned that all this would impact on the way how the ecosystem is looked after and improved.

In a second place, we can find the project's incidence on the social aspect, with an 88%. Without being a direct dimension to influence, participants understand the importance of environmental improvement as a social progress, then, the project's benefits offered will be reflected, in human development and quality of life, objetive of this kind of interventions. The majority of participants said that the Project will have an important influence on:

- People not to leave the lands to go to nearby cities looking for better opportunities, allowing them to live in and from their lands.
- This implies that the Project must encourage a higher community integration, which is reflected in benefits for the inhabitants' quality of life in general.

Finally, we found the impact on the economic aspect, with an 87%. Despite being the lowest one of the three, it is important to bear in mind that outside the surveys, participants mentioned a strong interest for the economic consequences of the Project, represented in spending as well as benefits, questions and concerns properly answered by the Masbosques professionals, when they explained the project's consequences and implications. At this point the participants made very clear their position as they said the Project would influence considerably on:

- The use of own resources in economic terms, what would be reflected on the generation of new vacancies in the zone.
- They believe the tax exemption due to CO_2 capture, and with it, the importance of the Project as a long term objective.
- Some of them expressed interest on the incursion in the coffee cultivation.
- The importance of the Project as a key contributor to the economic stability of the region

Two concerns should be mentioned form some of the respondents. The first one related to t he lack of information of the Project, and the second one about the lack of confidence on the possible economic benefit and the problem it would bring given its long term character, which could possibly be too long.

Report on consideration of comments received

Attendants manifested their preoccupation on the selection of exotic species like pine and cypress, arguing that they are only interested on sowing native species, because the foreign ones affect the hydric resource.

This preoccupation was managed by the forest professionals team, clarifying the chosen species selection criteria for the project's implementation, which suit the ecological conditions of the rural zones bringing economic and environmental improvement, according to the potential use of soil exposed on the Municipality of Medellin Territorial Organization Plan (POT 2007)

For local communities was absolutely clear that according to the proposed stand models for the forest establishments, the Project counts on a17 forestry species, which ensure the biodiversity conservation in the eligible areas of the project

In order to consolidate the confidence and the information processes of the community, an association of owners will be conformed, as part of the organizational structure of the Project. In that sense, in the activities performed by FRAGUA Corporation, it was identified the leaders and institutions availability and accessibility, in order to do the dissemination activities of the Project

ANEX I: LETTERS OF INTENTION

This information will be given upon request.