CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM FOR AFFORESTATION AND REFORESTATION PROJECT ACTIVITIES (CDM-AR-PDD) Version 04

CONTENTS

PROJECT DESIGN DOCUMENT FORM
FOR AFFORESTATION AND REFORESTATION PROJECT ACTIVITIES (CDM-AR-PDD) - Version 04

SECTION A. General description of the proposed A/R CDM project activity:

A.1. Title of the proposed A/R CDM project activity:

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Commercial reforestation on lands dedicated to extensive cattle grazing activities in the region of Magdalena Bajo Seco.
Version 9
February 14, 2013

History of the document

Version	Date	Nature of revision
07	April 28, 2011	Final version registered 07 Jun 11 (Date of registration action 05 Sep 11)
08	September 22, 2012	Corrected version as part of the verification process. The following minor changes are reported: - Project area has changed from 4,373.3 to 3,137.32 ha - In estimation of biomass loss due to site preparation, only aboveground non-tree biomass must be considered in accordance with the applied methodology, and correction of inconsistency between PDD and source of data Dufour (2005). - Methods and equations used to estimate actual net GHG removals by sinks were updated
09	February 14, 2013	Corrected version as part of the verification process. The following minor change is reported: - Root to shoot ratio for pre-existing tree vegetation was removed because it was already considered in the value of1.66 (total biomass).

A.2. Description of the proposed A/R CDM project activity:

The proposed A/R CDM project activity consists in the reforestation of 3 137,32 [1] ha of land traditionally devoted to extensive cattle grazing in the North of Colombia, department of Magdalena, in six municipalities located along the Magdalena River.

This area of the country is part of the Llanuras Secas del Caribe, sub-region Colombian Caribbean savannas, a region that has been determined as a strategic ecological area by the Government of Colombia due to its tendency of desertification as consequence of deforestation.

Deforestation was previously the traditional economic activity of “farmers without land”, who were renting their work force to stockbreeders in the aim to extend cattle grazing activities. Traditional extensive cattle ranching have been so far the dominant agricultural activity. Nowadays, deforestation is almost complete; currently, only about 10% of the initial Caribbean forest remains, which is

[1] At the time of validation, two third of the 4 373 ha were under control of project participants. However, at the time of first verification (April 2012), only 3 137,32 ha could be recognized under control of project participants with legal documentation. This is in accordance with paragraph 4(a) of the Guidelines on accounting of specified types of changes in A/R CDM project activities from the description in registered project design documents (V02.0). Therefore, this can be considered as a minor change that does not require approval by CDM Executive Board.

equivalent to 7,699 hectares, that represents 0.007% of the area of Colombia[2]. This large-scale of deforestation of the area already decades ago has dramatically increased the threat of desertification due to the dry climate, with the aggravation that the department of Magdalena is the third department with the largest area in the process of desertification in Colombia[3].

Consequently, increasing environmental and social issues spurred by:

- On one hand, deforestation has affected very negatively on soils erosion, in particular over the major Colombian river watershed: the basin of the Magdalena. Erosion is responsible for the lost of river navigability, the diminution of fish resources and the degradation of the corals in the Caribbean Sea[4].
- On the other hand, the very low productivity of traditional cattle ranching and the quasi absence of alternatives to such an activity along with the natural increase of demography, lead to a worrying social situation with important risks for the region, to follow into a spiral of violence[5].

The reforestation project in Magdalena Bajo aims at stopping and reversing this situation through:

- **The most optimal use of the land traditionally devoted to extensive livestock in the Magdalena Bajo, through higher cattle densities per surface unit in order to release areas for the establishment of commercial forest stands.** Thus, the local economy, based on cattle grazing activities, will not be hardly affected and will generate additional income from forest activities. This principle is to avoid potential leakage from the displacement of cattle by maintaining the same number of animals respect to the reference scenario (see section A.5.6).

- **The reforestation on private lands dedicated to extensive cattle grazing activities,** located on municipalities along the Magdalena River margin. The reforestation program of which 3,137.32**ha will be under A/R CDM project activities** will be implemented as:

- Single plantations of *Gmelina arborea*, with 2,380[6] ha under A/R CDM project activities
- Single plantations of *Tectona grandis*, with 225.6 ha under A/R CDM project activities
- Single plantations of *Bombacopsis quinata*, with 320.4 ha under A/R CDM project activities
- Single plantations of *Tabebuia rosea*, with 165.7 ha under A/R CDM project activities
- Single plantations of *Eucalyptus tereticornis*, with 45.7 ha under A/R CDM project activities

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[2] Becerra, 2004a. "Los múltiples servicios de los bosques y el desarrollo sostenible en Colombia", en Peter Saile y María A. Torres (Eds.), Conferencia Internacional de Bosques, Colombia País de Bosques y Vida, Memorias, págs. 99-114. Bogotá: GTZ.

[3] Vargas y Gómez, 2003. La desertificación en Colombia y el cambio global. Cuadernos de geografía. XII (1-2) pag 121-134

[4] Payen, 2003. Informe de presentación del Proyecto FFEM Control de la erosión y de la sedimentación de origen antrópico y sus efectos sobre los ecosistemas fluviales y lacustres del Magdalena y su zona de influencia, incluyendo la zona costera Caribe. pag 8-9

[5] ONF Andina, 2004. Elaboración de un catálogo de proyectos de manejo sostenible de los recursos naturales y de lucha contra el efecto invernadero en Azerbaidjan, Chili, Colombia y Gabón. Reforestación de pastos en la región del Magdalena Bajo. Informe final – agosto 2004. pag 1.

[6] It includes 2,368.2 ha already plated until 2011 and 11.8 ha to be planted in 2012.

- **<u>The creation of a forest sector</u>** integrated to the regional wood sector;

To achieve this objective, the Corporación Autónoma Regional del Río Grande de la Magdalena (CORMAGDALENA), initiated in 2000[7] a program of forest plantations with local landowners considering as a decisive factor the possibilities offered by the CDM as financiering mechanism.

The forest plantation program was designed through an innovated commercial reforestation model to the Colombian Caribbean savannas with the purpose to overtake those prohibitive barriers, so as to be exceeded prohibitive barriers that historically had not allowed the development of commercial forestry by landowners (see C.6. Step 3, Barriers Analysis). This model identified three key factors: i) Production factors needed and its property, ii) expected benefits of implementation, and iii) the strategy of development and financing[8].

This always, with the aim of launching an associative and participatory forest program, able to get environmental benefits and social and economic improvements to every social actors and stakeholders, which mean: government, entities and privates. On that vision, every one of these three key aspects were evaluated, and thus, the way of solved them was conceptualized.

The first key factor was conceptualized through the "Reforestation Equilateral Triangle" (RET); this identifies the mandatory and equally important production factors for forestry and also identifies its property. They have to be together to get a good performance for a forest project like this:

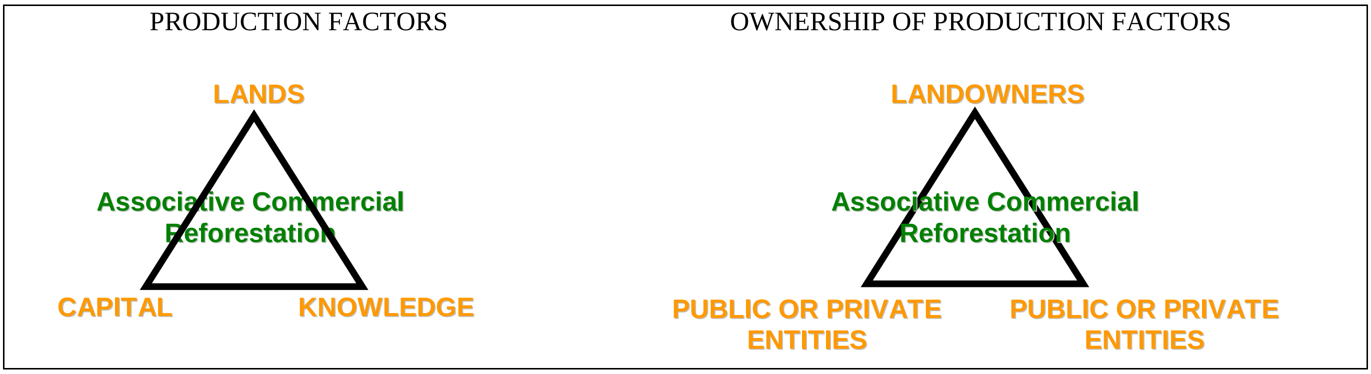

Figure 1. Associative Commercial Reforestation Model

The second key factor was designed with the concept of "benefits distribution model". It focused to get project participation from each of the partners with any of the three basic means of productions for forestry. This is based with the concept of balance between the rates of funds gave from each of the stakeholders and the same rate of the expected benefits from the project to them. The benefits are wood and carbon.

[7] The first plantations carried out under the project activity were established by under the Especial agreement of cooperation signed at 2 August 2000 for the Farm "La Gloria"

[8] ONF Andina, 2004, Op.Cit. pag 38 y 39

Finally, the third key factor was conceptualized with the design of a "strategy of development and financing", with this, the project could set a gradual process up in order to overtake some barriers and at the same time, go with the model evolution and integration of the different partners to the associative commercial forest business. This strategy splits on three next phases (detailed on Figure 2), which are built continuously and on an internal improvement and by each other, according the project features of using an innovating model and by being the first project in the region of this type.

- Initial phase of breaking barriers: Plantations phase 2000 – 2003.
- Transition phase of becoming to a business scheme: Plantations phase 2004 – 2006.
- Implementation phase of business scheme: Plantations phase 2009 – 2013

Under those general considerations, the project activity, since its beginning in 2000, has gone through several phases with different partners and investment schemes (as a response to the three decisive factors that we explained above). The core of the project participants has always been CORMAGDALENA, and investment schemes have always included private landowners, which takes share into the project by provision of their lands to be reforested.

As shown in the figure below, the project activity related to plantation establishment and management is implemented by CORMAGDALENA, the landowners or A.W. FABER CASTELL & T.H. REFORESTATION S.A.S, depends on the project phase. ONFI has conducted the project implementation, regarding its carbon components, and has been involving in the project activity since its start.

The different phases and partners of the project are presented Table 1

Table 1. Phases and partners of the project activity

Date of establishment of plantation	*Component of the project activity*	*Partners involved in the project activity*	*Species*	*Area*
2000 - 2003	Plantations phase 2000 – 2003	CORMAGDALENA[9], ONFI[10] and landowners (20 farms of 16 landowners)	*Gmelina arborea, Tectona grandis, Bombacopsis quinata, Tabebuia rosea, Eucalyptus tereticornis*	2,055
2004 - 2006	Plantations phase 2004 – 2006	CORMAGDALENA, FINAGRO[11], ONFI and landowners (18 farms of 16 landowners)	*Gmelina arborea, Tectona grandis, Bombacopsis quinata*	584

[9] CORMAGDALENA, Corporación Autónoma Regional del Río Grande de la Magdalena, is a Colombian public institution with industrial and commercial purpose in charge of the river Magdalena management, which has among its functions besides the sustainable use and preservation of the environment, fishing resources and other renewable natural resources in the basin of the Magdalena River.

[10] ONFI, ONF International, an international environmental and expertise bureau specializing in sustainable management of ecosystems (especially related to forest) and climate change mitigation. With subsidiaries in different parts of the world, one of which is ONF ANDINA, whose headquarters are located in Colombia and has an area for action to the Andean countries, Central America and the Caribbean.

[11] FINAGRO, Fondo para el Financiamiento del Sector Agropecuario de Colombia, a fund for the agricultural development of Colombia, which is fed from mandatory deposits of the Colombian financial sector

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Date of establishment of plantation	*Component of the project activity*	*Partners involved in the project activity*	*Species*	*Area*
2009 - 2013	Plantations phase 2009 – 2013	A.W. FABER CASTELL & T.H. REFORESTATION S.A.S[12], ONFI and landowners (43 farms of 42 landowners and 55 farm in area will be controlled)	*Gmelina arborea*	1,735

The Figure 2 presents the organizational framework. It shows for each phase, the functions of the various partners in the project activities and their interactions.

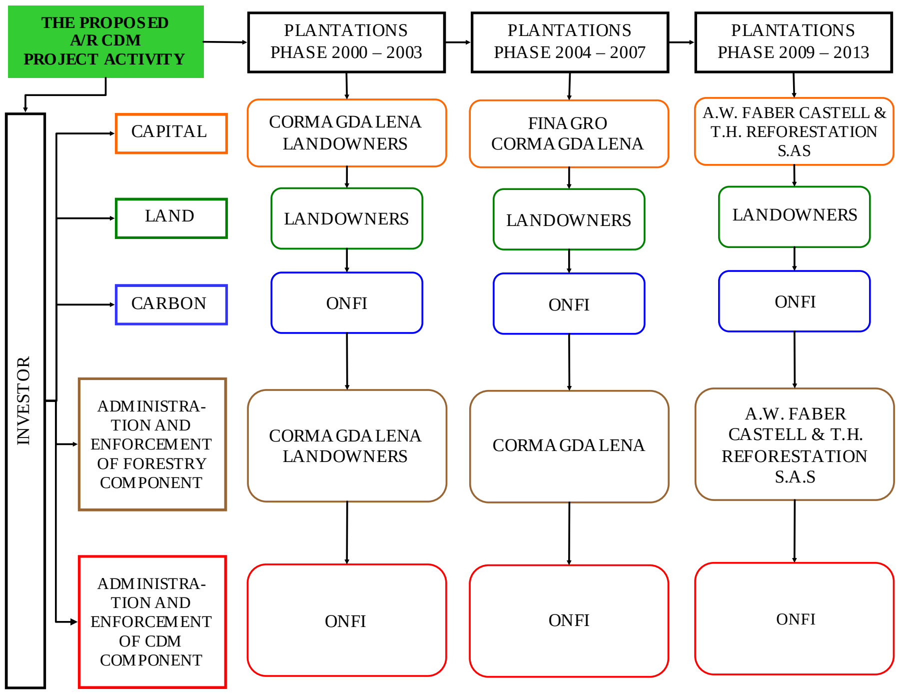

Figure 2. Project activity organization chart

The proposed A/R CDM activity will result in several important contributions to the sustainable development of the region:

- The reforestation of lands dedicated to extensive cattle grazing activities, on municipalities along the Magdalena River margin to reduce soil erosion and its related negative impacts;
- Reduction of pressure on the exploitation of natural forest by generating a long-term source for the supply of primary material for the forest industry of the country;
- Contribution to reduction of the risk for desertification of the region;
- Contribution to preservation of biodiversity and improvement of the hydrological cycle;
- Contribution to climate change mitigation;
- Demonstration of the technical and financial viability of reforestation activities, considering the absence of such activity in the area at the beginning of the proposed A/R CDM project;

[12] A.W. FABER CASTELL & T.H. REFORESTATION S.A.S, is a private company formed to continue funding and conducting from 2009 commercial reforestation activities under the project activity

- Diversification of incomes for small-scale farmers from the sale of tCERs and timber as well as by contracting them as labor for forest operations;
- Substantial creation of jobs for the establishment and maintenance of forest plantations;
- Transfer of technical knowledge and capacity building at the local level regarding plantation establishment and management;
- Contribution to equilibrate the wood sector balance at the national level

The project expects to generate incomes from timber sale, and tCERs from the net anthropogenic greenhouse gas removals by sinks of the proposed project activity over a 30-year crediting period.

A.3. Project participants:

Table 2 lists the project participants and Party(ies) involved. Contact information is provided in Annex 1.

The Colombian parties involved in the project activity (CORMAGDALENA, FINAGRO, A.W. FABER CASTELL & T.H. REFORESTATION S.A.S and Private landowners of Magdalena Bajo) have authorized ONF International to represent them and act on their behalf regarding all aspects related to the CDM component of the project activity (see section A.6)

As mentioned before, ONFI has a subsidiary located in Colombia, which is ONF ANDINA, and has been working since 10 years ago in Colombia in projects of sustainable management of ecosystems (especially related to forest) and climate change mitigation.

Table 2. Project participants

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Indicate if the Party involved wishes to be considered as a project participant (Yes/No)
Colombia (Host)	ONF International (ONFI)	No
(*) In accordance with the CDM A/R modalities and procedures, at the time of making the CDM-AR-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		
Note: When the CDM-AR-PDD is prepared to support a proposed new baseline and monitoring methodology (form CDM-AR-NM), at least the host Party(ies) and any known project participant (e.g. those proposing a new methodology) shall be identified.		

The Republic of Colombia has ratified the Kyoto protocol on 27 December 2000 on a voluntary basis (see Letter of Approval, dated March 11, 2011[13], issued by the Ministry of Environment, Housing and Territorial Development, acting as the Colombian DNA) and is not part of Annex I to the Kyoto Protocol.

[13] See LoA CDM Project File N°197. March 1, 2011. Ministerio de Ambiente, Vivienda y Desarrollo Territorial, Viceministerio de Ambiente. Republica de Colombia

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The Republic of Colombia has established a DNA[14], which has communicated the applicable thresholds for the definition of forests to the EB, in line with Decision 19/CP.9, annex, paragraphs 8 and 9 (see also section A.7). Therefore, the participation requirements defined in Decision 19/CP.9, annex, paragraph 12 a) are met.

A.4. Description of location and boundaries of the A/R CDM project activity:

A.4.1. Location of the proposed A/R CDM project activity:

A.4.1.1. Host Party(ies):

>>
Republic of Colombia

A.4.1.2. Region/State/Province etc.:

The project activity is located in the Caribbean region of Colombia, North-East of the country, in the lower part of the Magdalena River basin, called Magdalena Bajo seco, which includes the departments of Atlántico, Bolivar y Magdalena, and covers a surface of 917,165 ha, corresponding to 19.93% of the entire basin of the Magdalena River.

The proposed A/R CDM project activity is located in the Department of Magdalena.

A.4.1.3. City/Town/Community etc:

The area where the A/R CDM project activities will take place is named “Magdalena Bajo nucleus”. It includes 6 municipalities – *municipios* –, all located in the CORMAGDALENA jurisdiction: El Piñón, Zapayán, Tenerife, Pedraza, Plato and Santa Bárbara de Pinto (Department of Magdalena). The nucleus stretches between 9°23’22’’ and 10°28’19’’ of latitude North, and between 74º20’39’’ and 74º56’60’’ of longitude West, Figure 3 shows the location of these municipalities.

The Magdalena bajo nucleus is contiguous to the Magdalena River, on the occidental side of the department of Magdalena contiguous with the department of Bolivar, and in the south of the department of Atlántico.

[14] http://cdm.unfccc.int/DNA/view.html?CID=49

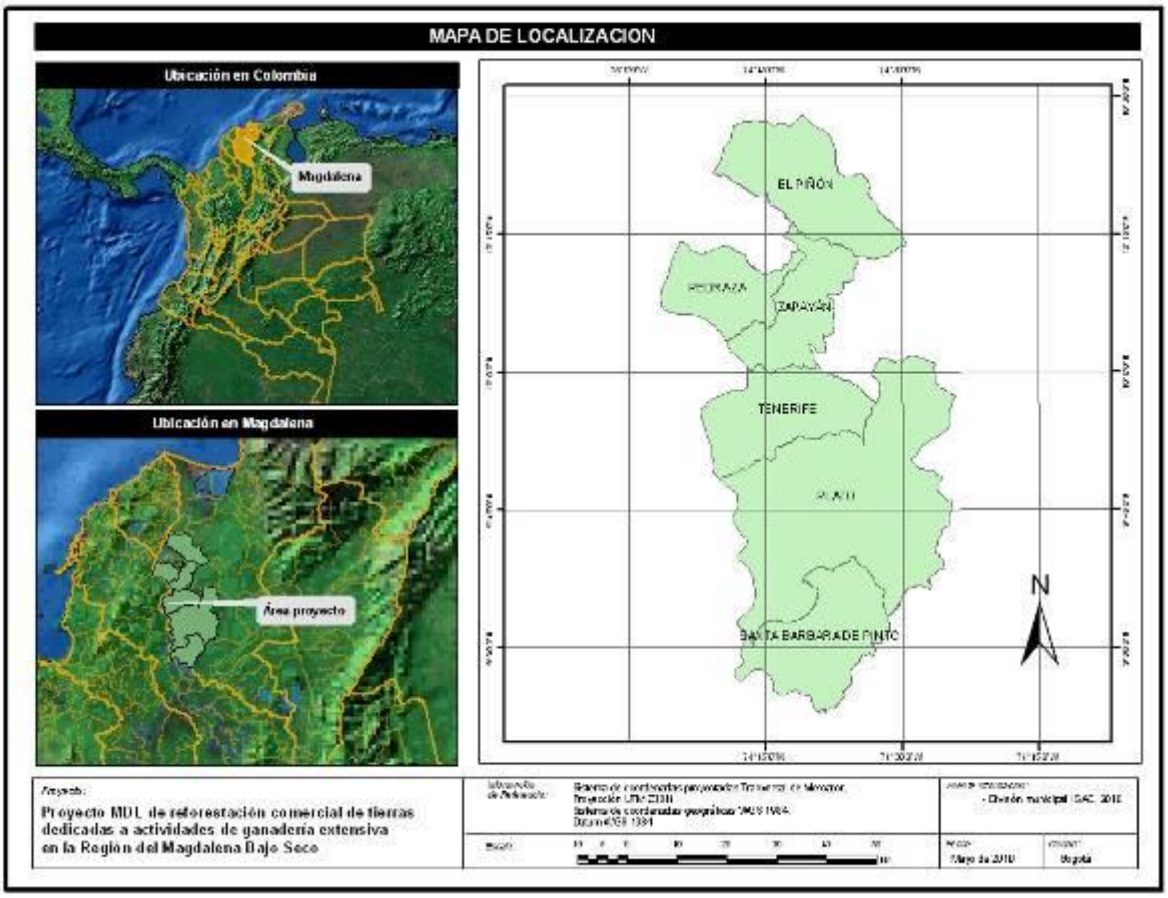

Figure 3. Compilation of maps locating the country, department and municipalities of the project

A.4.2 Detailed geographic delineation of the project boundary, including information allowing the unique identification(s) of the proposed A/R CDM project activity:

The project boundary corresponds to the plantation areas already established and currently under management, and the plantation areas to be established under the A/R CDM proposed project activity.

The project boundary is delineated as follows. Before planting, each potential planting site has been assessed regarding its suitability for reforestation activity; in accordance with CDM, requirements (*e.g.* land eligibility). These areas to reforest were proposed by private landowners willing to be involved into the project.

During site inspection, the project boundary is established as follows:

1. The perimeter of the planting site and its topological characteristics are established as a closed polygon with a Global Positioning System (GPS) receiver;
2. Any ineligible area regarding CDM requirements or regarding the technical requirements of reforestation activities is excluded, especially lands with temporary states of high vegetation ('rastrojo medio/alto'[15]), groups of trees, marshes, watersheds, etc. For plantations currently under

[15] *Rastrojo* is the local name to specify the temporary community of vegetation that occurs on pasture when they remain unused (see Section C.5.2)

management, the areas of mortality are excluded as well from the project boundary. Their topological characteristics are also identified as closed polygons with the GPS receiver and subtracted from the project boundary;

3. All GPS data developed, are stored in the Geographical Information System (GIS) of the project.
4. The individual planting sites are initially identified by the local name of the planted site and the name of the landowner. Once the information has been stored in the Geographical Information System (GIS) of the project, each individual planting site is identified with a unique consecutive code and the net area of the polygon.

In accordance with the EB 44 report Annex 16, pl, the area of land which is under control by project participants at the time of validation corresponds to 2/3 of the total land area determined for the A/R CDM project activity. Therefore, at first verification, the project boundary will be geographically established according to the A/R areas exclusively under the control of project participants.

The areas currently under control of project participants correspond to 2/3 of the project's total area. The total project area is mentioned in the list of sites of the project activity[16]. For the first verification, the areas corresponding to 1/3 of the project's total area will be controlled by the project. These areas are mentioned in the list of project activity sites as potential areas identified with a consecutive number and the area of the polygon (ONF Andina, 2010)[17]. In any case, with the implementation of the procedure above, regarding the delineation of the project boundary, for the first verification, the A/R areas included in the proposed A/R CDM project activity will be guaranteed under the control of project participants.

The forest plantations of the A/R CDM project activity are distributed in discrete areas according to the location of lands offered by the owners involved in the project. As an example, Figure 4 shows the location of the plantations in the municipalities of Zapayán and Piñón.

All the spatial information related to the project boundary is stored and accessible in the project´s GIS, run and maintained by ONFI.

[16] ONF Andina, 2010. Tabla resumen del banco de tierras del proyecto

[17] ONF Andina, 2010. Op Cit.

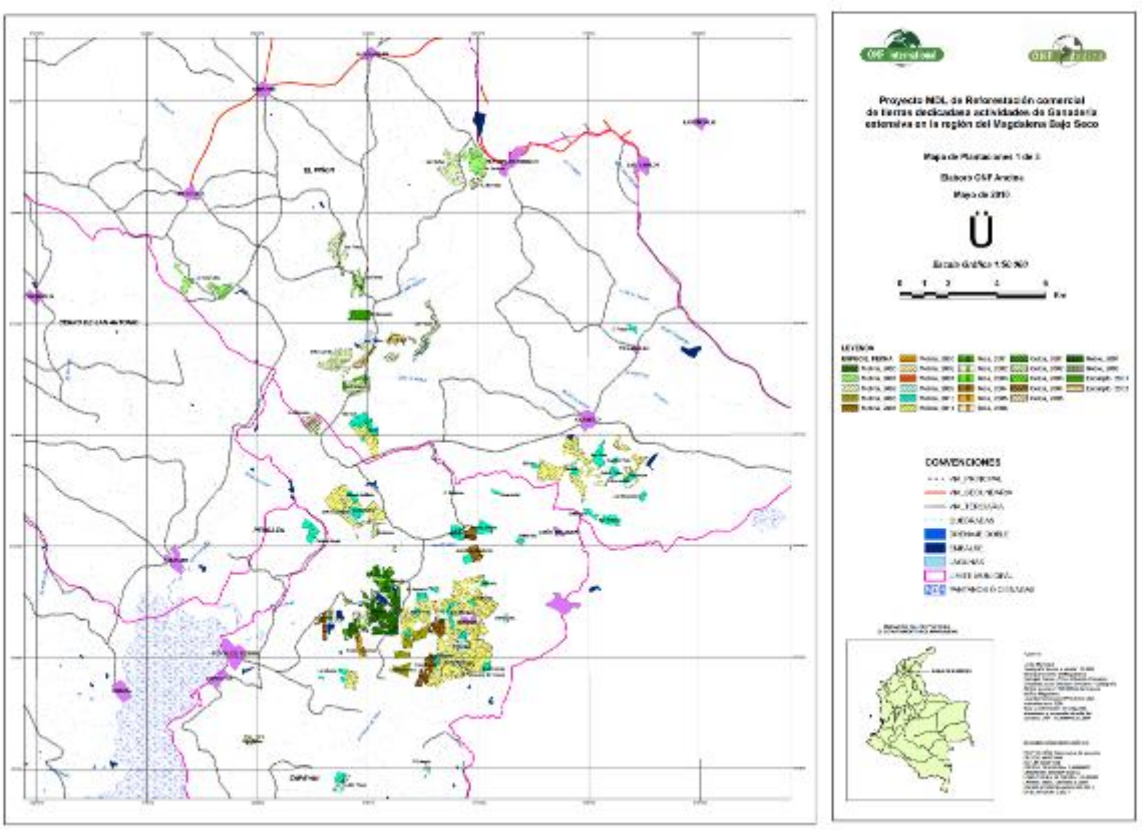

Figure 4. Location of discrete areas of plantation in the municipalities of Zapayán and Piñón

A.5. Technical description of the A/R CDM project activity:

A.5.1. Description of the present environmental conditions of the area planned for the proposed A/R CDM project activity, including a concise description of climate, hydrology, soils, ecosystems (including land use):

Climate

The nucleus of Magdalena Bajo is located in the Inter Tropical Convergence Zone characterized by a monomodal climate. During the dry season, the evapo-transpiration (ETP) (which representing the water-loss to atmosphere from vegetation and soil), is very high (up to 1,600 mm) and causes high water deficit between December and April (Figure 5).The rainy season occurs from May to November, with a concentration of rainfall from August to October. The mean annual rainfall is 1,300 mm. The relative humidity is around 70% on the year. The mean annual temperature is 27.9°C with low variations. The hottest months, from February to April, present temperatures oscillating between 28.4°C and 28.8°C.

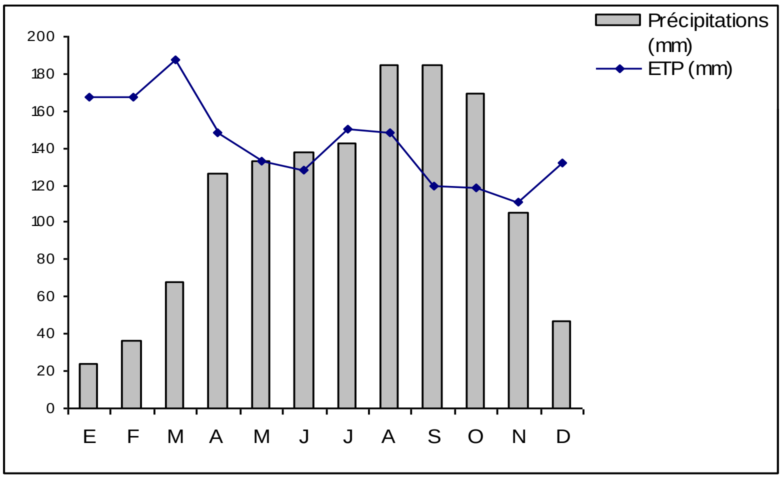

Figure 5. Diagram of precipitations and evapo-transpiration department of Magdalena (2003)[18]

Hydrology

The project area presents an important influence of the Magdalena River and its complexes of lakes on the eastern margin (Figure 6). As a important lakes are included Coposo, Zapayán, Potrero, Cotoré, Heredia, el Morro, Doña Francisca, San Juan, Tapegua, Zura, Ceiba, Silencio, Zárate, Malibú, Guayacán, Totumito, Sapo, and Guacamayo among others. The ravines and rivers which drain the project area come from the hills of Ariguani, on the eastern side of the department of Magdalena. Usually they are temporary, remaining dry almost all year. Among rivers that cross the project area, it can be mentioned: la Palma, los Limones, Palma de Vino, el Mico, Carbonero, Guimaro, el Pital, Santa María, Veguero, Gabinero, Si Dios Quiere, Cantaleta, Cuatro Bocas, Candelaria, and Mulero. The most important ravines are Zapayán and Arena.

The river Magdalena shows its lower flows and levels between February and April, the driest period of the year. The highest flows occur between October and December, occasionally until January, at the end of the moist season. With a mean flow of 4,086 $m^3.s^{-1}$, the level of the river range between 6.17 meters above sea-level in March and 13.00 meters above sea-level in November with a flow of 9,960 $m^3.s^{-1}$. These conditions explain the floods occurring in the eastern part of the project area, and the lack of water irrigating the wide complex of channels during the dry season.

Topography and soils

Located on the eastern side of the Magdalena River, in the heart of the Magdalena watershed, the project area presents some relatively flat landscapes. Five landscape units compose the horizon: alluvial terraces on river margin and, while moving away towards east, plains, slopes, small valleys and piedmont (Figure 7).

Plains and slopes represent the most frequent landscape. Plains are characterized by soft slopes, usually minor to 10%, and by superficial to moderately deep soils with argillaceous texture. The

[18] Dufour, 2005. Reboisement Commercial dans la Région du Magdalena Bajo, Colombie. La Composante Carbone: Niveau de référence et plan de surveillance. Mémoire de Mastère ENGREF. ONF International. Pp 16.

landscape mentioned as slope presents average slopes (3% to 15%) and superficial to very superficial soils with thin and thick textures. The soils of these lands are characterized by a low content of carbon and phosphor.

In the small valleys lands, slopes are soft in average up to 50% sometimes. Soils are moderately deep with an argillaceous texture, imperfect drainage, and abundant organic matter.

In the piedmont are found two kinds of reliefs, the glacis of accumulation and the glacis of erosion. The relief varies between flat and undulated with slopes ranging between 0% and 12%. Laminar erosion is encountered but mainly moderated. The parental material is composed by alluvial sediments derived from clay, sand and aggregates.

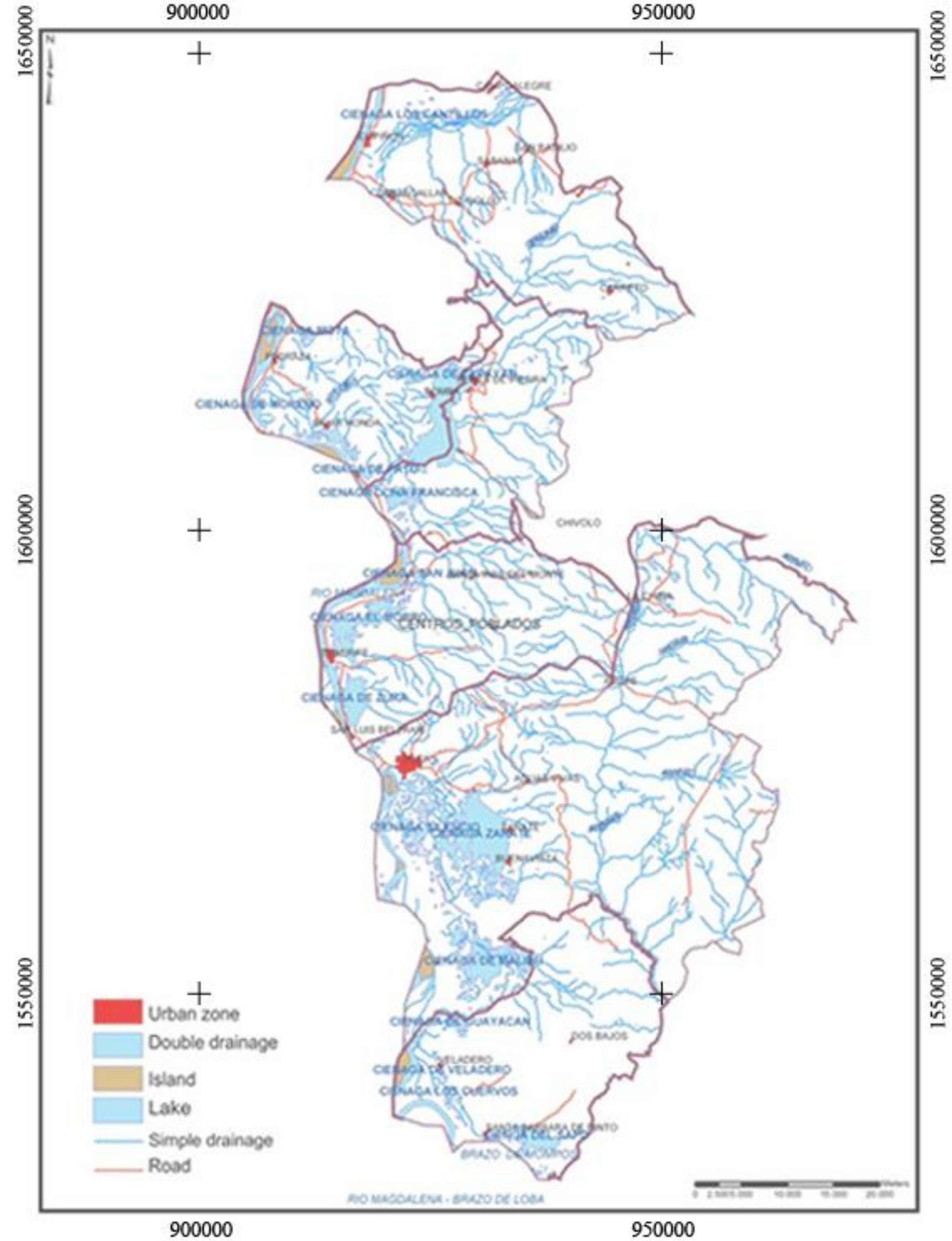

Figure 6. Map of hydrological network of the project zone

The soils of the region belong to three groups: entisoils, inceptisoils and alfisoils. The two last ones are considered as Vertisoils. All of them have an alluvial origin with a high proportion of stones and are relatively deep except the less advanced entisoils. Inceptisoils present some soil fertility characteristics less favorable than alfisoils located on the alluvial terraces of the Magdalena River.

Figure 7. Landscape units of Magdalena. A: alluvial terraces; B: plains; C: slopes; D: piedmont; E: small valleys

Therefore, the ecological conditions are favorable for forest plantations: some precipitations between 1,000 and 2,000 mm, a dry season and some good soils.

A classification of soil units was made by the Colombian geographical institute Agustin Codazzi (1976, 1989)[19], the Figure 8 shows the soils associations of high and medium land productivity in the project area.

[19] IGAC, 1976. Estudio de suelos de los municipios Cerro de San Antonio, El Piñón, Salamina, Remolino, Sitio Nuevo y Pueblo (Departamento del Magdalena). Instituto Geográfico Agustín Codazzi. Santa Fé de Bogota, Colombia.

IGAC, 1989. Estudio general de suelos de los municipios de Ariguaní, Chivolo, Pedraza, Plato y Tenerife (Departamento del Magdalena). Instituto Geográfico Agustín Codazzi. Santa Fé de Bogota, Colombia.

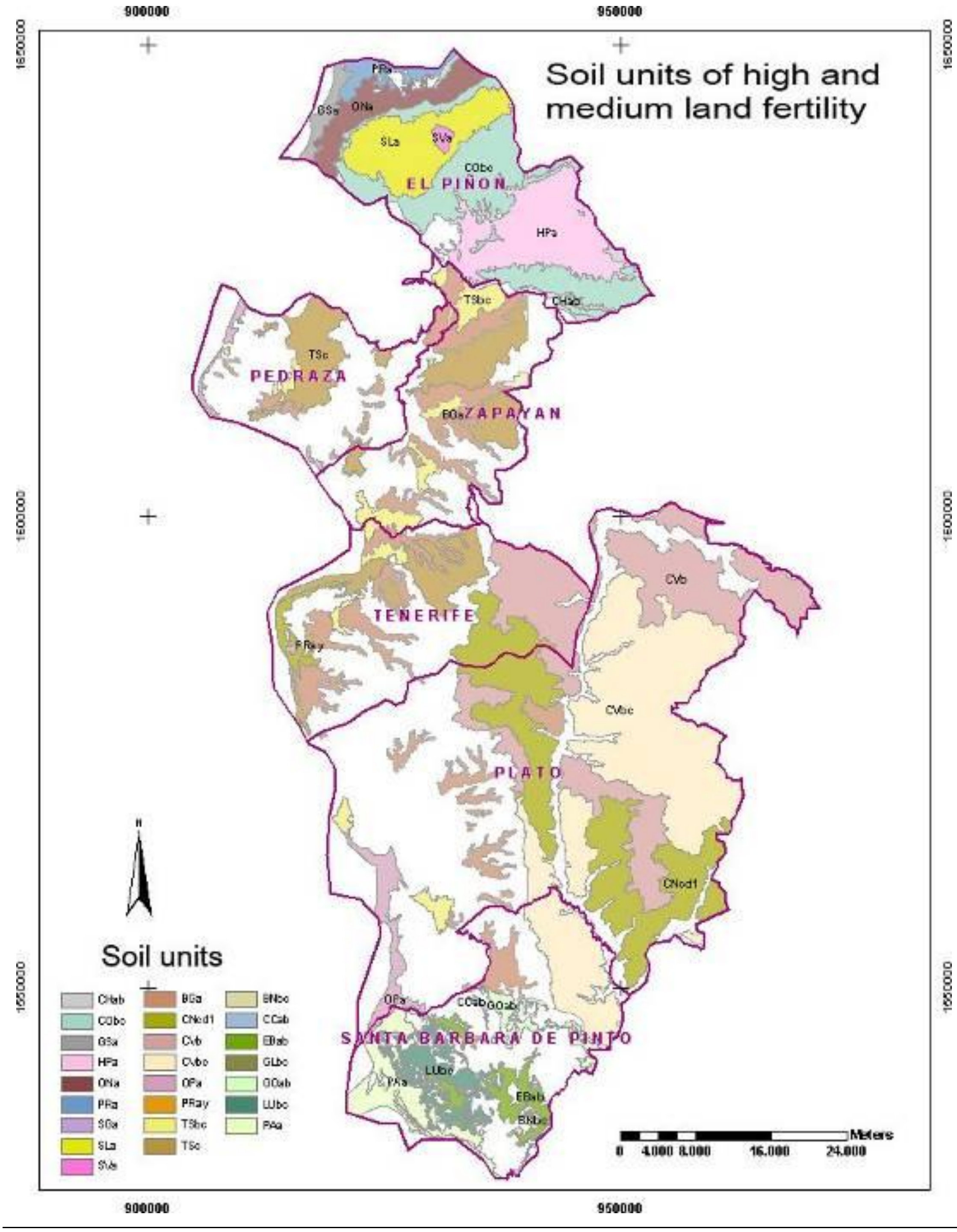

Figure 8. Map of soils associations of high and medium land productivity in the project area

Ecosystems

According to the Colombian Natural Regions, the project is located in the dry plains of the Caribbean region, and the Caribbean Savannahs sub region[20].

[20] IGAC, 1997. Regiones Naturales. Mapa. Instituto Geográfico Agustín Codazzi, Bogota, Colombia.

The original vegetation is the Caribbean forest in the Holdridge classification (1967), a semi deciduous tropical forest. Located between the sea level and 1,000 m of altitude, the Caribbean forest stretches on a large part of the Atlantic Colombian coast. Caribbean forest are the most deforested ones in Colombia and are considered threaten of extinction. Between 1970 and 1990, the watershed of Magdalena River suffered strong deforestation activities. More than 4.5 million hectares were changed to pastures and cultures. Currently, only reserves and sanctuaries as “Los Colorados”, and disseminated relics settlements of original Caribbean forests can be found. Nowadays, these forests cover 7,700 ha corresponding to 10% of the initial Caribbean forest.

The most representative floristic species in the Caribbean forest remains are: *Curatella Americana*, *Hymenea courbaril*, *Xylopia aromatica*, *Bowdichia virgilioides*, *Byrsonima sp*., *Cochlospermum vitifolium*, *Prosopis juliflora, Acacia farnesiana, Pereskia guamacho, Tabebuia rosea, Capparis flexuosa and C. odoratissima, Pithecelobium lanceolatum, Cordia dentata, Hura crepitans, Mastichodendron colombianum, Bursera simarouba, Sterculia apetala)* and *Astronium graveolens;* mixed with specific tropical dry forest and river margin forest species like *Byxa sphaerocarpa*, *Machaerium capote*, *Guazuma ulmifolia*, *Vismia sp*., *Genipa caruto*, *Jacaranda caucana*, *Cecropia sp*., *Senna fruticosa*, *Mabea sp*., and *Bactris major*.

Amphibians and reptiles are the most represented surviving fauna, 32 species of amphibians are found in the region. The most representative specimens belong to the family of Leptodactylidae, with 13 species. Reptiles are represented by 101 species. Among them, the most numerous are the Colubridae with 31 species. Among reptiles the iguana (*Iguana iguana*) and the turtle (*Goechelone carbonaria*) suffered a great pressure for their eggs. Among mammals, the endemic presence of the stag, *Odocoileus virginianus curassavicus*, and the rabbit, *Sylvilagus floridanus*, can be mentioned.

Since the colonization carried out by the Spaniards, increasing human influence, the introduction of cattle and the extension of cattle grazing activities have almost led to complete deforestation and severe degradation of the relics of original semi-deciduous forests and other natural ecosystems.

Currently the basic agro-ecosystem, in general terms, is the dominant ecosystem of the project area and is characterized by the combination of extensive cattle grazing and agricultural activities. These activities become unsustainable by generating soil erosion and, consequently, high sedimentation in rivers. Furthermore, they reduce the minimal survival area of faunistic and floristic species. As mentioned above, the Magdalena watershed was the place of strong human activities. Currently, pastures represent more than 70% of the total area, and crops only 3%. These proportions illustrate the dominance of cattle grazing activities in the region[21]. The tree coverage represents 12% of the area but is essentially composed of slack sub-forest formations reaching a height of only a few meters, known as the “*rastrojos*”.

This large-scale deforestation of the area, already happening decades ago, has dramatically increased the threat of desertification due to the dry climate. The IDEAM, the Colombian national institute on meteorology and environmental studies, highlights the department of Magdalena, encompassing the project area and part of the Caribbean savannah ecological zone, as one of the most exposed to desertification with 35% of the department in process of desertification. Therefore, contributing to reduce the risk of desertification in this area is one of the main environmental objectives of the project activity (see section C.2).

Fire risk

[21] ONF Andina, 2004. pag 33. Op.Cit.

According to IDEAM – CONIF, 2009[22], for municipalities where the project is located, the total fire risk of land cover during "El Niño" phenomenon, is low and very low, specialty to areas nearby the Magdalena River and other water bodies, and in the other areas, the risk are high and very high[23].

Under the project activity, fire protection develops from avoidance/prevention activities: Firewalls building and annual maintenances, periodic cleaning, plantation monitoring to reduce and eliminate flammable materials, dam construction (*jagüéis*), educational activities towards fire risk and acquisition and maintenance of tools and necessary machinery for fire mitigation. Finally, fire managing and control activities for fires when they happen.

A.5.2. Description of the presence, if any, of rare or endangered species and their habitats:

Information of flora and fauna species presented below, corresponds to a general bibliographic review available to the region where the project is located. Generally, these species are associated with a forest or lands with temporary states of high vegetation association, group of trees and marshes. Those types of land covers are not specifically included in the project boundaries (see section A.4.2).

List of weird species or threatened species in the Project area:

Next list refers the species determined as species on extinction risk. The timber tree species on risk (Table 3) are from the research developed by the Amazonia Research Institute *(Instituto de Investigaciones Amazónicas)* (SINCHI)[24]. The fauna and flora lists Table 4 and Table 5 are from filtered registers by the *Instituto de Investigación de Recursos Biológicos Alexander von Humboldt*[25]. The risk classification categories were based on the global categories from the International Union for Conservation of Nature (UICN). The geographical unit for the association of species under threat is the Arid Peri-Caribean Belt, (*Cinturón Árido Pericaribeño*) (IAvH, 2003)[26].

Timber tree species

The next tree species (Table 3) are referred on the Red Book of Plants of Colombia, timber tree species of Colombia. From 50 species evaluated, it was found that there are three species on a dangerous level to the area of the project, and one in a vulnerability condition. However, as detailed on that research, risk or vulnerability are determined by deforestation processes and intervention of forest areas in Colombia. Natural forests are not included within the boundaries of the proposed project (see section A.4.2).

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[22] IDEAM – CONIF, 2009 En proceso de publicación. Mapa nacional de zonificación de riesgo a incendios de la cobertura vegetal.

[23] IDEAM – CONIF, 2009 conclusion's are in general for all types of vegetal coverage

[24] SINCHI, 2006. Especies Maderables Amenazadas. Instituto de Investigaciones Amazónicas, Ministerio de Ambiente y Desarrollo Territorial. 169 pg.

[25] http://www.humboldt.org.co/conservacion/Listas_Preliminares.htm. Consultado 03 de Noviembre del 2010.

[26] IAvH, 2003. Unidades Biogeográficas de Colombia, Mapas. Instituto de Investigación y de Recursos Biológicos Alexander von Humboldt. Biota Colombiana. Vol 5 (1). Pp 108-110.

Table 3. Timber tree species with a threat level in the Project region.

Scientific Name	Common Name	Level of risk	Family
Aspidosperma polyneuron	Carreto	Threatened	Apocynaceae
Bulnesia arborea	Guayacán, Guayacán de bola	Threatened	Zygophyllaceae
Pachira quinata Sin. *Bombacopsis quinata*	Ceiba tolua	Threatened	Bombacaceae
Peltogyne purpurea	Nazareno	Vulnerable	Caesalpinaceae

Only species in the vulnerability level/scale below were taken on account:

Vulnerability scale (Level of risk):

CR: High Threatened.
EN: Threatened.
VU: Vulnerable.
LRca: Low risk, almost threatened.

Table 4. List of Mammals, birds, reptiles, amphibians and fishes at high risk of extinction, in the project area.

a. MAMMALS.			
Taxon	**Level of risk**	**Taxon**	**Level of risk**
DIDELPHIDAE		**FELIDAE**	
Chironectes minimus	LRca	*Felis wiedii*	VU
MARMOSIDAE		*Felis concolor*	VU
Marmosops impavida	LRca	*Panthera onca*	VU
Gracilinanus marica	LRca	**DELPHINIDAE**	
Gracilinanus perijae	VU	*Sotalia fluvitilis*	VU
MYRMECOPHAGIDAE		**TRICHECHIDAE**	
Myrmecophaga tridactyla	VU	*Trichechus manatus*	CR
PHYLLOSTOMIDAE		**TAPIRIDAE**	
Leptonycteris curasoae	LRca	*Tapirus terrestris*	VU
CALLITRICHIDAE		**TAYASSUIDAE**	
Saguinus oedipus	EN	*Tayassu pecari*	VU
CEBIDAE		*Tayassu tajacu*	LRca
Alouatta seniculus	LR/VU	**CERVIDAE**	
Aotus lemurinus	VU	*Mazama americana*	LRca
Lagothrix lagothricha	VU	*Mazama gouazoubira*	LRca
Cebus albifrons	LRca	*Odocoileus virginianus*	VU

CANIDAE		**AGOUTIDAE**	
Speothos venaticus	VU	*Agouti paca*	LRca

b. BIRDS

ORDER	FAMILY	SPECIES	Common Name	National Risk Level
ANSERIFORMES	**Anhimidae**	*Chauna chavaria*	Chavarría	VU
	Anatidae	*Netta erythrophthalma*	Pato Negro	CR
GALLIFORMES	**Cracidae**	*Pauxi pauxi*	Paujil Copete de Piedra	VU
		Crax alberti	Pavón Colombiano, Paujil de Pico Azul	CR
	Phasianidae	*Odontophorus atrifrons*	Perdiz Carinegra	VU
PSITTACIFORMES	**Psittacidae**	*Ara militaris*	Guacamaya Verde	VU
		Pionopsitta pyrilia	Cotorra Cariamarilla	VU
APODIFORMES	**Trochilidae**	*Lepidopyga lilliae*	Colibrí Cienaguero	CR
		Metallura iracunda	Metalura de Perijá	EN

c. REPTILES

ORDER	FAMILY	SPECIES	Common Name	National Risk Level
CROCODYLIA	**Crocodylidae**	*Crocodylus acutus*	Cocodrilo Americano, Caimán del Magdalena	CR
TESTUDINATA	**Testudinidae**	*Geochelone carbonaria*	Morrocoy, Morrocoyo	CR
	Chelidae	*Batrachemys dahli*	Carranchina, Carrancha, Cuello Torcido	EN
	Pelomedusidae	*Podocnemis lewyana*	Tortuga de Río	EN

d. AMPHIBIANS

Taxon	National Risk Level
ANURA **Dendrobatidae** *Dendrobates truncatus*	LR:ca

e. FISH

ORDER	FAMILY	SPECIES	Common Name	National Risk Level

CHARACIFORMES	**Curimatidae**	*Curimata mivartii* *Prochilodus magdalenae* *Ichthyoelephas longirostris*	Vizcaína, Cachaca, Sardina Bocachico, Chico de Boca Jetudo, Pataló, Besote	VU CR EN
	Characidae	*Salminus affinis* *Genycharax tarpon*	Picuda, Rayada, Rubia, Salmón Boquiancho, Boquifarol	VU VU
	Anostomidae	*Abramites eques*	Totumito, Bonito	VU
SILURIFORMES	**Pimelodidae**	*Pseudoplatystoma fasciatum* *Sorubim cuspicaudus*	Tigre, Rayado, Bagre Rayado, Pintadillo Bagre Blanco, Blanquillo, Paletón	EN EN
	Callichthyidae	*Callichthys fabricioi*	Roño	VU
	Ageneiosidae	*Ageneiosus caucanus*	Doncella, Niña, Gata, Fría, Señorita	EN
GYMNOTIFORMES	**Gymnotidae**	*Ubidia magdalanensis*	Caballo	VU
PERCIFORMES	**Sciaenidae**	*Plagioscion magdalenae*	Pácora, Burra, Corvina	VU

Flora.

Table 5. List of flora and briophytes at high risk of extinction, in the project area.

a. Flora				
FAMILY	**SPECIES**	**Common Name**	**National Risk Level**	**Observations**
Bombacaceae	*Cavanillesia platanifolia*	Macondo, Bonga	NT/VU	
	Pseudobombax maximum	Ceiba botella, Ceibo barrigón, Majagó, Majagua	VU	
Chrysobalanaceae	*Licania arborea* Seem	Garcero	EN	Threatened by Wood overexploitation (as well firewood use in the Magdalena riverbanks), and agricultural boundary expansion.
	Parinari pachyphylla Rusby	Perehuétano	EN	Most of the known Colombian locations for this specie is without protection and strongly exploited.

Dichapetalaceae	*Dichapetalum bernalii* Prance,	-	VU	Threatened by the destruction of dry forest in the Magdalena valley to establish livestock and intensive agriculture.
Lecythidaceae	*Cariniana pyriformis* Miers	Abarco	CR	It is a kind of high economic value, especially the resistance of its wood, even outdoors. It has a very high demand on market. Is a very threatened species by wood overexploitation, logging and land clearance for agriculture and extensive livestock.

b. Bryophytes

FAMILY	SPECIES	National Risk Level
Ricciaceae	*Riccia weinionis*	VU

A.5.3. Species and varieties selected for the proposed A/R CDM project activity:

Five species for the A/R CMD project activities have been selected, *Bombacopsis quinata* (Ceiba roja) and *Tabebuia rosea* (Roble) for native species, and *Gmelina arborea* (Melina), *Tectona grandis* (Teca) and *Eucalyptus tereticornis* (Eucalipto) for exotic species. These are selected for their results in the ecological conditions of the region, availability of vegetal material and genetic quality, forest technological knowledge, and for their local (national and international) economic potential.

During the phase of project design, CORMAGDALENA in collaboration with CONIF carried out the selection of the potential tree species, based on the review and the adaptation of the knowledge, practice and forest technology developed by PIZANO S.A. and Reforestadora de la Costa Company. This information was the result of research made between 1981 and 1999 and focused on tree species used for previous reforestation projects in the region, as well as the result of the available experience related to these species in other country regions with similar environmental conditions. Then, in the first stage of the project, all these species were tested and their corresponding forest toolkits were developed.

In Table 6, the main characteristics of the selected species are summarized.

Table 6. Selected species and their main characteristics for cultivation

Common Name	Scientific Name Family	Origin Geographical Distribution	Botanical Description	Life zone	Suitable value					
					Elevation m.s.n.m	**Temperature °C**	**Mean annual precipitation mm**	**Topography %**	**pH**	**Texture and drainage**
Melina[27] Gmelina, gmelina, yemani	*Gmelina arborea* Verbenaceae	Origin in India and is widely distributed in the tropical and sub-tropical Asian regions. It is cultivated in Africa, Brasil, Costa Rica, Venezuela and Colombia	Melina has good shape and fast growing characteristics Height: 20 a 30 m. Diameter: 60 a 100 cm. Deciduous specie	Dry tropical forest Humid tropical forest	0 – 1,000	24 - 35	750 – 2,000	0 – 7 Plains and hills	6.5-7.5	Loam and clay loam Well drained, does not resist to floods
Teca[28] Teak, saca, teka	*Tectona grandis* Verbenaceae	Origin in Myanmar and is widely distributed in tropical and sub-tropical Asian regions. It is cultivated in Central America and northern countries of the south of America.	Height: 40 a 45 m. Diameter: 100 a 150 cm. Deciduous specie	Dry tropical forest Humid tropical forest	0 – 1,200	22 - 27	1,000 – 2,000	0 – 25 Plains and hills	6.5 - 7.5	Clay loam to sandy loam Well drained, does not resist to floods
Ceiba[29] Cedro macho, ceiba tolúa, ceiba roja, saqui saqui,	*Pachira / Bombacopsis quinata* Bombacaceae	Origin in Central America and can be found also in Colombia and Venezuela	Height: 32 m. Diameter: 4,2 m. Deciduous specie	Dry tropical forest Humid pre-mountain tropical forest Very dry forest	0 - 600	25 - 28	1,000 – 3,000	0 – 25 Plain	6.5 - 7.5	Sandy, clay loam or clayey Moderate to well drained
Roble[30] Roble morado, guayacán morado, flor rosado, flormorado, ocobo	*Tabebuia rosea* Bignoniaceae	Origin in south of Mexico, Central America and northern countries of the south of America	Height: 30 m. Diameter: 40 a 100 cm. Deciduous specie	Dry tropical forest Humid tropical forest	0 – 1,900	21 - 30	1,200 – 2,500	0 - 15	5.5-6.5	Loam Regular drainage, resist to floods
Eucalipto[31]	*Eucalyptus*	Origin from Australia to New	Height 45 m.	Dry tropical	0 – 1,000	24 - 35	1,000 – 2,000		6.5-	Silty, sandy

[27] CONIF. 2002a Guía Forestal para de Melina (*Gmelina arborea*). Bogotá

[28] CONIF, 2002b Guía Forestal para Teca (*Tectona grandis*). Bogotá

[29] CONIF, 2002c Guía Forestal para Ceiba (*Bombacopsis quinata*). Bogotá

[30] CONIF, 2002d Guía Forestal para Roble (*Tabebuia rosea*). Bogotá

[31] CONIF, 2003 Guía Forestal para Eucalipto (*Eucalyptus tereticornis*). Bogotá

Common Name	**Scientific Name** **Family**	**Origin Geographical Distribution**	**Botanical Description**	**Life zone**	**Suitable value**					
					Elevation m.s.n.m	**Temperature °C**	**Mean annual precipitation mm**	**Topography %**	**pH**	**Texture and drainage**
	tereticornis Myrtaceae *s*	Guinea	Diameter: 100 a 140 cm.	forest					7.5	Well drained

A.5.4. Technology to be employed by the proposed A/R CDM project activity:

As explained above above, the technology employed by the proposed A/R CDM project activity is based on the revision and adaptation of the knowledge, practice and technology developed by previous reforestation projects in the region, and on the experience available in other regions of the country with similar environmental conditions. Then, the selected species were tested in the first stage of the project, in order to develop a technological forest toolkit for each species.

These technological forest toolkits, are in accordance with national regulations, which in the plan of forest establishment and management are defined. This plan was designed considering the environmental, economic and social characteristic of the forest plantation area.

The coordination of forest operations, as well as the technical assistance, the training sessions and the supporting activities to ensure the implementation of the project, are carried out regarding the three plantation phases (see Figure 2); in accordance with the forest management plan. Phase 1 is carried out by CORMAGDALENA and the landowners (plantations phase 2000-2003), phase 2 by CORMAGDALENA (plantations phase 2004-2006) and phase 3 by A.W. FABER CASTELL & T.H. REFORESTATION S.A.S (plantations phase 2009-2013).

The implementation of forest operations is then carried out directly by landowners, trained in the framework of the proposed A/R CDM project activities. Workforce is also hired around their farms, when the landowners are not able to implement the forest operations.

In this framework, the following forest practices are used by the project:

- Techniques for the production of vegetal material:
    - Nursery Assessment
    - Purchase of seedlings in trays multipost
    - Creation of nurseries for production
    - Purchase of seeds and seedling production of Pellets "Jiffy" in nurseries with project owners
    - Production in bags is not used because of high transportation costs
    - *Gmelina* origin: seeds of the Monterrey Forest seed orchard in the municipality of Zambrano, and seeds from plantations in the municipalities of Repelon and Zapayán
    - *Pachira / Bombacopsis* origin: seedling of 2nd generation from the Monterrey Forest seed orchard Forest
    - *Tectona* origin: seedling of the Reforestadora de la Costa seed orchard, and seeds from Santa Cruz, province Guanacaste, Costa Rica certified by CATIE
    - *Tabebuia* origin: seed and seedling of seed orchard Reforestadora de la Costa
    - *Eucalyptus* origin: seed and seedling of seed orchard Reforestadora de la Costa

- Techniques for site preparation:
    - Soil fertility study
    - Design of management plots preferably of 10, 25, 50, 75 and 100 ha, when this is possible

- Rehabilitation of access ways to lands and creation of new roads through pastures. The roads are opened in December-January, before plantation, and maintained in priority the years of harvest
- Removal of existing vegetation in the plantation site: mechanical removal (*e.g.* by ploughing) or manual removal cutting with machete. The vegetal material is occasionally incinerated, depending on accessibility of lands and the status of pre-project vegetation. Since 2009, a Colombian law forbids the incineration of vegetal material resulting from forest operations, therefore the removed biomass is piled and left on site
- Cleaning of main trees with chainsaw
- After main trees, the following cleaning for remaining vegetation is motorized (D6)
- Motorized ploughing with tractor 80 HP
- Lines of plantations marked out following forest management plan to facilitate maintenance, thinning and final harvest
- Subsoiling motorized with tractor 120 HP. This activity is made with a blade of 40 centimeters, along plantation lines. Therefore, only a thin furrow of 30cm to 40cm of depth and 20 to 25 cm of width is made in soil for each plantation line, without turning over the soil, thus generating minimum soil disturbance.
- Installation of fences to delimitate plantations and avoid entrance of cattle into the project boundary

- Techniques for plantations:

  - Plantations realized in March if possible, at the beginning of the rainy season. However, *Bombacopsis quinata* can be planted until one month before the dry season as it resists to dry conditions.
  - Holes are made manually by local manpower along marked plantation lines
  - In the case of lack of rain during the following days after planting, 2 to 3 liters of water are provided to each plant
  - The Plantations phase 2000 – 2003 was planted with a density of 1,098 plants per hectare (3.5 m x 2.6 m)
  - The Plantations phase 2004 – 2006 was planted with a density of 830 plants per hectare (4 m x 3 m)
  - The Plantations phase 2009 – 2013 are planted with a density of 1,000 plants per hectare (4 m x 2.5 m)

- Technique for fertilization

  If soil conditions require, are use NPK and/or Urea if the results of the soil analysis indicate it, at dosage of 150 gr/tree of NPK and 50g/tree of Urea, in the first year only.

- Techniques for the maintenance of plantations:

  - Manual maintenance with machete against competitive vegetation
  - Eventually, mechanical weed control with tractor
  - Chemical maintenance to eliminate competitive vegetation. Roundup is used at a dose of 1.5kg per hectare
  - Pruning of formation will be realized after the dry season with local manpower
  - Crown pruning (3 times in years 1 to 3 to get a clean bole of 6 m height)

- Techniques for thinning:
  - Realized by local manpower
  - Realized at years 3 and 7 for *Gmelina arborea*
  - Realized at years 5, 12 and 19, for *Tectona grandis*
  - Realized at years 6 and 13 for *Bombacopsis quinata*
  - Realized at years 6, 11 and 15 for *Tabebuia rosea*
  - Realized at years 3 and 7 for *Eucalyptus tereticornis*

- Techniques for pest and disease control:
  - Application of fungicide at a dose of 10g per hectare
  - Application of products against pests at a dose of 2kg per hectare

- Techniques for fire control:
  - Annual maintenance of firebreaks with tractor 80 HP equipped with plow and rake

- Techniques for final harvest:

Final harvest will be done as follows (no final harvesting has been made so far):
  - It will be realized at year 12 to 15 for *Gmelina arborea*
  - It will be realized at year 20 to 25 for *Tectona grandis* and *Bombacopsis quinata*
  - It will be realized at year 20 for *Tabebuia rosea*
  - It will be realized at year 10 for *Eucalyptus tereticornis*

A.5.5. Transfer of technology/know-how, if applicable:

During the first phase of the project, some “sylviculture toolkits” were designed for each one of the species selected for the A/R CDM project activities. These toolkits were elaborated in collaboration with landowners with the first forest plantations and are generalized to all landowners involved in the A/R CDM project activities.

The toolkits deal with all techniques from site preparation to final harvest (no final harvesting has been made so far). A special care was developed for techniques of maintenance as landowners play an important role in plantation maintenance.

Landowners who will be involved in the A/R CDM project activities, and other interested landowners, will participate to capacity-building workshops to get technical acknowledgement concerning the establishment and the maintenance of forest plantations as toolkits will be improved during project duration.

The project also allowed the transfer of technology and know-how between different stakeholders regarding CDM aspects, like: remote sensing imagery, carbon estimation techniques and software; carbon database management; CDM project cycle and resulting documentation requirements (*e.g.* in the application of A/R CDM methodologies and formulation of the PDD).

The know-how transfer to host party is not foreseen.

A.5.6. Proposed measures to be implemented to minimize potential leakage:

The activity displacements of the baseline could be the potential leakages in the case for livestock and fuel-wood collection activities in the area.

In section D.2 explains how leakages by concept of cattle grazing (livestock) are not considered, due to the total number of animals attached for the livestock activity in the project are lower of the potential number estimated for the project area in the baseline. As is indicated by Roncallo *et al* (2009)[32], producers and owners of the *Magdalena Bajo* micro-region have made a bad management of soils because an extensive cattle grazing activity.

Likewise, after a historic evaluation of livestock behavior performed in the Colombian Caribbean area, the Ministry of Agriculture and Rural Development of Colombia foresees a projection of a high carrying capacity of animals in cattle grazing systems of the region, with the implementation of technology adequate and cost-effectiveness. For that, it pretends to generate diverse politics programs and financial funds. In addition, technology transfers in the processes[33]. This process plans to raise 0.6 animals per hectare from 2006 to 1.3 animals an hectare in 2020, in a national rank. This evidences the soil capacities for maintaining a high capacity of livestock in addition of getting an intensive cattle activity.

Therefore, Project foresees in the future, to promote the adequate technology in order to maximize the cattle potential in the region, also the best use of non-reforested lands by their owners, by means of land development by intensive cattle grazing lands. In addition, it will promote activities to a better genetics quality for cattle in the region, using funds from carbon credits selling, timber selling and public funds. Thus cattle ranchers are protected, without compromise their livelihood and, with a compatible CDM activity proposition on the owners interests. Moreover, it will avoid the leakages by displacement of cattle grazing activity.

Agricultural activities don´t belong to baseline, only a few food crops are in the project area for livelihood to the farmers. In order to get minimize these potential leakages, a proposed strategy already implemented is to allow small farming areas between planted tree lines, with the intention that quick harvest crops could be established in there (e.g. corn, sorghum, yucca, etc.). As well, it could be possible to locate crops in non-intervened areas by the project proposal, in each farm.

On the consumption of firewood, leaks are not considered under this concept (see section D.2) and an approach to mitigate potential leakage that may occur is making available to the community the vegetable waste from thinning, clean, and harvesting of trees for fuel consumption from this energy source. Finally, alternative leakage mitigation is the implementation of efficient wood stoves in order to a better use of wastes, and by this, the requirements of biomass for cooking will decrease instead of the traditional stoves

[32] Roncallo, B., J. Barros, R. Bonilla, J. Murillo y R. Del Toro. 2009. Evaluación de arreglos agrosilvopastoriles en explotaciones ganaderas de la microrregión bajo Magdalena. Revista Corpoica-Ciencia y Tecnología Agropecuaria. 10 (1). Págs. 60-69.

[33] Ministerio de Agricultura y de Desarrollo Rural. *s.f.* Apuesta exportadora agropecuaria, 2006-2020.

systems. This system is trying to implement a national level for their energetic benefits, as well for the human health[34].

A.6. Description of legal title to the land, current land tenure and rights to tCERs / lCERs issued for the proposed A/R CDM project activity:

Legal title of the land and current land tenure

All the region of Magdalena Bajo is mostly under private land tenure. The project is not located in the jurisdiction of any indigenous or African-American communities, and there is no legal dispute about land tenure rights on any of the project lands.

The process of selection of lands to be reforested within the proposed A/R CDM project activity involves a sound juridical revision of the legal titles of each landowner, to check land titles legality. In each phase of the project, this revision is made directly by the juridical department responsible for carrying out the administration and enforcement of forest component (see Figure 2).

- For phase 2000 - 2003: CORMAGDALENA
- For phase 2004 - 2006: CORMAGDALENA
- For phase 2009 - 2013: A.W. FABER CASTELL & T.H. REFORESTATION S.A.S.

For the areas currently under control of project participants, the legal titles of land of each landowner who participates in the project are archived by ONFI and are available for review by the Designated Operational Entity (DOE)[35].

Rights to tCERs / lCERs

The relationship between the landowner and the administrator, and the implementation of the forest component in each phase, is ruled by a specific contract called "Joint Venture Contract" for the administration of the plantation until the end. This contract, also defines for each party the participation in the earnings for the plantation, including the tCERs.

As it was mentioned in the previous paragraph, each project partner is owner of a percentage of the rights of each tCERs. Hence, the relationship between each partner and ONFI in the administration and execution of the CDM project is ruled by a specific contract called "Mandate Contract".

This contract stipulates that ONFI is responsible for the funding, implementation and follow up of all the aspects of the project related to CDM (finalization of the project perimeter, planning and redaction of the PDD, validation, registration, monitoring and commercialization of tCERs). In return, ONFI will receive a given proportion of the tCERs emitted for the proposed A/R CDM project activity.

Contracts were firmed separately between ONFI and the project partners for the phases 2000-2003 and 2004-2006, and a unique contract was firmed between ONFI and A.W. FABER-CASTELL & T.H.

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[34] http://www.colombiasinhambre.com/logros_detalle.php?idb=129
http://www.cornare.gov.co/index.php?option=com_content&view=article&id=75&Itemid=83

[35] ONF Andina, 2010b. Base de datos de documentos tenencia y de contratos para los componentes forestal y carbono de la actividad de proyecto.

REFORESTATION S.A.S. for the phase 2009-2013. It should be added that the contracts linking A.W. FABER-CASTELL & T.H. REFORESTATION S.A.S. with the landowners of the project phase 2009-2013 secure the contractual relation with ONFI for the rights to tCERs.

To share the incomes generated by tCERs between project partners, ONFI will establish a spreadsheet protocol and the distribution of incomes according to area of existing plantation by participant, as defined in the “Mandate Contract” (see section E.1).

All these contacts are archived by ONFI and are available for review by the Designated Operational Entity (DOE)[36].

For areas currently not under control of project participants, the same contractual mechanism will be applied in order to establish the relationship between the landowner and the administrator and executor of the forest component, for the forest component of the project. Also to establish the relationship between the landowner and ONFI, for the CDM component of the project.

A.7. Assessment of the eligibility of the land:

This section has been developed in accordance with the methodological tool elaborated by the CDM Executive Board, “Procedures to Demonstrate the Eligibility of Lands for Afforestation and Reforestation CDM Project Activities”-Version 01[37].

1(a). Demonstrate that at the time of the start of the project the lands have no forest coverage:

(i) Vegetation on the land is below the forest thresholds adopted for the definition of forest by Colombian DNA

As communicated by the Colombian DNA to EB[38], the project adopts the definition of forests as land:

- Growing trees with a minimum land area of 1.0 hectare;
- With a minimum tree crown coverage of 30%;
- And a minimum tree height of 5m.

To demonstrate the eligibility of lands, a historical analysis of land coverage was carried out using a GIS within the project zone. At project start no areas was found with the previous three criteria over the thresholds established by the DNA for the forest definition. All the following information is available for validation and verification.

The LANDSAT images used for this eligibility analysis are listed in Table 7. These images were already processed and ready to be used. As plantations were developed since the year 2000, the demonstration of eligibility was carried out in each project phase using a LANDSAT image before the start year of each project phase, thus really demonstrating the eligibility at the moment before planting.

[36] ONF Andina, 2010b. Op. Cit.

[37] 35th Report of the CDM Executive Board, Annex 18. URL: http://cdm.unfccc.int/EB/035/eb35_repan18.pdf

[38] Available on the UNFCCC web site on the following link : http://cdm.unfccc.int/DNA/ARDNA.html?CID=49

All these images have a resolution of 30m. The Tranversal Mercator coordinate system and the UTM 18N Zone projection were used.

Table 7. Images used for the eligibility analysis, from 1989 and from the project start date

Plantations phase	Path - Row	Sensor	Date
All phases	9-53	Landsat 4 TM	1989/01/11
2000 – 2003	9-53	Landsat 7 ETM	2000/11/25
2004 – 2006	9-53	Landsat 7 ETM	2002/04/03
2009 – 2012 (areas currently under control)	9-53	Landsat 5 TM	2008/06/16
2009 – 2013 (areas wich will be under control for first verification)	9-53	Landsat 5 TM	2010/01/29

The following procedure was applied:

- The selection of the electromagnetic bands most appropriate to identify these types of vegetation has proven to be bands 4 (near infra-red), 5 (mid infra-red) and 3 (visual red) in combination with RGB. This combination is the most commonly used in vegetation studies because it permits the adequate discrimination of vegetal coverages.
- Using the Software Spring 5.0.4.1 and following the digital method for the satellite images analysis, a digital classification method was carried out, based on classes of land eligible for future proposed project activities: Pastures, pastures with fallows and fallows in early stages (see section C.5.2 for a detailed description of these coverages)
- These eligible vegetal coverages were defined according to the "*Mapa de Cobertura de la Tierra Cuenca Magdalena*" (Coverage Map of the land Magdalena basin); a CORINE Land Cover Method adapted for Colombia at a 1:100,000 scale, and local expert knowledge on land cover in the project area, in order to select the pixels (samples) that represent the eligible land covers to be analyzed.
- Quality Control and Verisimilitude Control, by local professional knowledge of land cover in the project zone.
- Combination of information related to project boundary (see section A.4.2.) and information related to the historical analysis of land cover.

The results of the eligibility analysis and their distribution in the baseline strata for the project are shown in Table 8.
As an example, the Figure 9 illustrates the eligible areas in the baseline strata of the project for the municipalities of Zapayán and Piñón.

Table 8. Summary of eligible areas in the baseline strata (ha) of the project

Land use in BL	Area (ha)
Clean pastures	1,709
Pastures with fallows	2,060
Fallows	604

Land use in BL	Area (ha)
Total	**4,373**

(ii) All young natural stands and all plantations on the land are not expected to reach the minimum crown coverage and minimum height chosen by the host country to define forest

The proposed A/R CDM project activities will be implemented on lands dedicated to extensive cattle ranching with very low productivity compared to the lands potentialities (see section A.5.6). Such an activity has led to almost complete deforestation over the last decades. Currently, about 10% only of the initial Caribbean forest remains[39]. This large-scale deforestation that occurred decades ago has – due to the dry climate – dramatically increased the threat of desertification, to the extent that the department of Magdalena is the third department with the largest area in process of desertification in the country[40].

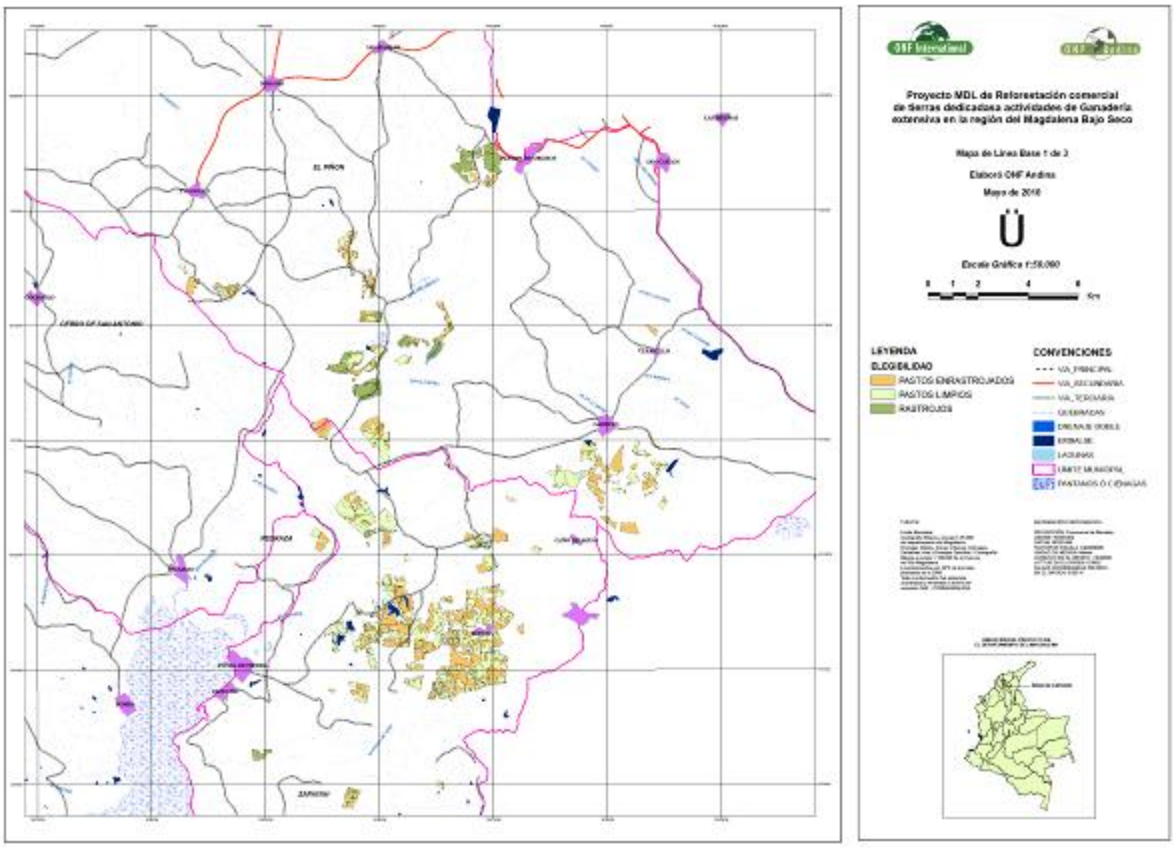

Figure 9. Eligible areas in the baseline strata of the project for the municipalities of Zapayán and Piñón

[39] Becerra, 2004a. Op.Cit.

[40] Vargas y Gómez, 2003. Op.Cit.

In such a context, the land cover in the project area is mainly constituted with managed and unmanaged pastures or fallows (rastrojos). The fallows (rastrojos) make part of the traditional cattle ranching. They are not changed to pastures after a few years for the following main reasons:

- Given the very low charge of animals on the project area (in average 0.64 / ha[41]), landowners can decide to postpone the renewal of pastures for private reasons (diminution of cattle, heritance and others);
- Due to insecure conditions caused by the presence of militia, local communities were forced to abandon their land and saw their cattle sold or slaughtered, particularly between 1999 and 2003 and again in 2007. For similar reasons, new landowners (often from paramilitary groups) with unclear legal titles preferred not to invest in cattle grazing activity before improvement of the social situation, and therefore leave their lands unmanaged.

In conclusion, the traditional dynamic of land use – the cattle grazing activities in estates – within project boundary, induces the presence low pastures/fallows with vegetation in early stage of ecological succession that are changed again to permanent pasture.

And due to the forced abandonment of lands as a result of the presence of militia between 1999 and 2003, some fallows with vegetation in later stages of succession could be observed in the region (see section C.5.1, Step 3).

Even if such fallows in later stages of succession, in certain conditions, can reach the forest thresholds, the expected land use remains pasture for cattle grazing and not forest. However, in the proposed A/R CDM activity, any land with closed vegetal coverage or above the forest thresholds was discarded (see section A.4.2). The reason is not only land eligibility under the CDM but also the fact that site preparation for reforestation purpose is much cheaper on pastures and pastures/fallows with vegetation in early stage of succession; than on land with high vegetal coverage.

Regarding pastures/fallows in early stage of succession (rastrojo bajo) at the starting date of the A/R CDM project activity, it is very unlikely that this vegetation would have been left reaching the threshold values of the forest definition. Indeed, as mentioned above, the normal expectation of land use is for cattle grazing, representing the prevailing practice, and not forest.

This expectation of land use was demonstrated, through local interviews conducted by ONF International after the period of insecurity between 1999 and 2003. These interviews proved that all farmers were on their way to revert their abandoned land to productive uses again, or stated that they would clear the pasture/fallow to re-establish pastures for cattle grazing[42]. The reason is that such fallows (even fallows with vegetation in later stages of succession) do not provide any incomes to landowners as the woody vegetation has no commercial use on their point of view. Moreover, old fallows are more expensive to clean than young fallow and landowners prefer to cut them before they get too expensive to be cleaned.

It is therefore very unlikely that, in absence of the proposed A/R CDM project activities, any young natural stands, even the ones that emerged during the forced abandonment of lands, would have reached the minimum crown coverage and minimum height as defined for forest by the Colombian DNA.

[41] Lenne, 2004. Programa de tecnificación de la ganadería dentro del proyecto de reforestación de CORMAGDALENA en el núcleo Bajo Magdalena. ONFI-CORMAGDALENA 2005.

[42] Cazaux, 2003. Restricciones y motivaciones de los ganaderos frente al proyecto de reforestación comercial de CORMAGDALENA. ONF INTERNATIONAL, Santa Fé de Bogotá, Colombia.

(iii) The land is not temporarily unstocked, as a result of human intervention such as harvesting or natural causes

Lands in the Llanura de Caribe, sub-region Sabanas del Caribe, have been deforested for decades for cattle ranching, in result the deforestation of natural forest is almost complete. Traditional extensive cattle ranching have been so far the dominant agricultural activity. Only after 1981, some commercial plantations were established in the region. The location of these plantations can clearly be identified from the IDEAM statistics and underlying registries[43] and does not overlap with the project boundary.

When analysing the traditional dynamics in the use of land within the project boundary, it is clear that the pastures are predominant and are also increasing, given the tendency of the existing pastures/fallows to be changed in order to make them new permanent pastures. Thus, this dynamic prevents the fallows from growing and ultimately becoming forests. Besides, the compaction and alteration of the properties of soils, resulting from the traditional livestock record in the region, making more difficult the restoration processes of the natural coverages.

Therefore, as of December 31st 1989 and on the A/R project activity start date, the land included within the project was not temporarily unstocked, as a consequence of the human intervention, such as harvesting or natural causes.

(bi) Demonstrate that the activity is a reforestation project activity

The forest of the region of Magdalena Bajo was mostly cleared before 1990. Almost the whole forest ecosystem was changed by human activities between 1970 and 1990 to pasture and croplands.

The analysis of the land cover inside the project boundary from the LANDSAT image of 1989 proves that the land was not forest on 31 December 1989; therefore the proposed activity is a reforestation project activity. As an example, the Figure 10 illustrates the eligible areas for plantations phase 2004 – 2006 on 31 de December 1989, for the municipality of Zapayán.

[43] IDEAM, 2009. En proceso de publicación. Estadísticas de plantaciones forestales productivas o comerciales periodo 1975 – 2007. Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM), Bogotá.

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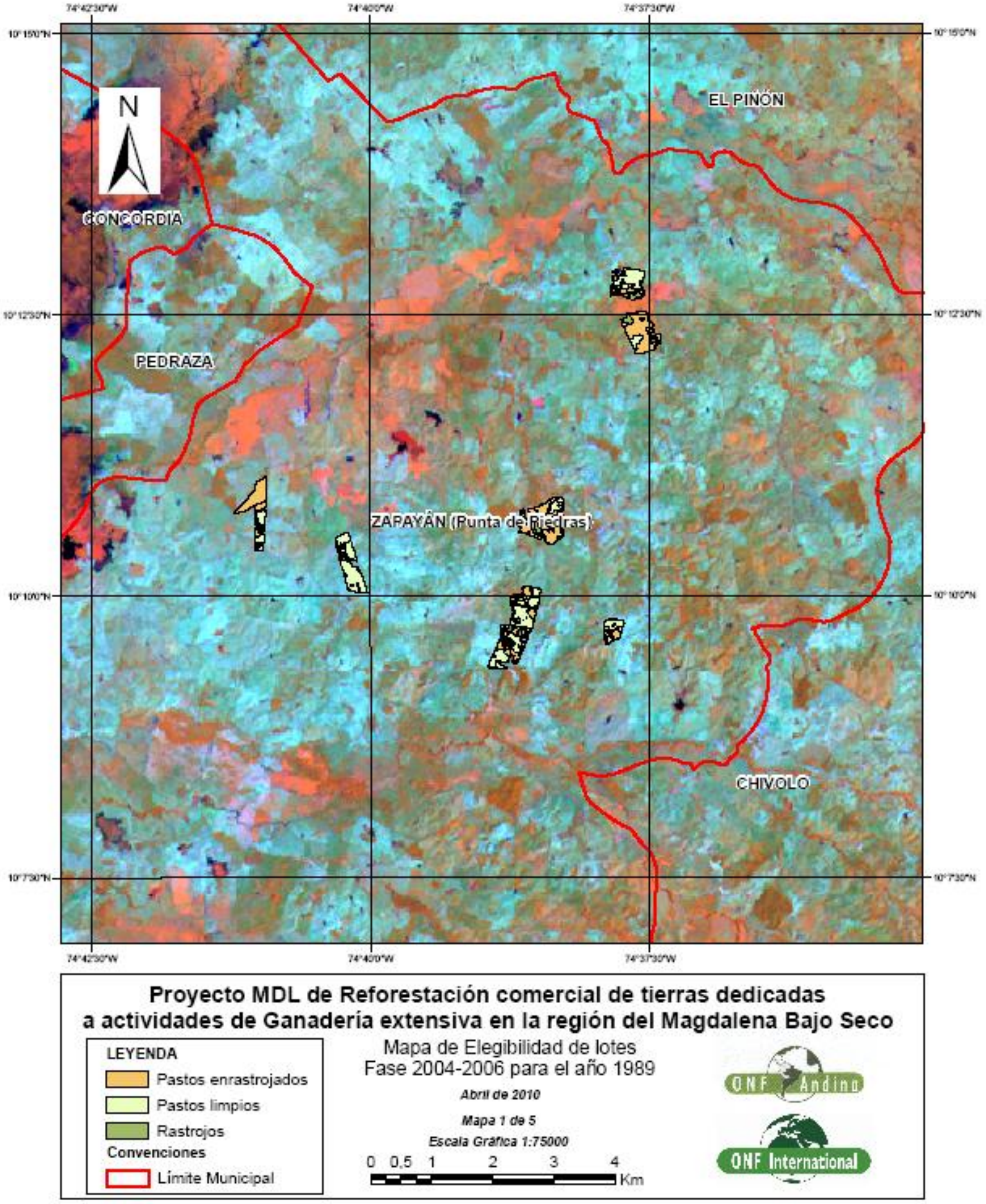

Figure 10. Eligible areas for plantation phase 2004 – 2006 on 31 de December 1989, for the municipality of Zapayán

A.8. Approach for addressing non-permanence:

The project will use tCERs to address non-permanence in accordance to paragraph 38 and section K of the modalities and procedures for afforestation and reforestation projects.

A.9. Estimated amount of net anthropogenic GHG removals by sinks over the chosen crediting period:

The net anthropogenic GHG removals by sinks within the project scope ($C_{AR\text{-}CDM}$), were determined with equation 54 of methodology AR-AM0004/Version 04.

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

$C_{AR\text{-}CDM}$ = Net anthropogenic greenhouse gas removals by sinks; t CO_2-e
C_{ACTUAL} = Actual net greenhouse gas removals by sinks; t CO_2-e
C_{BSL} = Baseline net greenhouse gas removals by sinks; t CO_2-e
LK = Leakage; t CO2-e

The C_{BSL}, C_{ACTUAL}, and LK estimates are subsequently described in sections C.7, D.1 and D.2, respectively Figure 11 and Table 9 show the results of the estimates made during the entire crediting period.

The expected verifications will be in the years 12 (2011), 17 (2016), 22 (2021) and 27 (2026) of the project (Figure 11).

Figure 11. Net anthropogenic GHG removals by sinks (tonnes of CO2e)

Table 9. Summary of results obtained in sections C.7., D.1., and D.2.

Year	Estimation of baseline net GHG removals by sinks (tonnes of CO_2 e)	Estimation of actual net GHG removals by sinks (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of net anthropogenic GHG removals by sinks (tonnes of CO_2 e)
2,000	0	722.56	0	722.56
2,001	0	14 979.69	0	14 979.69
2,002	0	40 618.60	0	40 618.60
2,003	0	79 290.39	0	79 290.39
2,004	0	129 871.95	0	129 871.95
2,005	0	137 105.84	0	137 105.84
2,006	0	116 233.10	0	116 233.10
2,007	0	85 182.91	0	85 182.91
2,008	0	51 197.02	0	51 197.02
2,009	0	37 632.25	0	37 632.25
2,010	0	84 781.84	0	84 781.84
2,011	0	118 987.47	0	118 987.47
2,012	0	141 569.14	0	141 569.14
2,013	0	163 838.86	0	163 838.86
2,014	0	93 459.96	0	93 459.96
2,015	0	-4 728.91	0	-4 728.91
2,016	0	-135 582.40	0	-135 582.40
2,017	0	-157 506.98	0	-157 506.98
2,018	0	20 366.36	0	20 366.36
2,019	0	43 602.71	0	43 602.71
2,020	0	107 737.75	0	107 737.75
2,021	0	101 590.55	0	101 590.55
2,022	0	82 674.90	0	82 674.90
2,023	0	17 202.43	0	17 202.43
2,024	0	-189 015.97	0	-189 015.97
2,025	0	-122 318.50	0	-122 318.50
2,026	0	-110 150.28	0	-110 150.28
2,027	0	-86 877.99	0	-86 877.99
2,028	0	171 949.88	0	171 949.88
2,029	0	113 768.45	0	113 768.45
Total (tonnes of CO_2 e)	**0**	**1 148 183.58**	**0**	**1 148 183.58**

A.10. Public funding of the proposed A/R CDM project activity:

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All funds will be provided by public and private entities. The project will not receive any ODA funds for its implementation.

ONFI is a private company run without public funding. The funds from ONFI are from their own activities as a private company[44].

[44] ONFI, 2010. Extrait du registre du commerce et des societes ONF INTERNATIONAL

The funds provided from French cooperation during the first phase of the A/R CDM project activities were not ODA funds as French cooperation provides dedicated financiering for CDM projects.

SECTION B. Duration of the project activity / crediting period

B.1 Starting date of the proposed A/R CDM project activity and of the crediting period:

August 2, 2000 is the starting date of the project activity. This date corresponds to the Cooperation Contract signature date of first plantation establishment, under the project activities[45].

B. 2. Expected operational lifetime of the proposed A/R CDM project activity:

30 years, 0 months.

B.3 Choice of crediting period:

The project will use fixed crediting period. The first crediting periods begin in 2000 and end in the year 2029. This date will depend upon the validation and registry of the Project. This project qualifies with retroactive crediting in accordance with UNFCCC Executive Board guidance[46].

B.3.1. Length of the renewable crediting period (in years and months), if selected:

NA.

B.3.2. Length of the fixed crediting period (in years and months), if selected:

Fixed crediting period of 30 years, 0 month.

SECTION C. Application of an approved baseline and monitoring methodology

[45] CONIF, 2000. Convenio Especial de Cooperación para la ejecución de un Proyecto de transferencia y de adopción de tecnología de reforestación bajo la modalidad protectora - productora en los municipios ribereños del Río Magdalena del 2 de agosto de 2000.

[46] The Board, at its twenty-first meeting, clarified those provisions of paragraphs 12 and 13 of decision 17/CP.7 do not apply to CDM afforestation and reforestation project activities. A CDM afforestation and reforestation project activity starting after 1 January 2000 can also be validated and registered after 31 December 2005 as long as the first verification of the project activity occurs after the date of registration of this project activity. Given that the crediting period starts at the same date as the starting date of the project activity, the projects starting 2000 onwards can accrue tCERs/lCERs as of the starting date". (CDM GUIDELINES FOR COMPLETING THE PROJECT DESIGN DOCUMENT FOR A/R ACTIVIES, V.4, p.9).

C.1. Title and reference of the approved baseline and monitoring methodology applied to the proposed A/R CDM project activity:

Title of the methodology: *"Reforestation or afforestation of land currently under agricultural use"* *Reference of the methodology*: AR-AM0004 / Version 04. Following methodological tools for A/R CDM project activity have also been used based on the requirement of the methodology applied:

- Procedures to demonstrate the eligibility of lands for afforestation and reforestation CDM project activities, Version 01.
- Guidance on the application of the definition of project boundary to A/R CDM project activities, Version 01.
- Guidance on accounting GHG Emissions in A/R CDM Project Activities (paragraph 35 in the report of the EB 42 meeting).
- Tool for the demonstration and assessment of additionality in A/R CDM project activities, Version 02.
- Guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant, Version 01 (EB46, Annex 16).
- Calculation of the number of sample plots for measurements within A/R CDM project activities, Version 02.
- Guidelines on conservative choice and application of default data in estimation of the Net Anthropogenic GHG Removals by Sinks. Version 02 (EB 50, Annex 23).
- Guidelines for objective demonstration and assessment of barriers. Version 01, (EB 50, Annex 13).

C.2. Assessment of the applicability of the selected approved methodology to the proposed A/R CDM project activity and justification of the choice of the methodology:

In accordance with the applied methodology, the following issues are to be addressed for the methodology to be applicable:

Lands to be afforested or reforested are degraded and the lands are still degrading or remain in a low carbon steady state

By the year 2003, it was stated that 25% of land in Colombia was in a degradation state. This corresponds to 291,295 km^2, one of the highest estimates for Latin America; according to the study of soil degradation around the world, carried out by the World Soil Information (ISRIC) and FAO[47]. Now the documentation[48] —Figure 12– indicates that the northern area of Colombia is subjected to light processes of degradation. This process is a consequence of the high deforestation activities led to develop extensive traditional cattle grazing activities. The Global Assessment of Human-induced Soil Degradation –

[47] Bai, Dent, Olsson and Schaepman, 2008. Global assessment of land degradation and improvement. Identification by remote sensing. Report 2008/01, ISRIC – World Soil Information, Wageningen.

[48] FAO, 2005. National Soil Degradation Maps.

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GLASOD – carried on by ISRIC (1990)[49] gave the same conclusion, giving precision on the hydraulic nature of erosion.

The IDEAM (2001)[50], the Colombian national institute on meteorology and environmental studies, also pointed the department of Magdalena, encompassing the project area and part of the Caribbean savanna ecological zone[51], as one of the most exposed to desertification with 35% of the department in process of desertification (Figure 13). Vargas and Gómez (2003)[52] stated that the department of Magdalena has 831,705 ha in a state of desertification. Magdalena is the third department with the biggest area in process of desertification in the country (Figure 13).

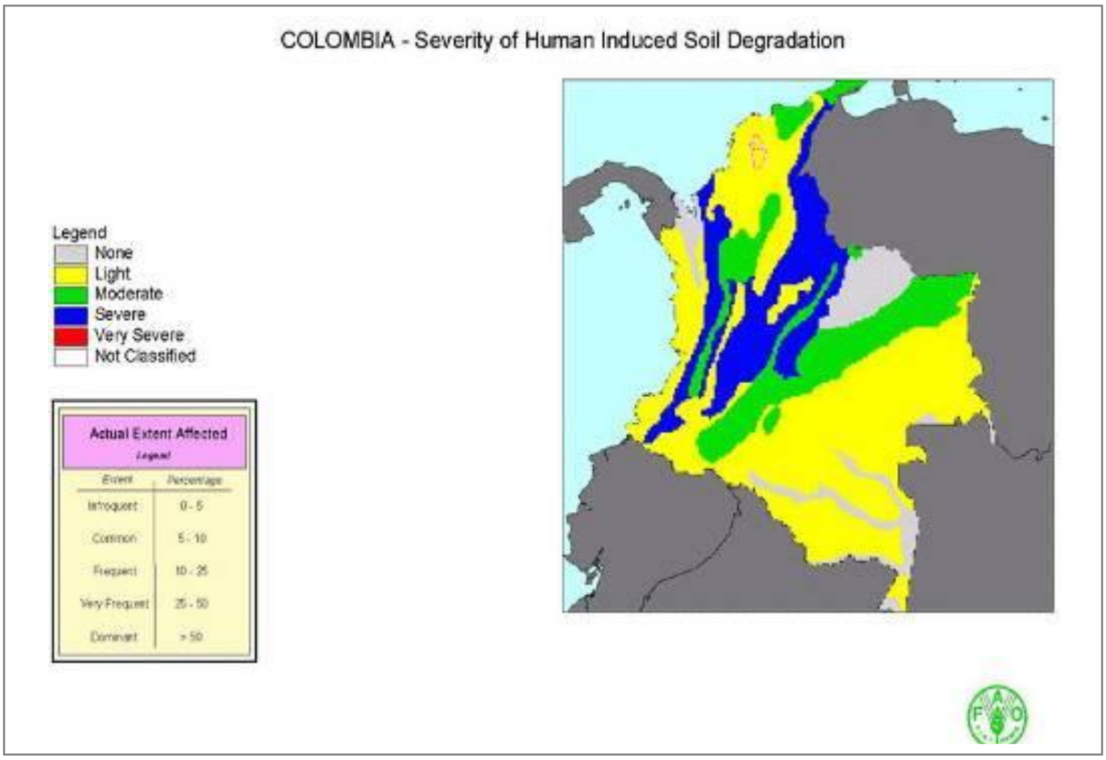

Figure 12. Map of soil degradation in Colombia. Source: FAO (2005)[53]. The six municipalities encompassing the project area are represented in purple.

[49] ISRIC, 1990. Global Assessment of Human-induced Soil Degradation (GLASOD).

[50] IDEAM, 2001.Tierras afectadas por la desertificación. Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM), Bogotá.

[51] IGAC, 1997. Regiones Naturales. Mapa. Instituto Geográfico Agustín Codazzi, Bogotá, Colombia

[52] Vargas y Gómez, 2003. La desertificación en Colombia y el cambio global. Cuadernos de geografía. XII (1-2) pag 121-134.

[53] FAO, 2005. Op. cit.

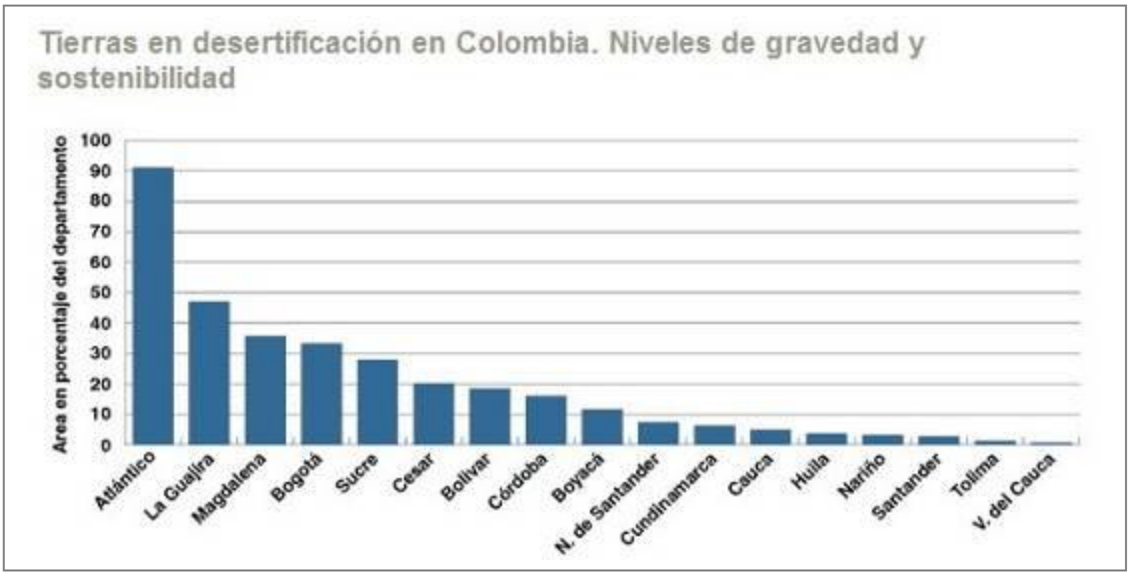

Figure 13. Area in process of desertification by department in Colombia. Source: IDEAM (2001)[54]

Indeed, in the project area, the extensive cattle grazing activities represent a traditional prevailing practice since decades, and a main driver of biomass loss[55]. The dynamic of pastures led to the almost complete elimination of forests in the Caribbean region. Except temporal abandonment of some pasture because of troubles related to public order, the dynamic of land use is the extension of pastures and, thus, the increase of land degradation.

Furthermore, a study was conducted by ONF International in order to estimate the evolution of biomass in the project area, based on a multi-temporal analysis of land-use change using the classes of biomass established by a former study in the project area[56]. The study pointed the decrease, in terms of surfaces, of dense vegetation classes (fallows - *rastrojos*) and the increase of light vegetation classes (pastures), leading to a global decrease of biomass in the project area.

According to what was stated above, the areas to be planted have low contents of carbon due to the historical tendency of degradation and desertification to which the region has been subjected, with the current use of soil and the advance of the global climate change, the contents of carbon will be decreasing steadily, therefore, this applicability condition matches with the proposed project activities.

Site preparation does not cause significant long-term net decrease of soil carbon stocks or increase of non-CO_2 emissions from soil

[54] IDEAM, 2001. Op. Cit.

[55] Wertz-Kanounniko, Kongphan-Apirak and Wunder, 2008. Reducing forest emissions in the Amazon Basin. A review of drivers of land-use change and how payments for environmental services (PES) schemes can affect them. Working paper N°40. CIFOR. Bogor. 26pp.

[56] Dufour, 2005. Reboisement Commercial dans la Région du Magdalena Bajo, Colombie. La Composante Carbone: Niveau de référence et plan de surveillance. Mémoire de Mastère ENGREF. ONF International.

The proposed project activities will be reforestation activities on grasslands, as demonstrated in section A.7. Scientific studies[57,58,59] showed that soil carbon stocks may decrease in the case of reforestation on pastures. However, from these authors the decrease is temporary and soil carbon stocks get back to their initial level or even higher levels of carbon stock on mid-term or long-term.

In the proposed A/R CDM project activities, the soil disturbance should then represent between 6.7% and 8.3% of the whole project area. No other soil preparation, as ripping, ploughing or mounding that generate more C loss than sub-soiling[60] is made. Thus, minimum soil disturbance is generated.

Therefore, this applicability condition matches with the project circumstances.

Carbon stocks in soil organic carbon, litter and dead wood can be expected to further decrease due to soil erosion and human intervention or increase less in the absence of the project activity, relative to the project scenario

As mentioned above for land degradation, some international studies[61,62], a national study[63] and local studies[64,65] presented the project area, and the whole region encompassing this latest, in a process of loss of vegetation due to the wide implementation of cattle grazing activities[66]. Therefore, with continuous loss of vegetation, leading to a probable desertification on the long-term, the quantity of carbon stocks in soil, litter and dead wood will logically decrease in absence of any activity fighting this process of degradation.

Moreover, the studies of ONF Andina (2004)[67] and Dufour (2005)[68], point the fact that it is unlikely that any human intervention occur to prevent the processes of biomass and soil degradation, the traditional cattle grazing activities representing the most cost-effective activity from the perception of local landowners.

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57 Paul, Polglase, Nyakuengama and Khanna, 2002. Change in soil carbon following afforestation. Forest Ecology and Management, 168, 241-257.

58 Polglase, Paul, Khanna, Nyakuengama, O'Connell, Grove and Battaglia, 2002. Change in soil carbon following afforestation or reforestation: Review of experimental evidence and development of a conceptual framework. National carbon Accounting System, technical report No.20. Australian Greenhouse Office. Pp 118.

59 Silver, Ostertag and Lugo, 2000. The potential for carbon sequestration through reforestation of abandoned tropical agricultural and pasture lands. Restoration Ecology, Vol.8, 4, pp 394-408.

60 Polgase, *et al.,* 2000. Op. Cit.

61 FAO, 2005. Op. cit.

62 ISRIC, 1990. Op. cit.

63 IDEAM, 2001. Op. Cit.

64 Dufour, 2005. Op. Cit.

65 See section C.5.1 b

66 ONF Andina, 2004. Elaboración de un catálogo de proyectos de manejo sostenible de los recursos naturales y de lucha contra el efecto invernadero en Azerbaidjan, Chili, Colombia y Gabón. Reforestación de pastos en la región del Magdalena Bajo. Informe final – agosto 2004.

67 ONF Andina, 2004. Op. Cit.

68 Dufour, 2005. Op. Cit.

Therefore, the carbon stocks in soil organic carbon, litter and dead wood are expected to decrease due to soil erosion due to human intervention. Thus, this applicability condition matches with the project circumstances.

Flooding irrigation is not permitted

Flooding irrigation will not be part of the proposed project activities as it is detailed in the section A.5.4., and because the selected tree species for the proposed project activities cannot support flooding[69].

Therefore this applicability condition matches with the project circumstances.

Soil drainage and disturbance are insignificant, so that non CO_2-greenhouse gas emissions from these types of activities can be neglected

These activities are not included in the project development as it is detailed in the section A.5.4.

Therefore this applicability condition matches with the project circumstances.

The A/R CDM project activity is implemented on land where there are no other on-going or planned A/R activities (no afforestation/reforestation in the baseline)

On one hand, as it was demonstrated in section A.7 above (demonstration of land eligibility) through satellite imagery, there is no other on-going A/R activity within project area.

On the other hand, there is no planned A/R activity within project boundaries since the proposed project activities will be implemented only with private landowners dedicated to traditional cattle grazing activities without knowledge of silviculture[70,71].

According to a socio-economic study related to the landowners of the project area and their perception of the project activities, some of the causes by which the A/F activities can not be carried out are: the lack of information about the forest activity, the lack of technological support and economical investment by the government. These, hinder the trade of the forest development in the zone. On the other hand, the extensive cattle grazing is easily implemented, since it requires low economical and technological investment. This situation has taken the extensive cattle grazing activity to be an important economical activity for the region[72].

In this way, the project was designed as a pioneer project as it involves public institutions, private landowners and local communities at a large scale. This innovative association of actors with direct

[69] CIRAD-Forêt, 2003. Capacidad del programa de reforestación comercial realizado en la zona Atlántica de Colombia de generar empleo y fomentar el desarrollo rural, desde la plantación hasta la transformación y comercialización de los productos. Consultoría para ONFI y CORMAGDALENA, Colombia.

[70] CIRAD-Forêt, 2003. Op. Cit.

[71] Cazaux, 2003. Restricciones y motivaciones de los ganaderos frente al proyecto de reforestación comercial de CORMAGDALENA. ONF INTERNATIONAL, Santa Fé De Bogotá, Colombia.

[72] Cazaux, 2003. Op. Cit.

transfer of know-how related to forest did not have any similar action implemented or planned in the region in 2000, mostly because of the context of economic crisis and public disorder.

Other punctual A/R activities that could be implemented around project area were the fact of industrial wood entities, and none of them in the framework of the CDM.

However, another A/R CDM project activity developed by the Colombian wood company PIZANO S.A and started in 2003 is currently under phase of validation in the same region (Colombian Caribbean savanna), but project boundaries of both projects do not overlap.

C.3. Assessment of the selected carbon pools and emission sources of the approved methodology to the proposed CDM project activity:

In accordance with the applied A/R CDM methodology, the selected carbon pools are presented in the Table 10.

Table 10. Selection of carbon pools under consideration

Carbon pools	*Selected*	*Justification / Explanation*
Above ground	YES	Major carbon pool subjected to the project activity
Below ground	YES	Major carbon pool subjected to the project activity
Dead wood	NO	Conservative approach under applicability condition
Litter	NO	Conservative approach under applicability condition
Soil organic carbon	NO	Conservative approach under applicability condition

In accordance with the applied methodology, the emission sources considered are presented in the Table 11.

Table 11. Gases considered from emissions by sources other than resulting from changes in carbon pools

Sources	*Gas*	*Included/ excluded*	*Justification / Explanation*
Burning of biomass	CO_2	No	However, carbon stock decreases due to burning are accounted as a carbon stock change.
	CH_4	Yes	Non-CO_2 gas emitted from biomass burning
	N_2O	No	Potential emission is negligibly small

On another hand, emissions from biomass burning will also be accounted in case of accidental fire within project boundary in the project scenario.

C.4. Description of strata identified using the ex ante stratification:

According to the applied methodology, two *ex-ante* stratifications shall be done: (i) baseline stratification and (ii) stratification for project scenario. As recommended by the methodology, baseline stratification of the proposed project area is made according to major vegetation types because baseline removals for degrading land are expected to be small in comparison with project removals.

Ex-ante baseline stratification

The vegetation types of the project area have been described through SPOT Image analysis in order to develop a methodology for classification of vegetation by photo interpretation[73], as a result of this study, could be distinguish all kinds of land-use and their related vegetation (or not) observed in the area encompassing the project boundary. This study was the basis for estimates carbon stocks by type of vegetation in the baseline of the proposed A/R CDM project activities[74].

These vegetation types were harmonized in accordance with the land cover classes established nationally, by CORINE Land Cover methodology adapted for Colombia[75].The advantage of this methodology, is its compatibility with the forest definition fixed by the DNA in the framework of the CDM. Indeed, vegetation classes are differentiated mostly depending on crown coverage and height that match with the parameters given by the forest definition fixed by the Colombian DNA (respectively 30% of maximum crown coverage and 5m of maximum height).

According to the vegetation types identified and characterized in the analysis previously mentioned, and considering the evolution expected from the baseline scenario, only three types of existing vegetation were considered as eligible within the project boundary. As a result, the three following strata comprise such baseline scenario:

- **Clean pastures**, usually “clean” pastures, with herbaceous, shrubs (*matorral*) and sporadic trees (around 10 tree/ha)
- **Pastures with fallows (rastrojos bajos)**, a dense medium-height shrub layer or young fallows;
- **Fallows in early stage of succession (rastrojos bajos),** temporarily abandoned pasture under vegetation in early state of succession (rastrojo bajo), with some minor shrub vegetation and equally very rare individual trees (around 10 tree/ha)

The strata of the baseline scenario will remain unchanged during the crediting period of the project activity.

[73] Grua, 2003. Manual metodológico de reconocimiento de uso y cobertura del suelo a partir de imágenes SPOT 5. ONFI, ENGREF y CORMAGDALENA 2004.

[74] Dufour, 2005. Op. Cit.

[75] IDEAM, IGAC y CORMAGDALENA, 2008. Mapa de Cobertura de la Tierra Cuenca Magdalena-Cauca: Metodología CORINE Land Cover adaptada para Colombia a escala 1:100.000. Bogotá, D.C., 200p. + 164 hojas cartográficas.

Ex-ante stratification for project scenario

In accordance with the applied methodology, the *ex-ante* stratification for the project scenario is based on the project planting/management plan. The proposed project activities plan to implement commercial reforestation following to modalities: species with short-term rotation (15 years) and species with mid-term rotation (30 years). The species with short-term rotation are *Gmelina arborea* and *Eucalyptus tereticornis*. The species with long-term rotation are *Bombacopsis quinata*, *Tabebuia rosea* and *Tectona grandis*. The project stratification is presented in the Table 12 and the map below.

According to the applied methodology, a stand model *k* is related to a tree species (*j*) planted at a determined year.

Table 12. *Ex-ante* stratification of the project scenario

ID stratum (*i*)	Stand model (*k*) Stratification criteria Management plan/rotation (*j*)	Species	Area A_{ik} (ha)
SM1	*Short-term rotation (1)*	*Gmelina arborea*	3,615.95
		Eucalyptus tereticornis	45.69
		Sub total SM1	**3,661.34**
SM2	*Mid-term rotation (2)*	*Bombacopsis quinata*	320.36
		Tabebuia rosea	165.68
		Tectona grandis	255.59
		Sub total SM2	**711.63**

Final ex ante stratification

All polygons which are part of the project strata were mapped using GPS, and are available Shape file form. Also, the monitoring plan shows the variables to be periodically verified, in order to detect the need for a possible additional stratification during the crediting period.

The baseline strata into which the stand models will be introduced, with their respective areas, are shown in Table 13. And as an example, the Figure 14 illustrates the stand models in the baseline strata of the project for the municipalities of Zapayán and Piñón.

Table 13. Distribution of the stand models in the baseline strata

Stand model		Baseline strata (ha)			Total Stand model
		Pastures	**Pastures with fallows**	**Fallows in early stage of succession**	
SM1	Short-term rotation (1)	1,491.56	1,817.70	352.08	3,661.34
SM2	Mid-term rotation (2)	217.62	242.14	251.87	711.63
Total Base line strata		**1,709.18**	**2,059.84**	**603.95**	**4,372.97**

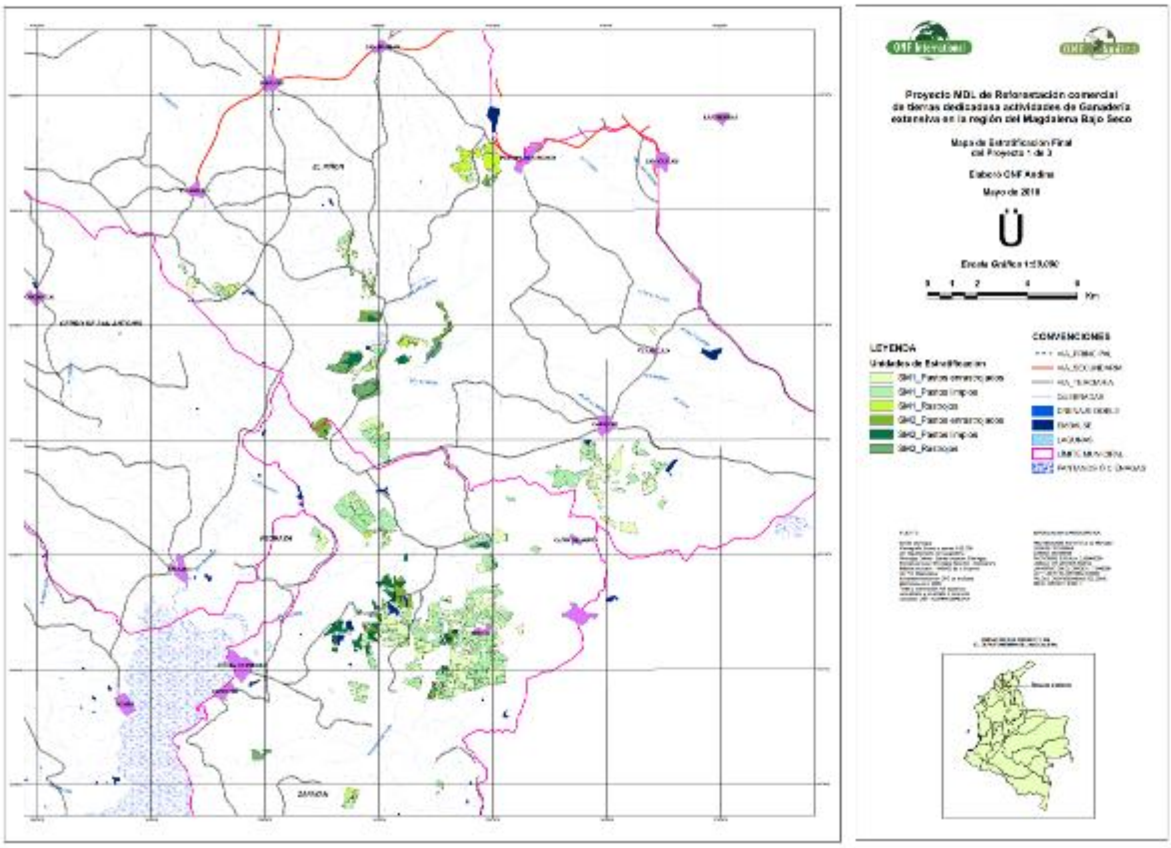

Figure 14. Final *ex ante* stratification map

C.5. Identification of the baseline scenario:

C.5.1. Description of the application of the procedure to identify the most plausible baseline scenario (separately for each stratum defined in C.4.):

Step 1. *The proposed AR CDM Project activity meets the conditions under which the proposed methodology is applicable, and the baseline approach 22(a) can be used.*

As demonstrated in section C.2, the proposed A/R CDM project activity meets the conditions under which the selected methodology is applicable. Therefore, the baseline approach 22(a) *Existing or historical, as applicable, changes in carbon stocks in the carbon pools within the project boundary* can be used.

Step 2. *Define the project boundary*

The project boundaries were explained in detail in the seciton A.4.2. The analysis of eligibility of lands included within the project boundaries was carried out by using the tool “Procedures to define the eligibility of lands for afforestation and reforestation Project activities” (see section A.7). The project scenario was defined by signing the corresponding joint venture contracts. This process, defined the area controlled by the project.

Step 3. *Analyze historical land use, local and sectoral land use policies or regulations and land use alternatives.*

a) Analysis of socio-economic conditions and prevailing practices, and key factors influencing land use and land-use change

As mentioned above, Cazaux (2003)[76] clearly identifies the errors when supporting the development of other agricultural activities in the project area This situation has promoted the development of the extensive cattle grazing activity, as the main economical alternative for the region.

The behaviour of the cattle grazing activity in the department of Magdalena from 1995 to 2002 is observed in Table 11. In accordance with this information, there is a growth in the use of soils for pasture activities per year. During that 7 year period, an annual average increase of 9,500 ha, in the areas used for cattle grazing was observed, rising to around 500,000 stock heads.

On the other hand, Lenne (2004)[77], shows that the cattle grazing activity prevails during the years following 2002, by providing higher income to the landowners given the fact that it needs low investment for its implementation. Hence, without any doubt, the cattle grazing activity is the most predominant practice for the project area as well as for the region.

Table 14. Changes in the cattle stock in the department of Magdalena (1995 -2002).

Year	1995	1996	1997	1999	2000	2001	2002
Female	685,161	929,127	875,508	1,058,365	586,975	995,191	981,434
Male	248,670	440,860	303,384	278,177	287,480	428,025	410,601
Total	**933,831**	**1,369,987**	**1,178,892**	**1,336,542**	**874,455**	**1,423,216**	**1,392,036**
Breeding	22,851	29,592	29,776	27,865	15,410	27,032	23,909
Area in pastures (ha)	977,795	953,999	987,508	895,843	905,826	1,048,382	1,044,352
Area in pastures and weeds (ha)	1,290,732	1,353,590	1,282,657	1,253,944	1,359,854	1,416,000	1,342,375
Capacity of pastures load	0.70	1.00	0.8	1.07	0.68	0.99	0.96
Capacity of pastures and weeds load	0.53	0.70	0.6	0.77	0.45	0.73	0.75

Source: Viloria, 2003[78]

b) Historical and current land use has led to progressive degradation of the land

To determine historical and current land use within project boundary, a multi-temporal analysis of LandSat satellite imagery was carried on with satellite pictures of 1984 and 2002[79], leading to a matrix of land-use change presented in the Figure 15.

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[76] Cazaux, 2003. Op. Cit.

[77] Lenne, 2004. Programa de tecnificación de la ganadería dentro del proyecto de reforestación de CORMAGDALENA en el núcleo Bajo Magdalena. ONFI-CORMAGDALENA 2005.

[78] Viloria, 2003. Op. Cit.

Mainly, the results given by the matrix show a clear decrease of fallows (81%) distributed almost between clean pastures (36% of total decrease of fallows) and pastures with fallows (32%). Land-use change involving pastures or fallows represented 89% of total land-use change between 1984 and 2002.

[79] ONFI, 2010a. Land use and land cover change maps. Summary document

2002

1984

Ha	112	211	227	231	232	233	241	242	243	244	311	3152	312	313	322	333	334	411	414	511	512	514	Total 1984
112	2,59	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**2,59**
211	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
227	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
231	0,00	0,00	0,00	886,29	94,12	294,61	0,00	0,05	0,00	147,12	0,00	87,47	0,00	5,52	24,67	0,00	0,00	0,13	0,00	0,00	0,00	0,00	**1.452,51**
232	0,00	0,00	0,00	0,00	0,50	98,29	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**98,79**
233	0,00	0,76	0,04	1.045,62	77,16	690,68	0,00	1,82	1,14	132,92	39,39	132,94	0,00	12,29	20,14	0,00	0,00	0,30	6,99	0,00	0,00	0,00	**2.029,24**
241	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
242	0,00	0,42	0,00	27,19	0,12	1,89	0,32	0,00	0,00	9,23	13,22	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**52,39**
243	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
244	0,00	0,00	0,00	88,11	99,06	91,92	0,00	0,10	0,00	89,94	0,00	0,00	0,00	0,00	5,78	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**374,91**
311	0,00	0,00	0,00	2,10	4,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,64	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**7,70**
3152	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
312	0,00	0,00	0,00	25,61	0,00	0,89	0,00	0,00	0,00	5,09	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**31,59**
313	0,00	0,00	0,00	18,89	0,98	3,31	0,00	0,00	0,00	0,46	0,00	0,00	0,00	43,60	0,11	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**67,34**
322	0,00	0,00	0,00	365,06	33,60	319,43	0,00	0,00	16,28	82,14	18,50	48,27	0,00	0,35	139,35	0,00	0,00	0,07	30,11	0,00	0,00	0,00	**1.004,89**
333	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
334	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
411	0,00	0,00	0,00	5,79	0,00	28,24	0,00	0,00	0,00	7,80	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,84	0,00	0,12	0,00	0,00	**43,79**
414	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
511	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
512	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
514	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,24	0,00	0,00	**0,24**
Total 2002	**2,59**	**1,18**	**0,04**	**2.464,67**	**310,49**	**1.529,26**	**0,32**	**1,97**	**17,42**	**474,68**	**71,11**	**268,68**	**0,00**	**61,76**	**190,70**	**0,00**	**0,00**	**2,34**	**37,10**	**0,36**	**0,00**	**0,00**	**5.165,99**

Figure 15. Matrix of land-use change for all strata between 1984 and 2002. All area in hectares.

Changes between 1984 and 2002 for each class of land cover are represented in the Figure 16.

The project area showed a net decrease of land lying fallow areas. This responds to a condition of applicability of the baseline methodology used for the present project.

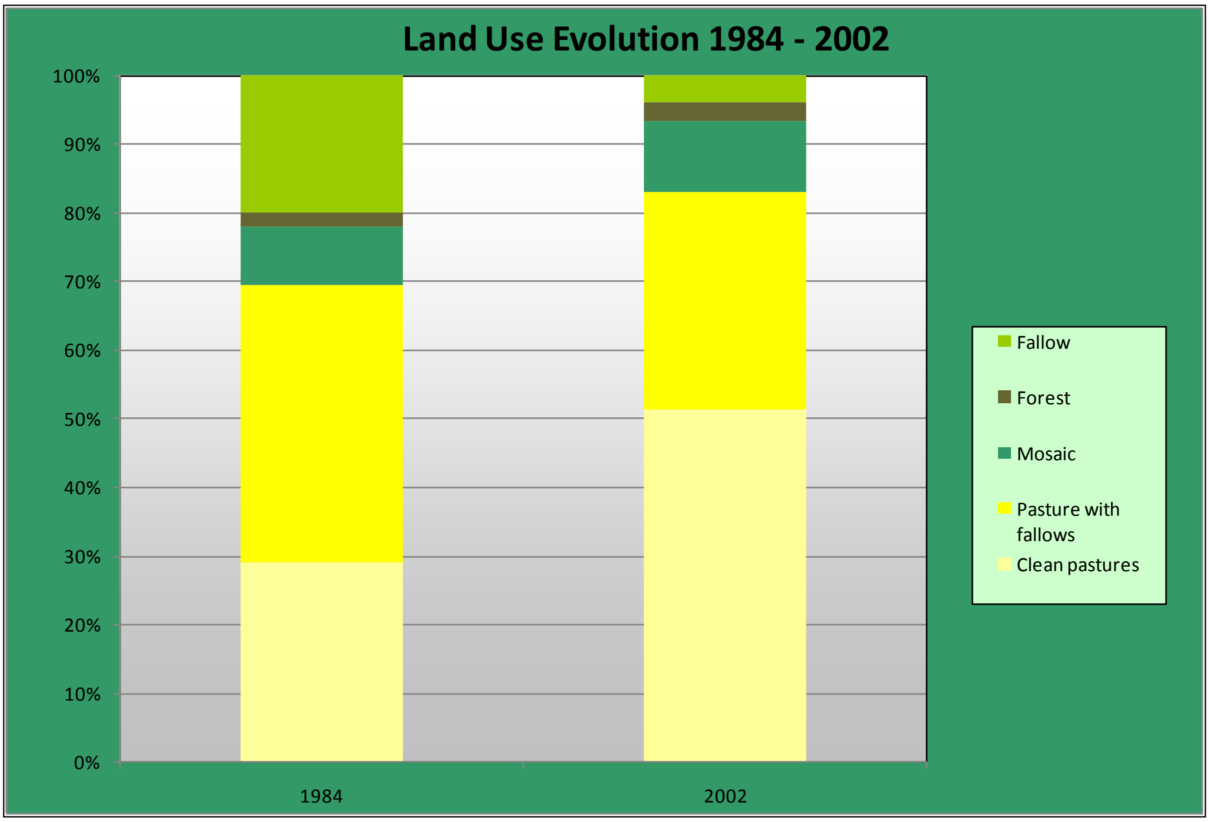


Figure 16. Evolution of vegetation coverages between 1984 and 2002.

As reforestation activities will specifically be implemented on pastures and young fallows, the probability of each one of these coverage to change to another one is estimated from the matrix above, and the results of land-use changes between 1984 and 2002 of clean pastures, pastures with fallows (rastrojos) are summarized and quantified in the Table 15.

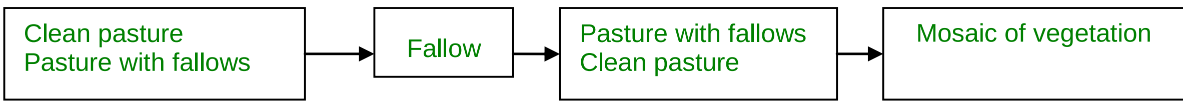
In the "Area (Ha)" columns, in 1984 the results of the area of each coverage can be seen, and in the "%"columns the results of land-use change, from 1984 to 2002 are shown. For example, in 1984 there were 1,004.89 ha of fallows, 13.87% of which were still fallows in 2002, changing respectively 36.33 ha and 31.79 ha to clean pastures and pastures with fallows in 2002.

Table 15. Land-use change from clean pastures, pastures with fallows, and fallows between 1984 and 2002**.**

1984 was	2002 went to…					
	Fallow		**Clean pasture**		**Pasture with fallows**	
	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%
Urban zone	0,00	0,00	0,00	0,00	0,00	0,00
Crops	0,00	0,00	0,00	0,00	0,80	0,04
Clean Pasture	365,06	36,33	886,29	61,02	1.045,62	51,53
Pasture with trees	33,60	3,34	94,12	6,48	77,16	3,80
Pasture with fallows	319,43	31,79	294,61	20,28	690,68	34,04
Mosaic	98,41	9,79	147,17	10,13	135,88	6,70
Forest	18,86	1,88	5,52	0,38	51,67	2,55
Fallow	139,35	13,87	24,67	1,70	20,14	0,99
Degraded land	0,00	0,00	0,00	0,00	0,00	0,00
Humid zone	30,18	3,00	0,13	0,01	7,30	0,36
Water zone	0,00	0,00	0,00	0,00	0,00	0,00
Total	**1.004,89**	**100,00**	**1.452,51**	**100,00**	**2.029,24**	**100,00**

The results given by matrix represent clearly the reality of facts in the project area. Field visit and socio-economic survey showed a clear decrease of forested areas and fallows. In the project area, local landowners use to clear existing forest lands and fallows for cattle grazing purpose.

From the precedent results, the most realistic succession of land-use in the project area can be set as:



Indeed, in accordance with the events that occurred in the project area, the dynamic of extension of pasture was suspended during periods of public disorder in the years 1990. Some pastures were abandoned and became unintentionally some fallows. When the public disorder decreased in the early 2000, the former dynamic of extension of pastures started newly with a decrease of "fallows" transformed in pastures as they were before.

As most of forest lands have disappeared and fallows decreased drastically, landowners cannot deforest anymore. Therefore, they clean their pastures (cutting of pre-existing trees shrubs) more and more in order to increase space for cattle within existing pastures. Moreover, this practice is reinforced by the fact that trees in pastures have traditionally no value for project landowners, as they represent only some space that cannot be used for fodder production.

Finally, pastures can be transformed in mosaics of vegetation which represent a mix of grassland, small patches of *rastrojos* and crops, within less than one hectare. Mosaics of vegetation are usually observed among landowners with small area and diversifying their activities to optimize their incomes.

The results from land-use change between 1984 and 2002 are extrapolated forward to estimate the land use change in terms of hectares that corresponds to the whole carbon pools for each stratum. The results are given in Table 16 and Table 17.

Table 16. Estimated result of land-use evolution of clean pastures, pastures with trees, pastures with fallows and fallow from the project start onward, on the basis of the previous 18 years land use. Result is given in the column on the right (from same table than before).

1984 was	2002 went to… Fallow		Clean pasture		Pasture with fallows		ha 2020
	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%	
Urban zone	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Crops	0,00	0,00	0,00	0,00	0,80	0,04	0,60
Clean Pasture	365,06	36,33	886,29	61,02	1.045,62	51,53	2.361,15
Pasture with trees	33,60	3,34	94,12	6,48	77,16	3,80	224,23
Pasture with fallows	319,43	31,79	294,61	20,28	690,68	34,04	1.081,02
Mosaic	98,41	9,79	147,17	10,13	135,88	6,70	370,80
Forest	18,86	1,88	5,52	0,38	51,67	2,55	51,89
Fallow	139,35	13,87	24,67	1,70	20,14	0,99	83,49
Degraded land	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Humid zone	30,18	3,00	0,13	0,01	7,30	0,36	11,44
Water zone	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	**1.004,89**	**100,00**	**1.452,51**	**100,00**	**2.029,24**	**100,00**	

Thus the evolution in terms of hectare for each stratum on a base year will be:

Table 17. Annual baseline land-use change trends for the strata. All area in $ha.yr^{-1}$.

Land use	1984	2002	Evolution (ha/yr)
Crops	0,00	1,22	0,07
Clean Pasture	1.452,51	2.464,67	56,23
Pasture with fallows	2.029,24	1.529,26	-27,78
Mosaic	427,31	494,39	3,73
Forest	106,63	132,87	1,46
Fallow	1.004,89	190,70	-45,23

In accordance with the applicability conditions of the methodology and, thus, with the baseline approach, the land-use evolution of the baseline scenario can be given by extrapolating the land-use evolution of the past (1984-2002) towards the future for each stratum. This land-use evolution corresponds to the evolution of area, in hectares, of each stratum within project boundary and during the chosen crediting period.

The baseline scenario is listed in Table 16 and Table 17 above. The evolution of baseline scenario is presented in the Figure 17.

In conclusion, this analysis pointed the decrease, in terms of surfaces, of dense vegetation classes (fallows - rastrojos) and the increase of light vegetation classes (pastures), leading to a global decrease of biomass in the project area.

Finally, it is important to consider that the degradation of the soils is produced by anthropic agents such as the cattle grazing, and at the same time, the impact of such activity are heavier due to the dry climate and the effects of the climate change in the region, resulting in a great risk of desertification of these soils given their high susceptibility towards degradation[80].

[80] Vargas y Gómez, 2003. Op. Cit.

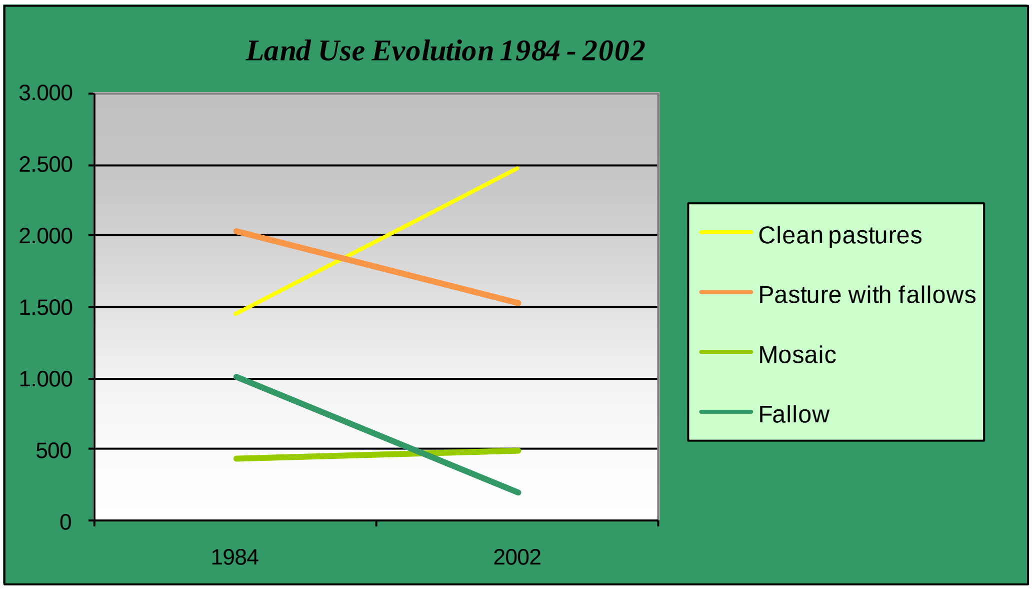


Figure 17. Baseline scenario for each strata. All area in ha

c) Description of national, local and sectoral land-use policies/regulations adopted before 11/11/2001, and show that they do not influence the project area

Policies related to the creation of wood sources

The Table 18 lists the national or sector polices with direct influence on land use and the proposed A/R CDM project activity. This analysis covers also national policies related to natural forests and A/R activities[81,82], as well as their implications in terms of demand and supply of forest products and the impacts on the existing and future land uses.

Table 18. National policies adopted before 11 November 2001

Policy	***Scope/objective***
Ley 2 de 1959. Sobre Economía Forestal de la Nación y Conservación de los Recursos Naturales Renovables Law 2 of 1959 on the Forest Economy of the Nation and the Conservation of Renewable Natural Resources	Law towards the development of the forest economy and the protection of soils, water, and wildlife. By means of this law, "Protecting Forest Zones" and "General Interest Woods" were established. Besides, this allowed to address efforts towards the implementation of Forest Reserve Zones in the Magdalena River.

[81] Aldana, 2004. Sector forestal Colombiano; fuente de vida, trabajo y bienestar. Serie de documentación no. 50. Corporación Nacional de Investigación y Fomento Forestal (CONIF), Bogotá.

[82] Orozco, 1999. Las Políticas forestales en Colombia. Análisis de procesos de formulación, contenidos y resultados globales. Santa Fe de Bogota. D.C. Colombia.

Policy	***Scope/objective***
Decreto 2811 de 1974. Código de los Recursos Naturales Renovables y de Protección del Medio Ambiente Decree/Law 2811/74, National Code of National Renewable Resources and of Protection of the Environment	This Decree focuses on the sustainable use of the natural renewable resources, including water, atmosphere, land, soil, subsoil, flora, fauna, among others. This Decree also deals with the regulation of the activities aimed at generating goods produced by the man or cultivated by him, which can cause deterioration in the environment. Provides definitions of forest related terms and serves as the basis for the Decree 1791/96 (see below).
Ley 37 del 1989, bases para el Plan Nacional de Desarrollo Forestal y creación del Servicio Nacional Forestal Law 37 of 1989, basis for the National Forest Development Plan and the creation of the National Forest Service	This law provided the structural basis for the National Forest Development Plan (PNDF), thus establishing the National Forest Service. The PNDF aims at the development of programs that must be carried out at a national level, in order to maintain the social and economical benefits of forests, and to solve the problems of the sector. This year, the national council of economical policies (CONPES), approved the National Forest Development Plan for Colombia, with the support of a budgetary allocation plus an international cooperation at a technical level.
Decreto 1791 de 1996. Régimen de aprovechamiento forestal Decree 1791/96, Regime for the use of forest resources	This decree rules the use of public and privately owned forests. It acknowledges that plantations serve to meet the demand of wood, maintain ecological processes and create job opportunities. It defines forest plantations, forest companies and the requirements for the registration of plantations at the regional environmental authority (Corporación Autónoma Regional) of their jurisdiction.
Política de Bosques – Documento CONPES 2834 (1996) Forest Policy (1996)	Among the specific objectives of the Forest Policy, one is to generate incentives for reforestation activities in order to decrease the pressure on natural forests. However, for the development of the proposed A/R CDM project activity, the existence of this policy did not have influence.
Plan estratégico para la restauración y la implementación de bosques en Colombia – PLAN VERDE (1998) Strategic Plan for the Restoration and the Implementation of Forests in Colombia – PLAN VERDE (1998)	The Plan Verde proposes to generate the basis to include reforestation for commercial purposes and agroforest in the environmental spatial planning. The strategies of the Plan Verde include the strengthening of CDM-related institutional capacity, A/R CDM pilot projects and investigation on the capacity of ecosystems to store carbon. However, this project activity and any reforestation project (*e.g.* as A/R CDM pilot projects) in the region (Sabanas del Caribe).have not received any support by the Plan Verde.
Acuerdo sectorial de competitividad cadena forestal aglomerados y contrachapados, muebles y productos de madera (1998) Sectoral agreement on the competitiveness of the wood chain, wood-based boards and plywood, furniture and wood products (1998)	Agreement between governmental agencies and the wood sector to strengthen national and international competitiveness of the Colombian wood chain via fostering technological innovation, structural changes, capacity building and market development.

Policy	***Scope/objective***
Plan Nacional de Desarrollo Forestal (2000) National Plan of Forest Development (2000)	This Plan is based on the participation of the actors of the forest sector in order to promote strategies and programs for the sustainable use of forest resources by adopting a vision of the chain between commercial reforestation, industrial development and the commercialization of environmental services, which are generated by forest ecosystems. One of the programs resulting from this plan is the program *Desarrollo de Cadenas Forestes Productivas*. In this way, the wood production related to the proposed A/R CDM project activity is framed in general at the regional forest chain. For the implementation of this Plan, some limited funds were available to improve the competitiveness of the wood chain via research and development projects. However, no funds were assigned to reforestation activities.

The resulting policy incentives and constraints for the project activity – also with regard to its impacts on natural forests – can be summarized as follows:

- Reforestation activities are in line with the prevailing sector policy objective to promote new plantations in order to decrease pressure from the use of natural forests.
- The existing sector policies have to a certain extend supported the activities along the wood chain, e.g. via investigation programs.
- The implementation of these policies, however, has not led to a noticeable implementation of new plantations in the region of the project activity.
- The prevailing sector policies do no alleviate three main problems hindering the implementation of new plantations: the limited access to capital, the long pay-back times and a low internal rate of return of investments into reforestation activities.

Legislation related to the requirements of A/R activities and land use

The results of the assessment of the impacts of prevailing legislation (national, state, local) on the A/R activities, including the mandatory requirements on the land uses is presented in the Table 19.

Table 19. Legislation related to the requirements of A/R activities and land use

Legal measures	***Scope/objective***
National legislation put into force/adopted ***before*** 11 November 2001:	
Decreto/Ley 2811/74, Código Nacional de Recursos Naturales Renovables y de Protección al Medio Ambiente Decree/Law 2811/74, National Code of National Renewable Resources and of Protection of the Environment	This Decree focuses on the sustainable use of the natural renewable resources, including water in any its states, atmosphere, land, soil and subsoil, flora, fauna, among others. It also deals with the regulation of the activities aimed at generating goods produced by the man, or whose production may be inducted or cultivated by him, and can cause a great deterioration in the environment. Provides definitions of forest related terms and serves as the basis for the Decree 1791/96 (see below).

Legal measures	*Scope/objective*
National legislation put into force/adopted ***before*** 11 November 2001:	
Decreto 2053/74, Régimen del impuesto a la renta y complementarios Decree 2053/74, Tax regime on return	Article 98 allows deducting up to 20% of investment costs related to reforestation activities up to 20% of corporate taxes on return.
Ley 37 del 1989, bases para el Plan Nacional de Desarrollo Forestal y creación del Servicio Nacional Forestal Law 37 of 1989, basis for the National Forest Development Plan and the creation of the National Forest Service	This law provided the structural basis for the National Forest Development Plan (PNDF), thus establishing the National Forest Service. The PNDF aims at the development of programs that must be carried out at a national level, in order to maintain the social and economical benefits of forests, and to solve the problems of the sector. This year, the national council of economical policies (CONPES), approved the National Forest Development Plan for Colombia, with the support of a budgetary allocation plus an international cooperation at a technical level.
Constitución política de Colombia (1991) Political Constitution of Colombia (1991)	This change in the constitution led to several laws that redistribute the ownership of 70% of Colombia's natural forests. This considerable amount of wood resource from natural forests can no longer be accessed via forest concessions (of 40 year) or use rights (of 10 year), but via contracts of buying and selling (contratos de compra y venta). These laws have shifted the focus of securing long-term commercial wood sources towards the establishment of plantations, though not providing the means for reforestation.
Ley 139/94, por la cual se crea el Certificado de Incentivo Forestal y se dictan otras disposiciones Law 139/94, by which the Certificate of Forest Incentive and other regulations are created	Instrument for the creation of plantations in Colombia by contributing to the costs of establishment of plantations of native and introduced species as recognition of the environmental and social externalities of plantations. Contributions consist in 75% of the costs for plantations with native species and 50% of the costs for plantations with introduced species The total volume of available (governmental) funds, however, has been unpredictable and very limited and compared to the requests for financial support (Aldana, 2004. p, 44[83]). As a matter of fact, this instrument has not had a noticeable impact on reforestation activities in the area of the project (see section C.6, Step 4, Common practice analysis).
Decreto 1791/96, Régimen de Aprovechamiento Forestal Decree 1791/96, Regime for the use of forest resources	This decree rules the use of public and privately owned forests. It acknowledges that plantations serve to meet the demand of wood, maintain ecological processes and create job opportunities. It defines forest plantations, forest companies and the requirements for the registration of plantations at the regional environmental authority (Corporación Autónoma Regional) of their jurisdiction. The plantations of years 2000 to 2005 of this project activity

[83] Aldana, 2004. Op. Cit.

Legal measures	***Scope/objective***
National legislation put into force/adopted ***before*** 11 November 2001:	
	have been registered according to this decree.
Ley 388/97, Ordenamiento Territorial Law 388/97, Spatial Planning	This law requests municipalities to elaborate plans of spatial planning, specifying, among others, areas for reforestation
Resolución 2822/06 del Instituto Colombiano Agropecuario (ICA) y Resolución 182/08 del Ministerio de Agricultura y Desarrollo Rural (MADR) Resolution 2822/06 made by the Colombian Agriculture and Livestock Institute (ICA) and the Resolution 182/08 made by the Ministry of Agriculture and Rural Development (MADR)	Regulations towards the registration of the agroforest or forest crops with commercial purposes before the Colombian Agriculture and Livestock Institute (ICA) The plantations of years 2006 onwards, have been registered according to these resolutions, according to its legal validity
Law 1377/10, which regulating the activity of commercial reforestation	In general, this law limits and regulates the forest plantations and the agroforest systems, with commercial purposes in Colombia

From the assessment of the impacts of prevailing legislation (national, state, local) on the A/R activities, including the mandatory requirements on the land uses, it can be concluded – also with regard to its impact on natural forests and existing and future land uses:

- There exists no legal obligation for the project participant and the associated landowners to engage in reforestation activities (see also policy objectives above);
- Current legislation does not oblige landowners in the region to cease cattle grazing activities.
- Governmental funds for incentivizing reforestation activities, e.g. the Certificate of Forest Incentive, exist but are very limited, unpredictable in its availability, and associated with high transaction costs (Aldana, 2004. p, 44[84]). As a matter of fact, they have not led to significant reforestation activities in the region of the project (see section C.6, Step 4, Common practice analysis). According to statistics of national plantations, in the period between 1995 and 2007, it had been established 6,087 ha of forest plantation throughout the department of Magdalena[85], which is equivalent to a rate of reforestation of 468 ha per year. This rate is very small, especially considering that the department has a total 500,000 ha of unrestricted lands with suitable aptitude to forest and 164,000 lands with minimal restriction[86]. However, the proposed A/R CDM project activity, especially at phase 2000 – 2003 and at year 2009, has been using this kind additional incentive (besides revenues from the CDM).
- Tax-related incentives have led to some reforestation activities in the past; their impact, however, has been limited to reforestation activities of large landowners in the years after 1981. Such incentives are only attractive for companies that generate sufficient turnover and have respective tax obligations, which may occur in other sectors but very seldom in the forest sector. This means also that tax-related

[84] Aldana, 2004. Op. Cit.

[85] IDEAM, 2009. Op. Cit.

[86] Aldana, 2004. Pg 86. Op. Cit.

incentives are sensitive to the overall economic development, which at the starting date of the project and subsequent was rather problematic indeed (Aldana, 2004. p. 47[87]).

• Finally, it is important to highlight that many of the forest policies, along with their associated laws have in common an important characteristic. They have been governmental policies and not State policies, by means of the Laws issued by the Republic, which have not provided continuity and improvement to the forest sector[88].

According to EB 23, annex 19 "National and/or sectoral land-use policies or regulations, which give comparative advantages to afforestation/reforestation activities and that have been implemented since the adoption by the COP of the CDM Modalities and Procedures (decision 17/CP.7, 11 November 2001), need not be taken into account in developing a baseline scenario (*i.e.* the baseline scenario could refer to a hypothetical situation without the national and/or sector policies or regulations being in place)".

d) Identification of alternative land use on the degraded lands

Three land uses might possibly and credibly be developed within project boundaries during the crediting period:

1. Continuation of cattle grazing activities.
   According to the record of the tendency of the use of soil, the cattle grazing activity is the appropriate to be implemented in the zone. Furthemore, this activity does not demand high economical and technological requirements. On the ther hand, the appropiate technologies have not been implemented in order to develop other alternative activities[89,90].
2. New culture of palm oil (*Elaeis guineensis*). This activity is being developed with a high level of acceptance in large portion of the region. Nowadays, these crops have a very important renown in Colombia. The Department of Magdalena is third in more number of hectares in Colombia in establishing this crop[91]. In 1998, reported about 50,000 ha established and concentrated in the north of the department in the municipalities of Aracataca, Ariguaní, Pivijay, Ciénaga, El Retén, Fundación, and Pueblo Viejo[92]. However, the conditions of the soil and the problem of insufficient water resources that prevails in the current project area do not provide suitable development of the palm oil activity. In general, project area is located in areas of soils strongly restricted for the crop of the species[93].

[87] Aldana, 2004. Op. Cit.

[88] Acosta, 2004. Estudio de tendencias y perspectivas del sector forestal en América Latina Documento de Trabajo. Informe Nacional Colombia. Corporación Nacional de Investigación y Fomento Forestal (CONIF) y FAO. Disponible en: http://www.fao.org/docrep/007/j4192s/j4192s00.htm#TopOfPage

[89] Cazaux, 2003. Op. Cit.

[90] Lenne, 2004. Op. Cit.

[91] Fedepalma, 2010. http://www.fedepalma.org/palma.htm

[92] Banco de la República. 2002. Centro de Estudios Económicos Regionales. Palma Africana en la costa Caribe: un semillero de empresas solidarias.

[93] Banco de la República. 2002. Op. Cit.

3. Reforestation activities not under A/R CDM. In the region, the reforestation activity has been hardly implemented given the lack of economic support and information (Cazaux 2003)[94]. Many of these initiatives can be done at a low extent and have not considered the possibility of the CDM as a financial tool towards its implementation[95].

e) Show that current land use will not change, or will lead to further degradation within project area

All of the three land uses mentioned above could possibly be the baseline scenario

A field survey, realized by Cazaux (2003)[96] aimed to study land-use evolution in the project area. The survey was based on interviews of local landowners distributed in all the project area where reforestation activities are envisaged and field observations, and lead to propose the following alternatives respect to actual land-use:

Table 20. Plausible land-use alternatives respect to actual land-use in the project area

Plausible land-use alternatives	***Proportion (%)***
Fallows	9
Reforestation activities	1
Cattle grazing activities	71
Forest reserve	3
Agriculture	3
Other (urban zone, water zones)	13

Reforestation activities presented in the table above represent the first plantations implemented in the framework of the present proposed A/R CDM reforestation activities. Others land-uses can be considered as they were encountered in the region near the project area.

Plausible land-use alternatives

Cattle grazing intensification

Culture of *Palma africana*

The reforestation program engaged by the present project with local landowners aimed to be generalized in the region. However, the program implemented in 2000 by a public entity (Cormagdalena) is expected to attract private investors as Cormagdalena will not be able to provide funds during all the crediting

[94] Cazaux, 2003. Op. Cit.

[95] Aldana, 2004. Op. Cit.

[96] Cazaux, 2003. Op. Cit.

period. Reforestation activities are only implemented with this kind of financial incentives if they are realized with rural population. Without these incentives it is very unlikely that others reforestation activities be implemented, especially spontaneously from landowners who do not have the capital and the skills to implement reforestation activities alone.

In the same way, it is unlikely that plantation of Palma africana takes place spontaneously in the region with the involvement of local landowners. Indeed, this kind of land-use activity requires funds for their installation that local landowners envisaged for the proposed A/R CDM project activities do not have for most of them.

These alternatives cited above could be implemented with rural credit. However, the critical point for implementation of reforestation activities is that Colombian rural population usually does not have access to credit, especially to long-term credit.

Furthermore local population is attached to cattle grazing activities and the interviews of local landowners showed that in the actual conditions most of them expect to continue this economic activity and no reference of willingness to intensify this activity was reported from part of landowners. This activity is marginal in the region as it needs investments and especially because stockbreeders are attached to the local rustic races of bovine (Zebú).

Thus, it is very likely that land-use remains the same according to landowner's wishes and their economic conditions that not allow them to really consider various alternatives except traditional cattle grazing activities and small agriculture. During the project duration, if the proposed reforestation activities were not realized, it is the most realistic to argue that local landowners will continue their traditional land-use activities.

Step 4: *Stratify the A/R CDM project area as recommended by the methodology**.***

Ex-ante baseline stratification was developed in Section C.4.

Baseline stratification of the proposed project area is made according to major vegetation types because baseline removals for degrading land are expected to be small in comparison with project removals.

The *ex-ante* stratification for the project scenario is based on the project planting/management plan. The proposed project activities plan to implement commercial reforestation following to modalities: species with short-term rotation (15 years) and species with mid-term rotation (30 years). The species with short-term rotation are *Gmelina arborea* and *Eucalyptus tereticornis*. The species with long-term rotation are *Bombacopsis quinata*, *Tabebuia rosea* and *Tectona grandis*. The project stratification is presented in the Table 12 and Table 13.

Step 5: *Determine the baseline land-use/land-cover scenario for each stratum. Analyse the possibility of self-encroachment of trees under the current conditions*

As indicated on section C.1., some researches pointed the department of Magdalena as one of the most exposed to desertification (IDEAM 2001[97], Vargas and Gómez 2003[98]). Indeed, in the project area, the

[97] IDEAM, 2001. Op. Cit.

[98] Vargas y Gómez, 2003. Op. Cit.

extensive cattle grazing activities is a general technique in the whole region and represent a traditional prevailing practice since decades, and a main driver of biomass loss[99]. In general, region shows a raise of clean pastures for the extensive cattle grazing activities[100]. This tendency, is presented in the three line base strata:

Clean pasture (BLS 1). The agricultural extensive cattle grazing activities are being carried out in these zones. The pastures have an average life span ranging from 15 to 20 years, before being reformed. Every year, considering that the burning activities are not common, these pastures are exposed to manual or mechanical interventions[101].

Pasture with fallows (BLS 2). The pastures with fallows are abandoned or used in very extensive pasture activities. The pastures with fallows represent a food source for cattle when there are no nearby pastures (for example, due to droughts)[102].

Fallows (BLS 3). In this scenario, the growth of biomass has been interrupted by a sucessional stagnation, which stops the dynamics of the sucessional process. Additionally, the cattle trampling has produced a compactation in the soil, generating the setting up of thin stems vegetation. Only in some areas, big trees can grow in a period no less than 10 years. On the other hand, there are no sources of seeds in nearby areas. In fact, only 0.007 % of the basin of the Magdalena River has forest coverage[103]. Therefore, the dissemination of species in sucessional stages of climax can be difficult, due to the low number of seeds available. In addition to that, fallows are currently composed only by pionner species. Therefore, the dynamics of growth of fallows can be interrupted by the impossibility of continuing the sucession to the secondary forest[104].

C.5.2. Description of the identified baseline scenario (separately for each stratum defined in section C.4.):

The baseline scenarios identified in C.4, are:

- **Clean pasture (BLS 1)**

Strata of herbaceous and grass coverage, apparently continuous, it could be clean or with brush (up to 30% coverage). The vegetation woody coverage is not more than 5% of the surface[105].

[99] Wertz-Kanounnik *et al*. 2008. Op. Cit.

[100] Dufour, 2005. Op. Cit.

[101] Dufour, 2005. Op. Cit.

[102] Grua, 2003. Op. Cit.

[103] Becerra, 2004a. "Los múltiples servicios de los bosques y el desarrollo sostenible en Colombia", en Peter Saile y María A. Torres (Eds.), Conferencia Internacional de Bosques, Colombia País de Bosques y Vida, Memorias, págs. 99-114. Bogotá: GTZ.

[104] Dufour, 2005. Op. Cit.

[105] Grua, 2003. Op. Cit.

The agricultural extensive cattle grazing activities are being carried out in these zones. The pastures have an average life span ranging from 15 to 20 years, before being reformed. Every year, considering that the burning activities are not common, these pastures are exposed to manual or mechanical interventions[106].

Some of the species characteristic of these coverages are[107]: cotorrón (*Corton sp.*), purgación (*Jathropha curcas*), malva (*Malvabiscus sp.*), escoba (*Sydapiramidalis sp.*), angletón (*Dichantium aristatum*), braquiaria (*Brachiaria brizantha*), pasto estrella (*Cynodon nemfuensis*), guinea (*Paniqum maximum*), pasto azul (*Poa sp.*), granadilla (*Passiflora ligularis*), cucaracho (*Vatairea lundelli*), arruinarrico (*Malvacea sp.*), bledo (*Amaranthus sp.*), campanilla (*Centrosema macrocarpum*) with very occasional trees of campano (*Samanea saman*).

- **Pasture with fallows (BLS 2)**

They are areas with pastures where low managing practices are carried out or pastures are abandoned being invaded by weeds and fallows. In these areas a mixture of pasture lands and some spots of fallows, are predominant with low wood vegetation. The pastures with fallows are abandoned or used in very extensive pasture activities. The pastures with fallows represent a food source for cattle when there are no nearby pastures (for example, due to droughts)[108].

Some of the species characteristics of these coverages are[109]: cotorrón (*Corton sp.*), trupillo (*Prosopis Juliflora*) and matarratón (*Gliricidia sepium*).

- **Fallows (BLS 3)**

The fallows correspond to natural low vegetation which are in abandoned areas. The fallows are product of anthropic activities, which constitute an early sucessional stage. The canopy coverage in fallows is a little dense and can be presented whether they are in the nearby tops or spread in the entire area. The fallows also correspond to underbrush formations that grew on some older pastures, where the percentage of forest coverage in vegetation is lower than 30%. In this stratum, multiple types of vegetation are present[110].

In this scenario, the growth of biomass has been interrupted by a sucessional stagnation, which stops the dynamics of the sucessional process. Additionally, the cattle trampling has produced a compactation in the soil, generating the setting up of thin stems vegetation. Only in some areas, big trees can grow in a period no less than 10 years.

On the other hand, there are no sources of seeds in nearby areas. In fact, only 0.007 % of the basin of the Magdalena River has forest coverage[111]. Therefore, the dissemination of species in sucessional stages of climax can be difficult, due to the low number of seeds available. In addition to that, fallows are currently

[106] Dufour, 2005. Op. Cit.

[107] Grua, 2003. Op. Cit.

[108] Grua, 2003. Op. Cit.

[109] Grua, 2003. Op. Cit.

[110] Dufour, 2005. Op. Cit.

[111] Becerra, 2004a. Op. Cit.

composed only by pionner species. Therefore, the dynamics of growth of fallows can be interrupted by the impossibility of continuing the sucession to the secondary forest[112].

When the areas with fallows are available for pastures activities, the elimination of the vegetation is carried out by a mechanical way using (bulldozers, tractors, among others). Later on, the material is collected by using a *machete* (a type of large knife), and fire is rarely used.

Some of the species present in these coverages are[113]: guácimo (*Guazumo ulmifolia*), matarratón (*Gliricidia sepium*) and trupillo (*Prosopis juliflora*).

Dufour (2005)[114] made some measurements of the biomass in the three baseline scenarios previously mentioned. The biomass values (tree and non-tree biomass) are shown in Table 18.

Table 21. Biomass contained in the baseline scerarions of the project. *BA*: Tree aboveground biomass (t d.m. ha^{-1}); *BB*: Tree bellowground biomass (t d.m. ha^{-1}); *Tr*: Trunks (t d.m. ha^{-1}); *Br*: branches (t d.m. ha^{-1}); *L*: leaves (t d.m. ha^{-1}); *Bu*: bush (t d.m. ha^{-1}); *Her*: herbaceous vegetation (t d.m. ha^{-1}); *Li*: litter (t d.m. ha^{-1}); *Dw*: deadwood (t d.m. ha^{-1}); *R*: roots (t d.m. ha^{-1}).

Scenario	Trees		Shrubs and fallows			Others					Total
	BA	***BB***	***Tr***	***Br***	***L***	***Bu***	***Her***	***Li***	***Dw***	***R***	
BLS1	0.00	0.00	0.28	0.16	0.28	0.00	6.54	2.77	0.11	1.09	**11.17**
BLS2	0.17	0.06	5.32	3.18	5.59	0.00	6.54	2.77	0.11	3.09	**26.78**
BLS3	0.87	0.27	4.09	4.36	9.72	0.00	3.94	2.13	0.27	3.32	**28.83**

For estimations of decrease in the carbon stocks in the living biomass by loss of pre-existing non-tree and tree vegetation in the year of site preparation (*Ebiomassloss*, see section D.1), herbaceous vegetation was excluded according to guidance contained in paragraph 35 of the EB 42 meeting report[115] (Table 22).

Table 22. Aboveground biomass of pre-existing non-tree vegetation in baseline scenarios. *Tr*: Trunks (t d.m. ha^{-1}); *Br*: branches (t d.m. ha^{-1}); *L*: leaves (t d.m. ha^{-1}); *Bu*: bush (t d.m. ha^{-1}); *Li*: litter (t d.m. ha^{-1}); *Dw*: deadwood (t d.m. ha^{-1}); *R*: roots (t d.m. ha^{-1}); $B_{pre,ik}$: Average pre-existing stock of non-tree pre-project biomass before the start of the proposed A/R CDM project activity for baseline stratum *i* (t d.m. ha^{-1}).

Scenario	Shrubs and fallows	Others	Total

[112] Dufour, 2005. Op. Cit.

[113] Grua, 2003. Op. Cit.

[114] Dufour, 2005. Op. Cit.

[115] In accordance with guidance contained in paragraph 35 of the EB 42 meeting report, GHG emissions due to removal (loss) of herbaceous vegetation as a component of non-tree biomass are neglected in this methodology. Hence, all references to GHG emission from removal of non-tree vegetation do not include GHG emissions from removal of herbaceous vegetation.

	Tr	*Br*	*L*	*Bu*	*Li*	*Dw*	($B_{pre,ik}$)
BLS1	0.28	0.16	0.28	0.00	2.77	0.11	**3.60**
BLS2	5.32	3.18	5.59	0.00	2.77	0.11	**16.97**
BLS3	4.09	4.36	9.72	0.00	2.13	0.27	**20.57**

In the baseline study of scattered trees was found an average around 10 trees/ ha[116]. According to this study, the stock of biomass in scattered trees in the baseline sceneries is 1.66 t d.m. ha^{-1}.

C.6. Assessment and demonstration of additionality:

This methodology uses the latest version of the 'Tool for the demonstration and assessment of additionality in afforestation and reforestation CDM project activities' approved by the CDM Executive Board, referred as '**AR additionality tool'**[117].

Step 0: Preliminary screening based on the starting date of the A/R project activity

- *Provide evidence that the starting date of the A/R CDM project activity was after 31 December 1999.*

The project has started on August 2, 2000. The analysis of the contracts established with landowners for the implementation of the project activities shows that the first contract was signed on August 2, 2000[118].

- *Provide evidence that the incentive from the planned sale of CERs was seriously considered in the decision to proceed with the project activity*

The Table 23 lists the proves that the benefits of the CDM were a decisive factor in the decision to proceed with the project activity. In accordance with EB 41, annex 46, paragraph 5 (a) (Guidance on the demonstration and assessment of prior consideration of the CDM); which demonstrate that the CDM was seriously considered in the decision to implement the project activity.

Table 23. Evidence that the benefits of the CDM were a decisive factor in the decision to proceed with the project activity before project start

Period	Activity by the Project Participant
1999	In 1999, CORMAGDALENA started the design and creation of its PROGRAMA DE REFORESTACIÓN COMERCIAL (Program of Commercial Reforestation) "PRC" by signing an agreement along with CONIF the CONVENIO ESPECIAL DE COOPERACIÓN (Special Cooperation Agreement) N° 000036/99. The purpose of this agreement was to carry out the Forest Zoning and to start the setting up of Forest nucleous in the CORMAGDALENA Jurisdiction.

[116] ONFA y C&B, 2010. Inventario de Árboles dispersos en los escenarios de línea base

[117] 'Tool for the demonstration and assessment of additionality in A/R CDM project activities' (EB 35 report, annex 17) of the CDM Executive Board, http://cdm.unfccc.int/Reference/Guidclarif/

[118] CONIF, 2000. Convenio Especial de Cooperación para la ejecución de un Proyecto de transferencia y de adopción de tecnología de reforestación bajo la modalidad protectora - productora en los municipios ribereños del Río Magdalena del 2 de agosto de 2000.

Period	Activity by the Project Participant
	This agreement was developed by CORMADALEMA explicitly considering the great potential of the Magdalena River basin in order to offer to the international community environmental services and benefits through the CDM mechanism, especially of CO2 sink from plantations and in this way obtain incomes from the forest carbon's sale[119]. Taking into account that for this year, the CDM concept and especially the forest CDM, was not clear enough, CORMAGDALENA moreover defined as a specific objective of this agreement, the realization of a first estimation and assessment of the carbon absorption that could be generated by the plantations, as well as that the design of the project and its commercialization strategy[120]. As result of the Special Cooperation Agreement N° 000036/99, forest areas allowed the delimitation of the forest potential under the administration of CORMAGDALENA, and at the same time, to prioritize the forest nucleus Magdalena Bajo Seco as the biggest potential site to be reforested. Furthermore, the environmental offer and the potential of Carbon sequestration were analyzed by the project, as well as the requirements for the implementation of the project to the Clean Development Mechanism.
2000	During the formulation phase of the project's activity, CORMAGDALENA elaborated respective basics studies, which were summarized in a document called: card "BPIN", this according to the normal procedure established for projects from entities like CORMAGDALENA These studies produced for the development of the Project, allowed alternatives to CORMAGDALENA to be identified along with indispensable factors necessary for the success of each one of these alternatives. As a result CORMAGDALENA chose to create a commercial reforestation program based on an associative and participative model (see section A.2) Also with these studies was defined the objective to participate in the CDM mechanism to offer environmental services of CO2 sink from plantations and in this way obtain incomes from the forest carbon's sale, as the critical factor to achieved the successful of the commercial reforestation program based on an associative and participative model. This is because only having within the project objectives, the CDM objective, be achieved in fact, developing a proposed reforestation of high impact and acceptance in the region, through which the project may plant a forest area of significant scale[121]. In this context, CORMAGDALENA started to develop the project activity in the nucleus Magdalena Bajo Seco, within the "Clean Development Mechanism" (CDM) of the Protocol of Kyoto. The purpose of the project activity was to promote and co-finance a project of reforestation of the commercial forest, focused on the diversity of the use of soil in areas historically dedicated and transformed into extensive cattle grazing activity. The project followed a dynamic and an adaptable strategy in the implementation of an action program for the CDM. So it could meet the conditions and requirements at an international level, towards the implementation of forest projects to the CDM

[119] CORMAGDALENA, 1999. Convenio especial de cooperación N° 000036/99. See Considerandos Literal c)

[120] CORMAGDALENA, 1999. Op. Cit. See CLÁUSULA SEGUNDA. ALCANCE DEL OBJETO, Numeral 2.3. Literal d)

[121] CORMAGDALENA, 2000a. Resumen Ficha BPIN Convenio especial de cooperación N° 000058/00

Period	Activity by the Project Participant
2000	In general, in Colombia and even more so in the project zone, there is no forest culture and the land owners confront great uncertainty and fear concerning the future (because of the institutional, economic and physical insecurity). Moreover, as we explained earlier, in the project region, land owners are historically and traditionally livestock farmers, with an livestock farmer culture, extensive and low tech. For these reasons, the landowners were neither prepared nor capable of making a long term investment in their land, as it was required for forest activities[122]. In this context, also from a land owner's point of view, just like for CORMAGDALENA, the objective to participate in the CDM mechanism to offer environmental services of CO_2 sink from plantations and in this way obtain incomes from the forest carbon's sale, was a critical factor, that made them make the decision to participate in the project proposal[123] [124].
2000	As explained above, CORMAGDALENA and the land owners, since the beginning have a clear objective and commitment to participate in the CDM mechanism to offer to the international community environmental services of CO_2 sink from plantations and in this way obtain incomes from the forest carbon's sale. To confirm this objective and commitment, it was decided to made investment and carry out the first study on carbon capture with SGS. This in spite of and also to clarify the great uncertainty that existed in this time concerning definitions and requirements to supply forest carbon from plantation and even more in the CDM context. In 2000, the study with SGS AGROCONTROL[125] was conducted, with the objective of making a first evaluation of the future potential and the carbon capture certification of commercial reforestation schemes developed in the Cerro Grande farm (private reforestation) and in the La Gloria farm (first participant farm in the project activity).
August 2, 2000	Starting date of the project activity as the first planting activity takes place as part of the component Plantations stage 2000 – 2003

FINAGRO[126] and A.W FABER CASTELL & T.H REFORESTATION S.A.S[127], the investment partners that subsequently got involved in order to give continuity to the strategy of development and financing, anticipated for the implementation of the project (see section A.2). They both did it following the

[122] Cazaux, 2003. Op. Cit.

[123] CORMAGDALENA, 2000b. Carta de intención de propietarios para participar en el Proyecto de reforestación

[124] Tschampel. 2000. Cartas iniciativa Proyecto MDL Forestal. From the point of view of the land owners participating in the project proposal, these letters made highlight the perception and importance that since the beginning, carbon and its expected revenues has had.

[125] See CARBON OFFSET VERIFICATION. PRE – ASSESSMENT REPORT. SGS AGROCONTROL

[126] GÓMEZ, 2002. Documento de diseño Proyecto Forestal FINAGRO. Versión aprobada por la Junta Directiva de FINAGRO. Establecimiento y manejo de plantaciones silvopastoriles comerciales en los departamentos del Cesar, Magdalena y sur de la Guajira, como medio para reactivar sosteniblemente la economía regional. Pag 3.

[127] ONF Andina, 2010b. Base de datos de documentos tenencia y de contratos para los componentes forestal y carbono de la actividad de proyecto

innovating commercial reforestation model's principles settled out since the beginning for the project proposal.

Just like CORMAGDALENA and the land owners, when FINAGRO[128] and A.W FABER CASTELL & T.H. REFORESTATION S.A.S[129] they went into the project. They also had the objective and commitment to participate in the CDM mechanism to offer to the international community environmental services of CO2 sink from plantations and in this way obtain incomes from the forest carbon's sale and this objective was the critical factor that made them to make the decision to participate in the project proposal.

Subsequently, up to the present date, many specific agreements and significant investments have been developed between the project associated entities in order to continue with all the institutional, technical, financial and other necessary activities, with the purpose of comply the objective and commitment to build, implement and turn into a real fact the CDM component of project activity.

Step 1: Identification of alternatives to the A/R project activity consistent with the current laws and regulations

Sub-step 1a: Define alternatives to the project activity.

A sound analysis of land use alternatives to the proposed A/R CDM project activity conducted in 2004[130] lists the following alternative scenarios presented in Table 24 and assesses the related levels of credibility.

Table 24. Alternative land uses to the project activity

N°	Alternative land uses to the project activity	Description	Credibility
1	Continuation of current land use	The traditional cattle ranching activity continues with managed and unmanaged pastures or fallows in early state of succession ('rastrojo bajo').	The analysis of the land uses and land use changes history in the project area clearly shows that this alternative is realistic (see section A-7 with the analysis of the main land uses and land use changes)
2	Reforestation not undertaken as an A/R CDM project activity	Reforestation activity are conducted on managed or unmanaged pastures without the CDM	Such an alternative is not realistic due to the existing barriers identified Step 3. Indeed, land use history over the project area (see section A-7) as well as the statistics of forest plantation in Colombia[131], clearly show that except from a few plantation projects conducted on the Colombian Caribbean Coast during the eighteen's

[128] GÓMEZ, 2002. Op. Cit. Pag 4, 7, 8, 11, 17

[129] AWFC, 2009. Certificado de existencia y representación legal A.W. FABER CASTELL & T.H. REFORESTATION S.A.S. See "Objeto social"

[130] Dufour, 2005. Op. Cit.

[131] IDEAM, 2009. Op. Cit.

N°	Alternative land uses to the project activity	Description	Credibility
			and nineteen's but in different conditions (see Step 4, Common practice analysis), there has been no reforestation at all over the project area before project start.
3	Palm oil culture	Cultures of oil palm trees	Oil palm plantations might be in the future a credible alternative scenario since Colombia has become the fourth provider of the world with the department of Magdalena being part of one of the fourth areas of production in the country, with the highest yields. However, all existing plantations are concentrated on the north of the department close to Santa Marta and not over the project area, which is remote from existing palm oil transformation units, with bad transportation network.

As a conclusion, it appears that the only land use alternative scenario to be realistic and credible is the continuation of pre-project land use, which means extensive cattle grazing with managed and unmanaged pasture or fallows in early state of succession ('rastrojo bajo').

Note that the natural change of fallows to forest (rastrojo alto) is not considered as a realistic and credible land use scenario for it may only occur under particular conditions and for a limited period of time (see section A.7 1(a) ii).

Sub-step 1b: Enforcement of applicable laws and regulations

Alternatives 1, 2 and 3 are consistent the enforced mandatory applicable laws and regulations.

1. Traditional cattle ranching is a legal activity, it complies with all national laws and regulations, and current legislation does not oblige landowners in the region to cease cattle grazing activities.

2. Reforestation activities are in line with the prevailing sector policy (section C.5.1, *Step 3*, c.).

3. Up to the present date, there are no restrictions regarding the palm oil crops. However, the IDEAM and the Ministry of Environment of Colombia are currently carrying out a study to identify the appropriate areas, in order to establish the plantations of palm oil trees in Colombia, with the purpose of preventing the deforestation areas and the setting up of such plantations[132].

All the activities mentioned above correspond to the national laws and are part of the regional and national economic chain. Nevertheless, the most viable alternative is to continue with the extenseive cattle grazing activity (See C.5.1.). The circumstances related to the specific alternative do not allow their accurate implementation. Such circumstances are associated, for example, to the lack of infrastructure towards the establishment of palm oil tree plantations, inadequate conditions of soils, lack of technology for the agricultural production, lack of information about the forest activity, among others.

[132] Foro Nacional: Cambio Climático después de Copenhague. CORANTIOQUIA, abril 14 de 2010. Medellín.

In relation to the reforestation activity, a low investment has been observed towards the implementation of the forest by the private sector (see the section below C. 6, step 3: Barrier Analysis)

In turn, the national government has proposed economical sources in order to promote the forest activity, as the Certificate of Forest Incentive (CFI). This incentive has not been widely accepted in the region as it has difficulties to be implemented. Therefore, the cattle grazing prevails over the other uses of soil with low motivation compared to other activities which require higher technical requirements.

The alternatives such as the reforestation are not considered an activity that generates the same economical benefits that cattle grazing activity produce. This situation does not promote the reforestation establishment in the region. In the project zone, only some reforestation activities have been observed within the CDM, which makes more attractive the change in the use of soil.

Sub-step 1c: Selection of the baseline scenario

AR-AM004 provides a step-wise approach justifying the selection and determination of the most plausible baseline scenario, resulting in the analysis documented in section C.5.1.

Step 2: Investment analysis

n/a

Step 3: Barrier analysis

Sub-step 3a: Identify barriers that would prevent the implementation of type of the proposed project activity

Institutional barriers

- Limited effects of governmental policy to stimulate plantations

Colombia has some 25 million hectares with soils suited to forestry, however, the forest plantation statistics of the country, recently built, highlight the fact that throughout all the history of reforestation of the country, for 2007 the total forest plantation area barely reach 303.466 hectares in all country[133].

The forest activity clearly has an important role for the interests of the state, given its wide regulations, plans and promotion programs (See Table 18 and Table 19). Nevertheless, the above statistics demonstrate the fact that historically these measures have lacked of leadership and effectiveness to promote the forest plantation and strengthen the development of the sector as a promising economical activity.

- Risks related to regulatory schemes and changes in government policies or laws

In Colombia, the legislation of the forest sector is wide but not clear. The regulations are based on a legislation, which has limited the development and strength of its institutional character, an adequate

[133] IDEAM, 2009. Op. Cit.

operating capacity, specific responsibilities and participants. In general, a mechanism that involves all the participants, mainly, the entities in charge of the administration of resources has not been created (Rivera y Moreno, 2002)[134].

As a result, there is in the country an lack of a institutional character, lack of a state policy and a clear and stable legislation for the forestry sector, which has led his stagnation[135].

For all this, there is a general recognition of the need of revising these laws, with the purpose of issuing a General Forest Law. It is expected that this regulation gather, simplify and plan the forest legislation towards the current social-economical context and the future of the country, in order to establish clear rules in the sustainable administration of natural forest and plantations, commercial as well as protecting ones[136]. However, up to the present date, has not been possible to reconcile all positions for issuing this law, nor has it been possible to define a unified structure of regulation for the forestry sector in Colombia.

Taking into account the above circumstances, at country level is expected that the promotion on the development of forest projects under the CDM, contribute to the organization and structure of the forest sector in Colombia. It is also expected, that the incentives produced by the sale of CERs, contribute to the increase in the participation of the sector in the GDP, which can play a more active role in the economy of the country.

At level of all participant of the project activity, the objective and commitment to participate in the CDM mechanism to offer environmental services of CO2 sink from plantations and in this way obtain incomes from the forest carbon's sale (see Table 23), allowed the design and the consolidation of an institutional structure in the framework of the project proposal.

This fact is demonstrated with the project proposal itself (see section A.2); which managed to gather and coordinate the owners of the three means of production essential for a commercial reforestation aimed at producing goods and services to be distributed among partners according to their contributions.

Therefore, the project wouldn't have been implemented without the objective and commitment with CDM of all his partners, and accordingly, the institutional barriers that exist, are an objective to overcome with CDM during the execution of the project.

Technological barriers

- Lack of access to planting materials and lack of technology

In Colombia, progress in investigations related to the basic and applied forest research has been slow, intermittent and with scattered results. They have failed to reach the bulk of the populations living in areas of forestry potential[137]. Consequently, the transfer of new technology for forestry has been

[134] Rivera y Moreno, 2002. Op. Cit.

[135] Acosta, 2004. Op. Cit.

[136] Becerra, 2004b. "Presente y futuro de los bosques en Colombia: bases conceptuales para el debate", Conferencia Internacional de Bosques, Colombia País de Bosques y Vida. Santa Marta, Colombia 18 – 20 Noviembre 2.003.

[137] Acosta, I. 2004. Estudio de tendencias y perspectivas del sector forestal en América Latina, Documento de Trabajo. Informe Nacional Colombia. Corporación nacional de investigación y fomento forestal (CONIF)-

minimal[138]. The solution to this problem when starting the project was not given because the state entities, as a result of the lack of forestry research development, lacked the elements neither the best quality of plant material for the access of this material to the remote rural populations and get the establishment of the forests with good conditions. Even today, there are no technological packages of commercial native species that can be implemented individually by the rural people under a system of commercial plantation of forestry production. This has frustrated the development of activities of the forest community in the region of Magdalena Bajo Seco.

In 2000, there were already counted in Colombia with four research institutes and three universities with forestry engineering programs contributing to research the development and promotion of reforestation in Colombia. However, these research centers are concentrated in the Andean region and southern Colombia, and none of them in northern Colombia (Project Region). This is an aspect that has limited the access to appropriate technologies in the project area and has not allowed the establishment of the infrastructure to develop commercial forestry activities[139].

The above situation has been documented in the Forest Development Plan created in 2000. This paper describes, from the technological, as the development of forestry models of several species researched in advance for major private enterprises related to forestry activities in Colombia, which have not been transmitted this knowledge to rural populations for local implementation. Furthermore, it highlights how there has been inadequate the support of populations of marginal areas to the development of community forestry projects[140].

- Lack of infrastructure for implementation of the technology

Among others, the road infrastructure is highlighted as a factor that has influenced against the development of forestry potential of the country: by one hand, navigability of the rivers close to the forest resource is not adequate nor there are any downriver consumption centers; by other hand, by the lack of roads or railways. Under the very small to nonexistent research on regional cost structures in the forest industry, CONIF estimated the cost of transport is between 10% and 30% of the value of the wood. In the Colombian market a large percentage of the wood is transported by road. This is a negative factor because the high costs of transportation[141] and a limiting factor for the implementation of forestry projects in marginal areas as is the region of Magdalena Bajo Seco.

Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO). http://www.fao.org/docrep/007/j4192s/j4192s00.htm#TopOfPage

[138] Acosta, 2006. Op. Cit.

[139] MINAMBIENTE, 2000. Plan nacional de desarrollo forestal Ministerio del medio ambiente, ministerio de comercio exterior, ministerio de desarrollo económico, departamento nacional de planeación, ministerio de agricultura y desarrollo rural, 42 p.

[140] MINAMBIENTE, 2000. Op. Cit.

[141] FAO y CONIF, 2005. Análisis de las principales fuerzas impulsoras que influyen en el desarrollo del sector forestal colombiano. En: Estudio de tendencias y perspectivas del sector forestal en América Latina, Documento de Trabajo. Informe Nacional Colombia. Corporación nacional de investigación y fomento forestal (CONIF), Organización de las Naciones Unidas para la Agricultura y la Alimentación.

However, the Regulatory Decree 1735 of 2001[142] provides high economic investments for the adaptation and improvement of existing national highway network and the creation of the Colombian central corridor for the integration with others neighboring countries. Therefore, it is remarkable that there is not yet an investment strategy for upgrading and building of new roads outside the areas of population centers. This affects the implementation of productive activities that require better rural roads for a better development, as is the case of forestry activities in the region of Magdalena Bajo Seco. In this region only ranching activities have overcome this limitation, given the easy mobility of their products to nearby points of marketing

- Nature of partners of the project proposal

Following is a summary of the nature of the project partners that involved in the project proposal with the objective and commitment to the CDM (see Table 23). This information allows to demonstrate the existing technological barriers according to the recommendations of the EB 50 Annex 13[143], because this it is proof that the partners do not have “the associative commercial reforestation” in its “reason to exist” or “social reason” and neither in their experience.

At local level, at landowners level:

The project, within the activities of research and promotion of reforestation in the region, conducted a survey among farmers and potential participants. As a result of this survey it was determined that some of the factors that prevent the development of forestry projects are: the lack of information that livestock farmers have in relation to the market of wood, the lack of forest culture, lack of general knowledge techniques for planting trees on a commercial level, among others (Cazaux, 2003[144]).

In addition, it has been saw the refusal of those owners to carry out forestry activities due to bad experiences at the individual level, or because the landowners have know or heard about the poorly technical management of forestry projects in Colombia (Cazaux, 2003 p.62[145]).

At the level of the involved institutions of the project proposal:

- CORMAGDALENA is a commercial and industrial state company, created through the article 331 of the National Political Constitution of 199[146] and organized by Law 161 of 1994[147]. In these documents, it will become evident that inside its specific functions, forest activity is not stipulated. Moreover, before getting involved in this project proposal, CORMAGDALENA had neither worked nor had experience in similar projects.
- FINAGRO is a mixed economy society from national order, organized as a credit establishment, linked to the Agriculture Minister, with own patrimony and administrative autonomy, constituted

[142] Colombia, 2001. Decreto 1735 de 2001.

[143] http://cdm.unfccc.int/EB/050/eb50_repan13.pdf

[144] Cazaux, 2003. Op. Cit.

[145] Cazaux, 2003. Op. Cit.

[146] República de Colombia, 1991. Artículo 331 de la Constitución Política Nacional

[147] República de Colombia, 1994. Ley 161 de 1994

by the Law 16 of 1990[148] and regulated by the decree 312 of 1991[149]. In these documents, it will become evident that inside its specific functions, forest activity was not stipulated. Moreover, before getting involved in this project proposal, FINAGRO had neither worked nor had experience in similar projects.

- A.W. FABER CASTELL & T.H. REFORESTATION S.A.S, is a private company formed to continue funding and conducting from 2009 commercial reforestation activities under the project activity. That is to say that this company was created already within the framework and as a consequence of the project proposal.

Commercial forestry activities are developed in a long time horizon during which it must have the technical and adequate support to provide continuity and ensure the success of the project. That is, technological barriers described faced throughout the forest cycle.

In this order of ideas, although the entities committed to the objectives and commitments of the CDM have been able to start setting activities, there are still today areas to be planted by the landowners (see Table 1); besides maintenance and harvesting activities required in the plantations established. It identifies and highlights the need for work and training on topics such as plant diseases, pest control, inventories and monitoring carbon stocks, production, harvesting, marketing of goods and services, among others.

At level of all participant of the project activity, the objective and commitment to participate in the CDM mechanism to offer to the international community environmental services of CO2 sink from plantations and in this way obtain incomes from the forest carbon's sale (see Table 23), allowed to include "knowledge" in the project proposal's framework, as a compulsory means of production for its development. In this way, the existing technological barriers are a goal to overcome with the CDM during the project implementation.

This fact was demonstrated with the project proposal itself (see section A.2), which managed to incorporate, from the beginning and in each phase, to an entity in charge of technical assistance and technology transfer[150], to such a point that the project activity framework, in the last phase 2009 – 2013, a company can be created to do this, A.W. FABER CASTELL & T.H. REFORESTATION S.A.S.

Barriers related to local tradition

Despite counting with institutions focused to the forest research, Colombia has research budget limitations that influence considerably the forest development results[151]. For example, the case of CONIF, that although being a nonprofit private corporation, focused on research and knowledge development, to impulse the productive forest development, hasn't reached its objective. After 27 years working, this entity shows the same historic financial limitations to perform long term research strategic projects and its

[148] República de Colombia, 1990. Ley 16 de 1990

[149] República de Colombia, 1991b. Decreto 312 de 1991

[150] For example, see CORMAGDALENA, 1999. Op. Cit.

[151] FAO, 2005. Análisis de las principales fuerzas impulsoras que influyen en el desarrollo del sector forestal colombiano. En: Estudio de tendencias y perspectivas del sector forestal en América Latina, Documento de Trabajo. Informe Nacional Colombia. Corporación nacional de investigación y fomento forestal (CONIF), Organización de las Naciones Unidas para la Agricultura y la Alimentación.

limited human resource doesn't have the specialized professionals required and less for the promotion and encouragement in marginal rural areas[152].

In this context, the main factors affecting the qualified forest research development in Colombia are[153, 154]:

- Lack of forest research adequate infrastructure, modern ways to perform it and economic resources to support it and give it the required continuity.
- Dispersion of the few resources and the dispersion of the executors of the research
- Lack of a forest research plan according to national priorities and lack of research statal politics
- Limited human resources research dedicated
- Insufficient resources to perform high level research
- Limited information and limited diffusion ways
- Low forest development for the research encouragement in different technical fields
- Lag in training and formation opportunities in forestal knowledge

The previous facts, without doubt, have been limiting the establishment of commercial plantations in Colombia and in the project region since the beginning of the project activity. All shows that this bad situation in terms of research for forest projects establishment, it has maintained in time, as reflected by the results reported by Aldana in 2004[155].

It must be highlighted that the forest projects face mainly risks related with plagues and forest pathologies. Such risks don't show up at the beginning nor when the trees are just planted, they show up during all the plantation life horizon. Moreover, the available information must be adapted to the specific and particular conditions of a determined forest mass growing in the environment. There are few forest phytopathologists in Colombia, being this a highly specialized area. This flaw has been related with the lack of market for the pathologists, because there are no plantations with large areas requiring them[156].

Specifically, in the project region, the degradation and dryness conditions lead to desertification, making the soil more acid and less productive (see cap. A). Therefore, it is necessary to develop the adapted species knowledge to the adverse conditions. In regions near the project areas, very few reforestations have been carried out and all of them have been made for private enterprise, so these enterprises have achieved to some extent overcome the technical difficulties to develop the forest activity (see step 4: Common practice analysis). However, this development hasn't been transmitted to the region and hasn't been implemented in marginal zones, like is the project zone.

At level of all participant of the project activity, the objective and commitment to participate in the CDM mechanism to offer to the international community environmental services of CO2 sink from plantations and in this way obtain incomes from the forest carbon's sale (see Table 23), allows the implementation of

[152] Acosta, I. 2004. Estudio de tendencias y perspectivas del sector forestal en América Latina, Documento de Trabajo. Informe Nacional Colombia. Corporación nacional de investigación y fomento forestal (CONIF)-Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO). http://www.fao.org/docrep/007/j4192s/j4192s00.htm#TopOfPage

[153] Aldana, 2004. Sector forestal Colombiano; fuente de vida, trabajo y bienestar. Serie de documentación no. 50. Corporación Nacional de Investigación y Fomento Forestal (CONIF), Bogotá.

[154] FAO. 2002. Estado de la Información Forestal en Colombia. 252 pág.

[155] Aldana, 2004. Op. Cit.

[156] FAO. 2002. Op. Cit.

some practices during all the plantation life horizon, as: artificial lakes building, technical assistance provision, training, provision of specialized machinery for the improvement of roads, use of seeds and improved characteristics seedlings to be adapted to the adverse conditions of the region, development of plans against plagues and forest fires and the creation of a permanent monitoring system of all the technical facts affecting the plantation right development through its life.

Nonetheless, all the mentioned above requires continuous training, development and updating of the people and landowners involved in the project, during all the life of the project. Accordingly, the barriers related to local tradition that exist, are an objective to overcome with the CDM during the project implementation.

Barriers due to prevailing practice

Currently the basic agro-ecosystem, in general terms, is the dominant ecosystem of the project area and is characterized by the combination of extensive cattle grazing and agricultural activities. The cattle grazing activities are dominant in the region (see section A.5.1).

The uncertainties regarding the lack of forest culture in Colombia, plus a fear towards the future (institutional, economical and physical insecurity), discourage the livestock farmers in making long-term investments to their lands, as required for forest activity[157].

The forest plantation statistics of the country demonstrate the fact that historically these measures have lacked of leadership and effectiveness to promote the forest plantation and strengthen the development of the sector as a promising economical activity (see above Institutional barriers).

According to IDEAM 2009[158], after analyzing the development of all forest plantations in the country, it is a fact that it has been implemented by just four actors and under very specific modalities, these are:

- CIF: Certificate of Forest Incentive, which is a partial governmental subsidy to natural or legal persons to encourage the establishment and maintenance of commercial forest plantations up to the fifth year of age. Created under Law 134 of 1994 (see Table 19), it began operating in 1995 and despite government targets until to 2007 had barely managed the planting of 114.284 Ha, of which only 6.087 hectares were planted throughout the Magdalena department, which in only its 15 riverside municipalities to Magdalena river, already have a large area of 695,108 hectares suitable for forestry.

- KfW Program: Program of Cooperation between Colombia and the German Bank KfW with the purpose of a protection - productive forestry in coffee producing areas in the Santander, Caldas, Tolima, Huila, Cundinamarca, Antioquia, Risaralda and Cauca departments. This program began in 1998 and until 2008 were established 25.622 hectares with the participation of coffee-crop owners exclusively.

- CAR: Primarily protective reforestation programs, developed by the Autonomous Regional Corporations (CAR) in lands under their administration or in state-owned lands. CAR´s are

[157] Cazaux, 2003. Op. Cit. Pag 62.

[158] IDEAM, 2009. Op. Cit.

public entities mandated by law to administrate and protect the environment and renewable natural resources in their jurisdiction area and they strive for a sustainable development. For the period 1975 – 2007 these programs were established with 105.415 hectares in several departments of the country but none in the department of Magdalena.

- Reforestation by private enterprises: Commercial reforestation from private enterprises in their own lands. For the period 1990 – 2007, were established 58,145 hectares[159] under this scheme in several departments of the country. From these, only 14,500 hectares were established by enterprises in the Colombian Caribbean savannas sub-region. All these before the year 2000 and different conditions and outside the six municipalities where the project proposal is in develop (see Step 4: Common practice analysis).

According to the previous information, for the beginning of the project (2000):

- The project activity was the first project in Colombia to be undertaken with the direct involvement of livestock farmers using their land

- The project activity is the first project in Colombia which joining in the same project the investors, the forest knowledge and the livestock landowners with the objective and compromise of developing a CDM project of commercial reforestation. This means that the project activity is the first CDM project of commercial reforestation in the country based on an associative and participative model

- Even nowadays, ten years after the start of the project, no other similar project is being developed in Colombia, because of this the project's continuity and their internal and external risks are even high

- Because of the pioneer and demonstrative character of the project activity, the incompliance of the CDM project objectives and compromises, will cause a huge negative impact on all the actors interested in participate eventually in this kind of forestal projects CDM.

It is concluded that the proposed A/R CDM project activity is undoubtedly a "first of its kind" since it started, there was no similar reforestation activity on the Caribbean Colombian Coast (except from a few projects of private companies, and therefore a different kind, see below step 4), and there was no A/R CDM project activity already registered or proposed in the country.

In this context, for the livestock landowners, the objective and commitment to participate in the CDM mechanism to offer to the international community environmental services of CO2 sink from plantations and in this way obtain incomes from the forest carbon's sale (see Table 23), will allow them in the future to obtain: short term incomes, improve cash flow and diversify the possible revenues from classical reforestation activity. All this, allows going beyond the high risk of the forest business[160].

[159] According to the same IDEAM, 2009, the statistics of reforestation by private enterprises should be reviewed, as they may have planted 3.901 hectares more under this modality

[160] Cazaux, 2003. Op. Cit.

Therefore the project wouldn't have been implemented without the objective and commitment with CDM of the livestock landowners, and accordingly, the barrier due to prevailing practice exiting is an objective to overcome with CDM during the execution of the project.

• Barrier due to social conditions

As widely detailed in the Section G.1., the project region corresponds to marginal zones far from village centers, which armed conflict in the 90's decade carried to the displacement of part of the population from their lands to urban areas[161;162]. Paradoxically, the criminal acts en Colombia can be explained by the desolation of some areas where the government does not have a permanent presence. In this way, one of the aspects that allow success in the cattle grazing activity en la region, is that it is not an activity that require the constant presence of staff; in contrast the reforestation project requires the permanent presence of population in rural areas.

A clear example of how the armed conflict affects the rural activities in Colombia and specifically in the project region, is the loss of some plantations made inside of this CDM project activity. In 2007, these plantations had to be abandoned and the technical assistance activities must be suspended, because of the impossibility to conduct field labors normally, due to pression of the groups outside the law[163].

Therefore, the armed conflict and the subsequent population displacement, don't allow the forestal activities to prosper: farmers can displace their cattle to more secured zones but it is not possible with trees. To the point that the armed conflict and the social insecurity issue in the country, have been identified as one of the basic factors that must be solved to draw more inversion and impulse effectively the forest sector development[164].

In the last decade (2000-2010), through the peace processes performed by the Colombian Government and cease-fire agreements in the region, the landowners have returned to their lands searching the economic activities reactivation. However, in absence of productive opportunities allowing the presence of the population in the rural area, the process of improving social conditions and returning to the lands hasn't been successful and the presence of armed groups continues[165].

[161] CIPCUM, *s.f.* Centro de Investigación para la Paz y la Convivencia, Universidad del Magdalena. http://cids.unimagdalena.edu.co/cipcum/subpages/justificacion.html

[162] Pérez y Trujillo, 2002. Reporte sobre el estado de la Región Caribe colombiana. Observatorio del Caribe Colombiano.

[163] In the municipality of Tenerife in 2007 for instance, 169 ha were lost, see internal project report: Programa de Reforestación Comercial – PRC – Magdalena bajo Contrato Finagro – Cormagdalena. 2007. Informe de pérdida de plantaciones PRC2006 Magdalena por causa de alteración del orden público.

[164] FAO, 2005. Análisis de las principales fuerzas impulsoras que influyen en el desarrollo del sector forestal colombiano. En: Estudio de tendencias y perspectivas del sector forestal en América Latina, Documento de Trabajo. Informe Nacional Colombia. Corporación nacional de investigación y fomento forestal (CONIF), Organización de las Naciones Unidas para la Agricultura y la Alimentación.

[165] Contreras, L. 2010. Dinámicas recientes del conflicto armado en el departamento del Magdalena. Observatorio Nacional de Paz. 10 pág.
http://www.observapaz.org/index.php?option=com_docman&task=cat_view&gid=35&Itemid=49&limitstart=10

The establishment of commercial plantations represents a great opportunity to fight against unemployment and the existing poverty levels in the rural areas of the country[166]. However, the fear of the landowners due to the lack of forest culture in the region, the ignorance about the forest products commercialization and the future of the land after harvesting the plantations (see Barriers due to prevailing practice and see Section H.2) generate uncertainty in the community to participate in this kind of projects.

The other hand, in the region, three types of landowners is identified: the owners of great land extensions, the medium-size landowners and the owners of small farms (Lenne, 2004). There are cultural as well as economical differences among them, which prevent from finding agreements in order to create unions and organizations that can represent them or represent a common interest. Besides, the social conditions have created a lack of interest towards the formation of these organizations.

Therefore, the incorporation of the forest CDM component and with it all the organizational infrastructure arising, achieve attract the community attention (see Section H.1). The landowners beginning to recognize that together with the productive proposal, there is the possibility to generate an environmental service: the carbon, get higher incomes, train their selves and associate.

The support of the committed entities with the project around the CDM, generated the propitious atmosphere and enough credibility to achieve that the landowners were step by step dedicating a portion of their land to the project proposal and become partners of it. Moreover, the project is in the position of representing the owners, in order to obtain the support of the institutions that take part or collaborate with project development.

Synthesizing, the project activity wouldn't have been carried out without the objective and commitment of all the partners with the CDM and only in long term the proposal success will contribute the social restructuration and improving of life quality in the zone, thus overcoming the barrier due to social conditions, due to characteristics of forest CDM, as[167]:

- The objective and commitment to participate in the CDM mechanism to offer environmental services of CO2 sink from plantations and in this way obtain incomes from the forest carbon's sale (see Table 23),
- Expectation and long term vision;
- Less vulnerability to the action of armed groups outlaw in comparison with livestock farming;
- The return and continued stay of the population to its land and the intensive utilization of labor compared to livestock farming.
- More employment opportunities in mid and long term even for the youngest,
- More income, from the sale of forest products and the carbon certificates
- Training in forest and carbon practices, involving the expansion of the knowledge in agricultural activities,
- Commitment of different private and public entities, allowing the generation of a organizational structure to promote and commercialize the project and its products

[166] FAO, 2005. Op. Cit.

[167] Cazaux, 2003. Op. Cit. Pag 79.

After the application of that '**AR additionality tool'**[168], the general and final conclusions are:

It is known that in 1999 and 2000, the CDM concept, especially Forest CDM, was not sufficiently clear. Nevertheless, at level of all participant of the project activity the objective and commitment to participate in the CDM mechanism to offer to the international community environmental services of CO2 sink from plantations, and in this way obtain incomes from the forest carbon's sale, was the critical and decisive factor to achieving the gathering and participation of the actors around the project proposal (see Table 23).

At the beginning of the project activity, that objective and commitment of all participants with the CDM, was what enabled to design a project proposal that includes all the necessary elements for effectively overcoming the barriers through the implementation of these elements during all the forest cycle. The barriers facing the project are: institutional barriers, technological barriers, barriers related to local tradition, barriers due to prevailing practice and barriers due to social conditions (see Step 3: Barrier analysis).

The existing barriers in the Project region are so significant that, today, 10 years after the starting date of the project activity, there are no similar projects and no business or landowners making significant forest investments outside of the forest CDM framework (see above barriers due to prevailing practice, and see below Step 4: Common practice analysis).

Consequently the registration and the development of the activity of the Project as CDM besides allow overcoming the existing barriers, also is the only way to the project activity for:

- Reducing the risks of the project activity, by providing a more steady, and guaranteed (fixed purchase price of CO2) income stream that makes the project more independent from timber market risks and the risks associated with long transport distances from timber markets

- Generate the CDM incomes which are expected since the beginning of the project activity due to forest carbon selling (see Table 23). Those CDM incomes jointed with the incomes from wood selling, will be used by the landowners of phase 2000-2003, for pay their debts with CORMAGDALENA due the investments of the project activity for planting and maintenance up to the second year of the plantations in their properties[169]

- Continuity of FABER CASTELL & T.H. REFORESTATION S.A.S, as investment enterprise's of the project activity. This enterprise was recently formed in 2009 in framework of the project proposal, specifically with the "reason to exist" or "social reason" of obtaining incomes from the sale of carbon of plantations through the CDM[170], and also this enterprise is linked as the "essential means" for continue planting and giving continuity to the project activity according with the initial strategy of development and financing (see section A.2)

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[168] 'Tool for the demonstration and assessment of additionality in A/R CDM project activities' (EB 35 report, annex 17) of the CDM Executive Board, http://cdm.unfccc.int/Reference/Guidclarif/

[169] CONIF, 2000. Convenio Especial de Cooperación para la ejecución de un Proyecto de transferencia y de adopción de tecnología de reforestación bajo la modalidad protectora - productora en los municipios ribereños del Río Magdalena del 2 de agosto de 2000. See CLAUSULA CUARTA

[170] AWFC, 2009. Op. Cit.

- The fulfillment of contracts signed between ONFI and each of the partners in order to develop the carbon component of the project and consequently generate the CDM incomes which are expected since the beginning of the project activity due to forest carbon selling (see section A.6). Thus, finally the project activity will be able to comply to all its participants with the initial objectives and commitment of CDM, which it also was the initial decisive factor for participating in it (see Table 23).

- Keep training to the landowners and the others partners of the project in the foresting and forest themes like these: planting, maintenance, harvesting, production and marketing of goods and services forest. And also keep training all the project partners on carbon themes like these: carbon monitoring, verification, certification, trading, and carbon project development in general.

- Landowners to keep learning and transmitting the forest and carbon knowledge, and the others lessons learned from the project. This way of “learning by doing” and the knowledge transfer to their neighbors will help to overcome all barriers that the project faced since the beginning and still is facing.

- Attract more participants of local, regional, national and international public and private sectors to develop this type of forestry projects and carbon finance activities. This is because the project activity is "first of this kind" (see above Barriers due to Prevailing practice) and their positive or negative results have a decisive and demonstrative effect on the perception of the real feasibility of achieving successful development of type of projects[171].

Sub-step 3b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The only activity that does not face the barriers identified is the continuation of baseline activities. The comparison between the reforestation activities with and without the CDM demonstrates that the CDM helps to overcome barriers and implement reforestation activities, which would not have happened in the absence of the CDM.

Step 4: ***Common practice analysis***

As explain above Colombia has some 25 million hectares with soils suited to forestry, however, the forest plantation statistics of the country, recently built, highlight the fact that throughout all the history of reforestation of the country, for 2007 the total forest plantation area barely reach 303.466 hectares in all country[172]. The analysis of common practice presented here, was conducted for the sub-region Colombian Caribbean savannas, which is the area where the project is developed (see section A.2).

From 303.466 hectares mentioned above, only 14.500 hectares were established by enterprises in the Colombian Caribbean savannas sub-region. All these before the year 2000 and different conditions and

[171] FEDEMADERAS, 2010. Mitos y realidades de los proyectos forestales en el mercado de carbono. Revista FEDEMADERAS, Agosto de 2010. Edición 015, Bogotá D.C. ISSN -1909-0242.

[172] IDEAM, 2009. Op. Cit.

outside the six municipalities where the project proposal is in develop (see above Table 25), according to the detailed explanation presented below:

The project area was largely deforested decades ago and changed to pastures, with only a few fragments of natural forest remaining from the original vegetal coverage (see section A.2).

Before the proposed A/R CDM project start, there was no reforestation activity in the six municipalities where the project takes place and only a few reforestation projects in all the related ecological region of Colombian Caribbean savannas. These few pre-existing projects were designed and implemented in different conditions:

In 1974, the Decree 2053/74, "Tax regime on return" came into force, which rewarded reforestation activities with tax benefits for the financing company (see also section C.5.1, Step 3 c) legislation related to the requirements of A/R activities and land use). The tax benefits consisted in a deduction of investments in reforestation up to 20% of the company's tax on taxable income.

As a result, three major companies started to engage in reforestation activities on the lands they owned in the region or had acquired for this purpose[173] (Table 25):

Table 25. List of reforestation activities in the region of the common practice analysis under-taken without the consideration of CDM

Date of establishment of plantation	***Localization***	***Owner of land/entities involved***	***Species***	***Area (ha)***	***Assessment as common practice***
1981 – 1999	Municipality of Zambrano (Department of Magdalena)	Pizano S.A.	*Pachira quinata Gmelina arborea*	8,800	No common practice due to dramatic changes in the corporative context as a consequence of the economic crisis in the late 1990-ies
1983 ~ 2000	Municipality of Monterrubio, (Department of Magdalena	Reforestadora de la Costa/Bavaria (Brewery)	*Tectona grandis*	3,000	
1982 ~ 2000	Municipalities of San Sebastián and San Zenón (Department of Magdalena)	Reforestadora San Se-bastián/ Grupo Corona (Ceramics)	*Eucalyptus sp.*	2,700	

Due to the prevailing economic crisis at the end of the 1990, all these reforestation activities were stopped because of severe economic problems of the investing companies and due to the fact that the planting schedules had been accomplished. In one case, these economic problems forced the company PIZANO S.A to enter a financial adjustment scheme (Ley 550/00; "Chapter 11") to avoid bankruptcy. As a consequence, the company will have to use its income to serve the debts including taxes until the year 2018. Therefore, its access to own financial resources to be invested in reforestation activities has been

[173] IDEAM, 2009. Op. Cit.

very limited; in addition, no taxable income has been and will be generated, from which potential investments in reforestation could be deducted[174].

The company Reforestadora de la Costa, REFOCOSTA, was sold to South African owners and subdivided; the company that obtained the ownership of these plantations is an investment company with comparably less taxable income and no interest in continuing an activity that it does not considered its core business[175].

The third company went bankrupt, transferring the ownership of its plantation to the Universidad National to benefit from a deferral of taxes, which can be achieved with such donations to institutions for research and development[176]. The ownership of the production plants was transferred to the workers.

Concluding, the plantations listed in Table 25 were established under different socio-economic conditions. The current prevailing corporate context does not allow considering the reforestation activities listed in Table 25 as common practice:

a) As a consequence of the economic crisis, none of the three companies originally involved in reforestation activities in the region has financial resources available to be invested in reforestation activities; this makes this scheme to stimulate reforestation activities virtually powerless (see above detail about the situation of companies).

b) Reforestation is not considered a core business of potentially interested companies; the absence of a crediting lines from banks for reforestation activities and long pay back times constitute additional burdens (Análisis del Mercado Crediticio para el Sector Forest Colombiano, developed by Juan Manuel Soto (CONIF 2002), cited by Acosta, 2004[177]).

Besides, Ministry of Agriculture (2005)[178] has concluded that the majority of wood and wood product's, are derived from exploitation of natural forests, given that commercial reforestation is not economically attractive and is not consolidated as a profitable activity. This is attributed to: the very low level of economic activity in the commercial forest sector is effect to several factors that include low rates of return, the high number of intermediaries, the long production cycle, the long periods between cash flow disbursements. As well the high concentration of costs in the first years of production and the long wait for economic returns, difficulties in obtaining credit for this type of activity, and the inflexibility in the use of land.

[174] B&R, 2007. Tablemac S.A: Una operación más rentable, pero incorporada en el precio de la acción. Investigación acciones Latinoamérica – Colombia sector madera. B&R Bolsa y Renta S.A Comisionista de bolsa. Noviembre 26 de 2007. Pag 11

[175] Camacho *s.f.* Colombianos quedarán en junta directiva de SABMiller. Portal Digital El Colombiano. En línea: http://www.elcolombiano.com/BancoConocimiento/C/colombianos_quedaran_en_junta_directiva_de_sabmiller/colombianos_quedaran_en_junta_directiva_de_sabmiller.asp

[176] Based on a law on science and technology

[177] Acosta, 2004. Op.Cit.

[178] Ministerio de Agricultura y Desarrollo Rural, 2005. "Características y estructura del sector Forestal-Madera-Muebles en Colombia. Una Mirada Global de su Estructura y Dinámica 1991-2005". Pag. 32, 34

c) No potentially interested medium to large company owns lands in the region, for which such a scheme could be interesting. After analyzing the dynamics of commercial reforestation in Colombia, the Ministry of Agriculture (2005)[179] has concluded that the reforestation process began at a very low level in the 40's. Then the activity had its peak in the 70's and 80 (in response to some big economic groups who were interested in "Tax regime on return"), but finally the activity fell by not responding to the expectations of producers.

Since the beginning of the proposed A/R CDM project activity in 2000, all the reforestation activities in the sub- region Colombian Caribbean savannas have been implemented under the CDM. As mentioned before (see Section C.2) in 2003 started another A/R CDM project activity and is currently under phase of validation in the same region (Colombian Caribbean savanna), but project boundaries for both projects do not overlap.

C.7. Estimation of the *ex ante* baseline net GHG removals by sinks:

As per the conditions under which the proposed methodology is applicable, lands to be afforested or reforested are degraded lands, either abandoned or subjected to pre-project grazing activity or agricultural crop activity, with vegetation having area, crown cover and tree high values below the thresholds used in the national definition of forest, and the lands are still degrading or remaining in a low carbon steady state.

(a) No growing trees or woody perennials exist; and
(b) No trees or other woody perennials will start to grow at any time during the crediting period; or
(c) No trees or other woody perennials will reach the threshold for the national definition of forest due to ongoing cutting and burning cycles that are part of shifting cultivation systems;

However, these conditions above are not met, due to baseline sceneries was found an average of 10 trees ha[180].

Pre-existing vegetation in the baseline strata

- **Non-woody vegetation**

To determine the carbon content/stock in the baseline sceneries of the Project, it was used the study of the baseline performed in the project area by Dufour (2005)[181], in the municipalities of El Piñón, Zapayán, Pedraza, Tenerife, Plato and Santa Bárbara de Pinto.

Dufour (2005), evaluated the carbon stock of the land cover found in the project area according to Corine Land Cover (CLC) classification adapted for Colombia. Between covers evaluated, it could be found:

[179] Ministerio de Agricultura y Desarrollo Rural, 2005. Op Cit.

[180] ONFA y C&B, 2010. Inventario de Árboles dispersos en los escenarios de línea base

[181] Dufour, 2005. Op. Cit.

Clean pastures, pastures with shrubs and fallows *(rastrojos)*. Now, considering that one of the patterns used for the Assessment of the eligibility of the project areas (Section A.7) was the CLC classification (and each vegetal compounds of these land covers), values from Dufour presented in 2005, are applicable to the baseline strata of the project correspondingly to the year its start (year 2000). That is, accordingly CLC definitions, baseline sceneries identified in the eligibility analysis correspond to the Dufour´s land covers surveys in the area for the project. Results founded by Dufour for baseline strata were are presented in Table 26:

Table 26. Aboveground biomass of pre-existing non-tree vegetation in baseline scenarios. $B_{pre,ik}$: Average pre-existing stock of non-tree pre-project biomass before the start of the proposed A/R CDM project activity for baseline stratum i (t d.m. ha^{-1}). AB: Aboveground biomass; BB: Belowground biomass, AC: Aboveground carbon; BC: Belowground carbon

Scenario	Biomass			Carbon		
	AB (t.d.m/ha) ($B_{pre,ik}$)	BB (t.d.m/ha)	**Total (t.d.m/ha)**	AC (tC/ha)	BC (tC/ha)	**Total (tC/ha)**
Clean pastures (*BS1*)	0.72	1.09	**1.81**	0.353	0.53	**0.89**
Pastures with shrubs (*BS2*)	14.09	3.09	**17.18**	6.90	6.41	**8.42**
fallows *(rastrojos)* (*BS3*)	18.17	3.32	**21.49**	8.90	1.63	**10.53**

Carbon Fraction: 0.49;

- **Scattered trees**

In this case, the carbon stock of scattered trees is estimated using the stock change method (Method 2), proposed in the AR-AM0004/Version 04.

$$C_{AB,ijt} = A_{ikt} \cdot nTR_{ijt} \cdot CF_J \cdot f_j\left(DBH_t, H_t\right) \quad \text{(Ecn 12 de ARAM004/V4)}$$

$C_{AB,ijt}$ = Carbon stock in the aboveground biomass for stratum *i*, species *j*, and time *t*; t C

A_{ikt} = Area of stratum *i*, tree stand model *k*, time *t*; ha

nTR_{ijt} = Number of trees per hectare in stratum *i*, species *j* and time *t*;

CF_j = Carbon fraction for the species.

$f_j(DBH_t, H_t)$ = Allometric equation

In order to determine the number of individuals (nTR*ijt*) and diameter chest-height (*DBH*), a 1 ha circle-parcels survey was developed in the area (see Annex 3: Baseline information). The allometric equations employed relates diameter with tree biomass and it was developed by tropical dry forest[182]. This survey found a population of 10 trees per ha[183] and, a biomass of 1.66 t.d.m./ha (Annex 3).

To get biomass estimations of scattered trees, default global values to tropical regions from IPCC (2003) were used, because local specific information was unavailable.

Following the procedures described in EB 46 Annex 16[184], *(Guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant)*, it was determined that the change in carbon stocks of live woody vegetation that exists within the project boundary prior to the project, and that would have occurred in the absence of this A/R CDM project activity, are insignificant and therefore shall be accounted for as zero.

(iii) Growth conditions are already, or are expected to become within 10 years (e.g., due to on-going land degradation), such that biomass in existing woody vegetation is expected to become static or to decline;

As demonstrated in section C.5.1, literal c): "*Historical and current land use has led to progressive degradation of the land*", developed by satellite images from 1984 and 2002, and section A.7, paragraph *1(a)*(*ii*), the traditional dynamics of use of land within the project's framework, determines the existence of low fallow pastures. These covers are found in early sucessional stages, which are cleaned for permanent pasture. Besides, the tendency shows that in the region, the areas of clean pastures, degraded lands and mosaic tend to increase, whereas the areas that eventually could start a sucessional process (pastures with shrubs and fallows) have a tendency to decrease (see Figure 17, section C.5.1). In addition, accordingly the land coverage map and the use of land of Colombia of 1995[185], lands of project area are identified as pastures and fallows *(rastrojos)* lands, for the use of distribution and rotation for cattle grazing.

Similarly, human pressure and recurrent extensive ranching activity, prevents the increasing of the contents of biomass in the baseline scenarios. The grassland areas are used for livestock and areas of stubble at some point be cleaned again to re-establish cattle grazing lands for pasture rotation. As most of forest lands have disappeared and fallows decreased drastically, landowners cannot deforest anymore. Therefore, they clean their pastures (cutting of pre-existing trees shrubs) more and more in order to increase space for cattle within existing pastures. Moreover, this practice is reinforced by the fact that trees in pastures have traditionally no value for project landowners, as they represent only some space that cannot be used for fodder production.

Finally, pastures can be transformed in mosaics of vegetation that represent a mix of grassland, small patches of fallows and crops, within less than one hectare. Mosaics of vegetation are usually observed among landowners with small area and diversifying their activities to optimize their incomes.

Therefore, as mentioned in Section C.5.1, none of the three baseline scenarios is possible to establish a natural succession processes, or that the biomass content increases. Then, the baseline net greenhouse gas

[182] Pearson1, S. Brown1 and N. H. Ravindranath. 2005. Integrating carbon benefit estimates into GEF projects. 64p.

[183] ONFA y C&B, 2010. Op. Cit

[184] Executive Board 46, Annex 16. Guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant. Annex 16 of the report of the Executive Board in its 46th session, UNFCCC.

[185] IGAC, 1995. Suelos de Colombia. Origen, evolución, clasificación, distribución y uso, 632p.

removals by sinks are expected to be negative due to ongoing degradation of the project areas and due to phases of slash and burn in fallows. For these strata the methodology conservatively assumes that baseline net greenhouse gas removals by sinks are zero (Table 27), according to equation 1 of the methodology:

C_{BSL} = 0 for all $t^* \leq t_{cp}$

Where:

C_{BSL} Baseline net greenhouse gas removals by sinks, tCO_2-e
t^* Number of years elapsed since the start of the A/R CDM project activity, yr
t_{cp} Year at which the first crediting period ends, yr

Table 27. Annual estimation of baseline net anthropogenic GHG removals by sinks

Please present final results of your calculations using the following tabular format.	
Year	**Annual estimation of baseline net anthropogenic GHG removals by sinks in tonnes of CO_2 e**
2000	0.00
2001	0.00
2002	0.00
2003	0.00
2004	0.00
2005	0.00
2006	0.00
2007	0.00
2008	0.00
2009	0.00
2010	0.00
2011	0.00
2012	0.00
2013	0.00
2014	0.00
2015	0.00
2016	0.00
2017	0.00
2018	0.00
2019	0.00
2020	0.00
2021	0.00
2022	0.00
2023	0.00
2024	0.00
2025	0.00
2026	0.00
2027	0.00
2028	0.00
2029	0.00
Total estimated baseline net GHG removals by sinks (tonnes of CO_2 e)	**0.00**

Please present final results of your calculations using the following tabular format.	
Year	**Annual estimation of baseline net anthropogenic GHG removals by sinks in tonnes of CO_2 e**
Total number of crediting years	**30**
Annual average over the crediting period of estimated baseline net GHG removals by sinks (tonnes of CO_2 e)	**0.00**

Table 28. Data needed for *ex ante* estimations

ID number[186]	Data variable	Data unit	Value applied	Data Source	Comment
C.7.1	Satellite image	Dimensionless		LandSat	
C.7.2	Landform map	Dimensionless		Local government	
C.7.3	Soil map	Dimensionless		Local government and institutional agencies (IGAC 1996)	
C.7.4	National and sectoral policies	Dimensionless			
C.7.5	UNFCCC decisions	Dimensionless		UNFCCC website	
C.7.13	$ERat_{CH4}$	Dimensionless	IPCC default emission ratio for CH4 (0.012)	IPCC. Global default	
C.7.14	MW_{CH4-C}	t CH4 $(t\ C)^{-1}$	Ratio of molecular weights of CH4 and C (16/12);	IPCC. Global default	
C.7.16	MW_{CO2-C}	t CO2 $(t\ C)^{-1}$	Ratio of molecular weights ofCO2 and C (44/12);	IPCC. Global default	
C.7.17	GWP_{CH4}	t CO2-e $(t\ CH4)^{-1}$	Global Warming Potential forCH4 (21 for the first commitment period);	IPCC. Global default	
C.7.19	A_i	ha	Area of stratum *i*	Estimated *ex ante*	
C.7.20	$A_{ij}t$	ha	Area of stratum *i*, species *j*, at time *t*	Estimated *ex ante*	
C.7.21	$A_{Remain\ ijt}$	ha	Area of the land-use type *j* that is expected to remain, in stratum *i*, between the year $t=tx$ and $t=tx+1$	Estimated *ex ante*	
C.7.22	$A_{Change\ ijt}$	ha	Area of the land-use type *j* that is expected to change, in stratum *i*, between the year $t=tx$ and $t=tx+1$	Estimated *ex ante*	
C.7.23	A_{ijT}	ha yr^{-1}	Average annual area for stratum *i*, species *j*, during the period *T*	Estimated *ex ante*	
C.7.25	$BEF_{2,,j}$	Dimensionless	GPG-LULUCF	GPG-LULUCF, national GHG	

[186] Please provide ID number for cross-referencing in the PDD.

ID number[186]	Data variable	Data unit	Value applied	Data Source	Comment
				inventory, local survey.	
C.7.26	B_i	t d.m. ha^{-1}	Average stock in aboveground living biomass before burning for stratum *i*	GPG-LULUCF, national GHG inventory, local survey	
C.7.27	$B_{non\text{-}tree,\ it}$	t d.m. ha^{-1}	Average non-tree biomass stock on land to be planted before the start of a proposed A/R CDM project activity for stratum *i*, time *t*	Estimated *ex ante*	
C.7.28	$B_{w,\ ijt}$	t d.m. ha^{-1}	Average above-ground biomass stock for stratum *i*, species *j*, time *t*	GPG-LULUCF, national GHG inventory, local survey	
C.7.29	$C_{AB,ijt}$	t C	Carbon stock in above-ground biomass for stratum *i*, species *j*, at time *t*	Calculated. Local and species specific.	
C.7.30	C_{ACTUAL}	t CO_2-e	Actual net greenhouse gas removals by sinks	Calculated. Project specific.	
C.7.31	$C_{BB,ijt}$	t C	Carbon stock in below-ground biomass for stratum *i*, species *j*, at time *t*	Calculated. Local and species specific	
C.7.35	*CE*	Dimensionless	Combustion efficiency (IPCC default =0.5)	IPCC GPG-2000, national GHG inventory. Global and national default	
C.7.36	CF_j	t C (t d.m)$^{-1}$	Carbon fraction of dry matter for species *j*	IPCC GPG-2000, national GHG inventory. Global and national default	
C.7.42	DBH_t	cm	Mean diameter at breast height at time *t*	Estimated	
C.7.44	D_j	t d.m. m^{-3}	Basic wood density for species *j*	GPG-LULUCF, national and local forest inventory, preferably investigated *ex post*	
C.7.46	$E_{BiomassBurn}$, *CH4*	t CO_2-e yr^{-1}	CH_4 emission from biomass burning in slash and burn	Calculated	
C.7.48	$E_{BiomassBurn,C}$	t C yr^{-1}	Loss of carbon stock in aboveground biomass due to slash and burn	Calculated	
C.7.49	$E_{biomassloss}$	t C yr^{-1}	Decrease in the carbon stock in the tree and non-tree living biomass, deadwood and litter carbon	Calculated	

ID number[186]	Data variable	Data unit	Value applied	Data Source	Comment
			pools of pre-existing vegetation in the year of site preparation up to time *t**		
C.7.53	$E_{Non\text{-}CO2,\ BiomassBurn\ t}$	t CO_2-e yr^{-1}	Non-CO2 emission as a result of biomass burning within the project boundary	GPG-2000, 2006IPCC Guideline, national GHG inventory	
C.7.58	FG_{ijt}	m^3 yr^{-1}	Annual volume of fuel wood harvesting of living trees for stratum *i*, species *j*, time *t*	Estimated *ex ante*, monitored *ex post*	
C.7.59	FG_{ijT}	m^3 ha^{-1} yr^{-1}	Average annual volume of fuel wood harvested for stratum *i*, species *j*, during the period *T*	Estimated *ex ante*, monitored *ex post*	
C.7.71	GHG_E	t CO_2-e yr^{-1}	GHG emissions as a result of the implementation of the A/R CDM project activity within the project boundary	Calculated	
C.7.75	H_{ijt}	m^3 ha^{-1} yr^{-1}	Annually extracted merchantable volume for stratum *i*, species *j*, time *t*	Estimated *ex ante*, monitored *ex post*	
C.7.76	H_{ijT}	m^3 ha^{-1} yr^{-1}	Average annual net increment in merchantable volume for stratum *i*, species *j* during the period *T*	Estimated *ex ante*, monitored *ex post*	
C.7.77	H_t	m	Mean tree height at time *t*	Estimated *ex ante*, monitored *ex post*	
C.7.78	*i*	Dimensionless	1, 2, 3, … *mBL* baseline strata	Estimated *ex ante*, monitored *ex post*	
C.7.79	$I_{v,ij}$	m^3 ha^{-1} yr^{-1}	Average annual increment in merchantable volume for stratum *i* species *j*	Estimated *ex ante*	
C.7.80	$I_{v,ijT}$	m^3 ha^{-1} yr^{-1}	Average annual net increment in merchantable volume for stratum *i*, species *j* during the period *T*	Estimated *ex ante*	
C.7.81	*j*	Dimensionless	1, 2, 3, … *sBL* baseline tree species	Estimated *ex ante*, monitored *ex post*	
C.7.97	M_{fijT}		Mortality factor = percentage of *Vijt1* died during the period *T*;	Calculated	
C.7.98	*mBL*		Total baseline strata	Calculated	

ID number[186]	Data variable	Data unit	Value applied	Data Source	Comment
C.7.99	*mPS*		Total strata in the project scenario	Calculated	
C.7.102	*Na*	Dimensionless	Total number of animals from the different livestock groups that are grazing in the project area (or in the sampled plots)	Estimated-measured	
C.7.103	$Na_{AR,t}$	Dimensionless	Number of animals allowed in the project area under the proposed ARCDM project activity at year *t*;	Estimated *ex ante*, monitored *ex post*	
C.7.104	Na_{BL}	Dimensionless	Average pre-project number of animals from the different livestock groups that are grazing in the project area	Estimated *ex ante*	
C.7.105	$Na_{EGL(t=1)}$	Dimensionless	Average number of animals present in the *EGL* areas selected for monitoring at project start;	Estimated *ex ante*, monitored *ex post*	
C.7.107	$Na_{outside,t}$	Dimensionless	Number of animals displaced outside the project area at year *t*;	Estimated *ex ante*, monitored *ex post*	
C.7.114	nTR_{ijt}	Dimensionless ha^{-1}	Number of trees in stratum *i*, species *j*, at time *t*;	Estimated *ex ante*, monitored *ex post*	
C.7.116	*pl*	Dimensionless	Plot index (*PL* = total number of plots)	Estimated *ex ante*, monitored *ex post*	
C.7.118	PBB_{ikt}	Dimensionless	Average proportion of biomass burnt for stratum *i*, stand model *k*, time *t*;	IPCC GPG-2000, nationa lGHG inventories	
C.7.119	R_j	Dimensionless	Root-shoot ratio appropriate to increments for species *j*;	IPCC GPG-2000, national GHG inventories	
C.7.126	*t*		1, 2, 3, …*t** years elapsed since the start of the A/R CDM project activity	Estimated *ex ante*, monitored *ex post*	
C.7.127	*T*		Number of years between times *t2* and *t1 (T = t2 – t1)*	Estimated *ex ante*, monitored *ex post*	
C.7.128	*t**	Yr	Number of years elapsed since the start of the A/R project activity;		

ID number[186]	Data variable	Data unit	Value applied	Data Source	Comment
C.7.129	*tCERs*		Number of units of temporary Certified Emission Reductions	Calculated	
C.7.131	t_cp	Yr	Year at which the first crediting period ends;		
C.7.132	*UE*		Percentage uncertainty of the sum		
C.7.133	U_i		Percentage uncertainties associated with each of the quantities		
C.7.134	U_i		Percentage uncertainty associated with source/sink *i*		
C.7.135	U_{total}		Percentage uncertainty in the product of the quantities (half the 95% confidence interval divided by the total and expressed as a percentage)		
C.7.136	V_{ijt}	m^3 ha^{-1}	Average merchantable volume of stratum *i*, species *j*, at time *t*	Forest inventory, yield table, local survey	
C.7.137	V_{ijt1}	m^3 ha^{-1}	Average merchantable volume of stratum *i*, species *j*, at time $t = t1$;	Forest inventory, yield table, local survey	
C.7.138	V_{ijt2}	m^3 ha^{-1}	Average merchantable volume of stratum *i*, species *j*, at time $t = t2$;	Forest inventory, yield table, local survey	
C.7.139	WB_{ht}	Dimensionless	Fraction of total above-ground biomass harvested as timber and as fuel wood at time *t* (not burned);	Estimated *ex ante* and *ex post*	
C.7.149	$\Delta C_{L,ikt}$	t CO_2-e yr^{-1}	Annual decrease in carbon *stock* due to biomass loss for stratum *i*, stand model *k*, time *t*	Estimated *ex ante*	
C.7.150	ΔC_{ikt}	t CO_2-e yr^{-1}	Annual carbon stock change in living biomass in stratum *i*, stand model *k*,time *t;*	Estimated *ex ante*	
C.7.152	$\Delta C_{P,LB}$	t CO2-e	Sum of the changes in living biomass carbon stocks in the project scenario (above- and below-ground);	Estimated *ex ante*, monitored *ex post*	

C.8. Date of completion of the baseline study and the name of person(s)/entity(ies) determining the baseline:

May 2010
ONF International-Carbono & Bosques.
The baseline study was elaborated under contractual arrangements between ONF International and Carbono & Bosques

SECTION D. Estimation of *ex ante* actual net GHG removals by sinks, leakage and estimated st amount of net anthropogenic GHG removals by sinks over the chosen crediting period

D.1. Estimate of the *ex ante* actual net GHG removals by sinks:

The actual net greenhouse gas removals by sinks represent the sum of the verifiable changes in carbon stocks in the carbon pools within the project boundary, minus the increase in greenhouse emissions by sources measured in CO_2 equivalents within the project boundary that are a result of the implementation of an A/R CDM project activity. Therefore it is estimated according to equation (13) of the methodology AR-AM0004 / Version 04:

$$C_{ACTUAL} = \Delta C_{P,LB} - GHG_E$$

where:

C_{ACTUAL}: Actual net greenhouse gas removals by sinks; t CO_2-e
$\Delta C_{P,LB}$: Sum of the changes in living biomass carbon stocks (above- and below-ground); t CO_2-e
GHG_E: Sum of the increases in GHG emissions by sources within the project boundary as a result of the implementation of an A/R CDM project activity; t CO_2-e

The changes in living biomass carbon stocks are estimated using the stock change method as proposed in the applied methodology AR-AM0004 / Version 04. Thus, the equations (9) to (11) are used:

$$C_{ikt} = C_{AB,ijt} + C_{BB,ijt}$$

$$C_{AB,ijt} = A_{ijt} \cdot V_{ijt} \cdot D_j \cdot BEF_{2,j}$$

$$C_{BB,ijt} = C_{AB,ijt} \cdot R_j$$

Where:

C_{ikt} Carbon stock in living biomass for stratum *i*, stand model *k*, time *t*; t C
C_{ABijt} Carbon stock in above-ground biomass for stratum *i*, species *j*, at time *t*; t C
C_{ABijt} Carbon stock in below-ground biomass for stratum *i*, species *j*, at time *t*; t C
V_{ijt} Average merchantable volume of stratum *i*, species *j*, at time *t*; m3 ha^{-1}
D_j Basic wood density of species *j*; t d.m. m-3 merchantable volume
BEF_{2j} Biomass expansion factor for conversion of merchantable volume to above-ground tree biomass for species *j*; dimensionless
Rj Root-shoot ratio for species *j*; dimensionless

Volume values V_{ijt} are determining by equation from Tabares (2000)[187] y CIRAD (2003)[188] for the five proposed tree species (*Gmelina arborea*, *Tectona grandis*, *Bombacopsis quinata*, *Tabebuia rosea* and *Eucalyptus tereticornis*).

[187] Tabares, 2000. Modelos de crecimiento de las cinco especies forestales (*Tectona grandis, Gmelina arborea, Bombacopsis quinata*, *Eucalyptus tereticornis* y *Tabebuia rosea*) contempladas en el proyecto piloto "SIG reforestación productiva". ONF Andina, Bogotá D.C, Colombia. 65p.

Table 29: Volume equations of *Gmelina arborea*, *Tectona grandis*, *Bombacopsis quinata*, *Tabebuia rosea* and *Eucalyptus tereticornis.*

Species	Equation	Source
G. arborea	$H = \text{Exp}\,[\text{Ln}\,(S) - 2.047 * (T^{-1} - 15^{-1})]$	CIRAD-Forêt, 2003
	$G = 0.00136 * T^{0.6771} * S^{1.480} * N^{0.5216}$	
	$V = 0.6661 * H^{0.8995} * G^{0.9518}$	
T. grandis	$D = 0.0393 * T^2 + 2.21 * T + 1.9844$	Tabares, 2002
	$\text{Log}\,H = 1.3672 – 1.2819 * T^{-1}$	
	$V = \pi/4 * D^2 \times H \times 0.48 \times N$	Vol. de Smalian
B. quinata	$H = \text{Exp}\,[\text{Ln}\,(S) - 3.369 * (T^{-1} - 15^{-1})]$	CIRAD-Forêt, 2003
	$G = 0.000987 * T^{0.799} * S^{1.278} * N^{0.714}$	
	$V = 0.910 * H^{0.620} * G^{0.965}$	
T. rosea	$D = 1.2492 * T + 2.5434$	Tabares, 2002
	$V = 0.01195 + 0.0001407 * D^{2.3414} + 0.00009 * D^2 + 0.0059094 * D^{0.3414}$	
E. tereticornis	$D = 3.6149 * T^{0.7247}$	Tabares, 2002
	$C = D * \pi /100$	
	$V = 0.01083 – 0.14824 * C + 0.82431 * C^2$	Tabares, 2002
Variables		
D	Diameter at breast height (dbh) (cm)	
H	Height (m)	
N	Number of trees	
G	Basal area ($m^2\ ha^{-1}$)	
S	Site index (m)	
T	Age (years)	
C	Circumference (m)	
V	Commercial Volume ($m^3\ ha^{-1}$)	

Additionally to $V_{ijt,}$ the following parameters are used:

Table 30. Parameters used for estimation of *ex-ante* changes in living biomass carbon stocks

Parameter	Value	Source
D_1	0.53	Basic wood density of *Gmelina arborea*. Winrock 1999[189]
D_2	0.55	Basic wood density of *Tectona grandis*[190]
D_3	0.45	Basic wood density of *Bombacopsis quinata*. Catie *et al. s.f.*a[191]

[188] CIRAD-Forêt, 2003. Capacidad del programa de reforestación comercial realizado en la zona Atlántica de Colombia de generar empleo y fomentar el desarrollo rural, desde la plantación hasta la transformación y comercialización de los productos. Consultoría para ONF-I y CORMAGDALENA, Colombia.

[189] Winrock, 1999**.** Fact Sheet. *Gmelina arborea* : A popular plantation species in the tropics.

[190] Weaver, Peter L. 1993. *Tectona grandis* L.f. Teak. SO-ITF-SM-64. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 18 p.

Parameter	Value	Source
D_4	0.54	Basic wood density of *Eucalyptus tereticornis*. Rao *et al*. 2002[192]
D_5	0.53	Basic wood density of *Tabebuia rosea*. Catie *et al. s.f.*b[193]
BEF_2	2.0	Table A1.3.10 of IPCC GPG LULUCF 2003
CF_j	0.49	IPCC 2006 default value
R_j	0.27	Table A1.3.8 of IPCC GPG LULUCF 2003
Mijt	5%	% Mortality caused by disturbance

Subsequently, the five species were grouped into two categories: short term (melina and eucalyptus) which form the Stand Model 1 (SM1); and the long-term species (teak, ceiba and oak tree) which form the Stand Model 2 (SM2). For each species, a percentage on its participation was established within the corresponding stand model. This percentage was calcuted based on the planted area. The volume equations for each one of the species and the *Dj* values were multiplied by this participation percentage (Table 31). Later on, the total volume of each stand model was defined, based on the average volume (Figure 18).

Table 31. Percentage of participation referring to the area planted, in the corresponding SM.

Stand Model	Specie	Area	Area percentage	*Dj*	Weighted *Dj*
SM1	Melina	3,616.65	99%	0.53	0.52
	Eucalipto	45.69	1%	0.54	0.01
Total SM1		**3,661.34**	**100%**		**0.53**
SM2	Teca	225.59	32%	0.55	0.17
	Ceiba	320.26	45%	0.45	0.20
	Roble	165.68	23%	0.53	0.12
Total SM2		**711.63**	**100%**		**0.50**

Figure 18, shows the estimated accumulation in average volume for each species and for each stand model. This accumulation was estimated by using the equations provided in Table 29.

[191] Catie *et al*. *s.f.*a. Árboles de Centro América. *Bombacopsis quinata.*

[192] Rao, R. V. S. Shashikala, P. Sreevani, V. Kothiyal, C. R. Sarma, P. Lal. 2002. Within tree variation in anatomical properties of some clones of *Eucalyptus tereticornis* Sm. Wood Science and Technology 36 (2002) 271–284.

[193] Catie *et al*. *s.f.*b. Árboles de Centro América. *Tabebuia rosea.*

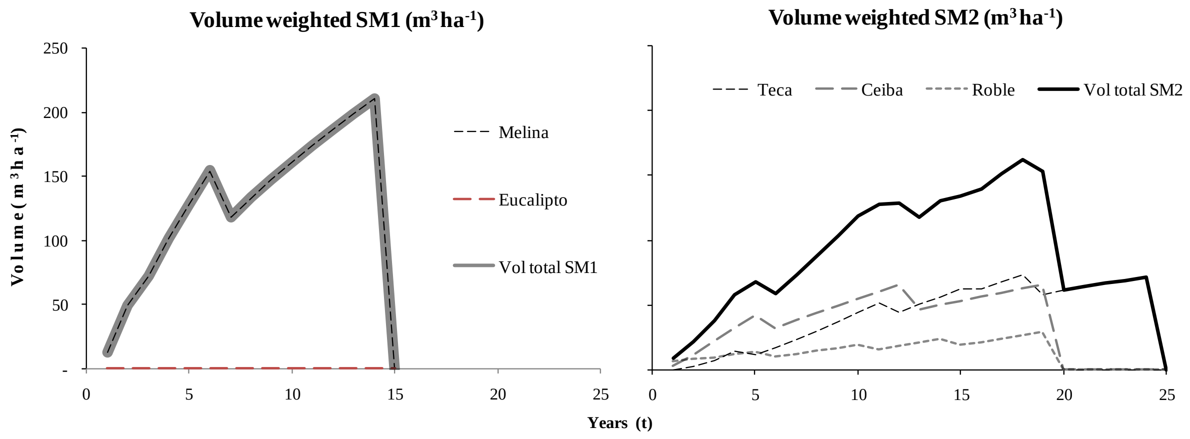

Figure 18. Weighted species volume by the percentage of participation and total volume in each SM.

Treatment of pre-existing vegetation

According to the methodology, the project emissions are related to the loss of pre-existing vegetation during site preparation, and calculated with equations (14) and (15):

$$\Delta C_{P,LB} = \Delta C_{P,LBt} - E_{biomasslos}$$

$$E_{biomasslos} = A_{ik} \cdot B_{pre,ik} \cdot CF_{pre} \cdot \frac{44}{12}$$

Where:

$\Delta C_{P,LB}$	Sum of the changes in living biomass carbon stocks (above- and below-ground); t CO2-e
$\Delta C_{P,LBt}$	Sum of the changes in living tree biomass carbon stocks (above- and below-ground); *t* CO2-e
$E_{biomassloss}$	Decrease in the carbon stocks in the living biomass carbon pools of non-tree vegetation in the year of site preparation, t CO_2-e
A_{ik}	Area of stratum *i*, stand model *k*, ha
$B_{pre,ik}$	Average pre-existing stock of non-tree pre-project biomass on land to be planted before the start of the proposed A/R CDM project activity for baseline stratum *i* and stand model *k*, t d.m. ha^{-1}
CF_{pre}	Carbon fraction of dry biomass in pre-existing vegetation, t C $(t\ d.m)^{-1}$

In accordance with guidance contained in paragraph 35 of the EB 42 meeting report[194], GHG emissions due to removal (loss) of herbaceous vegetation as a component of non-tree biomass are neglected in the

[194] "The Board clarified the guidance on accounting GHG emissions in A/R CDM project activities from the following sources: (i) fertilizer application, (ii) removal of herbaceous vegetation, and (iii) transportation; and agreed that emissions from these sources may be considered as insignificant and hence can be neglected in A/R baseline and monitoring methodologies and tools".

Methodology AR-AM0004 / Version 04. Hence, all references to GHG emission from removal of non-tree vegetation do not include GHG emissions from removal of herbaceous vegetation.

The project emissions are therefore calculated using the following parameters for non woody and woody pre-existing vegetation (Table 32 y Table 33):

Table 32. Parameters used to calculate *ex-ante* project emissions related to the loss of pre-existing non woody vegetation

Parameter	Value	Source
$B_{cleanpasture}$	1.81	Pre-existing stock in living biomass for clean pasture, from Dufour (2005)[195] including 0.72 t d.m of AGB and 1.09 t d.m of BGB
Bf_{allows}	17.18	Pre-existing stock in living biomass for fallows, from Dufour (2005) including 14.09 t d.m of AGB and 3.09 t d.m of BGB
$B_{pasturewithfallows}$	21.49	Pre-existing stock in living biomass for pasture with fallows, from Dufour (2005), including 18.17 t d.m of AGB and 3.32 t d.m of BGB
CF_j	0.49	IPCC 2006 default value

Dufour (2005)[196], evaluated the carbon stock of the land cover found in the area project according to Corine Land Cover (CLC) classification adapted for Colombia. Between covers evaluated, it could be found: Clean pastures, pastures with shrubs and fallows (*rastrojos*). Now, considering that one of the patterns used for the Assessment of the eligibility of the project areas (Section A.7) was the CLC classification (and each vegetal compounds of these land covers), values from Dufour projected in 2005, are applicable to the baseline strata of the project correspondingly to the year its start (year 2000). That is, accordingly CLC definitions, baseline sceneries identified in the eligibility assessment correspond to the Dufour´s land covers surveys in the area for the project.

Table 33. Parameters used to calculate *ex-ante* project emissions related to the loss of pre-existing trees

Parameter	Value	Source
B_{trees}	1.66	Pre-existing stock for scattered trees, from ONFA y C&B, 2010[197]
CF_j	0.49	IPCC 2006 default value

The calculations of the *ex-ante* actual net GHG removals by sinks are detailed in the attached Excel file of the PDD and in Tool for Afforestation and Reforestation Approved Methodologies Methodologies (TARAM V1.4).

Finally, the A/R CDM project activity may not increase GHG emissions due to the biomass burning because slash and burn activity is not a common practice in the site preparation.

The results of calculations are presented in Table 34.

[195] Dufour, 2005. Reboisement Commercial dans la Région du Magdalena Bajo, Colombie. La Composante Carbone: Niveau de référence et plan de surveillance. Mémoire de Mastère ENGREF. ONF International. Pp 16.

[196] Dufour, 2005. Op. Cit.

[197] ONFA y C&B, 2010. Inventario de Árboles dispersos en los escenarios de línea base

Table 34. Actual net GHG removals by sinks

Year	Carbon stock change in A/R living biomass (tCO_2 e yr^{-1})	$E_{biomassloss}$ (tCO_2 e yr^{-1})	GHG_E : $E_{biomassburn}$ (tCO_2 e yr^{-1})	C_{ACTUAL} (tCO_2 e yr^{-1})
2,000	4 470.66	-3 748.10	-	722.56
2,001	25 231.16	-10 251.47	-	14 979.69
2,002	56 342.23	-15 723.64	-	40 618.60
2,003	100 047.45	-20 757.05	-	79 290.39
2,004	133 564.33	-3 692.38	-	129 871.95
2,005	140 323.12	-3 217.28	-	137 105.84
2,006	117 961.56	-1 728.46	-	116 233.10
2,007	85 288.42	-105.52	-	85 182.91
2,008	51 197.02	0.00	-	51 197.02
2,009	39 675.60	-2 043.35	-	37 632.25
2,010	94 410.99	-9 629.15	-	84 781.84
2,011	126 174.47	-7 187.00	-	118 987.47
2,012	148 756.14	-7 187.00	-	141 569.14
2,013	171 025.86	-7 187.00	-	163 838.86
2,014	93 459.96	0.00	-	93 459.96
2,015	-4 728.91	0.00	-	-4 728.91
2,016	-135 582.40	0.00	-	-135 582.40
2,017	-157 506.98	0.00	-	-157 506.98
2,018	20 366.36	0.00	-	20 366.36
2,019	43 602.71	0.00	-	43 602.71
2,020	107 737.75	0.00	-	107 737.75
2,021	101 590.55	0.00	-	101 590.55
2,022	82 674.90	0.00	-	82 674.90
2,023	17 202.43	0.00	-	17 202.43
2,024	-189 015.97	0.00	-	-189 015.97
2,025	-122 318.50	0.00	-	-122 318.50
2,026	-110 150.28	0.00	-	-110 150.28
2,027	-86 877.99	0.00	-	-86 877.99
2,028	171 949.88	0.00	-	171 949.88
2,029	113 768.45	0.00	-	113 768.45
Total (tCO_2e)	**1 240 640.98**	**-92 457.40**	**-**	**1 148 183.58**

D.2. Estimate of the *ex ante* leakage:

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There is one source of leakages covered by the methodology AR-AM0004/ Version 04: Carbon stock decreases caused by displacement of pre-project agricultural crops, grazing and fuel-wood collection activities ($LK_{ActivityDisplacement}$). Acording to equations (27) and (28):

$$LK = LK_{ActivityDisplacement} = LK_{conversion} + LK_{fuel\text{-}wood}$$

Where:

LK	Leakage
$LK_{ActivityDisplacement}$	Leakage due to activity displacement; t CO2-e
$LK_{conversion}$	Leakage due to conversion of forest to non-forest; t CO2-e
$LK_{fuel\text{-}wood}$	Leakage due to displacement of fuel-wood collection; t CO2-e

1. $LK_{conversion}$

$LK_{conversion} = LK_{conv\text{-}graz} + LK_{conv\text{-}crop}$

$LK_{conv\text{-}graz}$	Leakage resulting from the conversion for grazing
$LK_{conv\text{-}crop}$	Leakage resulting from the conversion for cropland

As previously mentioned, there are no presence of agricultural activities in the project area (see also C.5.1 and C.5.2). Therefore, leakage resulting from cropland conversion is 0.

1.1. $LK_{conv\text{-}graz}$ (Leakage resulting from the conversion for grazing)

In the framework of the proposed A/R CDM project activity the potential leakage that could occur is related to the displacement of the pre-existing cattle grazing activities. In order to estimate the pre-project of cattle population in the project area (Na_{BLt} for eq. 30 AR-AM0004, V4) recollected information from Lenne (2004)[198] was used, from which it was established the cattle load density in the project area

$$Na_{BL} = \frac{sNa_{BL}}{SFR_{PAga}}$$

Na_{BLt} = Average pre-project number of animals from the different livestock groups that are grazing in the project area; dimensionless

sNa_{BL} = Sampled pre-project number of animals from the different livestock groups that are grazing in the project area; dimensionless

SFR_{PAga} = Fraction of total project area sampled for animal grazing; dimensionless

According to Lenne, 2004[199]:

sNa_{BL} = 711 UGG[200]

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[198] Lenne, 2004. Programa de tecnificación de la ganadería dentro del proyecto de reforestación de CORMAGDALENA en el núcleo Bajo Magdalena. ONFI-CORMAGDALENA 2005.

[199] Lenne, 2004. Op. Cit.

[200] The DANE (National Administrative Statistics Department, Colombia) establish the load capacity as the relation between the Large Livestock Unit (UGG) and the area in hectares (Ha). The UGG is equal to a 500 kg male; or a 400 kg female; or 4 calves younger than one year; or 2 steers from 12 to 23 months.

SFR_{PAga} = 1,400/4,373= 0.32

Na_{BL} = 2,220 UGG

Afterwards, according to eq. 31 de AR-AM0004, V4.

$$Na_{outside,t} = Na_{BL} - Na_{AR,t}$$

$Na_{outside,t}$ = Number of animals displaced outside the project area at year *t*; dimensionless

$Na_{AR,t}$ = Number of animals permitted in the project area, under the A/R CDM proposal.

Following forestry models proposed, it is not possible cattle grazing, so $Na_{AR,t}$ is 0; then, $Na_{outside,t} = Na_{BL}$ = 2,220 UGG. In consequence, the proposed A/R CDM project activities will lead to a displacement of the pre-existing cattle grazing activities. Thus, according to the applied methodology the case 2 of leakage due to conversion of land to grazing land is considered:

Case 2: $Na_{BL} > Na_{AR,t}$

The cattle populations will be displaced outside the project boundary. The cattle displaced outside project boundary will be only displaced to lands under the control of animal owners. Therefore, following equation (33):

GLA = EGL

Where:

GLA Total grazing land area outside the project boundary needed to feed the displaced animal populations; ha

EGL Total existing grazing land area outside the project boundary that is under the control of the animal owners (or the project participants) and that will receive part of the displaced animal populations, up to time *t**, ha

The following steps are required:

Step 1: Estimation of the annual animal biomass consumption over the project area to be planted ($\Delta C_{L\ PA,t}$ ecn. 34 AR-AM0004, V4).

$$\Delta C_{LPAt} = \sum_{p=1}^{P} \sum_{an=1}^{An} DBI_{an} \cdot n_{pgt} \cdot a_{gp} \cdot 30 \cdot 0.001 \cdot \frac{1}{SFR_{PAga}}$$

$\Delta C_{L\ PA,t}$ = annual biomass consumption over time *t*; t d.m. yr^{-1}

p = plot index (P = total number of plots); dimensionless

an = type of animal (An = total number of types of animals); dimensionless

DBI_j = daily forage consumption per type *j animal;* kg d.m. head^{-1} day^{-1}

n_{pgt} = number of individuals in the plot of land *p* of group *g* over time *t*; dimensionless

a_{gp} = number of months per year in which the animals in group *g* are present in plot of land *p*; dimensionless

30 = average number of days in a month; dimensionless

SFR_{Paga} = fraction sampled with respect to total grazing area of the project; dimensionless

De acuerdo a la informacion de Lenne (2004)[201] y un *DBI* = 6 (Tabla C, AR-AM0004, V4),

$\Delta C_{L\ PA,t}$ = 4,795 t d.m. yr^{-1}

Step 2: Establishment of the total existing grazing land area outside the project boundary that is under the control of the animal owners (or the project participants) and that will receive the displaced animal populations (*EGL*).

According to recollected information from Lenne, 2004[202], land owners will include between 12 and 47% of their lands to forest activities, and they could have the opportunity of keeping cattle activities in the remaining area of their properties.

Assuming that 47% of area of a plot will be reforested and taking into account that all properties are under grazing cover, available area to relocate animal population (livestock) EGL, is:

EGL = 4,373 * (1/0.47) * (1-0.47) = 4,931 ha

Step 3: Estimate the number of animals that can be displaced in *EGL*-areas:

a) Using equation 34, calculate the maximum annual biomass that these grazing areas can produce for animal feeding (ΔC_{Lmax});

Lenne, 2004[203] established an average cattle load of 0.64 UGG.ha^{-1} (between 0.38 UGG.ha^{-1} and 0.97 UGG.ha^{-1}). The study led us various conclusions regarding the pre-existing cattle grazing activities:

- The pastures are underexploited considering current fodder production potential
- The capacity of charge could be extended by a factor of 1.5 to 2, till reaching 1.5 UGG.ha^{-1}

In other hand, according to a record analysis of cattle grazing activity in the Magdalena valley, cattle load capacity estimated for the department is around to 1 UGG[204]. Therefore, when the actions are

[201] Lenne, 2004. Op. Cit..

[202] Lenne, 2004. Op. Cit.

[203] Lenne, 2004. Op. Cit.

implemented in order to improve the technical capacity of livestock production in the region, in some cases, this load capacity could be even doubled. According to this and considering a load capacity of 1.5 UGG per ha,

$\Delta C_{Lmax} =$ 15,977 t d.m. yr^{-1}

b) Using equation 34, calculate the annual biomass that these grazing areas are currently producing for animal feeding ($\Delta CL_{current}$).

$\Delta C_{Lcurrent} =$ 5,407 t d.m. yr^{-1}

c) Determine if the *EGL* areas are sufficient for feeding the entire population of displaced animals;

$(\Delta C_{Lmax} - \Delta C_{Lcurrent})_{EGL} \geq \Delta C_{L\ PA}$, this is: 15,977 t d.m. yr^{-1} - 5,407 t d.m. yr^{-1} = 10,569 t d.m. yr^{-1}

10,569 t d.m. yr^{-1} $\geq$ 4,795 t d.m. yr^{-1}; Then: Leakage due to activity displacement is set as zero (e.g. $LK_{conversion} = 0$).

Finally, we conclude that the load capacity of an animal in the region is sufficient in order to have a spreading of the cattle grazing activity to other areas, outside the project boundary. That is, the vegetation in different coverages different to pastures will not be eliminated in order to continue the cattle activity[205].

i.2. $LK_{fuel\text{-}wood}$ (Leakage due to displacement of fuel-wood collection)

Estimations of firewood consume in the project area, as a reference of the results reported by the National Energetic Balance Inform 1975-2006 for Colombia, developed by the Unit of Mining Planning and Energy (UMPE, 2007)[206] of the Ministry of Mines and Energy of Colombia.

The monthly fuel consumption nationwide was estimated at 233,835,982 kg, for a population of 1,878,601 households using this source of energy, gives an average value of 124.47 kg per month per household. Now, for the department of Magdalena, the value is 8,311,007 kg and, based on the rural households population report from DANE (2005) which estimated on 244,942 households, gives an average value fuel consumption for the department of 33.93 kg per month (see below).

$C_{Firewood.Avg} = C_{Firewood,}t$ / Household

Where

$C_{Firewood,\ prom}$:	Monthly average of firewood consumption per householder (Kg)
$C_{Firewood,}t$:	Global monthly firewood consumption (kg)
Household:	Households in the rural area for the department

[204] Sierra, 2010a. Análisis sucinto del comportamiento de la capacidad de carga animal en pasturas del valle del Magdalena. ONF Andina, Corporación Carbono y Bosques. 9p.

[205] Sierra, 2010a. Análisis sucinto del comportamiento de la capacidad de carga animal en pasturas del valle del Magdalena. ONF Andina, Corporación Carbono y Bosques. 9p.

[206] UMPE, 2007. Op. cit.

$C_{Firewood.Avg}$ = 8,311,007 / 24,492 = 33.93 kg

The number of homes included in the Project, are a estimation of 189[207], which is assumed they are direct consumers of firewood in the project area and, who may be affected and potentially, they could shift this activity outside the project area. Then, estimation of biomass consumption of wood is defined by:

$C_{Firewood}$ = ($C_{Firewood.Avg}$ * Household * 12 * 30) / 1000

Where:

$C_{Firewood}$:	Firewood consumption in the Project area (Kg).
$C_{Firewood, prom}$:	Monthly firewood consumption per house (Kg)
Household:	Global number of houses into the project
12:	Months of the year
30:	Accreditation time project
1000	Conversion to tons

Applying the formula above, and using the estimated household value and the firewood consumption values for the department of Magdalena, were calculated the tonnes of fuel consumption and CO2 equivalent:

$C_{Firewood}$ = 33.93 x 189 x 12 x 30 = 230,8597.2 (kg) equivalent to 2,308.6 t or 4.236,3 tCO_2 of fuelwood

Now, net anthropogenic removals by sinks for the project are 988,987 tCO_2. The possible leakages due the displacement of fuelwood (4,236 tCO_2) are less than 2% of net anthropogenic removals by sinks (19,779 tCO_2). Then, according to the procedures by the approved methodology, AR-AM 0004, ver. 04, in subsection 8.1.4 of Section II, the possible leakages due the displacement of fuelwood consumption is zero.

- *LK* $_{fuel\text{-}wood}$ < 2% *of actual net GHG removals by sinks* (See EB 22, Annex 15).

Thus, it can be considered that:

$$LK\ fuel\text{-}wood = 0$$

Finally,

$$LK = LK_{ActivityDisplacement} = LK_{conversion} + LK\ fuel\text{-}wood = 0$$

Table 35. Estimation *ex ante* of leakage for the entire crediting period

Year	Project year	Estimation of leakage (tonnes of CO_2 e yr^{-1})
2000	1	0.00
2001	2	0.00
2002	3	0.00

207 Sierra, 2010b. Estimación del consumo de leña en el proyecto “Commercial reforestation on lands dedicated to extensive cattle grazing activities in the region of Magdalena Bajo Seco”. ONF Andina, Corporación Carbono y Bosques. 6p.

Year	Project year	Estimation of leakage (tonnes of CO_2 e yr^{-1})
2003	4	0.00
2004	5	0.00
2005	6	0.00
2006	7	0.00
2007	8	0.00
2008	9	0.00
2009	10	0.00
2010	11	0.00
2011	12	0.00
2012	13	0.00
2013	14	0.00
2014	15	0.00
2015	16	0.00
2016	17	0.00
2017	18	0.00
2018	19	0.00
2019	20	0.00
2020	21	0.00
2021	22	0.00
2022	23	0.00
2023	24	0.00
2024	25	0.00
2025	26	0.00
2026	27	0.00
2027	28	0.00
2028	29	0.00
2029	30	0.00
	Total (tCO_2e)	**0.00**

SECTION E. Monitoring plan

E.1. Monitoring of the project implementation:

Application of the approved methodology AR-AM 0004 ver 04 "*Reforestation of Land Currently Under Agricultural Use*"

E.1.1. Monitoring of forest establishment and management:

>>

a. Monitoring of the boundary

The project activity will be developed in a wide area of the savanna dedicated to the cattle grazing. In such activity, 4,373ha are planned to be established of commercial species. These areas fully met the criteria of eligibility of lands, as accepted by the UNFCCC. (See Section C.1).

This is meant to demonstrate that the actual area afforested conforms to the afforestation area outlined in the project plan. The following activities are foreseen:

- Field surveys concerning the actual project boundary within which A/R activity has occurred, site by site;
- Measuring geographical positions (latitude and longitude of each corner polygon sites) using GPS;
- Checking whether the actual boundary is consistent with the description given in section A.4.2. ;
- Input the measured geographical positions that are in conformity with the description given in section A.4.2. into the GIS system and calculate the area of each stratum and stand;
- The project boundary will be monitored periodically throughout the crediting period. If the boundaries present changes within this period due to natural (plagues, fire, landslides, etc.) or anthropogenic damages (harvests or deforestation these areas will be located and determined, making the relevant assessment of the carbon loss. The modified boundaries will be reported to the DOE for their subsequent verification, the deforested lands will be excluded from the project and the tCERs issued for these areas will be deducted. Similarly, if the planting on certain lands within the project boundary fails these lands will be documented;
- Personnel involved in the monitoring will be trained to identify the changes in the boundary and to record changes in the project database for reporting of project verification.

The field survey was carried out using Global Positioning Systems (GPS), differentiated by stratum, species and year of planting. All data obtained were downloaded and analyzed in the SIG platform ArcGIS, to generate the maps of areas under control of the project participants, to be able to monitor them over time.

Table 36. Variable used in monitoring the project boundary

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of data points / Other measure of number of collected data	Comment
E.1.1.01	Stratum ID	Stratification map	c	Each monitoring	100 % of the area	Identifier of the project strata; includes strata with different conditions from those initially established. (Determined via E.1.1.06 and E.1.1.07) for the project.
E.1.1.02	Geographical positions. Coordinates of the polygons added.	Latitude and longitude	m	Continuously and validated every 5 years.	100 % of the area.	Validated every 5 years, in the monitoring periods. Formed by latitude and longitude coordinates of each polygon constituting the project; includes the areas affected by natural or human disturbances.
E.1.1.03	*Aikt*	hectare	c	5 years	100%	Polygons of the areas incorporated into the project during time *t*, for stratum *i*, in tree stand model *k*. Calculated with the information obtained through E.1.1.02.
E.1.1.04	*AT*	hectare	c	Every 5 years	100% of the area	Total area at time *t*. Correspond to the sum total of areas under control (E.1.1.02) in period *T* (monitoring times).
E.1.1.06	*Adistikt*	hectare	c	annually	100% of the affected area.	Areas altered by natural (fires, plagues, etc.) or human (harvests are deforestation) conditions, for stratum *i*, in tree stand model *k*, in time *t*.
E.1.1.07	*AdistikT*	hectare	c	5 years	100% of the affected area.	Average areas altered by natural (fires, plagues, etc.) or human (harvests are deforestation) conditions, for stratum *i*, in tree stand model *k*, during period *T*.

b. Monitoring of forest establishment

The monitoring of the forest establishment will cover site preparation, planting and establishment of the forest. These should be in agreement to the practices described in the section A.

- The monitoring of site preparation activities covers the identification and recording of the area under site preparation. The area affected by site preparation will be assessed using the GPS. These data form the basis for calculation of project emissions from the loss of biomass in site preparation.
- Information on planting schedule, location, area, species planted, spacing will be recorded in plot journals and archived in the project database;
- Survival rates of planted trees are counted during the three months of the planting and replanting is done to fill the gaps. The area and location of supplemental plantings undertaken to fill the gaps and recorded in the project database are identified on the strata maps. Re-planting will be conducted if the survival rate is lower than 90 percent of the final planting density expected.

To guarantee that the activities of project has developed in line with the PDD, changes in the activities such as species, density and others, must be justified and promptly reported to the DOE.

In order to guarantee the good development of the activities of establishment, it is tried to follow protocols standardized by the participants of the project, for each of the works of the residing in the forest (See Annex 7).

The necessary variables to monitor the establishment of the forest models are presented in Table 37.

Table 37. Variables used in the monitoring of the project establishment

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of data points / Other measure of number of collected data	Comment
E.1.2.01	stratum *ID*	Alpha numeric	Defined	periodically	100%	Each stratum and tree stand model established by compartment, is associated with a single alpha numeric identifier.
E.1.2.02	Location	Grid /geographical units	m	eleven	100%	Using GPS to locate geographical coordinates of the compartment boundary included the project.
E.1.2.03	*Aikt*	hectare	c	continuously	100%	Polygons of the areas planted during time *t*, for stratum *i*, in tree stand model *k*. Calculated with the information obtained through E.1.2.01 and E.1.2.02.
E.1.2.04	Site preparation	ha	m	At the start of the establishment	100% of all planted areas	Area intervened for the establishment of the forest tree stands.
E.1.2.05	Quantity of biomass eliminated before the planting	t d.m.ha^{-1}	c	annually	100%	Only the biomass that is eliminated is considered, as this is not subject to burning, according to Secc A. Only trees biomass removed is considered in the emission of project.
E.1.2.06	Species choice in each stratum	-	Defined	annually	100%	Type of species actually planted in the areas under control.
E.1.2.07	Check for survival *I*,*j*, *k*.	Trees ha^{-1}	m, c	Three months after planting and a final check during the third year	100% of the survival monitoring plots.	The quantity of survival in each monitoring plot is measured and calculated per hectare unit established, for stratum *i*, of species *j*, in tree stand model *k*.
E.1.2.08	Date of planting	Alpha numeric	m	Start of each planting	100%	Date of planting of each Lot

c. Monitoring of forest management

The monitoring of forest management will cover silviculture management, maintenance of plantation, and firebreaks, harvesting of trees and replanting or sowing actions.

- Date, location and type of weeding actions in pure plantation will be recorded and archived in the project database;
- Date, location and type of maintenance actions in plantations will be recorded and archived in the project database;
- Date, location and type of maintenance actions for firebreaks will be recorded and archived in the project database;
- Date, location, volume or biomass harvesting will be recorded and archived in the project database;
- Re-planting and re-sowing actions will be checked. Date, location and type of stand will be recorded and archived in the database. These replanting activities correspond to short-cycle species, and specifically for the CDM project, their cycles end with the project crediting period.

Deviations in the forest management activities implemented in the field and the ones outlined in section A.4.2 will be monitored, and reasons for deviations will be recorded.

The data used to monitor forest management are shown below in Table 38:

Table 38. Variables used in monitoring forest management

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored / Other measure of number of collected data	Comment
E.1.3.01	Area cleaning$_{i,j,t}$	ha	m	continuous	100%	Area subject to cleaning for the establishment of tree stand models by stratum and species, during a time *t*.
E.1.3.02	Biomass stock lost per ha during cleaning	t d.m.ha^{-1}	c	continuous	100%	Biomass contained in the vegetation which is eliminated for the establishment of each of the forest tree stands.
E.1.3.03	Area planting$_{(i),j,t}$	ha	m	continuous	100%	The areas are measured before planting the seedlings in the areas under control of the project, for stratum *i*, species *j*, during time *t*.
E.1.3.04	Area fertilized	ha yr^{-1}	c	continuous	100%	Implemented for the good development of the plantation and agreeing to the methodology it is not included in accounting of the emissions
E.1.2.05	Area weeded	ha yr^{-1}	c	First, second, third and fourth year.	100%	The cleanings will be carried out in different intensities during the first years of establishment of the tree stand.
E.1.2.06	Area Coppicing	ha yr^{-1}	c	annually	100%	Coppicing are differentiated by tree stand model, species, degree of development of the trees during time *t*.
E.1.2.07	Biomass removed in the coppicing	t d.m.ha^{-1}	c	annually	100%	Biomass extracted in each coppicing, calculated for each stratum and species, through calculations of E.1.2.06.
E.1.2.08	Thinning	ha yr^{-1}	m, e	annually	100%	The areas to be subjected to thinning are estimated based on the management information activities for each stratum and species.
E.1.2.09	Biomass removed	t d.m.ha^{-1}	c	annually	100%	Biomass extracted in each thinning, calculated for

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored / Other measure of number of collected data	Comment
	in the thinning					each stratum and species, through calculations of E.1.2.08.
E.1.2.10	Area harvested	ha	C	annually	100%	According to the management plans, the areas to be harvested and which meet the rotation period (according to the harvest scheme) estimated by model, stratum and species are identified through the forest management SIG information.
E.1.2.11	Volume harvested	m3 $ha^{-1}yr^{-1}$	c	annually	100%	According to the harvesting reports. Harvests are variable over time following the planting scheme.
E.1.2.12	Biomass harvested	t d.m.ha^{-1} yr^{-1}	c	annually	100%	Calculated as of E.1.2.11, for each stratum, species and during time *t*.
E.1.2.13	Area re-planted	ha yr^{-1}	m	annually	100%	The quantity of re-planted areas is evaluated, after the final harvest, in each stratum and for each species, according to the forest management program. These areas will be similar to those estimated in E.1.2.10.
E.1.2.14	Area disturbed	ha	m	periodically	100%	The areas affected are measured using a GPS (geographical coordinates), identifying the type of disturbance. Documented in the periodic reports of the manage of the plantation
E.1.2.15	Area disturbed	ha	m	Annually	100%	Sum of the areas altered during one year extracted E.1.2.14
E.1.2.16	Biomass loss	t d.m.ha^{-1} yr^{-1}	c	annually	100%	Biomass loss as a consequence of disturbances in the plantations for stratum *i*, species *j*, during time *t*.

d. Monitoring of delivery of tCERs to landowners

In order to guarantee a fair delivery of the economic resources corresponding to the tCERs sale, the issued certificates will be supervised, as well as the participants, according to the signed contracts.

The information and documentation related to the distribution and delivery of tCERs shall be saved in physical and digital formats and will be periodically verified and cross checked with the reports from the forest activities.

Table 39. Variables to be monitored for the distribution between the participants of the project of the income generated by the sale of the certificates

ID	Variables	Units	Comment
01	Proprietor	Numerical	Codification of the farm and the owner.
02	Plot	Alfa-numeric	Differentiation of plots in the farms for a specific owner 01
03	Date of Planting	DD/MM/YY	Exact date. This information enables to value the volume growing data, biomass and Carbon accumulation to each lot, to determine the tCER's.
04	Area Planted	Hectare	The area affectively planted and with good development.
05	Net anthropogenic removals	t CO_2e	Estimate using 03 and 04
06	*tCERs*	Numerical	It is calculated using the growing data, and 05.
07	Project Participants	Numerical	It refers to the landowners that actually planted their lots within the evaluated period *p*.
08	Participation	%	Actual percentage of stand participation with the species *i*, in the stratum *j*, in a specific farm. In relation to the complete project within a evaluated period *p*.
09	Receipt of payment	Numerical	Receipt of payments made to the landowner corresponding to the sale of the certificates that correspond to the period *p*.

Before each verification, a revision on the amount of landowners that have effectively planted their lands and their status will be carried out. Moreover, the joint venture contracts will be revised. With this supervision, a list of all the participants who will be included as certification beneficiaries is issued for the actual evaluation period. This process will guarantee that those lots or farms that have not still been planted, not to be counted to the delivery of certificates generated in such period.

Initially, the certificates will be distributed, according to the participation agreed of the signed contracts. Then, these will be distributed based on the area, age and state of development of the stands of each owner.

E.1.2. If required by the selected approved methodology, describe or provide reference to, SOPs and quality control/quality assurance (QA/QC) procedures applied.

To develop a credible plan for measuring and monitoring carbon on the afforestation sites, steps must be taken to control for errors in sampling and data analysis. To provide confidence to all stakeholders that the reported carbon credits are reliable and meet minimum measurement standards, a quality assurance and quality control (QA/QC) plan is necessary. This plan includes formal procedures to verify methods used to collect field data and the techniques to enter and analyze data. To ensure continuity, it is important that all data collected use the same procedures during the project life. Adhering to these procedures will ensure that in the event there is a change in personnel at CORMAGDALENA, or if any of the people involved are questioned about any aspect of the project, all will be well informed. In addition to following the procedures outlined below, it is also important that a record be maintained to demonstrate that the steps are being followed; this needs to be done by developing a series of check sheets for each step.

For this purpose, procedures have been developed for:

- Collecting reliable field measurements
- Verifying methods used to collect field data
- Verifying data entry and analysis techniques
- Data maintenance and archiving

a) Procedures to ensure reliable field measurements

Collecting reliable field measurement data is an important step in the quality assurance plan. Those responsible for the measurement work shall be fully trained in all aspects of the field data collection and data analyses. Standard operating procedures for each step of the field measurements will be adhered to at all times so that future field personnel can check past results and repeat the measurements in a consistent fashion.

- Field-team members are fully cognizant of all procedures and the importance of collecting data as accurately as possible; before field measurements all procedures are reviewed with the whole monitoring team
- All field measurements are properly supervised by a project coordinator fully aware of all monitoring procedures, and any errors in techniques are corrected;
- The field forms are filed in accordance with the standard operating procedures. The document will list all names of the field team and the project leader will certify that the team is trained;
- New staff is adequately trained by its homologue fully aware of all procedures.

b) Verification of field data collection

To verify that plots have been installed and the measurements taken correctly:

- All measurements are observed by two persons for cross-checking
- At the end of the field works, 10% of the measurements will be independently checked by different personnel. Field data collected at this stage will be compared with the original data. Any errors found will be corrected and recorded. Any errors discovered will be expressed as a percentage of all plots that have been rechecked to provide an estimate of the measurement error.

c) Verification of data entry and analysis

Surveys data are entered into a computer-based information system especially designed for the project. Reliable estimates require proper entry of data into the data analysis spreadsheets. Possible errors are minimized by reviewing entries using expert judgment and, where necessary, comparison with independent data to ensure that the data are realistic. Communication between all personnel involved in measuring and analyzing data allow resolving any apparent anomalies before the final analysis of the monitoring data is completed. If there are any problems with the monitoring plot data that cannot be resolved, the plot is not used in the analysis.

- Data entry is made by two trained persons for cross-checking
- Final analysis is made by the person who prepared the monitoring
- Minimum files shall be used in order to avoid losses of data in time and to facilitate data analysis

The following elements shall be particularly considered:

- Stratum ID: cross-check with previous monitoring and management plans
- Age of plantations: shall be integrated into GIS
- Number of trees: shall be integrated into the GIS for initial plantations and for natural regeneration
- Diameter at breast height (DBH): circumference shall be preferred. Measurements shall be cross-checked by two trained persons. Painted marks will be made permanently so that subsequent control measurements (audit) are to be made to the initial one. Such marks will be used in order to monitor the diametric growth.
- height (H): Some allometric equations equations use hegith as independent variable, and others dominant height, as all trees can not be measured within a plantation, the dominant height will be estimated from measured trees.
- Wood density shall be updated by the project coordinator based on scientific studies on wood density
- Biomass expansion factor (BEF) shall be updated by the project coordinator based on scientific studies on BEF
- Carbon fraction shall be updated by the project coordinator based on scientific studies on carbon fraction
- Root: shoot ratio shall be updated by the project coordinator based on scientific studies on root: shoot ratio.
- It is important that the lots where the parcels are located must have the same management as the other lots; with the purpose of collecting all the effects resulting from the biomass silviculture activities.

d) Data maintenance and archiving

Data will be archived in both electronic and paper forms, and conserved at least two years after the end of the crediting period. All electronic data and reports will be copied on durable media and update format, such as compact discs (CDs), and copies of the CDs will be stored in multiple locations. The archives include:

- Copies of all original field measurement data, laboratory data, data analysis spreadsheets;
- Estimates of the carbon stock changes in all chosen carbon pools and non-CO_2 GHG sources and corresponding calculation spreadsheets;

- GIS products and update software;
- Copies of the measurement and monitoring reports.

In choosing key parameters or making important assumptions based on information that is not specific to the project circumstances, such as in use of default data, values will be selected to lead to an accurate estimation of net GHG removals by sinks, taking into account uncertainties. If uncertainty is significant, data will be chosen in order to under-estimate, rather than over-estimate, net GHG removals by sinks.

The uncertainty for each species in each stratum can be estimated from re-measurement of randomly selected plots and/or from the measurement of replicate plots. Uncertainties will be estimated and expressed as half the 95% confidence interval width divided by the estimated value,

$$U_s(\%) = \frac{\frac{1}{2}(95\% ConfidenceIntervalWith)}{\mu} \cdot 100$$
$$= \frac{\frac{1}{2}(4\sigma)}{\mu} \cdot 100$$

Where:
Us = percentage uncertainty of each species within sub-stratum, %
μ = mean value
σ = standard deviation

If the default parameters are used, uncertainty will be higher than if locally measured parameters are used, and can be only roughly estimated with expert judgment. The percentage uncertainties on quantities that are the product of several terms are then estimated using the following equation:

$$U_S = \sqrt{U_1^2 + U_2^2 + \cdots U_n^2}$$

Where:
US percentage uncertainty of product (emission by sources or removal by sinks);
Ui percentage uncertainties associated with each term of the product (parameters and activity data),*i* = 1,2,…,*n*

The percentage uncertainty on quantities that are the sum or difference of several terms can be estimated using following simple error propagation equation

$$U_c = \frac{\sqrt{(U_{s1} \cdot C_{s1})^2 + (U_{s2} \cdot C_{s2})^2 + \cdots + (U_{sn} \cdot C_{sn})^2}}{\left|C_{s1} + C_{s2} + \cdots + C_{sn}\right|}$$

Where:
Uc = combined percentage uncertainty of sub-stratum, %
Usi = percentage uncertainty of species *i* in the sub-stratum, %
Csi = mean carbon stock of species *i* in the sub-stratum

The stratum and total percentage uncertainties are further combined in the same way as above.

Table 40. Verification and checklist recommended by AR-AM0004/Version 04 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 used	• 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. • 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

QC activity	Procedures
	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.

E.2. Sampling design and stratification

The stratification of the project is based on the type of stands *k* (tree species *i* x planting year *t*) used in the project. The need for *ex post* stratification will be evaluated at each monitoring event based on expected disturbance, management activities that are different from the one described in section A.5.4. or variation in carbon stock change for each stratum. Changes in the strata will be reported to the DOE for verification. A stratification map is prepared outlining the project boundaries, species composition. The physical features relating to the project boundary and management variables will be represented on the stratification map. The carbon stock changes in each stratum shall be monitored by adopting the sampling strategy outlined below.

a. Monitoring of strata

The *ex post* project stratification presented will be used as a basis for monitoring. The updating of *ex ante* stratification will be conducted on the basis of:

- Unexpected disturbances occurring during the crediting period (*e.g.* due to fire, pests or disease outbreaks), affecting different parts of an originally homogeneous stratum in a different way;
- Forest establishment and management (clearing, planting, harvesting, replanting) may be implemented at slightly different intensities and spatial locations than originally planned in section A.5.4.;
- Two different strata may be similar enough to allow merging into one stratum.

b. Sampling size and plot allocation among strata

A stratified sampling design is used to estimate the verifiable changes in carbon stocks in the carbon pools of the project and the corresponding sampling error. The monitoring data are based on the record of field measurements at each monitoring interval as per the monitoring frequency adopted for the pool. The plot markers of permanent plots will not be prominently displayed to ensure that the sample plots do not receive differential treatment. The GPS coordinates would also be used to identify the plots.

Above-ground tree vegetation: Considering the large covariance between the observations at successive sampling events, permanent sample plots are used to estimate the changes in the biomass pool. Permanent sample plots facilitate the development of plot and management histories as the tree vegetation grows.

The methodological tool "Calculation of the number of sample plots for measurements within A/R CDM project activities" (version 02) is used to calculate the number of plots for each stratum for the vegetation. The step to calculated number plot, as describe below.

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:

$$N = \frac{A}{AP}\ ; \quad N_i = \frac{A_i}{AP}\ , \qquad \text{(Ecn 1 tool)}$$

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:

$$E_1 = Q_1 * p \qquad \text{(Ecn 2 tool)}$$

Where:

E_1 = allowable error ($\pm$10% of mean)
$z_{\alpha/2}$ = value of statistical z, for $\alpha = 0.05$ (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.

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

(Ecn 5 tool)

And the sample number by stratum

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

(Ecn 6 tool)

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

In compliance with the applied methodology, the targeted precision level for biomass estimation within each stratum is +/- 10% of the mean at a 90 % confidence level. The sample size for subsequent monitoring interval will be modified if variation observed in carbon stock changes after the first monitoring event based on *n* samples.

Size of the plots or sampling units

In the propose project, Circular lots will be established with an area of 500 m^2 (12.62 m of radius) in all forest systems. The circular plots are cost-effective. Besides, tis type of parcels enable to make not too flashy marks during its installing and location. This is a guarantee for the management of the plantation, such as (prunning activities, fertilizations, cutting activities, etc.), so they can be carried out in the same way inside the lots as well as other areas of the plantation. When these marks are very visible, the people in charge of maintenance of the stands, try to implement a different management in the monitoring lots. With the circular lots, this situation will be avoided.

Total samplings units

A sample size of 68 permanent sample plots is estimated as the sample size required for the first monitoring the aboveground biomass. The sample size estimation assumes a standard deviation of the mean value obtained from the volume estimations by each stand model (SM1 and SM2). These estimations are based on the models developed by Tabares (2002)[208] and CIRAD (2003)[209], and are the same used in the TARAM, for the estimations ex ante net anthropogenic removals by sink. Table 41 presents the number of sample plots calculated for monitoring the carbon stock changes in the above ground biomass. The sample size calculations will be revised further based on the availability of the species composition data of the major species groups during the pre-inventory at monitoring time.

The average values to estimate the amount of necessary plots were obtained from the volume estimations by each stand model (SM1 and SM2). After this, the sample size plot will be re-calculated according to the obtained results.

Table 41. Number of sample plots for measuring the changes in living tree biomass

Strata	Size plots (ha)	Area(ha)	Reference value (Vol. m3 year 5).	Standard deviation (% of the expected value)	Total plots for each stratum
SM1_ Pastures whit fallows	0.05	1,818	92.91	59.71	30
SM1_Clean pastures	0.05	1,492	92.95	59.71	24
SM1_Fallows	0.05	352	95.49	59.71	6
SM2_Pastures whit fallows	0.05	242	67.87	44.17	3
SM2_ Clean pastures	0.05	218	72.13	44.17	3
SM2_ Fallows	0.05	252	63.41	44.17	3
Total		***4,372.97***			***68***

c. Monitoring frequency

To avoid the coincidence with peaks in carbon stocks, the first monitoring (for above-ground and belowground biomass) and verification is expected to be conducted in the year 2011, with a subsequent monitoring (for above-ground and belowground biomass) and verification interval of 5 years, *i.e.*, in 2016, 2021 and 2026.

E.3. Monitoring of the baseline net GHG removals by sinks, if required by the selected approved methodology:

[208] Tabares, 2000. Modelos de crecimiento de las cinco especies forestales (*Tectona grandis, Gmelina arborea, Bombacopsis quinata, Eucalyptus tereticornis* y *Tabebuia rosea*) contempladas en el proyecto piloto "SIG reforestación productiva". ONF Andina, Bogotá D.C, Colombia. 65p.

[209] CIRAD-Forêt, 2003. Capacidad del programa de reforestación comercial realizado en la zona Atlántica de Colombia de generar empleo y fomentar el desarrollo rural, desde la plantación hasta la transformación y comercialización de los productos. Consultoría para ONF-I y CORMAGDALENA, Colombia.

As recommended by the methodology, the carbon stock changes do not need to be monitored after the project is established as the accepted baseline approach 22(a) assumes continuation of existing changes in carbon pools within the project boundary.

Moreover, as the chosen crediting period is a fixed crediting period of 30 years, as mentioned in section B.3, no relevant date is necessary for further renewed crediting period.

ID number[210]	**Data variable**	**Data unit**	**Measured (m), calculated (c) estimated (e) or default (d)**[211]	**Recording frequency**	**Number of sample plots at which the data will be monitored**	**Comment**

E.4. Monitoring of the actual net GHG removals by sinks:

Above-ground and below-ground biomass

Permanent sample plots located in the plantation plots will be located systematically with a random start. All data (location, stratum, sub-stratum) and coordinates will be recorded and archived. Those sampling plots to be located by GPS, will not display signs of sample plots to avoid discriminating treatment.

The growth of individual trees in sample plots will be measured at each monitoring event. Non-tree vegetation such as herbaceous plants, grasses, and shrubs will not be measured and accounted as per the guidance of the methodology.
For *Gmelina arborea*, *Eucalyptus tereticornis*, *Bombacopsis quinata* and *Tabebuia rosea*
step-wise procedures for BEF method and equation (67)-(70) in Section II.5.1 of the approved baseline and monitoring methodology (AR-AM0004/version 04) will be followed to monitor the verifiable carbon stock changes in the above-ground and below-ground living biomass within the project boundary.

The above-ground biomass ($MC_{AB,ijt}$) in equation (67) of the methodology will be estimated using the following equations for determining MV_{ijt}:

[210] Please provide ID number for cross-referencing in the PDD.

[211] Please provide full reference to data source.

Melina	$Age \leq 4\ year$ $V = \left[\sum_{i=1}^{n} v_i\right].F_e$ $where$ $v_i = 0.022894 + 0.0000149.d^{2.163941}.h^{1.0327856}$ $F_e = \frac{10000}{Size\ plot}$	López *et al.* (2011)[212]
	$Age \geq 5\, años$ $v = \frac{0.32932 \cdot (d/100)^2.(h-0.1)^{2.62}}{(h-1.3)^{1.62}}$	Vallejo (1991)[213]
Ceiba	$V = 0.910.H^{0.620}.G^{0.965}$ R^2= 98,0% n=64	CIRAD-Forêt (2003)
Oak	$V = \left[\sum_{i=1}^{n} v_i\right].F_e$ $where$ $v_i = 0.01195 + 0.0001407.d^{2.3414} + 0.00009.d^2 + 0.0059094.d^{0.3414}$ $F_e = \frac{10000}{Sizeplot}$	Tabares (2002)
Eucalyptus	$V = \left[\sum_{i=1}^{n} v_i\right].F_e$ $where$ $v_i = 0.017039 + 0.00003639.d^2.h - 0.00019893.d^2$ $F_e = \frac{10000}{Size\ plot}$ R^2 98% Sy.x = 0.02	López *et al.* (2011)

In equations above v_i corresponds to MV_{ijt}, *d* corresponds to DBH and *h* to total height and *H* to dominant height. (Hd)

Where:

MV_{ijt} Mean merchantable volume per tree of species j, m^3

212 LÓPEZ A.M.; BARRIOS, A.; NIETO V.; TRINCADO G. 2011. Monitoreo y modelamiento de crecimiento como herramienta para el manejo de plantaciones forestales comerciales. Corporación Nacional de Investigación y Fomento Forestal CONIF® – Ministerio de Agricultura y Desarrollo Rural. Bogotá D.C. 100p

213 Vallejo, A. ,1991. Ecuaciones de conicidad y volumen para Bombacopsis quinata y Gmelina arbórea. Informe de Investigación No. 16 . Monterrey Forestal., Colombia

DBH Diameter at breast height, in cm
G Basal area, in m^2 ha^{-1}
Hd Dominant height, defined as the mean height of 100 biggest diameter trees per hectare

MC_{ABij} and MC_{BBij} will then be determined by using MV_{ijt} in the equations (67) and (68) of the applied methodology:

$$MC_{ABj} = MV_j \cdot D_j \cdot BEF_j \cdot CF_j$$

$$MC_{BBj} = MC_{ABj} \cdot R_j$$

Where:
MC_{ABij} Mean carbon stock in the above-ground biomass per unit of area for stratum i and species j t C
MV_j Mean merchantable volume per tree of species j, m^3
D_j Volume weighted average wood density, t d.m. m^3 merchantable volume
BEF_j Biomass expansion factor for conversion of biomass of merchantable volume to above-ground biomass, dimensionless
CF_j Carbon fraction, t C (t d.m)$^{-1}$
R_j Root-shoot ratio, dimensionless

The following parameters will be used:

Table 10: Parameters used to calculate ex-post carbon stocks in A/R CDM project activities

Parameter	Value	Source
D_j	0.53	Trujillo, 2007[214]
BEF_j	2.7	Table A1.3.10 of IPCC GPG LULUCF 2003
CF_j	0.5	According to the applied methodology, IPCC default value
R_j	0.27	Table A1.3.8 of IPCC GPG LULUCF 2003

These values shall be updated every five years if the values from the national inventory or literature are updated for more accuracy.

For this species, the parameters monitored will be therefore: DBH and H

For *Tectona grandis*, step-wise procedures for allometric method and equations (73)-(86) in Section II.5.1 of the approved baseline and monitoring methodology (AR-AM0004/version 04) will be followed to monitor the verifiable carbon stock changes in the above-ground and below-ground living biomass within the project boundary.

The above-ground biomass (TB_{AB}) in equation (74) of the methodology will be estimated using the following equation:

[214] Trujillo Navarrete, Enrique (2007). Guía de Reforestación, Primera Edición 2007. Bogotá Colombia. 267 p

***Tectona grandis*[217].** $TB_{AB} = 0.131748 \cdot d^{2.406413}$

Where:

TB_{ABj} Above-ground biomass of a tree; kg tree^{-1}
d Diameter at breast height (DBH), in cm

Step 3: Carbon stock in above-ground biomass per tree is estimated according to the following equation

$$TC_{ABj} = TB_{ABj} \cdot CF_j \qquad \textbf{(74)}$$

where:

TC_{AB} Carbon stock in above-ground biomass per tree; kg C tree^{-1} (*Spreadsheet SM8, SM9*)

TB_{ABj} Above-ground biomass of a tree of species *j*; kg tree^{-1}

CF Carbon fraction (IPCC default value = 0.5); t C (t d.m.)$^{-1}$

Step 4: Calculate the increment of above-ground biomass carbon accumulation at the tree level. As explained in BEF Method, t_1=0 then $TC_{ABj,t1}$ =0. And equation 75 can be expressed as follow:

$$\Delta TC_{ABjT} = TC_{ABj,t2} \qquad \textbf{(75)}$$

where:

ΔTC_{ABjT} Carbon stock change in above-ground biomass per tree of species *j* between two monitoring events; kg C tree^{-1}

$TC_{ABj,t2}$ Carbon stock change in above-ground biomass per tree of species *j* at monitoring event t_2; kg C tree^{-1}

Step 5: Calculate the above-ground biomass carbon per plot on a per area basis. Since, to obtain carbon on a per area basis is just necessary to multiply for a constant value, this step is applied for total carbon stock (above-ground and below-ground) instead for tree individually. (*Spreadsheet Removals 1, columns AJ and AO*).

$$\Delta PC_{ABikT} = \frac{XF \cdot \sum_{tr=1}^{TR} \Delta TC_{ABjT,tr}}{1000} \qquad \textbf{(76)}$$

$$XF = \frac{10{,}000}{AP} \qquad \textbf{(77)}$$

[217] Tabares J., 2002. Modelos de crecimiento de las cinco especies forestales (*Tectona grandis*, *Gmelina arborea*, *Bombacopsis quinata*, *Eucalyptus tereticornis* y *Tabebuia rosea*) contempladas en el proyecto piloto "SIG reforestación productiva". ONF Andina, Bogotá D.C, Colombia. 65p.

where:

$\Delta PC_{AB,ijT}$ Plot level carbon stock change in above ground biomass in stratum *i*, species *j*, between two monitoring events; t C ha^{-1}

ΔTC_{ABjT} Carbon stock change in above-ground biomass per tree of species *j* between two monitoring events; kg C $tree^{-1}$

XF Plot expansion factor from per plot values to per hectare values

AP Plot area; m^2

tr Tree (TR = total number of trees in the plot)

Step 6*:* Calculate mean carbon stock within each stratum. Calculate by averaging across plots in a stratum:

$$\Delta MC_{ABikT} = \frac{\sum_{pl=1}^{PL_{ik}} \sum_{j}^{J} \Delta PC_{ABikT,pl}}{PL_{ik}} \qquad \textbf{(78)}$$

where:

ΔMC_{ABikT} Mean carbon stock change in above-ground biomass in stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1}.

ΔPC_{ABijT} Plot level mean carbon stock change in above-ground biomass in stratum *i*, species *j*, between two monitoring events; t C ha^{-1}.

pl Plot number in stratum *i*, species *j*; dimensionless

PL_{ik} Total number of plots in stratum *i*, stand model *k*; dimensionless

j Species *j* (J = total number of species)

In the tool CAMARA, this estimation is done for mean carbon stock in total biomass (above-ground + below-ground) which is equivalent because of is just to divide for a constant per stratum. (*Spreadsheet Removals 1, cells AL8 and AQ8*)

Step 7: Estimate carbon stock in below-ground biomass using root-shoot ratios and above-ground carbon stock and apply Steps 4 and 5 to below-ground biomass.

$$TC_{BBj} = TC_{ABj} \cdot R_j \qquad \textbf{(79)}$$

$$\Delta TC_{BBjT} = TC_{BBj,t2} - TC_{BBj,t1} \qquad \textbf{(80)}$$

$$\Delta PC_{BB,ikT} = \frac{XF \cdot \sum_{tr=1}^{TR} \Delta TC_{BBjT}}{1000} \qquad \textbf{(81)}$$

$$\Delta MC_{BB,ikT} = \frac{\sum_{pl=1}^{PL_{ik}} \Delta PC_{BBikT,pl}}{PL_{ik}} \qquad \textbf{(82)}$$

where:

TC_{BBj}	Carbon stock in below-ground biomass per tree of species *j*; kg C tree^{-1}
TC_{ABj}	Carbon stock in above-ground biomass per tree of species *j* as calculated in Step 1; kg C tree^{-1}
R_j	Root-shoot ratio appropriate to increments for species *j*; dimensionless
ΔTC_{BBjT}	Carbon stock change in below-ground biomass per tree of species *j* between two monitoring events; kg C tree^{-1}
$\Delta PC_{BB,\ ijT}$	Plot level carbon stock change in below-ground biomass of species *j* between two monitoring events; t C ha^{-1}
XF	Plot expansion factor from per plot values to per hectare values (see equation 80); dimensionless
tr	Tree (*TR* = total number of trees in the plot)
ΔMC_{BBikT}	Mean carbon stock change in below-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1}
ΔPC_{BBikT}	Plot level carbon stock change in below-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1} *pl* = plot number in stratum *i*, stand model *k*; dimensionless
PL_{ik}	Total number of plots in stratum *i*, stand model *k*; dimensionless

Monitoring GHG emissions by sources increased as results of the A/R CDM project activity

The GHG emissions that will occur during the implementation of the A/R CDM project activity are:

- CO_2 losses from pre-existing vegetation removal.

Emissions from site preparation activities will be assessed by monitoring the area affected in the site preparation. This monitoring will be done based on field surveys. Amount of biomass lost will be calculated by multiplying the area affected in the site preparation with the biomass of the unit area affected by the site preparation and the carbon fraction of the biomass.

E.4.1. Data to be collected in order to monitor the verifiable changes in carbon stock in the carbon pools within the project boundary resulting from the proposed A/R CDM project activity:

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Table 42. Necessary variables to monitor the verifiable changes in carbon stock in the carbon pools within the project boundary

ID number[220]	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.01	*DLP*	%	defined	At stand establishment	100%	To guarantee the carrying out of the QA/QC activities, in the monitoring process.
2.1.1.03	*PLID*	Alpha numeric	m	At the start of the project	100%	Each parcel will have a number or id in accordance with the stratum and the tree stand model.
2.1.1.04	*PLik*	Dimensionless	m	5-year	100%	The values of the totality of the parcels will be redefined in accordance with the results obtained in the ensuing monitoring activities.
2.1.1.05	R_j	dimensionless	e	5 years	100%	It is recommended to obtain them empirically in accordance with the species and growth conditions. Otherwise, values obtained in the literature or factors by default determined by the IPCC will be used.
2.1.1.09	*Confidence level*	%	Defined	At the start of the project	100%	To guarantee the carrying out of the QA/QC activities, and guarantee the precision of the values obtained in the monitoring process.

[220] The identifiers correspond to the numbering of the methodology (Table E).

ID number[220]	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.10	*A*	Hectares	m	At the start of the project, and adjusted every 5 years	100%	Corresponds to the totality of the project areas, in accordance with the GIS database of the project.
2.1.1.11	*Ai*	Hectares	m	At the start of the project, and adjusted every 5 years	100%	Participation of the areas in each stratum. Monitoring with GPS.
2.1.1.13	A_{ikt}	Hectares	m	Yearly	100%	Areas under control which have been established with the proposed tree stand models.
2.1.1.15	*AP*	Sample plot area (m^2)	m	5 year	100%	In accordance with that established in the monitoring plan.
2.1.1.16	*BEF*	dimensionless	e	5 years	100%	Intrinsic to each species. Locally-derived and species-specific values have priority or, national inventory, and default values GPG for LULUCF.
2.1.1.19	$C_{AB,ij}$	t C	c	5 years	100%	Calculated from eq. 69 via 2.1.1.13 and 2.1.1.53
2.1.1.20	C_{ACTUAL}	t CO_2-e.	c	5-year	100%	Net removals made, estimated with equation 63 with the information of 2.1.1.19 and 2.1.1.21, in addition to biomass elimination in the preparation of the sites.
2.1.1.21	$C_{BB,ijt}$	t C	c	5 years	100%	Calculated with equation 70 via 2.1.1.19 and 2.1.1.13.

ID number[220]	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.23	*CF*	$tC(td.m)^{-1}$	e	5 years	-	Average value of the carbon content. Priority will be given to locally-established values and for particular species, or the default value of 0.5 established by the IPCC will be assumed.
2.1.1.24	CF_j	$tC(td.m)^{-1}$	e	5 years	100% of species	It is possible to determine values for each particular species. Otherwise the default value of 0.5 established by the IPCC is assumed.
2.1.1.25	*Ci*	$ Col pesos	m	5 year	100%	NA. It is considered a cost equal to the establishment of the monitoring parcels, given the close proximity between the areas of the project.
2.1.1.28	*DBH*	cm	m	5 years	100% of trees in each plot	Measured during each monitoring period, following the sampling method. The DAP is established at a height of 1.3m.
2.1.1.29	D_j	$t\ d.m.m^{-3}$	e	5 years	100%	Values determined for each particular species. Priority will be given to information empirically obtained in the project species or information from locally generated literature will be used.
2.1.1.30	*D*	$t\ d.m.\ m^{-3}$	e	5 years	100%	Average value estimated from the species that make up the project.
2.1.1.31	*E*	Depends on the variable calculated	c	5 years	100%	Is established in accordance with the variable to be monitored and is applicable to all the variables considered.

ID number[220]	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.42	*fj(DBH,H)*	kg $tree^{-1}$	m-e-c	Yearly	100%	Equations in accordance with the species. Equations will be developed or equation will be used from the relevant technical literature that report from similar conditions, or IPCC equations will be used as applicable.
2.1.1.48	*H*	m	m	5 years	100%	Measured during each monitoring period, following the sampling method..
2.1.1.49	H_{ijt}	m^3	c	Yearly	100%	Form part of the statistics and management of the tree stand model. Evaluated annually with the Project data bases.
2.1.1.50	i_{ID}	Alpha numeric	Defined	At stand establishment	100% of stratum	Each stratum is defined by a single identifier, which are in turn associated with a planting date
2.1.1.51	ID_{ikt}	Alpha numeric	Defined	At stand establishment and next.	100% of stratum and adjusted every 5 years	In accordance with the years since the planting of the tree stand and its growth. Will be adjusted if necessary in accordance with the results of each monitoring cycle.
2.1.1.52	*Lat/long*	Alpha numeric	Defined	At stand establishment	100% plots	Stand, map, GIS, GPS.
2.1.1.53	$MC_{AB,ijt}$	$tCha^{-1}$	C	5 years	100%	Calculated from eq. 67 via 2.1.1.16, 2.1.1.29, 2.1.1.24 and 2.1.1.55.
2.1.1.54	$MC_{BB,ijt}$	$tCha^{-1}$	C	5 years	100% of samples of the stratum	Calculated from eq. 68 via 2.1.1.53 and 2.1.1.05
2.1.1.55	MV_{ijtt}	m3 ha^{-1}	c, m	5 year	100% of sampling plots	Calculated using local-derived equations via 2.1.1.13. or directly measured by field instrument.

ID number[220]	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.56	*N*	Dimensionless	c	At start of project	100% sampling plots	Calculated from eq. 57. Will be reevaluated in the first monitoring period to determine changes in the number of established parcels
2.1.1.57	*n*	Dimensionless	c	At start of project	100% sampling plots	Is obtained through equation 60 of the methodology.
2.1.1.58	*Ni*	Dimensionless	c	At start of project	100% sampling plots	Calculated through ec. 57, with 2.1.1.11 and 2.1.1.15.
2.1.1.59	*ni*	Dimensionless	c	At start of project	100% sampling plots	Calculated through equation 61 of the methodology.
2.1.1.64	nTR_{PLikt}	Alpha numeric	m	5 year	100%	All trees recorded within each plot of land.
2.1.1.69	*PLID*	Alpha numeric	Defined	Before the start of the project	100 % sample plots	Each parcel will have a unique ID in accordance with the totality of parcels estimated and for each stratum.
2.1.1.70	*PLik*	Dimensionless	Defined	Before the start of the project	100 % sample plots	Estimations from each stratum.
2.1.1.71	*Rj*	Dimensionless	e	5 year	100%	Values estimated for each of the species considered at the local or national levels, or derived from existing information, will have priority. As the final option IPCC values can be used.
2.1.1.72	*sti*	Dimensionless	e	At each monitoring event	100%	Resulting from the statistical data of the monitoring activities that permit the estimation of the ideal sample size that guarantees the QA/QC.

ID number[220]	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.73	*TBABj*	kg dry matter tree^{-1}	c	5 year	100%	Is estimated for those trees with diameters at chest height (1.3m) greater than 10 cm.
2.1.1.74	*TCABj*	kg C tree^{-1}	c	5 year	100%	Calculated with equation 74 with 2.1.1.73 y 2.1.1.24.
2.1.1.75	*tID*	Year	m	At establishment	100%	Measured with the reports of establishment of each parcel and the moment of the respective monitoring.
2.1.1.76	tr_{ID}	Alpha numeric	m	5 year	100%	For all trees by plot of land.
2.1.1.77	*XF*	Alpha numeric	c	5 year	100%	Calculated from eq 77, via 2.1.1.15.
2.1.1.78	$z_{\alpha/2}$	Dimensionless	m	5 year	-	Values established for the statistical methods described in the technical literature.
2.1.1.79	$\Delta C_{AB,ijt}$	t C yr^{-1}	c	5 year	100%	
2.1.1.80	$\Delta C_{AB,ikt}$	tCha^{-1}	c	5 years	100% of samples of the stratum	Calculated from eq. 71 or 85, accord to specie via 2.1.1.86 from a time t_1 and time t_2.
2.1.1.81	$\Delta C_{BB,ijt}$	t C yr^{-1}	c	5 years	100% of samples of the stratum	
2.1.1.82	$\Delta C_{BB,ikt}$	t C yr^{-1}	c	5 year	100%	Calculated from eq. 72 or 86 via 2.1.1.80 from a time t_1 and time t_2.
2.1.1.83	$\Delta C_{LB,ikt}$	tCha^{-1}	c	5 years	100% of samples of the stratum	Determines the sum of the changes in the stocks of carbon of the live above and below biomass.

ID number[220]	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.84	$\Delta C_{P,LB}$	tC-e year^{-1}	c	5 years	100% of samples of the stratum	Changes in living biomass carbon stocks. Calculated from eq 64.
2.1.1.85	ΔMC_{ABikT}	t C ha^{-1}	c	5 years	100%	Average changes in living biomass carbon stocks in above biomass from a period *T*.
2.1.1.86	ΔMC_{ABikt}	t C ha^{-1}	c	5 years	100%	Average changes in living biomass carbon stocks in above biomass from a time *t*.
2.1.1.87	$\Delta MC_{BB,ikt}$	t C ha^{-1}	c	5 years	100%	Average changes in living biomass carbon stocks in above biomass from a time *t*. Calculate via 2.1.1.86.
2.1.1.88	ΔMC_{BBikT}	t C ha^{-1}	c	5 years	100%	Average changes in living biomass carbon stocks in above biomass from a period *T*. Calculate via 2.1.1.85.
2.1.1.89	$\Delta PC_{AB,ijT}$	t C ha^{-1}	c	5 years	100%	Mean change in the stock of carbon in the above ground at plot level
2.1.1.90	$\Delta PC_{BB,ijT}$	t C ha^{-1}	c	5 years	100%	Mean change in the stock of carbon in the above ground at plot level. Calculate via 2.1.1.89.
2.1.1.91	$\Delta TCABjt$	kg C tree^{-1}	c	5 years	100%	Change in the stock of carbon in the above-ground at tree level from each species.
2.1.1.92	$\Delta TCABjT$	kg C tree^{-1}	c	5 years	100%	Change in the stock of carbon in the above-ground at tree level from each species between two monitoring. Calculate via 2.1.1.90.
2.1.1.93	$\Delta TCBBjt$	kg C tree^{-1}	c	5 years	100%	Change in the stock of carbon in the below-ground at tree level from each species. Calculate via 2.1.1.91.

ID number[220]	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.94	*ΔTCBBjT*	kg C $tree^{-1}$	c	5 years	100%	Change in the stock of carbon in the below-ground at tree level from each species between two monitoring. Calculate via 2.1.1.92.

E.4.2. Data to be collected in order to monitor the GHG emissions by the sources, measured in units of CO_2 equivalent, that are increased as a result of the implementation of the proposed A/R CDM project activity within the project boundary:

According to the methodology, AR-AM0004 version4, there is potentially one emission by sources, i.e., biomass burning. The increase in emissions is defined by equation 87 of methodology AR-AM0004 / Version 04, as shown below

$$GHG_E = E_{BiomassBurn} \qquad \text{eq. 87.}$$

where:

GHG_E = increase in GHG emission as a result of the implementation of the proposed AR CDM project activity within the project boundary; t CO_2-e.

$E_{BiomassBurn}$ = increase in GHG emission as a result of biomass removal within the Project boundary; t CO_2-e.

Estimation of $E_{BiomassBurn}$ (GHG emissions from biomass removal)

According to the methodology, the project emissions are related to the loss of pre-existing vegetation during site preparation. Besides, in accordance with guidance contained in paragraph 35 of the EB 42 meeting report[221], GHG emissions due to removal (loss) of herbaceous vegetation as a component of non-tree biomass are neglected in the Methodology AR-AM0004 / Version 04. Hence, all references to GHG emission from removal of non-tree vegetation do not include GHG emissions from removal of herbaceous vegetation. According to the methodology, the amount of material of the vegetation removed is closely related to the areas of land that will be planted with trees. The ones aside from the methodology suggest that the estimate has to be made with the herbaceous component like bushes and young trees. Although assumes that biomass is cut and then burned, it will not be burned as explained in the Secion A.5.4. of the proposal of the present project, it must be considered as a removal of such material. The steps to be followed in the quantification of emissions according to the methodology AR-AM0004 version 4 are:

***Step 1*:** Estimate the amount of biomass removed. Said estimate is made in systems with existing non-woody or shrub-like vegetation and for the pasture lands the maximum stock present is considered, in order to be conservative. The amount of the biomass removed will be possible, based on the report of procedures and results provided by Dufour (2005). These were developed in the project area for pastures, bushes and trees, and following destructive procedures as the methodology suggests. An evaluation of the systems with mosaic vegetation will be made, taking into account the proportion of pastures, bushes and trees, in terms of their biomass. This biomass removed value is then transformed into CO_2 per ha emissions.

[221] "The Board clarified the guidance on accounting GHG emissions in A/R CDM project activities from the following sources: (i) fertilizer application, (ii) removal of herbaceous vegetation, and (iii) transportation; and agreed that emissions from these sources may be considered as insignificant and hence can be neglected in A/R baseline and monitoring methodologies and tools".

Step 2. Estimate the average biomass proportion harvested (with the information and procedures of step 1) and apply the respective GHG emission factor. The emission factors established in Tables 3.A 15 and 3.A.16 of the IPCC GPG-LULUCF will be used.

Step 3: Estimating of GHG emissions resulted from the slash and burn based on revised IPCC 1996 Guideline for LULUCF and IPCC GPG-LULUCF (eq. 88, 89 and 90 of methodology):

$$E_{BiomassBurn} = E_{BiomassBurnCO_2} + E_{BiomassBurnCH_4} \qquad \text{(Eq. 88)}$$

where:

$E_{BiomassBurn}$ = total *GHG* emission from biomass burning in slash and burn; t CO_2-e.
$E_{BiomassBurn,CO2}$ = CO_2 emission from biomass burning in slash and burn; t CO_2-e.
$E_{BiomassBurn,\ CH4}$ = CH_4 emission from biomass burning in slash and burn; t CO_2-e.

and

$$E_{BiomassBurn,CO_2} = \sum_{t=1}^{t^*}\sum_{i=1}^{m_{PS}}\sum_{k=1}^{K_p}(A_{ikt\_sb} \cdot B_{ikt} \cdot PBB_{ikt} \cdot CE \cdot CF) \cdot \frac{44}{12} \qquad \text{(Eq. 89)}$$

where:

A_{ikt_sb} = area of slash and burn for stratum *i*, stand model *k*, time *t*; ha
B_{ikt} = average above-ground biomass stock before burning for stratum *i*, stand model *k*, time *t*; t d.m. ha^{-1}
PBB_{ikt} = average proportion of biomass burnt for stratum *i*, stand model *k*, time *t*; dimensionless (NA)
CE = average biomass combustion efficiency (IPCC default = 0.1); dimensionless (NA), the biomass slash but not burning
CF = carbon fraction (IPCC default = 0.5); t C $(t\ d.m.)^{-1}$

$$E_{Biomassbun,CH_4} = E_{Biomassbun,CO_2} \cdot \frac{12}{44} \cdot ER_{CH_4} \cdot \frac{16}{12} \cdot GWP_{CH_4} \qquad \text{(Eq. 90)}$$

Where:

12/44 = ration of molecular weights of carbon and CO_2; dimensionless
16/12 = ration of molecular weights of CH_4 and carbon; dimensionless
ER_{CH4} = emission ratio for CH_4 (IPCC default = 0.012); t CO_2-e./t C
GWP_{CH4} = Global Warming Potential for CH_4 (IPCC default = 21 for the first commitment period); t CO_2-e./t CH_4

The steps 2 and 3 will not be used, since this biomass will not be burned. These steps will be only implemented, in case the conditions are adverse (e.g. sudden fires caused by high temperatures and droughts, or by human actions). Therefore, the emissions considered in the vegetation cutting will not include the CH_4emissions resulting from burnings in the biomass.

The information to be monitored, necessary to calculate the emissions, is detailed in Table 43.

Table 43. Information necessary to estimate the emissions[222]

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.06	*16/12*	Dimensionless	Universal constant	-	-	NA. Constant value of the relation of the molecular weight of CH_4 and C. Is not considered given that burning of biomass is not foreseen.
2.1.1.07	*44/12*	Dimensionless	Universal constant	-	-	NA. Constant value of the relation of the molecular weight of CO_2 and C. Is not considered given that burning of biomass is not foreseen.
2.1.1.08	*44/28*	Dimensionless	Universal constant	-	-	NA. Constant value of the relation of the molecular weight of N_2O y el N. Is not considered given that burning of biomass is not foreseen.
2.1.1.14	A_{B,ikt_sb}	Hectares	m	Yearly	100%	NA. Burning is not considered.
2.1.1.17	B_{ijt}	t d.m. ha^{-1}	m	After burning	Sample plots	N.A. the material is removed but not burned.
2.1.1.18	*N/C ratio*	Dimensionless	e	Once per species or group of species		Value established from IPCCC in 0.01.
2.1.1.22	*CE*	Dimensionless	e	At star of the project	100%	NA. Burning of biomass is not foreseen, nor extraction of firewood.
2.1.1.32	$E_{BiomassBurn}$	t CO_2-e	c	5 years	100%	NA. Burning of biomass is not foreseen
2.1.1.33	$E_{BiomassBurn, CH4}$	t CO_2-e	c	5 years	100%	NA. Burning of biomass is not foreseen
2.1.1.34	$E_{BiomassBurn,N2O}$	t CO_2-e	c	5 years	100%	NA. Burning of biomass is not foreseen

222 The identifiers correspond to the numbering of the methodology (Table E).

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of sample plots at which the data will be monitored	Comment
2.1.1.35	$E_{BiomassBurn,CO2}$	t CO_2-e	c	5 years	100%	NA. Burning of biomass is not foreseen
2.1.1.40	ER_{N20}	Dimensionless	e	Yearly	100%	NA. The methodology in its version 03 eliminated the emissions to be considered from this component of fertilization. In addition, there is to be no burning of biomass in the Project activity that would promote the emission of this compound.
2.1.1.41	ER_{CH4}	Dimensionless	e	Yearly	100%	NA. The methodology in its version 03 eliminated the emissions to be considered from this component of fertilization. In addition, there is to be no burning of biomass in the Project activity that would promote the emission of this compound.
2.1.1.46	GHG_E	t CO_2-e	c	5 years	100%	Calculated from eq.101 via 2.1.1.26, 2.1.1.27, 2.1.1.37 and 2.1.1.38
2.1.1.47	GWP_{CH4}	t CO2-e	c	5 years	100%	NA. The source of this emission is the burning of biomass, an activity not contemplated for this project activity.
2.1.1.67	PBB_{ikt}	Dimensionless	m	Yearly	100% of sample plots	NA. Cutting and burning of biomass is not permitted.
2.1.1.68	PBB_{ikt}	Dimensionless	e	Before burning	100% sample plots	NA. Cutting and burning of biomass is not permitted.

E.5. Leakage:

Leakage represents an increase in GHG emissions by emitting sources in areas located outside the project boundary, as a result of the implementation of A/R-CDM activities.

The project area has a low stocking rate per ha. However, the pastures in that area can withstand a bigger capacity. That is, the cattle grazing activity can be intensified without technical requirements. In consequence, the cattle grazing activity will not be displaced to areas that are not pastures.

On the other hand, wood collection activities are not carried out within the project boundary. As a result, such wood collection activities will not be displaced.

E.5.1. If applicable, please describe the data and information that will be collected in order to monitor leakage of the proposed A/R CDM project activity:

Table 44. Necessary variables to monitor leakage

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of data points	Comment
3.1.01	*44/12*	Dimensionless	Universal constant	-	-	Molecular ratio
3.1.02	*aLKNGL*	t CO_2 -e. $animal^{-1}$	c	Before at start of the project	100 % of the plots	NA. The Project does not consider leakage from displacement.
3.1.03	*aLKXGL*	t CO_2 -e. $animal^{-1}$	c	Before at start of the project	100 % of the plots	NA. The Project does not consider leakage from displacement.
3.1.05	*BEF2*	Dimensionless	e	5 year	100%	NA. The Project does not consider leakage from displacement
3.1.06	*c*	Dimensionless	Defined	Years 0, 1 and 5		The Project does not consider leakage from displacement
3.1.07	*CFj*	t C (t d.m.)$^{-1}$	e	Once per species or group of species	100%	The Project does not consider leakage from displacement
3.1.08	*CSi*	t CO_2-e. ha^{-1}	m	Years 0, 1 and 5	100%	The Project does not consider leakage from displacement
3.1.09	*CS*	t CO_2-e. ha^{-1}	m	Years 0, 1 and 5	100%	The Project does not consider leakage from displacement
3.1.11	*Dj*	t d.m. m^{-3}	e	5 years	100 %	NA. Cattle will rotate in the areas of the Project and will not be displaced outside the project.
3.1.12	*dNaEGLt*	Dimensionless	c	yearly	100%	NA. Cattle will rotate in the areas of the Project and will not be displaced outside the project.
3.1.13	*dNaNGLt*	Dimensionless	c	yearly	100%	NA. Cattle will rotate in the areas of the Project and will not be displaced outside the project.

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of data points	Comment
3.1.14	*dNaXGLt*	Dimensionless	c	yearly	100%	NA. Cattle will rotate in the areas of the Project and will not be displaced outside the project.
3.1.17	*FGAR,t*	m^3 yr^{-1}	m	yearly	100%	NA. This activity will not be carried out within the Project boundary.
3.1.18	*FGBL*	m^3 yr^{-1}	e	yearly	100%	NA. This activity will not be carried out within the Project boundary.
3.1.19	*FGNGL,t*	m^3 yr^{-1}	m	yearly	100%	NA. This activity will not be carried out within the Project boundary.
3.1.20	*FGoutside,t*	m^3 yr^{-1}	c	Yearly	100%	NA. Displacement of this activity is not foreseen, as it has not been observed within the area of the e Project.
3.1.21	*FGt*	m^3 yr^{-1}	c	Yearly	100%	NA. Displacement of this activity is not foreseen, as it has not been observed within the area of the e Project.
3.1.22	*FNRP*	Dimensionless	m	5 years	100%	NA. Cattle will rotate in the areas of the Project and will not be displaced outside the project.
3.1.24	*hh*		Defined	Years 0, 1 and 5	100%	NA. Cattle will rotate in the areas of the Project and will not be displaced outside the project.
3.1.25	*i*	Dimensionless	Defined	Years 0, 1 and 5		NA. It is assumed that displacement of these activities will not occur.
3.1.26	*IAChi*	ha	m	Years 0, 1 and 5	100%	NA. It is assumed that displacement of these activities will not occur.
3.1.27	*IAChci*	ha	m	Years 0, 1 and 5	100%	NA. It is assumed that displacement of these activities will not occur.
3.1.29	*LK*	t CO_2-e.	c	Yearly	100%	Only considers leakage from the use of vehicles.
3.1.30	*LK fuel-wood*	t CO_2-e.	c	Yearly	100%	NA. This activity is not considered in leakage.

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of data points	Comment
3.1.31	*LKActivityDisplacement*	t CO_2-e.	c	Yearly	100%	NA. This activity is not considered in leakage.
3.1.32	*LKconversion*	t CO_2-e.	c	Yearly	100%	NA. This activity is not considered in leakage.
3.1.33	*LKconv-graz*	t CO_2-e.	c	Yearly	100%	NA. This activity is not considered in leakage.
3.1.34	*LKconv-crop*	t CO_2-e.	c	Years 0, 1 and 5	100%	NA. This activity is not considered in leakage.
3.1.35	*LKconv-crop,c*	t CO_2-e.	c	Years 0, 1 and 5	100%	NA. This activity is not considered in leakage.
3.1.37	*LKNGL*	t CO_2-e.	c	Yearly	100%	NA. Cattle will rotate in the areas of the Project and will not be displaced outside the project.
3.1.42	*LKXGL*	t CO_2-e.	c	Yearly	100%	Cattle will rotate in the areas of the Project and will not be displaced outside the project.
3.1.43	*NaAR,t*	dimensionless	m	Yearly	100%	Cattle will rotate in the areas of the Project and will not be displaced outside the project.
3.1.44	*NaBL*	dimensionless	m	Yearly	Ex ante in AR-CDMPDD	Es estimated in the ex ante calculations.
3.1.45	*NaEGL,t*	dimensionless	m	Yearly	-	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.46	*NaEGL,t=1*	dimensionless	m	Yearly	Ex ante in AR-CDMPDD	Is presented in the calculations of the PDD.
3.1.47	*NaNGL,t*	dimensionless	m	Yearly	-	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.48	*NaNGL,t=1*	dimensionless	m	Yearly	Ex ante in AR-CDMPDD	Is presented in the calculations of the PDD.
3.1.49	*Naoutside,t*	dimensionless	m	Yearly	-	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.52	*SF*	dimensionless	c	Yearly	-	NA. Monitoring of this component is not planned, as displacement is not expected.

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of data points	Comment
3.1.53	*SFc*	dimensionless	c	Yearly	-	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.54	*SFREGL*	dimensionless	Defined using statistical criteria	Ex-ante	-	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.55	*SFRNGL*	dimensionless	Defined using statistical criteria	Ex-ante	-	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.56	*SFRP*	dimensionless	Defined using statistical criteria	Ex-ante	-	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.57	*SFRPAfw*	dimensionless	Defined using statistical criteria	Ex-ante	-	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.58	*SFRPAga*	dimensionless	Defined using statistical criteria	Ex-ante	-	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.59	*SHH*	dimensionless	Defined	Year 0	-	Include in the estimations of the PDD.
3.1.60	*SHHc*	dimensionless	Defined	Year 0	10% of communities (or at least 10), 10% of households per community or at least10	NA. Monitoring of this component is not planned, as displacement is not expected.
3.1.61	*TACP*	ha	m	Year 0	10% or at least 30 households	Was evaluated in the ex ante phase.
3.1.62	*TACPc*	ha	m	Year 0	10% or at least 30 households	Was evaluated in the ex ante phase.
3.1.63	*TACPh*	ha	m	Year 0	10% or at least 30 households	Was evaluated in the ex ante phase.
3.1.64	*TNHH*	dimensionless	m	Year 0	10% or at least 30 households	Was evaluated in the ex ante phase.
3.1.65	*TNHHc*	dimensionless	m	Year 0	10% or at least 30 households	Was evaluated in the ex ante phase.

E.5.2. Specify the procedures for the periodic review of implementation of activities and measures to minimize leakage, if required by the selected approved methodology:

NA, See section A.5.6 and D.2

E.6. Provide any additional quality control (QC) and quality assurance (QA) procedures undertaken for data monitored not included in section E.1.3:

For surveys and data collection on field, technical personnel (engineers or foresters) and with experience in forest inventory will be hired. They will follow the guidelines established in the monitoring plan. The field staff and those in charge of digitizing the information will establish training processes in order to deliver the information clearly and consistent according to the process, protocols and standards. In the monitoring process, control lines will be established to identify the responsible persons at each level of the process (Figure 19).

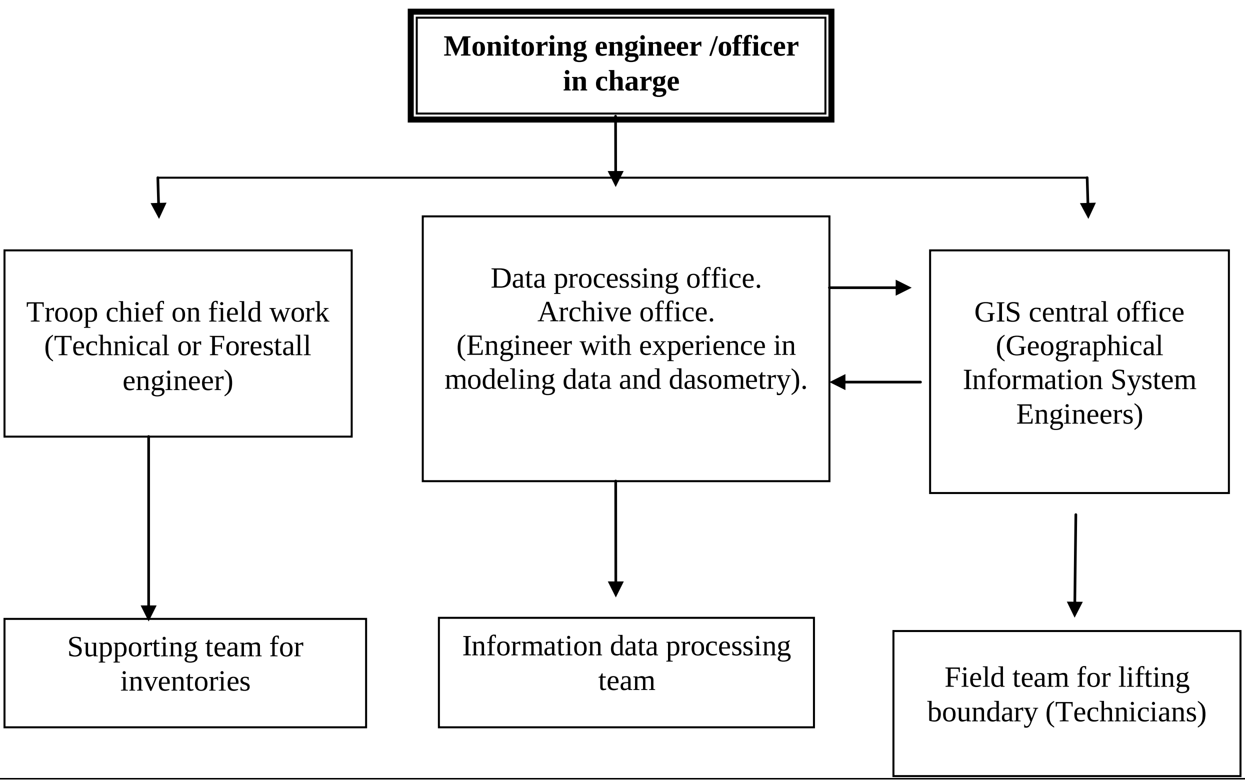

Figure 19. Proposed hierarchical framework: Responsibilities in quality control of information project's.

For verification of the proper procedures in making field data, will follow the processes defined in the methodology.

Identification of measurement errors

This audit procedure consists of carrying out a subsequent verification of the data obtained from the forest inventory or monitoring, and shall have the following characteristics and steps:

- ✓ It shall be performed by different personnel from that carrying out the inventory, which shall be characterized by a wide experience in forest inventory procedures and
- ✓ Between 10 and 20% of the total plots of land established in the forest inventory shall be included.
- ✓ The instruments used must have similar characteristics to those used in the initial inventory.
- ✓ The measurement procedures shall be adjusted according to the steps established in the measurement protocol with which the personnel was trained:
  - Location of the plots
  - Survey of the plots
  - Measurement of chest height diameters (chd) and total heights.
- ✓ Compare the information obtained with the original information gathered by the forest inventory crews.
- ✓ Error identification. This is done by comparing both pieces of information (original and audit inventory) in a paired manner.
- ✓ Should any errors be identified, these will be corrected and recorded, expressed as a percentage of all plots remedied, in order to obtain an estimate of the measurement error. According to Pearson *et al* (2005), the estimate error is given by:

$$Measurement\ error\% = \frac{Biomass_{Before\ corrections} - Biomass_{after\ corections}}{Biomass_{after\ corrections}}\ x\ 100$$

The permissible error must not exceed 5%. Otherwise, the remediation of all plots of land must be carried out.

Verification of data entry and analysis

Data transcription is a determinant factor in the quality of information from field, so this should be developed by qualified and trained staff. They will be in charge of typing all information to digital spreadsheets, and then, this information will be given to the responsible people for the analysis and modeling.

In order to detect errors in the transcription of data into the spreadsheets, a different person from the one in charge of initially entering the data, shall enter between 10 and 15% of the field forms into an additional spreadsheet. The results of both calculations (original and audit) are compared to detect errors. Any error observed shall be corrected in the original file.

Estimate of the data entry error

$$Mesurement\ error(\%) = \frac{Number\ of\ errors\ checked\ sample}{Total\ number\ checked}\ x\ 100$$

If an error greater than 10% is detected, the data on the field forms must be reentered into the digital form. Subsequently, the estimates made will be compared against data external to the project, but with similar activity conditions (literature information, forest inventories in adjacent areas, etc.), in order to verify the presence of errors or strange data.

In order to correct inconsistencies or doubts based on the analyses, the persons involved in the inventory and typing data, will be in permanent contact. ONF Andina is in charge of monitoring and verifying the correct procedure of workers responsible of obtaining and processing the information and basic data.

A report on the inconsistencies and errors observed during the analysis process shall be prepared and these must be reported to the project proponent in order for said situations to be corrected in subsequent monitoring.

Uncertainty.

The uncertainties are associated to the lack of methodology rigor's at the moment to realize removal/emission assessments, errors to equation adjustment, statistic methods application, and natural variability, among others. Following the methodological procedure and according to the GPG, the possible sources of uncertainty should be identified, characterized and valuated.

According to GPG, the sources of errors and their uncertainty grade depend on value’s sources. Therefore, uncertainties from Tier 1 are related with values established by default (this are frequent use, when there is no available information from the specific project area). Uncertainties from Tier 2, which are characterized to a lower uncertainty valuation, given that come from for a real estimations made by the project.

The Project proposal, will concentrate efforts in mitigating at a greater degree, the eight most important sources of error identified by the IPCC and characterized in the GPG (2006)[223], these are:

1- *Lack of exhaustively*
2- *Adjusted model type*
3- *Lack of data*
4- *Lack of collect information’s representation*
5- *Statistical sampling random error*
6- *Measuring error*
7- *Reports generation or erroneous classification*
8- *Missing information’s*

The quality control processes will try to decrease the uncertainty degree, calculated with the equations 5.2.1 y 5.2.2 of the GBP (2000) according with a level 1 uncertainty estimate.

[223] Directrices del IPCC de 2006 para los inventarios nacionales de gases de efecto invernadero.

The quality control processes are trying to achieve decrease the uncertainty grade, which one is calculated with equation 5,2,1 y 5,2,2 from GPG (2000), based on a uncertainty estimation Tier 1

The uncertainty for each species in each stratum can be estimated from re-measurement of randomly selected plots and/or from the measurement of replicate plots. Uncertainties will be estimated and expressed as half the 95% confidence interval width divided by the estimated value,

$$U_s(\%) = \frac{\frac{1}{2}(95\% ConfidenceIntervalWith)}{\mu} \cdot 100$$
$$= \frac{\frac{1}{2}(4\sigma)}{\mu} \cdot 100$$

Where :
Us = percentage uncertainty of each species within sub-stratum, %
μ = mean value
σ = standard deviation

If the default parameters are used, uncertainty will be higher than if locally measured parameters are used, and can be only roughly estimated with expert judgment. The percentage uncertainties on quantities that are the product of several terms are then estimated using the following equation:

$$U_S = \sqrt{U_1^2 + U_2^2 + \cdots U_n^2}$$ Ec 5,2,1 GPG (2000)

Where :
US percentage uncertainty of product (emission by sources or removal by sinks);
Ui percentage uncertainties associated with each term of the product (parameters and activity data),*i* = 1,2,…,*n*

The percentage uncertainty on quantities that are the sum or difference of several terms can be estimated using following simple error propagation equation

$$U_c = \frac{\sqrt{(U_{s1} \cdot C_{s1})^2 + (U_{s2} \cdot C_{s2})^2 + \cdots + (U_{sn} \cdot C_{sn})^2}}{|C_{s1} + C_{s2} + \cdots + C_{sn}|}$$ Ec 5,2,2 GPG (2000)

Where :
Uc = combined percentage uncertainty of sub-stratum, %
Usi = percentage uncertainty of species *i* in the sub-stratum, %
Csi = mean carbon stock of species *i* in the sub-stratum

The stratum and total percentage uncertainties are further combined in the same way as above.

Table 45. Quality control (QC) and quality assurance (QA) procedures

Data (Indicate table and ID number e.g. 3.-1.; 3.2.)	Uncertainty Tier of data (High/Medium/Low)	**Explain QA/QC procedures planned for these data, or why such procedures are not necessary.**
Table 42. ID 2.1.1.52 Plot Location	Low	The use of GPS will ensure a random verification of the monitoring plots for changes in carbon contents in the project.
Table 42. ID 2.1.1.50 Stratum ID	Medium	Is determined by the species and forest activities.
Table 37. ID E.1.2.06 Tree species	Low	Random verification in the project boundary, ensuring that the types of tree species planted are well estimated.
Table 37. ID E.1.2.08 Date of planting	Low	Random verification in the project boundary that the plantation age is correctly determined.
Table 42. ID 2.1.1.64 Number of trees	Low	Random verification of the plots of land
Table 42. ID 2.1.1.28 Diameter at breast height (DBH)	Low	Random verification of the plots of land. Several plots of land are selected and various diameters are measured, enabling their comparison against the records and finding possible measurement errors. The re-measurement of a portion of the individuals will be promoted after completing the measurement of each plot of land.
Table 42. ID 2.1.1.29 Wood density	Low	The density values of the species planted will be estimated and compared against those initially established in the project and, if such were the case, said values will be replaced.
Table 42. ID 2.1.1.23 and 2.1.1.24 Carbon fraction present in the biomass.	Low	Value established by default by the IPCC which may be verified
Table 42. ID 2.1.1.05 Root -shoot biomass ratio	Low	Value established by default by the IPCC which may be verified

Some default values established by the IPCC, has their uncertainty estimations, which are used when it is impossibility to count on these parameters valuation inside the project[224].

- Above-ground volume increment of existing woody vegetation: 50%;
- Above-ground biomass increment of existing woody vegetation: 50%;
- Above-ground biomass of existing woody vegetation: 50%;
- *BEFs* of existing woody vegetation based on biomass stocks: -40% below the mean to +100% above;
- *BEFs* of existing woody vegetation based on increment in biomass stocks: 10%;
- Root:shoot ratios for use in estimation of below-ground biomass: 35% for both trees and shrubs.

[224] EB 50 Annex 23.

The previous approximations intrinsically have other parameters that generate uncertainty, like: DAP, height, wood density and the carbon content, which likewise will be measured by the project in order to decrease its uncertainty grade or in the opposite case (for values of difficult measurement), the updated values from IPCC will be used.

E.7. Please describe the operational and management structure(s) that the project operator will implement in order to monitor actual GHG removals by sinks and any leakage generated by the proposed A/R CDM project activity:

CORMAGDALENA and A.W. FABER CASTELL & T.H. REFORESTATION S.A.S dispose of field teams in permanence in the project area. They will be in charge to monitor data from permanent plots and all other relevant data to be monitored. It is done following the QA/QC procedures detailed in section E.1.2 of the present PDD.

ONFI be responsible for training and supervising field teams will, and also responsible to receive, organize, store and analyze all monitoring information.

E.8. Name of person(s)/entity(ies) applying the monitoring plan:

ONF International – ONF Andina

SECTION F. Environmental impacts of the proposed A/R CDM project activity:

F.1. Documentation on the analysis of the environmental impacts, including impacts on biodiversity and natural ecosystems, and impacts outside the project boundary of the proposed A/R CDM project activity:

Environmental concerns into the project area

In the national context, the Colombian Caribbean region is the one with less forest coverage, this happens because the region has had a process of intense deterioration. The Colombian Caribbean is the ecosystem that has withstood the biggest transformation of the natural resources because of the productive and extractive systems. Besides, this region has been the receiver of the biggest part of the effects of anthropic processes occurred in the Andean Region[225].

In the region, the predominant plant coverages have produced diverse ecosystems such as dry tropical forests, xerophytic formations and marshes. Dry forests have been almost completely used, and there are some relic which compose the genetic data *in situ*. The benefits these ecosystems provide are associated to the soil protection in rainy seasons. Paradoxically, the rainfall intensity is higher in these environment types. Consequently, the effects of the superficial erosion rates increase dramatically on the vegetation deterioration. This increase in the superficial erosion rates is reflected on the sedimentation that swamps and rivers suffer (FAO 2002)[226].

The process of soil deterioration in the region is significant, because of the cattle grazing activity and the intense natural forest explotation. The lack of forest coverage in the region generates a very important erosion process with the loss of soil and organic matter. Because of such loss, disturbances on the water cycle are generated[227].

Besides the erosion, the cattle grazing activity has other negative impacts, such as: compactation of soil, single-crop farming grass and genetic uniformity; the elimination of plant succesion by chemicals means (herbicides) or physical products; wetland drying; the increasing demand of wood for fencing and corrals, to handle water and soil contamination caused by synthetic fertilizers and pesticides (Cazaux 2003)[228].

In this context, the deterioration processes have dramatically reduced the seaworthiness in the Magdalena River. This lack of seaworthiness has been traumatic for the population and has stopped the economical

[225] FAO, 2002. Estado de la Información Forestal en Colombia. Monografías de países. Vol 5.

[226] FAO, 2002.Op. cit.

[227] ONF Andina, 2004. Elaboración de un catálogo de proyectos de manejo sostenible de los recursos naturales y de lucha contra el efecto invernadero en Azerbaidjan, Chili, Colombia y Gabón. Reforestación de pastos en la región del Magdalena Bajo. Informe final – agosto 2004.

[228] Cazaux, 2003. Restricciones y motivaciones de los ganaderos al proyecto de reforestación comercial de CORMAGADALENA. ONF Internacional, CORMAGDALENA, SCIENCES PO.

development in the region[229]. At the same time, this deteration process has taken the department of Magdalena to be the third department with the highest area in process of desertification in the country[230].

The forest plantations to be established on the project area will contribute in a tangible way to moderate the environmental impact, resulting from the cattle grazing activity and the exploitation of the wooded areas. At the same time, strategies to take advantage of the sustainable use of the resources can be implemented in these plantations. Some of the benefits that can be obtained are:

Soils

- The reconstruction of a minimal forest layer in the regions ecologically unstable, where pastures and scrublands are predominant. This, will generate a diversity in the ecological environment, and will guarantee the preservation of edaphic resources, and will reduce the erosion processes. These aspects will help the regulation of hydrological cycle and contribute reduce the risk of potential desertification.
- The stabilization of soil against all erosion types. It is expected the improvement of the soil texture (contribution in the nitrogen and organic matter), and a better rainwater infiltration. This will be reflected on a better hydric reserve which is necessary for the expansion of the vegetation[231].
- When permanent forest coverage is available, the conditions are appropriate for the accumulation of organic matter in the soil, which in time will be part of it.
- The forest roots system increases the porosity of the soil, improves the composition of the soils and improves their internal and superficial structure.

Water

As stated Waterloo (2002)[232], slash and burn activities common periodic in agricultural processes, implies afterwards, the establishment of an unproductive regeneration of weeds or pastures. This is the scenario presented in the project area, as detailed in section A.7., C.2. among others. The impact on soil and water is accented with slash and burn activities in a region characterized by low rainfall and by having a dry climate (Dufour, 2005[233]).

In terms of change in land coverage for these ecosystems, from pastures and stubbles to areas with forest cover, is undoubtedly generating changes in water cycles. Some authors emphasize the negative impacts

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[229] Payen, 2003. Informe de presentación del Proyecto FFEM Control de la erosión y de la sedimentación de origen antrópico y sus efectos sobre los ecosistemas fluviales y lacustres del Magdalena y su zona de influencia, incluyendo la zona costera Caribe. pag 8-9

[230] Vargas y Gómez, 2003. La desertificación en Colombia y el cambio global. Cuadernos de geografía. XII (1-2) pag 121-134.

[231] ONF Andina, 2004. Op. Cit.

[232] Waterloo, M.J. 2002.Water and Dinamics of *Pinus caribaea* plantation forest on former grassland soils in southwest Viti Levu, Fiji. 462 pg.

[233] Dufour, 2005. Reboisement Commercial dans la Région du Magdalena Bajo, Colombie. La Composante Carbone: Niveau de référence et plan de surveillance. Mémoire de Mastère ENGREF. ONF International.

of tree crops can generate in the water cycle[234] and even more, with eucalyptus and pine species in dry lands[235]. For Colombia, there are few studies carried out in order to identify water yields and the decreasing behavior by land use change from pastures to reforestation and much less in arid areas. However, referring to the study by Waterloo, which assessed the impacts of the conversion from pasture to *Pinus caribaea* afforestation in an arid region of the Fiji Islands. He determined that in fact, tree crops increase evaporation and decrease amount of water reaching the soil due to the interception of the leaves and as well, the impact on water yields would be more pronounced during periods of lower rainfall or dry periods.

However, he highlights the importance of hedges for erosion control, which is generated during the rainy season in areas without vegetation or herbaceous vegetation. Malagnoux *et al*. (2007)[236], show the importance for soil protection in regions with arid to semi-arid lands, with forest coverage and more in those where they are subjected to high-impact activities on the ground, like cattle. He also, highlights that the trees should be planted only in areas where planting is necessary and possible, and in the time when is required. This has been the case with the formation of forest nucleus in the region of Magdalena Bajo Seco, thus, the benefits of forest plantations in the project region include:

- The vegetation coverage reduces the direct action of factors such as the wind and water in the transport of sediment. With the soil structure improvement and the internal and external drainage, an improvement on the water infiltration process is expected. As a result, the absorption of the root in plants will be improved, and a contribution to the water-bearing reserves and ground water level will be provided, which will regulate the hydrological cycle.

As has been detailed (see Section A.5.1), Magdalena Bajo Seco region, is clearly influenced by a number of water sources, and there, the most important river of Colombia (Río Magdalena) is crossing it. In addition, around the project, there is a complex of marshes of medium to large size (Figure 6), which sustain fishing activities and provide resources to the people of the region. Water deficit has been one of the constraints to the establishment of agricultural activities, fir this situation, is possibly there are abundant grassland and livestock in the region. Actions such as the construction of the irrigation district to the north of Magdalena department has been resolving in part this problem, and, it allowed the establishment of regional agricultural activities (Cormagdalena, *s.f.*[237], National Planning Department, 2007[238]).

Without doubts, impacts are bigger when villages are near the project areas and those depend on water from watersheds for their livelihood. This is the case of the Magdalena Bajo Seco.

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[234] Pérez, C. 2007. Plantaciones forestales e impactos sobre el ciclo del agua. Un análisis a partir del desarrollo de las plantaciones forestales en Uruguay. 56 pg.

[235] Waterloo, M.J. 2002. Op. Cit.

[236] Malagnoux, M. E.H. Sène y N. Atzmon. 2007. Bosques, árboles y agua en las tierras áridas: un equilibrio delicado. Organización de las Naciones Unidas para la Agricultura y la Alimentación FAO. Unasilva Vol 54:4. Pág 24-29.

[237] Corporación Autónoma Regional del río Grande de la Magdalena - Cormagdalena. Visión Colombia 2019: Colombia segundo centenario. 25 pág.

[238] Departamento Nacional de Planeación. 2007. Agenda Interna para la Productividad y la Competitividad. Documento regional, Magdalena. 52 pág.

The project, despite of commercial reforestation is not distributed in masses or large nuclei, by contrast, is spread over several municipalities. This reduces water impacts. Additionally, due to the high water requirements for the establishment of the fire controls of the forests, the project has spawned a network of artificial lakes (*jagüey*) in the seeded areas, which raises the available water reserves, even for the inhabitants of the region (Figure 20). Thus, despite displaying some effects of plantations on water yield, this does not appear as a threat, much less a major impact on the environment of the project area. By contrast, it has brought benefits to people who do not have either technical, economic or government support for the construction of these reservoirs. Therefore, in terms of water resources impacts, the project generates low importance impacts for the region.

Figure 20. A. natural *Laguna* at the collection point of timber produced in the project. This realizes the availability of water in natural water sinks. B. Artificial lakes (*Jagüey*) established within the forest area planted in the project proposal.

Biodiversity

- The loss of biodiversity in the project comes from the extinction of natural forest that provides shelter to the flora and fauna. It is expected that the settlement of plantations that will be established on the project activity will serve as belts in the remaining wooded areas. Actually, the plantations will have role of shelter and fauna road (the creation of a secure environment for the continuity of natural forest).
- In comparison to the pasture areas, the forest plantations offer better food resources and shelter for the native fauna. The implementation of a small understory in the plantations can generate conditions of shadow, relative humidity, winds, grazing, zoochorous dispersion and weeds control, among others.[239] Consequently, the understory can become in shelter for the species that cannot live in open areas (ONFA 2004). Similarly, it is expected that the appearance of a small understory the floristic diversity under the plantation shows an increase (CONIF 2000b)[240].

[239] ONF Andina, 2004. Op. Cit.

[240] CONIF, 2000b. Impacto Ambiental de las Plantaciones Forestales. Síntesis de resultados: 1996-2000. Serie Técnica No 47.

- The woodcutting and prunning activities plus the existent of the same plantation are beneficial for the local flora and fauna. These activities generate a bigger structure and diversity in the forest ecosystem. In general, the existence of an adequate handled forest plantation help in the presence and consolidation of the local biota, in comparison to the cattle grazing activity (CONIF 2000)[241].

- It is evident that fallow areas have a specific biodiversity; that is associated to the microclimate and environmental conditions existing in this coverage; however, periodic cutting and burning activities, which are part of the common agricultural practices of the region of the project activity, generate a subsequent establishment of an unproductive weed or grazing land regeneration[242].

  Also this is confirmed by the tendency of land use, showing that in the region, the areas of clean pastures, degraded lands and mosaic tend to increase, whereas the areas that eventually could start a sucessional process (pastures with fallows and fallows) have a tendency to decrease (see Section C.5.1).

  In spite of the large debate concerning the possible environmental effects caused by some foreign species (pine, eucalyptus), it has been established, as a general point of view, that the ecosystem processes, occurring within the commercial plantation of these kind, principally depend on the management submitted to. Therefore, no evidences are reported concerning the erosive o biodiversity loss processes in these forestall systems and, on the contrary, it is stated that in comparison with witness plots from damaged areas, theses parameters are positively affected in the above mentioned plantations[243].

  Finally, Sicard and Palacios (2005)[244] conclude that the general effect of the reforestation processes results to be positive for biodiversity as a whole, when they are executed in damaged areas or in course of degradation, like is the case of the project proposal.

Natural Forests

- The local communities still exploit the natural forest wood for firewood, stakes and wood for small constructions. The project activity will supply the local wood trade, the pruning activities, in particular. This will have an impact on the reduction in deforestation rate of the residual biomass[245]. The project activity will lower the pressure on the natural forest that remain in the region, and in all the related diversity (ONFA 2004).

On a global scale, the main impact of the commercial reforestation program in the Magdalena Bajo Seco will be on the CO_2 collection, estimated to be around 32,966 tCO_2/year.

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241 CONIF, 2000.Op. Cit.

242 Waterloo, M.J. 2002. Op. Cit.

243 Sicard, T. L. y Palacios, M. T. 2005. Incorporación de consideraciones de biodiversidad en política sectorial agropecuaria. Instituto de Investigación de recursos Biológicos Alexander von Humboldt. Bogotá, Colombia. Pg: 122-123.

244 Sicard, T. L. y Palacios, M. T. 2005. Op. Cit.

245 ONF Andina, 2004. Op. Cit.

Within the project frame: "Estudio de factibilidad del proyecto forestal en áreas ecológicas estratégicas" (Feasibility analysis of the forest project in strategic ecological areas), an analysis of the environmental impact on the establishment of the forest plantations. The baseline activities of this project were agriculture and extensive cattle grazing. Therefore, in such analysis the impact of plantations and the impact of the agriculture and extensive cattle grazing were evaluated. [246]

In the anaalysis above mentioned (See Table 46), the cattle grazing activity has a higher negative impact (-42). When the cattle grazing activity is intensified (higher number of stock heads per are unit), the impact is less negative (-35). On the other side, in the forest activity the impact value is -7 (including the activities of harvest plantation). This means that the impact on the plantations is less in comparison to the cattle grazing activity. Besides, the social-economical aspect of the reforestation activity has a positive impact in comparison to the cattle grazing activity (178 against 20) (See Table 46)

Finally, it is well-known that forest plantations are strategic to increase the production and employment of rural marginalized areas. Also, such plantations contribute to the environmental land zoning and basins, and to the maintenance of ecological processes. Besides, the forest plantations have a fundamental function in the production of renewable energy, supply of raw materials, expansion in the demand of wood sources and the social-economical development of the country[247].

To conclude, the negative impacts arising from the baseline activities, the historical use of soil and the inappropriate practices in the region have caused an intensive deterioration process. Such impact can be lowered with the settlement of forest plantations within the project activity.

Fire risk

According to IDEAM – CONIF, 2009[248], for municipalities where the project is located, the total fire risk of land cover during "El Niño" phenomenon, is low and very low, specialty to areas nearby the Magdalena River and other water bodies, and in the other areas, the risk are high and very high[249].

Under the project activity, fire protection develops from avoidance/prevention activities: Firewalls building and annual maintenances, periodic cleaning, plantation monitoring to reduce and eliminate flammable materials, dam construction (small damming), educational activities towards fire risk and acquisition and maintenance of tools and necessary machinery for fire mitigation. Finally, fire managing and control activities for fires when they happen[250].

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[246] Consorcio ONFI – Ecoforest, 2006a. Estudio de factibilidad del proyecto forestal en Áreas Ecológicas estratégicas: Draft CDM_AR_PDD Zambrano. Pag 66 – 75.

[247] Colombia, 1996. Política de bosques. Documento CONPES No. 2834. Minambiente - DNP: UPA. Santafé de Bogotá, enero de 1996.

[248] IDEAM – CONIF, 2009 En proceso de publicación. Mapa nacional de zonificación de riesgo a incendios de la cobertura vegetal.

[249] IDEAM – CONIF, 2009 conclusion's are in general for all types of vegetal coverage

[250] ONF Andina, 2010a. Protocolo de establecimiento y manejo de las plantaciones forestales comerciales en el marco del proyecto reforestación comercial de tierras dedicadas a actividades de ganadería extensiva en la región del magdalena bajo seco

Fitosanitary control

The plague and diseases illness constitute another risk during the establishment and the preservation of the forest plantation. Even if in the plantation in the tropical dry forest the activity of defoliators, until now, has not reached damaged in an economic level. Other minor problem could reach such condition instead of not taking the necessary measures of prevention o control[251].

Among the illnesses that could be present in the plantation, there is: dumping off and the attack from different defoliators (grasshoppers, caterpillars, worms and ants), insects (*atta sp y Phyllophaga sp*); also, the destruction of the root of seedlings of less than 3 years of age and attacks by borers at any age. Some rodents eat the bark of seedlings and young trees[252].

Pest and disease control activities are conducted periodically during the first years of the plantations, by application of fungicide at a dose of 10g per hectare and application of products against pests at a dose of 2kg per hectare (see section A.5.4).

As the plantations grow up, the risks of plague and diseases decrease, depending if the silvicultural practices are opportunely executed; these practices considered into the project activities, such as is: pruning, thinning and fertilization[253].

Under the project activity and during all the plantation life, its finosanitary status is monitored and defined as a result of periodic technical evaluations. If necessary, the execution of specific fitosanitary protection activities, are scheduled and executed through adjustment concerning the technical itinerary and with the assistance and supervision of the project field team[254].

[251] GOMEZ, 2002. Documento de diseño Proyecto Forestal FINAGRO. Versión aprobada por la Junta Directiva de FINAGRO. Establecimiento y manejo de plantaciones silvopastoriles comerciales en los departamentos del Cesar, Magdalena y sur de la Guajira, como medio para reactivar sosteniblemente la economía regional. Pag 18.

[252] CIRAD-Forêt, 2003. Capacidad del programa de reforestación comercial realizado en la zona Atlántica de Colombia de generar empleo y fomentar el desarrollo rural, desde la plantación hasta la transformación y comercialización de los productos. Consultoría para ONFI y CORMAGDALENA, Colombia.

[253] GOMEZ, 2002. Op Cit. Pag 28

[254] ONF Andina, 2010a. Op Cit.

Table 46. Matrix for the evaluation of the environ-mental impacts of the baseline scenario and project activity

Environmental Components	Environmental Impacts	Baseline	Project												Total of project
		Extensive cattle grazing	Intensive cattle grazing	Reforestation											
		Activities													
		1	1	2	3	4	5	6	7	8	9	10	11	12	
Atmosphere	Physical matter in the atmosphere				-0,5	-0,5								-0,3	-1,3
	Chemical matter in the atmosphere	-1,7	-1,6	-0,1							-1,1				-2,8
	Gases in the atmosphere	-2,0	-1,8			-0,7	-0,2	5,1	-0,4	-0,4	-1,1	-1,1	-0,7	-0,5	-1,8
Soils	Soil losing or adding	-5,2	-4,4		-0,7	-0,7		2,2					-0,7		-4,3
	Chemical quality of soils	-2,0	-1,8			-0,7	1,1	2,2	1,1	0,4	-1,1				1,2
	Physical quality of soils	-4,1	-3,6		-0,2	-1,1		2,6							-2,3
	Biological quality of soils	-2,6	-2,0		-0,2	-1,1	0,7	2,6	1,1	0,4	-1,1		-0,7		-0,3
	Water accessibility in soils	-2,6	-2,0			-0,7		2,2					-0,7		-1,2
Water	Water regulation	-2,6	-2,0			-0,7		2,2					-0,7		-1,2
	Physical quality of superficial waters				-0,2	-0,1									-0,3
	Chemical quality of superficial waters			-0,1		-0,1					-0,3				-0,5
	Chemical quality of underground waters										-0,4				-0,4
Flora and fauna	Shrubs, forbs and grasses	-7,9	-6,4		-7,3	-3,8	1,5	2,2	2,4	2,0	-1,0	-0,7	-1,0		-12,1
	Fauna species	-6,3	-5,1		-3,0	-3,0		2,2	1,8	0,7	-1,0	-0,7	-1,0		-9,1
	Habitat and food supply	-5,2	-4,4		-2,2	-2,2	1,3	2,2	0,7	0,7	-1,0	-0,5	-1,0		-6,4
	Relictual forest and high fallows					-0,7									-0,7
Socio-economic factors	Farmer jobs	5,0	5,0	5,0	8,5	8,5	5,0	10,0	5,0	5,0	5,0	8,5	8,5	5,0	79,0
	Additional incomes for farmers	5,0	5,0										3,8		8,8
	Diversity of farming economic activities			3,0									3,8		6,8
	Technical knowledge to farmers			6,8	5,0	5,0	5,0	7,9	6,5	5,0	8,5	8,5	8,5		66,7
	Land ownership for farmers	10,0	10,0		10,0	6,5		10,0							36,5

Subtotal, activity impacts (non socio-economic component)	**-42**	**-35**	0	-14	-16	4	26	7	4	-8	-3	-7	-1	**-7**
Subtotal, activity impacts (only socio-economic component)	20	20	15	24	20	10	28	12	10	14	17	25	5	178
Total of activity impacts	**-22**	**-15**	15	9	4	14	54	18	14	5	14	18	4	**169**

Activities			
1.	Cattle grazing/livestock	7.	Manual cleaning
2.	Vegetal matter yield	8.	Pruning
3.	Site preparation	9.	Pest and disease control
4.	Fencing, firebreaks and roads	10.	Plantation maintenance
5.	Organic fertilization	11.	Harvesting and sale of forest products
6	Plantation establishment	12.	Harvest transport

Source: Adapted from Consorcio ONFI – Ecoforest, 2006a. Estudio de factibilidad del proyecto forestal en Áreas Ecológicas estratégicas: Draft CDM_AR_PDD Zambrano. Pag 66 – 75.

F.2. If any negative impact is considered significant by the project participants or the host Party, a statement that project participants have undertaken an environmental impact assessment, in accordance with the procedures required by the host Party, including conclusions and all references to support documentation:

The expected negative environmental impacts of the implementation of the activities of project A/R CDM are considered not to be significant, and are even lower in reference to baseline activity (see section F1).

The present regulations of the Colombia Republic does not require environmental impact studies or environmental license for reforestation projects[255]. The timber harvesting, mobilization and construction of forest roads not requires authorization by the environmental authority[256].

F.3. Description of planned monitoring and remedial measures to address significant impacts referred to in section F.2. above:

NA

The environmental impact of the Project activity is globally positive, since it improves the environmental and socioeconomic conditions in the project area, owing to change in land use. Even the Colombian State, with in the CIF (Law 139/1994), recognize the positive reforestation externalities, meanwhile the environmental and social benefits generated would be appropriated by the whole population[257].

[255] Ministerio de Ambiente, Vivienda y Desarrollo Territorial, 2010. Decreto 2820 de 2010.

[256] República de Colombia, 2010. Ley 1377 de 2010

[257] República de Colombia, 1994. Ley 139 de 1994.

SECTION G. Socio-economic impacts of the proposed A/R CDM project activity:

G.1. Documentation on the analysis of the major socio-economic impacts, including impacts outside the project boundary of the proposed A/R CDM project activity:

Socioeconomic characteristics of the region

Population in the 6 municipalities of the project is around 150,000 inhabitants; an average population density of 41 inhabitants per km2. The region has been characterized by an important migratory flow from towns to the coastal cities, mainly Barranquilla, Cartagena, Santa Marta, among others. The per capita income level is quite modest, however, has important natural assets (communication facilitated by the Magdalena River and flat lands), combined with a certain stability of public order (Consorcio ONFI - Ecoforest 2006b[258]).

Population consists mostly of farmers who have "*fincas*" (rural property) of varying size, usually between 10 and 1000 ha, with the average size of 50 ha approximately.

Due to the low coverage of public services (basic facilities) in rural areas, rural population makes firewood collecting in the forest areas, for some domestic activities. Firewood consumption is estimated at 396 kg / year (33 kg / month) (section D.2).

Traditionally, Agriculture and livestock are the most important economical activities in the Magdalena department. Fishing, which could be a driving factor in local development, only practiced for subsistence. At farm level, the main crop is the banana that occupied 112,000 ha in 1973. Also, there are other important perennial crops: cotton, rice, maize, sorghum and sugarcane, coconut, banana and cocoa. However, in the project area, cattle grazing (livestock) is the dominant activity. Pastures occupy more than 70% of the land and extensive cattle ranching, is characterized by low stocking rates. Productions records show a low yield: 4 liters of milk per cow per day and weight gain of 380 (g/day) for calves. These modest yields are caused by the low technological level, use of rudimentary techniques and lack of information. In addition, a lack of activities such as genetic improvement, pasture rotation, dietary supplements during the dry season, among other (Consortium ONFI - Ecoforest 2006b [259]).

The land tenure is clearly defined for areas included into the project[260]. In the project area there isn´t presence of ethnic communities, either black communities or African descent[261], for which there is no archaeological or sacred sites that could be affected by the project.

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[258] Consorcio ONFI – Ecoforest, 2006b. Estudio de factibilidad del proyecto forestal en Áreas Ecológicas estratégicas: Plan de negocios para la expansión del núcleo forestal de CORMAGDALENA. Pag 64 - 67.

[259] Consorcio ONFI – Ecoforest, 2006b. Op. Cit.

[260] ONF Andina, 2010b. Base de datos de documentos tenencia y de contratos para los componentes forestal y carbono de la actividad de proyecto

[261] Ministerio del Interior y de Justicia de Colombia, 2010. Cartas de certificación de no presencia de comunidades indígenas y/o negras en el área del Proyecto MDL de "Reforestación comercial de tierras dedicadas a actividades de ganadería extensiva en la Región del Magdalena Bajo Seco"

The predominant religion in the project area is Catholicism, as well in the country. Commonly, the church and religious sites of concentration of catholics, are in the main square of the village or in the municipal head of each municipality.

From a cultural view, in general, restrictions are presented in the comprehensive development process, since no cultural activities aimed to highlighting the ancestral values and ancestral customs. The infrastructure for sport and recreation in rural areas is low. Commonly, religious celebrations and festivals are the most representative cultural and folklore expressions in the region. People still keep some dances and legends of great importance. However, despite the limitations noted, the region has a cultural potential. Within these values are remarkable poets, writers, composers, *decímeros*, dancers, singers, accordion players, guitar players, among others.

The architectural heritage is represented by elements that keep the town's architectural past. In infrastructure matter, there is a small place as functions as a municipal library, which has no endowment and matching technique to achieve the purpose of its existence[262, 263].

Problematical

During the 90s, the Caribbean region of Colombia was affected by the displacement of population, caused by the economical crisis and the internal armed conflict. Since 1996, the problem of violence got worse because of the expansion of the different armed illegal groups (CIPCUM)[264]. At that moment, this situation affected the social and the demographic composition in the rural and urban areas, in the country as well as the Caribbean (Pérez y Trujillo 2002). This situation had a direct impact in aspects such as poverty, education, development, among others.

In 2002, the Caribbean region was populated by the 36% of the displaced people in the country. Particularly, in Magdalena, the number of displaced families was 11.646, equivalent to 53.387 inhabitants (Pérez y Trujillo 2002)[265].

The municipalities that participated in the proposed project activity are not unaware of such circumstances. The displacement of rural population towards urban areas has increased the abandonment of lands. This has caused problems of invasion to lands that are not related to the agricultural or cattle grazing activities (CORPAMAG 2002)[266].

At an economical level, additionally, the extensive cattle grazing faced the risks of the specialized world markets. Such markets demand high quality products, with high technical requirements. The limited

[262] EOT Santa Bárbara de Pinto

[263] EOT El Piñón

[264] CIPCUM, *s.f.* Centro de Investigación para la Paz y la Convivencia, Universidad del Magdalena. http://cids.unimagdalena.edu.co/cipcum/subpages/justificacion.html

[265] Pérez y Trujillo, 2002. Reporte sobre el estado de la Región Caribe colombiana. Observatorio del Caribe Colombiano.

[266] CORPAMAG, 2002. Plan de Gestión Ambiental Regional del Magdalena 2002-2012. Corporación Autónoma Regional del Magdalena.

generation of income in relation to the extensive use of land was the result of the biological inefficiency and the lack of employment opportunities (Cazaux 2003)[267].

Subsequently, by the end of the year 2002 the peace process began with the illegal armed groups, and the statement of unilateral cease of hostilities (CIPCUM)[268], as well. This process has gradually allowed the landowners to go back to their lands, in search of reactivating their productivity.

The execution of the proposed project activity the Magdalena Bajo Seco region, represents new opportunities, benefits and options for the revival of the rural activities, the economic development and the inhabitant social empowering. In general, some of these benefits were identified by the ONFI – Ecoforest consortium 2006b[269]:

- The opportunity for the rural communities to go back to work to their lands and to reactivate their rural activities. The landowners will be able to improve the conditions of their lands by means of appropriate handling. However, this use of land does not imply the traditional productive activities to be totally and radically changed, since they are an important part of their culture.
- Mid and long term job opportunities, given the managing activities of the plantations require more people for the production of plant material, land conditioning, maintenance, harvests and commercialization of products, among others.
- The opportunity to improve their income, obtain a bigger profitability and with this the improvement in their existing living conditions.
- The possibility of social empowering, provided that new alliance opportunities are promoted between the landowners and the private and governmental entities. Such alliances facilitate the access to external opportunities for the landowners.
- Access to new technical knowledge concerning the forest activities provided by the community.
- The reforestation with commercial purposes may promote economical development of the municipalities involved. From this new market, transformation companies can be established and the new commerce will generate an increase in fluvial traffic. As a whole, this would promote river trade (Cazaux 2003)[270].

As it can be seen on the "Matrix of environmental impact of the baseline and project activities" (See Table 46, Section F), the forest activity has a positive a greater social-economical impact, regarding the baseline activities, mainly in the increase of job opportunities of the forest activity fosters the positive social-economical impact of the reforestation actitivity. The evaluation of the impact on the forest activity results in a positive value of 178 against 20 to cattle grazing activity.

The region of the project corresponds to wide areas far from the populated centers. One of the aspects that allow success in the cattle grazing activity is that it is not an activity that require the continue presence of staff. The reforestation project requires the permanent presence of population in rural areas. Such presence has a direct social and cultural impact in the region as well as in the country. Paradoxically, the

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[267] Cazaux 2003. Restricciones y motivaciones de los ganaderos frente al proyecto de reforestación comercial de CORMAGDALENA. ONF INTERNATIONAL, Santa Fé De Bogotá, Colombia.

[268] CIPCUM, *s.f.* Op. Cit.

[269] Consorcio ONFI – Ecoforest, 2006b. Op. Cit.

[270] Cazaux, 2003. Op. Cit.

criminal acts can be explained by the desolation of some areas where the government does not have a permanent presence. The repopulating of the areas related to the silviculture activities and the implementation of transformation *in situ*, can motivate the State to take back the power in such secluded areas[271].

Besides, workforce demand per area unit is higher in the forest activity regarding the cattle grazing activity. In the forest activity, 4 to 6 jobs are generated per ha (ONFA 2004). As a result, the opportunities of employment and higher job rates promote the prevention, and struggle against the insecurity. This means a restructuring of the social web and the improvement of the quality of life for the rural population.

In addition to this, the landowners can count on the possibility of diversifying the economic activities of their lands. If the owners intensify the cattle grazing activity, they will be able to have areas available for other uses. In the first stage, these systems will improve the competitiveness of the cattle grazing activity of the region. As a result, the improvement of such competitiveness will decrease the vulnerability to the variability of the forest and livestock market (ONFA 2004)[272]. The consequences are doubled: not only a productive forest chain is developed but also an improvement of livestock working conditions as well (Cazaux 2003)[273].

The forest development will benefit the construction and renovation of the basic structures (aqueduct, electricity, road network, sewer system, etc.). The existence of alternative activities related to the traditional livestock, will be beneficial for the settlement of population in the rural areas under acceptable conditions.

Complementary to the reforestation program, these activities intend to improve the agricultural techniques implemented in the region (genetic improvement, rotation and collection of pastures, automatization of activities, etc.), which also provide an economical development. The success of this project will reproduce the model in other areas inside and outside the Magdalena basin. This will contribute to empower the forest sector in a country with a great potential in this area.

The execution of divulgation, consensus and socialization activities of the project, promote the active participation of the community, which make possible the consolidation of unions among the landowners as well as the rise of new community leaders. Especially, regarding the CDM context and the environmental problems at a local and a global level, such events are part of the environmental education within the community. Since the beginning of the project, in the year 2000, the local coordination team set up a group of socialization activities of the project for the rural communities (ONFA 2004). Some landowners “reforesters” gradually considered as local leaders, shared their experiences with other landowners. This sharing of knowledge has consolidated the socialization processes of the project. Additionally, the participation of ONF International has benefited the transfer of technology and the academic and professional exchange as well (ONFA 2004).[274].

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271 Cazaux, 2003. Op. Cit.

272 ONF Andina, 2004. Elaboración de un catálogo de proyectos de manejo sostenible de los recursos naturales y de lucha contra el efecto invernadero en Azerbaidjan, Chili, Colombia y Gabón. Reforestación de pastos en la región del Magdalena Bajo. Informe final – agosto 2004.

273 Cazaux, 2003. Op. Cit.

274 ONF Andina, 2004. Op. Cit.

Finally, it is relevant to highlight that the positive social-economic impact of the project does not only involve the direct participants. Besides, the economic incentive, better life conditions, safety empowering, social web empowering and environmental awareness are provided within the project boundary.

G.2. If any negative impact is considered significant by the project participants or the host Party, a statement that project participants have undertaken a socio-economic impact assessment, in accordance with the procedures required by the host Party, including conclusions and all references to supporting documentation:

No negative impacts we identified on the socio-economic due to the implementation of the project (section G.1).

The present regulations of the Colombia republic do not require socio-economic impact studies for reforestation projects.

G.3. Description of planned monitoring and remedial measures to address significant impacts referred to in section G.2 above:

NA

SECTION H. Stakeholders' comments:

H.1. Brief description of how comments by local stakeholders have been invited and compiled:

>>

Comments on the proposed A/R CDM project activities by local stakeholders have been invited following four modalities as presented below.

- Local, national and international workshops

Some workshops, meetings and conferences have been organized by project participants from 2000 onward in order to sensitize stakeholders to the proposed A/R CDM project activities.

At local level, various meetings were organized from 2000 onward in different municipalities in order to (i) present the project, (ii) get feedback and comments once the project described, and (iii) meet landowners who could be potentially interested in participating to the proposed project activities.

Figure 21. Socialization of the project in the municipality of Piñón

At national level, a workshop was organized in Bogotá in 2003, and open to the public. Various institutions, companies and NGOs were invited (Colombian DNA, Colombian Ministry of Environment, University El Externado, French Embassy, the national institution for research and promotion of forest – CONIF, the centre of economic studies related to environment - CAEMA, etc.). Furthermore, the workshop was coupled to a field visit in the project area with the participants of the workshop.

Other workshops and conferences at regional scale represented opportunities to present the project and get feedback from the participants of these events.

The project was also presented at international level through workshops of the Latin-American Discussion Group on forests and climate change (GLAD-CC) in Buenos Aires (Argentina) and Lima (Perú). However, the comments invited through this modality were mostly informal by taking the form of discussions with international experts.

- Programmed interviews of local population

Another modality of the consultation process was to interview stakeholders directly. This modality was implemented in 2003[275] through a socio-economic study approaching also the motivations of local landowners to potentially participate to the proposed A/R CDM project activities, and the restrictions to the implementation of the project.

- Questionnaires

Another modality was to prepare questionnaire to get intermediary feedback after a few years of project implementation. The questionnaires were distributed by ONF Andina to all local stakeholders in the field and took back once the questionnaires fulfilled.

[275] Cazaux, 2003. Restricciones y motivaciones de los ganaderos frente al proyecto de reforestación comercial de CORMAGDALENA. ONF INTERNATIONAL, Santa Fé De Bogotá, Colombia.

The questionnaires pointed three main issues: (i) the perception of stakeholders about the project, including positive and negative issues (ii) the perception of stakeholders if their former suggestions were taken into account, and (iii) new suggestions.

- Not programmed interviews

The last modality took the form of spontaneous interviews since project start with people interested in participating, or not, in the proposed project activities, and looking for information on the project. These interviews, occurring with local stakeholders in the project area, were always the opportunity to get feedback regarding the proposed A/R CDM project activity once described.

The table below presents the various steps of consultation process close to local and national stakeholders, and abroad.

Table 47. Steps of consultation process close to local and national stakeholders, and abroad.

Source of data	***Modality***	***Date***	***N° requests/ participation***	***Archive***
Pool of Lands of project	The project carries out periodically (yearly, half yearly or quarterly) explanatory meetings and calls. The purpose of such meetings is to call the landowners who are interested in being part of the data in the bank of lands of the project. For the aspiring owners, in a specific period of time, a campaign towards the certification of soils and a legal analysis of the documentation of the possession of land is carried out.	From 2000 onward	Approximately 8.000 ha evaluated in the process "banco de tierras" of the project	ONF Andina - archived letters of application and land qualification studies
Socio-economic study in the project area	**Interviews** with landowners of the project area to determine their willingness to participate to the proposed A/R CDM project activities	October-November 2002	23 people interviewed	ONF Andina – archived a report was produced[276]

[276] Cazaux, 2003. Op. Cit.

Source of data	*Modality*	*Date*	*N° requests/ participation*	*Archive*
CDM Workshop in Bogotá and Zapayán	**Meeting** with national and local coordinators for a presentation of the project	May 2003	≈ 100 people	All the presentations of the workshop were summarized and archived by ONF International
Bi-regional Latin American seminar (Montevideo, Uruguay)	**Presentation** of the project to the Latin-American discussion group on forests and climate change	October, 28th 2004	61 people	Informal discussions on technical and methodological issues
Regional seminar on CDM (Neiva, province of Huila, Colombia)	**Conference**/presentation of the project to regional authorities and to the public	November, 2005	≈ 50 people	Presentation PowerPoint of the project
Latin-American seminar on CDM (Buenos Aires, Argentina)	**Presentation** of the project to the Latin-American discussion group on forests and climate change (GLAD-CC)	December, 12th 2005	≈ 30 people	Presentation PowerPoint of the project and report of the seminar archived by ONF International
Latin-American seminar on CDM (Lima, Peru)	**Discussions** related to the project with international experts on forests and climate change (Latin-American discussion group on forests and climate change – GLAD-CC)	March, 16th 2006	≈ 20 people	Informal discussions on methodological issues (AR-NM0030)
Integrated seminar on forest sciences (Ibague, province of Tolima, Colombia)	**Conference**/presentation of the project to the University of Tolima	April, 6th 2006	≈ 100 people	
Meetings for CDM component of the project	Presentation and negotiation of the CDM component of the project	2007, 2008 2009	≈ 70 people	ONF Andina – archived actas de reunión
Questionnaires to local project participants	A **questionnaire**, that had to be fulfilled, was given to project participant	2010	≈ 30 - 40 people	ONF Andina – archived all questionnaires

H.2. Summary of the comments received:

>>

1. From local and national consultation

The comments were received from interviews and local/regional workshops and gave mostly positive comments. The local consultation made by Cazaux in 2002[277] showed that 85% of consulted people were completely positive with the project. The others had some doubts or not enough information to answer. The various comments received could be divided in institutional, social and technical issues.

Institutional issues

[277] Cazaux, 2003. Op. Cit.

i. It was mentioned by many stakeholders a fear regarding the involvement of the State, as they have from their experience a perception of heavy inertia of the public bureaucracy;
ii. It was mentioned a lack of information regarding the proposed project activities. The project was not divulgated enough around project area;
iii. If their was the possibility to participate to the proposed project activities, most of stakeholders require transparency, in order to be informed of any change in the project and to give their opinion on possible options;
iv. The participation of the institutions has been very positive. The owners have expressed their confidence on such institutions, since they consider them as consolidated institutions committed to the development of the project.

Social issues

v. It was mentioned that the project would have positive impact by leading cattle breeders to act in group, and cooperate in front of the guerilla and robbery;
vi. As most of stakeholders were positive regarding the project, they proposed to transfer the information to other landowners in order to extend the proposed project activities to a maximum area; comment that was linked to the previous one;
vii. A main positive impact desired by stakeholders was the creation of employment in order to decrease exodus of young people towards cities;
viii. It was mentioned almost systematically that the project would be positive if it could lead to the improvement of cattle grazing activities and an increase of incomes;
ix. Some of the landowners have seen the environmental benefit that promotes this forest project. They recognize the environmental awareness promoted by the socialization of the project;
x. A great number of the stakeholders expect an improvement of the quality of life in the region by means of the increase in the productivity of lands plus their economic appreciation.

Technical issues

xi. Some fears raised from local stakeholders regarding the valorization or wood from forest plantations; something should be done to ensure this valorization for project participants;
xii. All local stakeholders recognized their lack of skills in forest activities and, in consequence, their doubts regarding the correct maintenance of forest plantations; participate to the proposed project activities would be better with permanent technical assistance in the field;
xiii. Due to the lack of forest culture in the region, the landowners are uncertain about the commercialization of forest products at the end of the term and also about the future of the lands after the harvest of the stands planted.
xiv. All stakeholders recognized that forest plantation is not just plant trees and wait for them to grow; it needs investment in time and financial resource they don’t have; some financial resource should be brought to be able to participate to the proposed project activities;
xv. Some potential problem with water could raise (period of dryness)
xvi. It was mentioned that the forest plantations could likely have problems with liana invasion.

2. From international consultation

The comments received from international consultation close to international experts mainly focus on methodological issues. The comments supported the necessity of developing a new A/R CDM baseline and monitoring methodology focusing on the issues regarding the control of the land by project participants, the pre-project activities (cattle grazing) and the related potential leakage.

H.3. Report on how due account was taken of any comments received:

>>
The process of consultation close to stakeholders led to take the following measures.

Institutional

- ONF International and ONF Andina, acting as project developer, coordinate the proposed project activities and relations between project participants (answer to i);
- Local workshops and conferences were carried on from 2003 onward (answer to ii);
- A local representation of ONF International/ONF Andina was installed in Barranquilla, close to the project area, with regular field visit and direct communication with project participants and other stakeholders not directly involved in the proposed project activities (answer to ii, iii, iv and vi);

Social

- Promote local manpower by using mostly manual techniques (answer to v and vii);
- A program of improvement of cattle grazing activities was initiated (answer to viii);

Methodological and technical

- Selection of tree species by project participants;
- Contracts with wood companies to ensure valorization of forest plantations (answer to x and xiii);
- Global technical assistance to coordinate breeders regarding forest activities and cattle grazing activities (answer to xii);
- Project with only land to provide and maintenance of plantations (answer to xiv)
- Installation of artificial water points (answer to xv);
- Weed control 2 times per year (see section A.5.4, answer to xvi).

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROPOSED A/R CDM PROJECT ACTIVITY

Organization:	ONF International (ONFI)
Street/P.O.Box:	2 avenue de Saint mandé
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E-Mail:	
URL:	
Represented by:	
Title:	Responsable Paises Andinos & America Central
Salutation:	Mr
Last Name:	CORNET
Middle Name:	
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Mobile:	
Direct FAX:	
Direct tel:	
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No additional information regarding public funding is provided. See information in section A.10. of the present PDD

Annex 3

BASELINE INFORMATION

1. Delineation of project boundary

Before planting, each potential planting site has been inspected with regard of its suitability for the reforestation activity, in the respect of its compliance with the requirements of the CDM (e.g. eligibility). During this site inspection, the project boundary is established as follows:

1. The perimeter of the planting site and its topological characteristics are established as a closed polygon with a Global Positioning System (GPS) receiver;
2. Any ineligible area regarding the CDM requirements or regarding the technical requirements of reforestation activities are excluded, in particular the high temporary states of vegetation ('rastrojo medio/alto'), groups of trees, marshes, watersheds, etc. For the plantations currently under management, the areas of mortality are excluded as well from the project boundary. Their topological characteristics are also established as closed polygons with the GPS receiver and subtracted from the project boundary;
3. All GPS informations are stored in the Geographical Information System (GIS) developed for the project.
4. The individual planting sites are initially identified by means of the name of the planted site and the name of the land owner; once the information has been stored in the Geographical Information System (GIS) of the project, each individual planting site is identified with a sole consecutive code and the polygon's net surface.

The plantations of the A/R CDM project activity are fragmented into discrete areas according to the location of lands offered by the owners involved in the project. All the spatial information related to the delineation of the project boundary is stored and accessible in the project´s GIS, run and maintained by ONFI.

2. Evaluation of the eligibility of the project area

As communicated by the Colombian DNA to EB[278], the project adopts the definition of forests as land:

- Growing trees with a minimum land area of 1.0 hectare;
- With a minimum tree crown cover of 30%;
- And a minimum tree height of 5m.

To demonstrate the eligibility analysis, LANDSAT images were used (Table 48). Given the fact that the plantations which are part of the project activity have been developed since the beginning of the project, in the year 2000, the eligibility demonstration was carried out for each phase using a LANDSAT image previous to the start year of each phase, which really demonstrates the eligibility at the moment before planting.

All these images have a pixel resolution of 30m. The Tranversal Mercator coordinate system and the UTM 18N Zone projection were used.

[278] Available on the UNFCCC web site on the following link : http://cdm.unfccc.int/DNA/ARDNA.html?CID=49

Table 48. Images used for the eligibility analysis, from 1989 and from the project start date

Plantations phase	Path – Row	Sensor	Date
All phases	9-53	Landsat 4 TM	1989/01/11
2000 – 2003	9-53	Landsat 7 ETM	2000/11/25
2004 – 2006	9-53	Landsat 7 ETM	2002/04/03
2009 – 2013 (areas currently under control)	9-53	Landsat 5 TM	2008/06/16
2009 – 2013 (areas wich will be under control for first verification)	9-53	Landsat 5 TM	2010/01/29

From these images, we performed the classification of coverage in the different municipalities of the project (Zapayán, Piñón, Pedraza, Tenerife, Santa Barbara de Pinto and Plato) with the Corine Land Cover methodology for Colombia. These classifications were developed with the software Spring Software 5.0.4.1 through a segmentation methodology of digital satellite images; which was preliminary edited, and besides were adjusted to plantations years. In this way was determined the eligibility in the three series of lots with respect to 1989 and then, separately for each phase in their respective year (Table 48).

Below shows a brief description of every coverage unit classified through eligibility assessment, this units represent the general legend used for all classifications made for the project activity.

- **Forest:** It´s a unity that have a vertical and continue structure which shows a moderate degree of disturbance or human intervention. Vegetation are typically dominated by trees with more than 8 feet high; these must form at least one continuous layer of canopy (dossal); trees have an apparent cover (from floor to the crown) over 90%. Including shrubs and bushes covered by the trees.

- **Rivers and water bodies:** Lakes and natural or artificial reservoirs of freshwater (non saline) as well as rivers. Artificial water bodies including channels and dams.

- **Fallows (rastrojos):** Vegetation predominantly herbaceous and shrubby in early stage of succession (rastrojos bajos), grasslands temporarily abandoned under vegetation in early state of succession (rastrojo bajo) with some minor shrub vegetation and equally some individual trees

- **Clean pastures**: Designated areas for pastures; these areas used to be for extensive and intensive farming. Land covered with grasses without notable weeds or trees, because the cultural practices (crop cleaning, liming and / or fertilization, etc.) and technological level used doesn´t allows their presence.

- **Pastures with fallows (rastrojos bajos):** Designated areas for pastures invaded for weeds or scrub as consequence of a poor management practices or neglected areas. Coverage of weeds and shrubs: 5% <density ≤ 30% **-** 50%. The height of this vegetation cover is less than 1.5 m.

- **Urban area:** Based on buildings. Buildings, roads and artificially covers more than 80% of the soil surface, exceptional existence of nonlinear vegetation and bare soils.

The cover units that were deemed potentially eligible into CDM project activity are: *Clean Pasture, Pastures with fallows (rastrojos bajos) and Fallows (rastrojos).*

The procedure applied was described in Section A.7. The results of the eligibility analysis and their distribution in the baseline strata for the project are shown in Table 8.

Table 49. Summary of eligible areas in the baseline strata (ha) of the project

Land use in BL	Area (ha)
Clean pastures	**(a)** 1,709
Pastures with fallows	**(b)** 2,060
Fallows	**(c)** 604
Total	**(d) 4,373**

3. *Ex-ante* baseline stratification

The vegetation types of the project area have been described through SPOT Image analysis in order to develop a methodology for classification of vegetation by photo interpretation[279], as a result of this study, could be distinguish all kinds of land-use and their related vegetation (or not) observed in the area encompassing the project boundary. This study was the basis for estimates carbon stocks by type of vegetation in the baseline of the proposed A/R CDM project activities[280].

These vegetation types were harmonized in accordance with the land cover classes established nationally, by CORINE Land Cover methodology adapted for Colombia[281]. According to the vegetation types identified and characterized in the analysis previously mentioned, and considering the evolution expected from the baseline scenario, only three types of existing vegetation were considered as eligible within the project boundary. As a result, the three following strata comprise such baseline scenario:

- **Clean pastures**, usually "clean" pastures, with herbaceous, shrubs (*matorral*) and sporadic trees
- **Pastures with fallows (rastrojos bajos)**, a dense medium-height shrub layer or young fallows;
- **Fallows in early stage of succession (rastrojos bajos),** temporarily abandoned pasture under vegetation in early state of succession (rastrojo bajo), with some minor shrub vegetation and equally very rare individual trees

The strata of the baseline scenario will remain unchanged during the crediting period of the project activity.

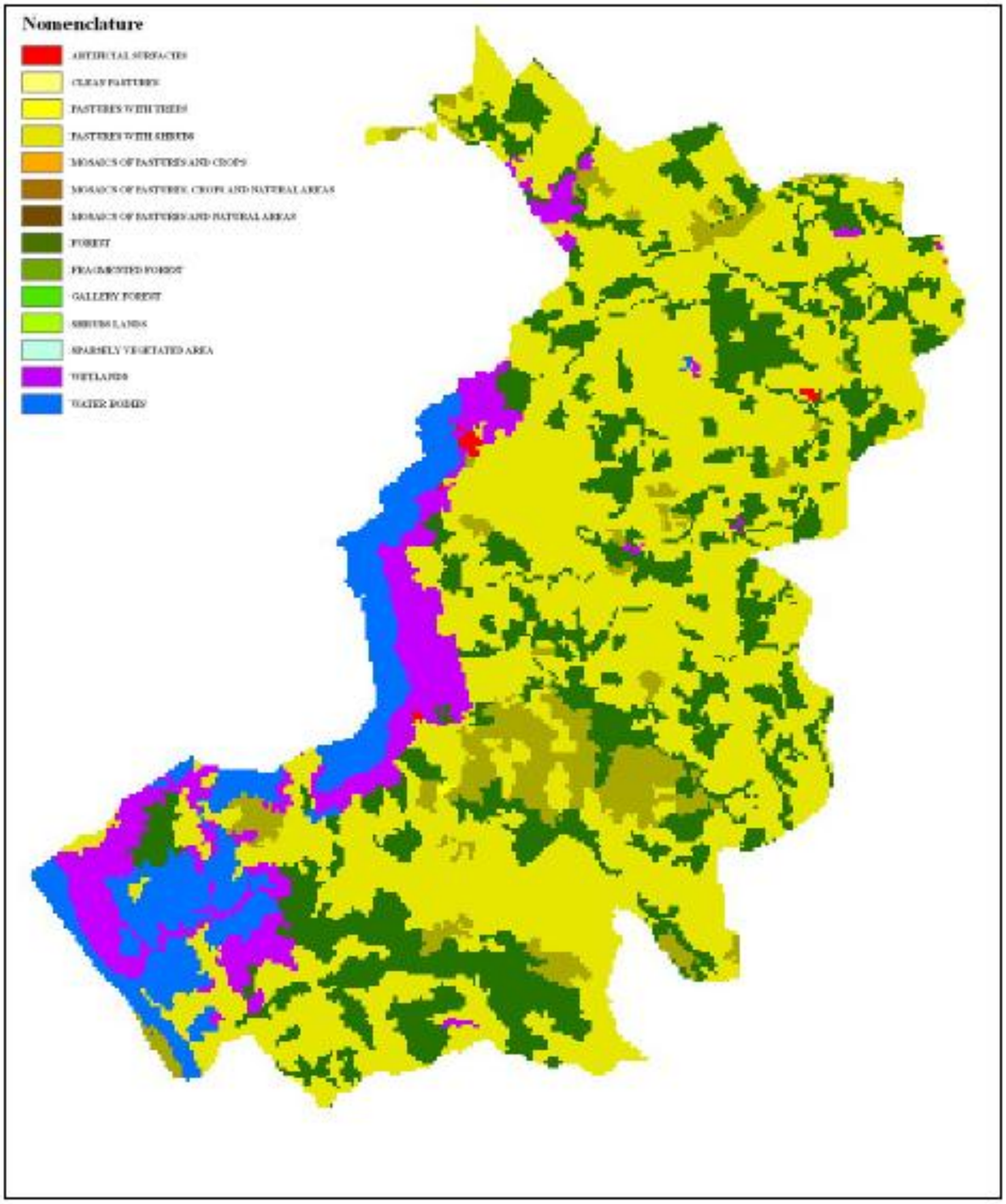
4. Historical land use/cover changes

[279] Grua, 2003. Manual metodológico de reconocimiento de uso y cobertura del suelo a partir de imágenes SPOT 5. ONFI, ENGREF y CORMAGDALENA 2004.

[280] Dufour, 2005. Reboisement Commercial dans la Région du Magdalena Bajo, Colombie. La Composante Carbone: Niveau de référence et plan de surveillance. Mémoire de Mastère ENGREF. ONF International.

[281] IDEAM, IGAC y CORMAGDALENA, 2008. Mapa de Cobertura de la Tierra Cuenca Magdalena-Cauca: Metodología CORINE Land Cover adaptada para Colombia a escala 1:100.000. Bogotá, D.C., 200p. + 164 hojas cartográficas.

The proposed AR CDM Project activity meets the conditions under which the proposed methodology is applicable, and the baseline approach 22(a): *Existing or historical, as applicable, changes in carbon stocks in the carbon pools within the project boundary*, can be used.
To determine historical and current land use within project boundary, a multi-temporal analysis of LandSat satellite imagery was carried on with satellite images of 1984 and 2002[282] (Figure 22 y Figure 23).



[282] ONF INTERNATIONAL, 2010. Land use and land cover change maps. Summary document

Figure 22. Map of land use of Zapayán in 1984 with the CLC elaborated with the CLC methodology.

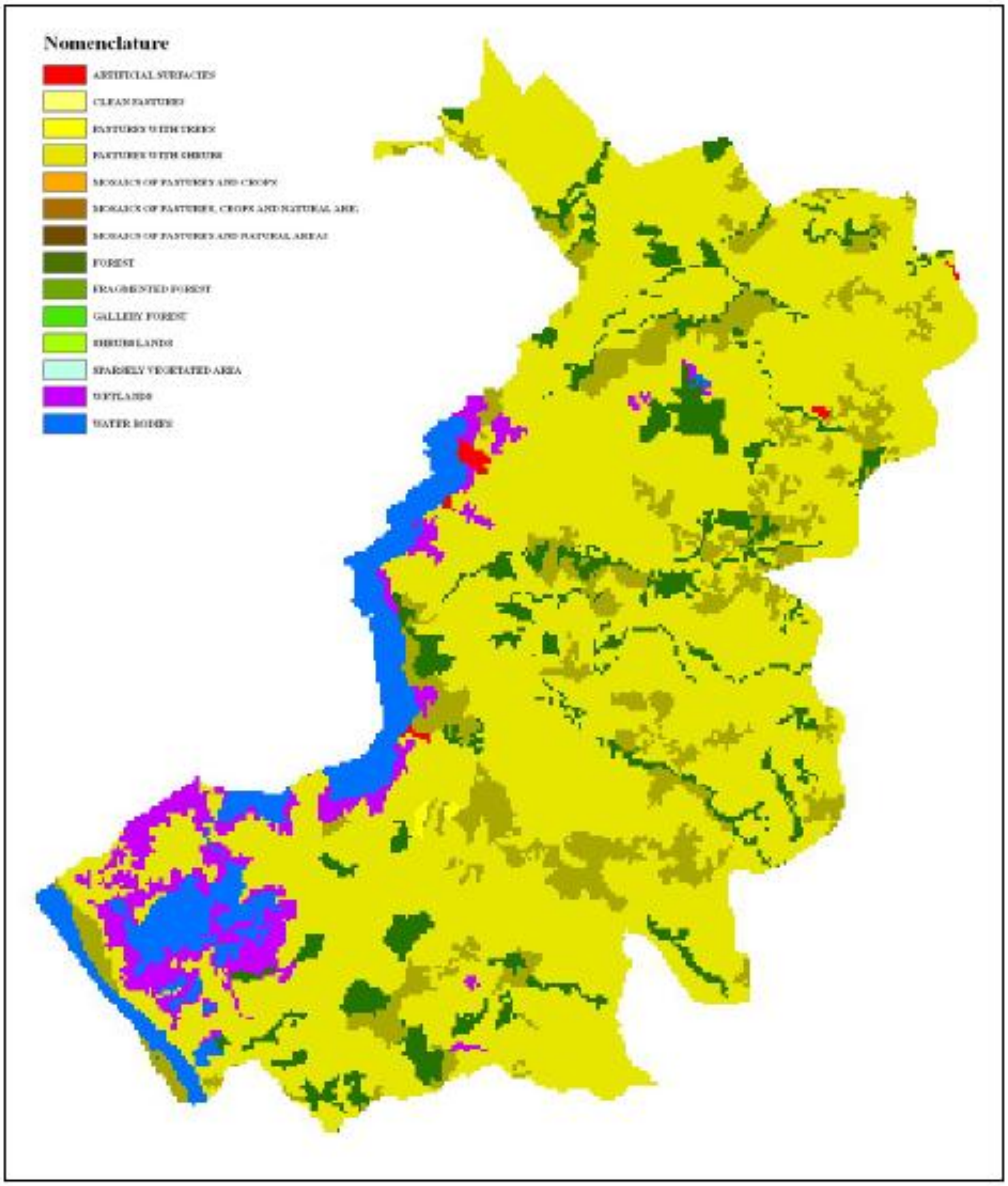


Figure 23. Map of land use of Zapayán in 2002 with the CLC elaborated with the CLC methodology.

Mainly, the results given by the maps above show a clear decrease of fallows (89%) distributed almost between clean pastures (44%) and pastures with shrubs (30%). Land-use change involving pastures or fallows represent 82% of total land-use change. On one hand this results show clearly the importance of cattle grazing activities in the project area. On the other hand it demonstrates clearly that fallows have not a forest purpose even if they can reach the limits fixed by the DNA for the ones older than 10 years. Only 1,7% of fallows reached the status of forest during the 18 years considered in the study of the project area.

The results from the multi-temporal analysis show a clear decrease of fallows (81%) mainly distributed between clean pastures (36% of total decrease of fallows) and pastures with fallows (32% of total decrease of fallows). Land-use change involving pastures or fallows represented 89% of total land-use change between 1984 and 2002. Changes between 1984 and 2002 for land cover are represented in the Figure 24.

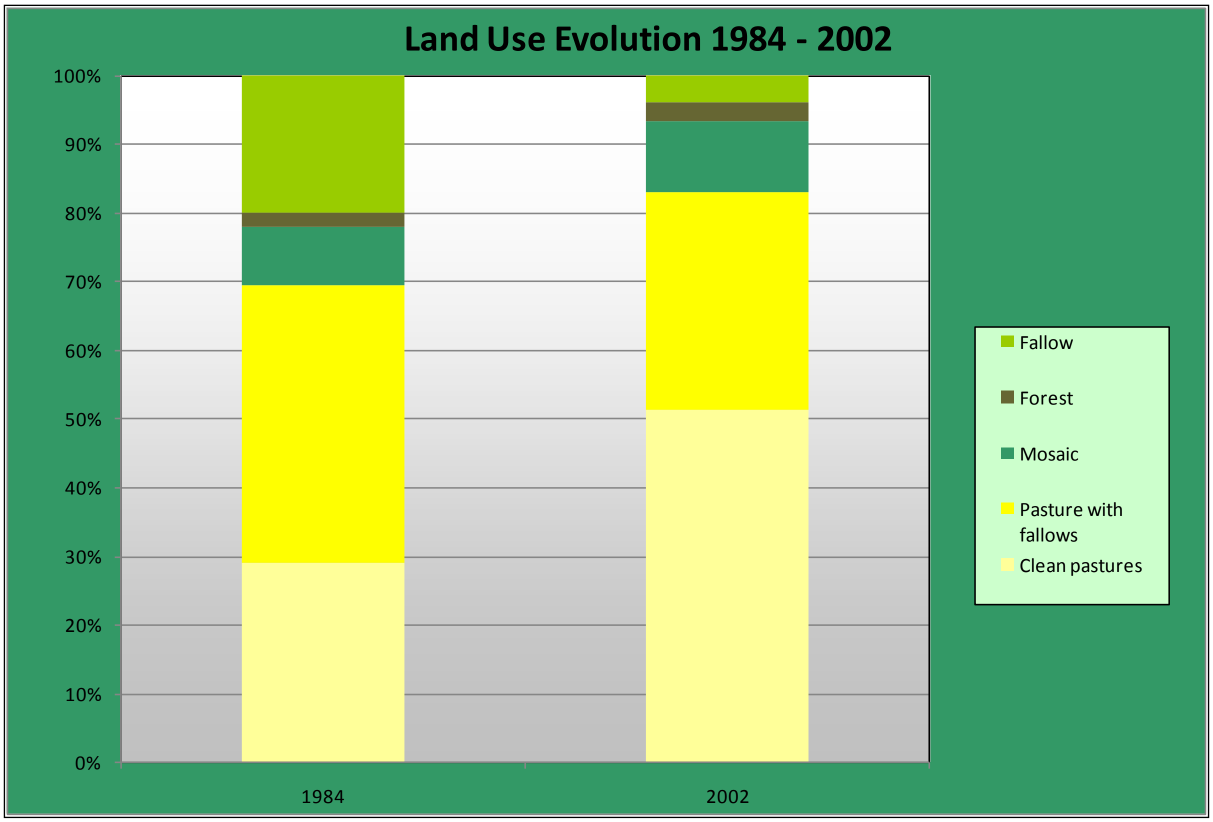
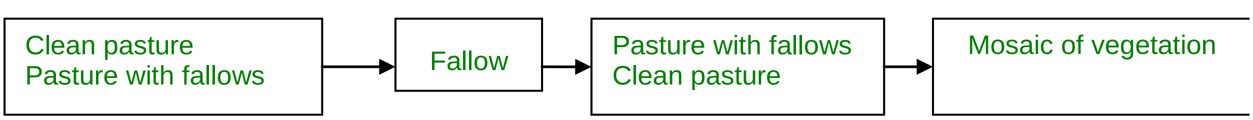


Figure 24. Evolution of vegetation cover between 1984 and 2002.

The project area showed a net decrease of fallow areas. Field visit and socio-economic survey showed a clear decrease of forested areas and fallows. In the project area, local landowners use to clear existing forest lands and fallows for cattle grazing purpose.

From the precedent results, the most realistic succession of land-use in the project area can be set as:



Indeed, in accordance with the events that occurred in the project area, the dynamic of extension of pasture was suspended during periods of public disorder in the years 1990. Some pastures were abandoned and became unintentionally some fallows. When the public disorder decreased in the early 2000, the former dynamic of extension of pastures started newly with a decrease of "fallows" transformed in pastures as they were before.

As most of forest lands have disappeared and fallows decreased drastically, landowners cannot deforest anymore. Therefore, they clean their pastures (cutting of pre-existing trees shrubs) more and more in order to increase space for cattle within existing pastures. Moreover, this practice is reinforced by the fact that trees in pastures have traditionally no value for project landowners, as they represent only some space that cannot be used for fodder production.

Finally, pastures can be transformed in mosaics of vegetation which represent a mix of grassland, small patches of fallows (*rastrojos*) and crops, within less than one hectare. Mosaics of vegetation are usually observed among landowners with small area and diversifying their activities to optimize their incomes.

In accordance with the applicability conditions of the methodology and, thus, with the baseline approach, the land-use evolution of the baseline scenario can be given by extrapolating the land-use evolution of the past (1984-2002) towards the future for each stratum. This land-use evolution corresponds to the evolution of area, in hectares, of each stratum within project boundary and during the chosen crediting period (Table 50 and Figure 17).

Table 50. Annual baseline land-use change trends for the strata. All area in $ha.yr^{-1}$.

Land use	1984	2002	Evolution (ha/yr)
Pastures	1,452.51	2,464.67	56.23
Pastures with fallows	2,029.24	1,529.26	-27.78
Fallows	1,004.89	190.70	-45.23
Crops	0.00	1.22	0.07
Mosaic	427.31	494.39	3.73
Forest	106.63	132.87	1.46

In conclusion, this analysis pointed the decrease, in terms of surfaces, of dense vegetation classes (fallows - rastrojos) and the increase of light vegetation classes (pastures), leading to a global decrease of biomass in the project area. Finally, it is important to consider that the degradation of the soils is produced by anthropic agents such as the cattle grazing, and at the same time, the impact of such activity are heavier due to the dry climate and the effects of the climate change in the region, resulting in a great risk of desertification of these soils given their high susceptibility towards degradation[283].

[283] Vargas y Gómez, 2003. La desertificación en Colombia y el cambio global. Cuadernos de geografía. XII (1-2) pag 121-134.

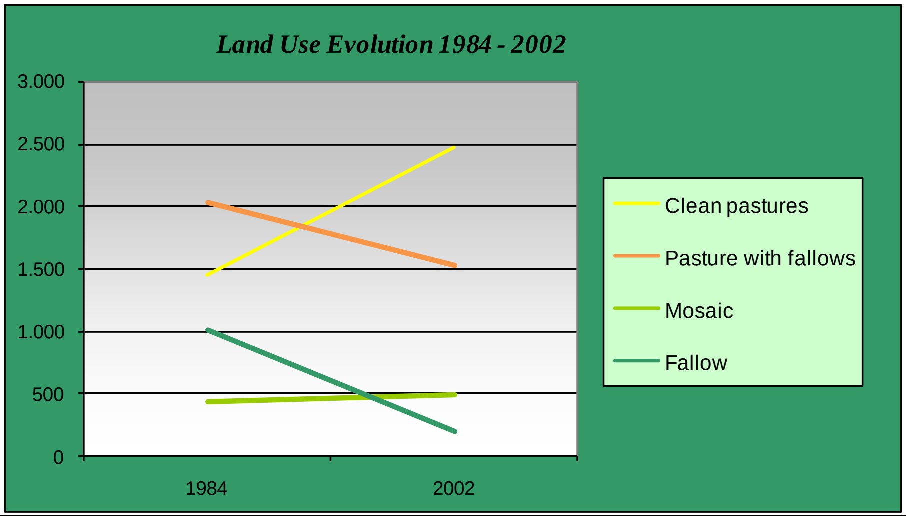


Figure 25. Land use evolution between 1984 and 2002. All area in ha

Following the procedures described in EB 46 Annex 16, *(Guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant)*, it was determined that the change in carbon stocks of live woody vegetation that exists within the project boundary prior to the project, and that would have occurred in the absence of this A/R CDM project activity, are insignificant and therefore shall be accounted for as zero, because:

(iii) Growth conditions are already, or are expected to become within 10 years (e.g., due to on-going land degradation), such that biomass in existing woody vegetation is expected to become static or to decline;

5. Estimation of the baseline net GHG removals by sinks

Timberline vegetation

To determine the carbon content and the number of trees existing within the stratums of the project (nTR*ijt*), we performed a counting of trees (inventory) (ONFA and C&B, 2010[284]), by establishing permanents circular plots of 1 ha. Additionally, the **cap** was measured (circumference at breast height), in order to determine the chest-height diameter (*DBH*) and then estimate above-ground timberline biomass, by using equation of Pearson (2005)[285]. This equation was developed for tropical dry forest, and it uses the basal diameter as a predictor variable (Equation 1). Where *B* is the above-ground biomass and *dap* is the basal diameter.

$$B = Exp(-1.996+2.32 \times \ln dap) \qquad (1)$$

From the plots established before, we calculated the number of sampling units required in order to represent the variability of estimation of the number of trees per hectare and basal diameter (which is the

[284] ONFA y C&B, 2010. Inventario de Árboles dispersos en los escenarios de línea base

[285] Pearson, S. Brown and N. H. Ravindranath. 2005. Integrating carbon benefit estimates into GEF projects. 64p.

predictor variable of biomass) with an error of sampling of 20% (± 10). Adequate sample size was calculated using the following equation (Equation 2):

$$n = [(CV^2\ t^2)/\ E + (CV^2 t^2/N)] \qquad (2)$$

Where *n* is the number of plots required; *CV* (%) is the coefficient of variation calculated based on the variable analyzed; *E* (%) is the maximum permissible error and *t* is the *t* distribution value for α / 2 and n-1 degrees of freedom[286].

The number of trees per hectare in the project is between 1 and 18 trees ha^{-1}, the basal diameter ranged between 14,67 and 36,61 cm and the total above-ground biomass varied between 0,33 and 3,12 t ha^{-1} (Table 4).

Table 51. Values of the variables analyzed for the sample units established

No. Plot	No. Tree (t ha^{-1})	DBH (cm)	Biomass (t ha^{-1})	Carbon (t ha^{-1})
1	9	23,02	1,77	0,87
2	4	15,76	0,33	0,16
3	14	16,78	1,32	0,65
4	6	32,31	2,59	1,27
5	8	21,80	1,39	0,68
6	6	22,71	1,14	0,56
7	4	19,42	0,53	0,26
8	14	20,42	2,08	1,02
9	18	16,64	1,67	0,82
10	11	23,18	2,20	1,08
11	12	15,84	0,99	0,49
12	6	29,66	2,12	1,04
13	15	22,45	2,78	1,36
14	12	25,97	3,12	1,53
15	10	23,30	2,02	0,99
16	6	16,87	0,57	0,28
17	16	18,42	1,87	0,92
18	14	14,85	0,99	0,49
19	17	17,08	1,67	0,82
20	17	21,31	2,79	1,37
21	17	15,69	1,37	0,67
22	3	26,00	0,78	0,38
23	5	19,80	0,69	0,34
24	7	21,87	1,22	0,60
25	1	36,61	0,58	0,28
26	8	22,20	1,45	0,71
27	10	14,67	0,69	0,34
28	9	26,07	2,36	1,16

[286] Steel, G.D. & J.H. Torrie. 1960. Principles and procedures of statistics with special referent to the biological sciences. McGraw-Hill, New York.

No. Plot	No. Tree ($t\ ha^{-1}$)	DBH (cm)	Biomass ($t\ ha^{-1}$)	Carbon ($t\ ha^{-1}$)
29	12	22,55	2,25	1,10
30	17	18,12	1,92	0,94
Average	10	21,38	1,57	0,77
Standard deviation **(SD)**	4,88	5,22	0,76	0,37
n	30	30	30	30
CV (%)	47,51	24,42	48,34	48,34
Confidence interval	1,75	1,87	0,27	0,13

Average of number of trees per hectare is 10 ± 4,88 trees ha^{-1}, the average basal diameter 21.38 ± 5.22 cm and the biomass average of 1,57 ± 0,76 t ha^{-1}. The carbon stored in vegetation is equivalent to 49% of the biomass, which is about 0,77 ± 0,37 t ha^{-1}. The greatest variability occurred in the above-ground biomass (48,34%), followed by the number of trees per hectare (47,51%) and finally the average basal diameter (24,42%).

On the other hand, according to Equation 2, the required number of samples to estimate the average biomass of trees scattered is 24 sampling units in reference to the variable of *No. of trees*. And is 8 sampling units in reference to the variable of *DBH* (considering both sampling error of 20% and a CV of 47,51% and 24,42%). The relative sampling error (RE%) (Eq. 3, 4 and 5) was 17,74% and 9,12% for the variables No. of trees and DBH, respectively (Table 5).

Table 52. Statistical parameters used to calculate the number of plots of Freesse (n_f) and relative sampling error (RE%), average *DBH* and *No. of trees.* In plots sampling established

Parameter		Variables	
		No. of trees	***DBH***
No of plots	*n*	30	30
Average value	$\bar{x}$	10	21,38 cm
Standard deviation	S^2	4.88	5,22 cm
Coefficient of variation	*CV%*	47,51%	24,42%
*No maximum of plots**	*N*	4.372	4.372
Desired maximum error	*E*	20%	20%
No of plots of Freesse	n_F	24,01	8,32
Relative sampling error	*ER%*	17,74%	9,12%

* In this case, plots are 1 ha, therefore the maximum number of plots is equal to the total area of the project (in hectares).

Accordingly this information, content of biomass was measured for trees scattered presented in the baseline scenario of the project ($C_{AB,ijt}$). By using Method 2 (stock change method), proposed in the AR-AM0004/Version 04, Ec. 9, 11 y 12, with allometric equations which are also considered to be good practice by the IPCC. Parameters and values used are below:

Table 53. Parameters and values used to estimate the carbon content of trees scattered in baseline project

Parameter /Variable	Value	Source
nTR_{ijt}	10	ONFA y C&B, 2010
CF_j	0.49	IPCC 2006 default value
$f_j(DBH_t, H_t)$	Ec 2	Pearson *et al.* 2005
DBH	21.38 cm	ONFA y C&B, 2010
$C_{AB,ijt}$	0,81 tC /ha	Ec 12, AR-AM0004/Version 04
Rj	0.27	Table A1.3.8 of IPCC GPG LULUCF 2003
$C_{BB,ijt}$	0.22 tC /ha	Ec 11, AR-AM 0004/Version 04
C_{ikt}	1.03 tC /ha	Ec 9, AR-AM 0004/Version 04

Non-timberline vegetation

To determine the carbon stock in the baseline sceneries of the Project, it was used the study of the baseline performed in the project area by Dufour, 2005[287], in the municipalities of El Piñón, Zapayán, Pedraza, Tenerife, Plato and Santa Bárbara de Pinto.

Dufour 2005, evaluated the carbon stock of the land cover found in the area according to Corine Land Cover (CLC) classification adapted for Colombia. Between the coverages evaluated was found: Clean pastures, pastures with fallows and fallows *(rastrojos)*. Now, considering that one of the patterns used for the eligibility analysis of the commercial reforestation project areas (Section A.7) was the CLC classification (and each vegetal compounds of these land covers), values from Dufour projected in 2002-2003, are applicable to the baseline strata of the project correspondingly to the year its start (year 2000). That is, accordingly CLC definitions, baseline sceneries identified in the eligibility analysis correspond to the Dufour's land covers surveys in the area for the project.

In Table 54 the biomass values are shown (non-tree biomass) in the 3 baseline scenarios of the project, for the different components taken by Dufour (2005), for estimations of decrease in the carbon stocks in the living biomass by loss of pre-existing non-tree vegetation in the year of site preparation (*Ebiomassloss*, see Section D.1). Herbaceous vegetation was excluded according to guidance contained in paragraph 35 of the EB 42 meeting report.

[287] Dufour, 2005. Reboisement Commercial dans la Région du Magdalena Bajo, Colombie. La Composante Carbone: Niveau de référence et plan de surveillance. Mémoire de Mastère ENGREF. ONF International. Pp 16.

Table 54. Aboveground biomass of pre-existing non-tree vegetation in baseline scenarios. *Tr*: Trunks (t d.m. ha^{-1}); *Br*: branches (t d.m. ha^{-1}); *L*: leaves (t d.m. ha^{-1}); *Bu*: bush (t d.m. ha^{-1}); *Li*: litter (t d.m. ha^{-1}); *Dw*: deadwood (t d.m. ha^{-1}); *R*: roots (t d.m. ha^{-1}); $B_{pre,ik}$: Average pre-existing stock of non-tree pre-project biomass before the start of the proposed A/R CDM project activity for baseline stratum *i* (t d.m. ha^{-1}).

Scenario	**Shrubs and fallows**			**Others**			**Total**
	Tr	***Br***	***L***	***Bu***	***Li***	***Dw***	($B_{pre,ik}$)
Clean pastures (*BS1*)	0.28	0.16	0.28	0.00	2.77	0.11	**3.60**
Pastures with fallows (*BS2*)	5.32	3.18	5.59	0.00	2.77	0.11	**16.97**
Fallows (*BS3*)	4.09	4.36	9.72	0.00	2.13	0.27	**20.57**

By using the values of CF_j: 0.49;; carbon content found is:

- Clean Pastures(*BS1*): 0.89 tC ha^{-1}
- Pastures with fallows (*BS2*): 8.42 tC ha^{-1}
- Fallows (*BS3*): 10.53 tC ha^{-1}

As demonstrated in the previous section, following the procedures described in EB 46 Annex 16, *(Guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant)*, it was determined that the change in carbon stocks of live woody vegetation that exists within the project boundary prior to the project, and that would have occurred in the absence of this A/R CDM project activity, are insignificant and therefore shall be accounted for as zero, because:

(iii) Growth conditions are already, or are expected to become within 10 years (e.g., due to on-going land degradation), such that biomass in existing woody vegetation is expected to become static or to decline;

Annex 4


Commercial reforestation on lands dedicated to extensive cattle grazing activities in the region of Magdalena Bajo Seco, Colombia
A/R CDM Monitoring Plan
ONF International

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1. OBJECTIVE AND COMPONENTS OF THE MONITORING PLAN

The monitoring plan is intended to facilitate monitoring, recording, reporting, and verification activities necessary for assessment of the project performance and determination of the emissions reductions achieved in compliance of the approved methodology AR-AM0004 version 4 under the Clean Development Mechanism of the Kyoto Protocol's Article 12 and other applicable requirements.

The following components are addressed in the monitoring plan (MP) for quantifying the carbon sequestered under the Commercial reforestation on lands dedicated to extensive cattle grazing activities in the region of Magdalena *Bajo Seco* project:

- Project boundary
- Sources of variability and management of heterogeneity in biomass pools via stratification
- Procedures for monitoring of the carbon pools
- Determination of sampling intensity required to achieve a desired precision
- Allocation of sample plots over the project area
- Measurement and calculation of changes in carbon pools
- Scheduling of monitoring, measurement and verification
- Implementation of quality assurance procedures
- Verification of results by a third party

2. PROJECT BOUNDARY

The project boundary is delineated to cover all land parcels of the project and the boundaries of the parcels are demarcated using global positioning system (GPS) and verified through field surveys. Project boundary will be periodically verified and any change is measured and recorded in the project database for submission to the DOE at the time of next verification.

3. STRATIFICATION AND SAMPLE SIZE FOR ABOVEGROUND BIOMASS POOLS

The following three strata of the baseline scenario define and these will remain unchanged during the crediting period of the project activity.

- **Clean pastures,** usually "clean" pastures, with herbaceous, shrubs (matorral) and sporadic trees (rare individual trees, between 0.5 and 3 tree/ha)
- **Pastures with fallows** (low fallows), a dense medium-height shrub layer or young fallows;
- **Fallows in early stage of succession** (low fallows), temporarily abandoned pasture under vegetation in early state of succession (low fallows), with some minor shrub vegetation and equally very rare individual trees (between 0.5 and 3 tree/ha).

Species forest composition.

The following groups of species will be proposed in the forest project:

- *Gmelina arborea*
- *Tectona grandis*
- *Pachira quinata*
- *Tabebuia rosea*
- *Eucalyptus teriticornis*

The species were separated in two group accord at long time of final harvesting, Short-term rotation and Mid-term rotation.

The finals strata for the project in the phase ex-ante are following:

Table 1. The *ex-ante* stratification

ID stratum (*i*)	**Stand model (*k*)** Stratification criteria **Management plan/rotation (*j*)**	**Species**	**Area A_{ik} (ha)**
SM1	*Short-term rotation (1)*	*Gmelina arborea*	3,615.95
		Eucalyptus tereticornis	45.69
		Subtotal SM1	**3,661.34**
SM2	*Mid-term rotation (2)*	*Bombacopsis quinata*	320.36
		Tabebuia rosea	165.68
		Tectona grandis	255.59
		Subtotal SM2	**711.63**

Where:
SM1 Stand model 1
SM2 Stand model 2

The procedures of *ex post* stratification of the project are outlined in the PDD. Sources of variability within project lands are managed by stratification, whereby the project is divided into a reasonable number of relatively homogeneous units in order to reduce the number of plots needed for monitoring.

Monitoring of stratification

The stratification of the project is based on the stands *k* (species *i* x year of plantation). The need for *ex post* stratification will be evaluated at each monitoring event based on expected disturbance, and management activities that are different from those described in section A.5.4 of the PDD or variation in carbon stock change for each stratum, the project boundaries, or species composition. The physical features relating to the project boundary and management variables will be represented on the project GIS. The carbon stock changes in each stratum will be monitored by adopting the sampling strategy outlined below.

Sample size for measuring changes in the above ground biomass pool

The sample size determines the number of plots needed in each stratum to reach targeted precision levels taking into account the variance of each stratum and the area of the stratum. This means that highly variable strata covering small areas will have less influence on the total number of plots needed than those strata that cover larger areas. Based on empirical experience, it is recommended that a targeted total precision level of about +/-10% of the mean at the 95% confidence level can be obtained at a modest cost.

The sample size estimation assumes a standard deviation of 50% of the mean value for all species. Taking into account lack of local specific data on biomass estimates in the early stages of the species, this assumption is reasonable and conservative[288] – especially because seeds of *Gmelina arborea*, *Tectona grandis* and *Bombacopsis quinata* will be procured from certified source to avoid variability in growing stock, which is expected to minimize the intra-species variability in growth rates and the resulting variability in the carbon stocks of stands.

In the Table 2, presents the reference values used for *ex ante* sample size calculations, accord to methodology applied.

Table 2: Reference values for *ex ante* sample size calculations for above-ground biomass

Stratum	Area (ha)	Reference value[289] (Vol. m^3 year 5).	Standard deviation (% of the expected value)	Target precision for AGB
SM1_Pastures_fallows	1,818	92.91	59,71	10 %
SM1_Pastures_clean	1,492	92.95	59,71	10 %
SM1_Fallows	352	95.49	59,71	10 %
SM2_Pastures_fallows	242	67.87	44,17	10 %
SM2_Pastures_clean	218	72.13	44,17	10 %
SM2_Fallows	252	63.41	44,17	10 %

The methodological tool "Calculation of the number of sample plots for measurements within A/R CDM project activities" (version 02) is used to calculate the number of plots for each stratum for the vegetation. The step to calculated number plot, as describe below.

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:

[288] "Guidelines on conservative choice of data when estimating biomass stocks and change in woody vegetation (EB 46, annex 17, version 01)" recommend a standard deviation equal to 50 % of the mean value for above-ground existing woody vegetation.

[289] Tabares 2002. Modelos de crecimiento de las cinco especies forestales (*Tectona Grandis, Gmelina Arbórea, Bombacopsis Quinata, Eucalyptus tereticornis y Tabebuia rosea*) contempladas en el proyecto piloto "sig reforestación productiva". Informe de pasantia. ONF Andina. Bogota. 76 pag.

$$N = \frac{A}{AP}; \quad N_i = \frac{A_i}{AP},$$ (Ecn 1 tool)

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:

$$E_1 = Q_1 * p$$ (Ecn 2 tool)

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

Assuming ignorance of the cost of developing a plot, applies the Equation 5 the tool, to determine the sample number.

$$n = \frac{\left(\sum_{i=1}^{m_{PS}} N_i \cdot st_i\right)^2}{\left(N \cdot \frac{E}{z_{\alpha/2}}\right) + \left(\sum_{i=1}^{m_{PS}} N_i \cdot (st_i)^2\right)}$$ (Ecn 5 tool)

And the sample number by stratum

$$n_i = \frac{\sum_{h=1}^{m_{PS}} N_i \cdot st_i}{\left(N \cdot \frac{E}{z_{\alpha/2}}\right)^2 + \left(\sum_{i=1}^{m_{PS}} N_i \cdot (st_i)^2\right)} \cdot N_i \cdot st_i$$ (Ecn 6 tool)

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

In compliance with the applied methodology, the targeted precision level for biomass estimation within each stratum is +/- 10% of the mean at a 90 % confidence level. The sample size for subsequent monitoring interval will be modified if variation observed in carbon stock changes after the first monitoring event based on *n* samples.

Size of the plots or sampling units

In the propose project, circular plots will be established with an area of 500 m^2 (12.62 m of radius) in all forest systems. The circular plots are cost-effective. Besides, they permit to make not catching marks during its installing and location, thus a management activities are guaranteed in the plantation (pruning activities, fertilizations, cutting activities, etc.) are carried out in the same way inside the plots like the rest of the plantation, because the marks in very visible corners in the boundaries of the plots, suggest to the people in charge of maintenance of the stands to make a different management. With the circular plots this situation will be avoided.

An additional 10% of plots are added to the intermediate estimation values, to support the loss of plots which may occur over time. Likewise, there must be at least three (3) plots of land per tree stand model. The Table 3 presents the number of sample plots calculated for monitoring the carbon stock changes in the above ground biomass. The sample size calculations will be revised further based on the availability of the species composition data of the major species groups.

Table 3: Number of sample plots for measuring the changes of carbon stocks in living tree biomass

Strata	Size plots (ha)	Area(ha)	Total plots for each stratum
SM1_Pastures_fallows	0.05	1,818	30
SM1_Pastures_clean	0.05	1,492	24
SM1_Fallows	0.05	352	6
SM2_Pastures_fallows	0.05	242	3
SM2_Pastures_clean	0.05	218	3
SM2_Fallows	0.05	252	3
	Total	***4.372,97***	***68***

4. ALLOCATION OF PERMANENT SAMPLE PLOTS

Permanent sample plots will be used for monitoring aboveground biomass. Each plot will have its coordinates recorded using a GPS. The plot centre of circular sample plots (radius = 12.6156 cm) will be located and the GPS coordinates noted. Plot markers will not be prominently displayed to ensure that permanent plots do not receive differential treatment from technical staff. The distribution plots are randomly assigned in the sampling area, using the *ArcView* software "*Random Point Generator*" tool, which is considered a good practice in GPG-LULUCF (IPCC 2003).

Having assigned the centre points of the permanent sample plots using the above procedure, it is possible that, due to inherent and unavoidable uncertainty in mapping and/or sample plot location, during sample plot installation part of a sample plot may be found to fall outside of the area that is forested. In this case, the plot centre will be moved towards the centre of the parcel of land such that the outer edge of the plot coincides with the estimated position of the outer edge of the forest canopy at tree maturity. The direction of movement of the plot centre shall be at right-angles to the edge of the parcel of land.

The Figure 1, show an example of the distribution of the monitoring plots, making use of the "*Random Point generator*" tool of the *ArcView* software, and the Table 4, presents the number and coordinates of monitoring plots in the project boundary.

Table 4. Number and coordinates of monitoring plots in the project boundary.

Plot number	Stratum	COORDINATES		Plot number	Stratum	COORDINATES	
		E	N			E	N
0	*SM2 R*	74° 40' 24.58"	10° 16' 0.74"	44	*SM1 P_L*	74° 34' 22.54"	10° 14' 14.05"
1	*SM2 R*	74° 36' 43.97"	9° 41' 9.72"	45	*SM1 P_L*	74° 40' 19.92"	10° 18' 17.64"
2	*SM2 R*	74° 40' 13.71"	10° 16' 4.86"	46	*SM1 P_L*	74° 35' 28.96"	10° 14' 5.09"
3	*SM2 P_L*	74° 40' 10.07"	10° 10' 42.00"	47	*SM1 P_L*	74° 39' 27.93"	10° 10' 40.58"
4	*SM2 P_L*	74° 39' 25.56"	10° 16' 43.01"	48	*SM1 P_L*	74° 40' 9.54"	10° 12' 59.55"
5	*SM2 P_L*	74° 39' 25.59"	10° 12' 24.42"	49	*SM1 P_L*	74° 38' 50.42"	10° 10' 49.60"
6	*SM2 P_L*	74° 34' 28.56"	9° 56' 47.04"	50	*SM1 P_L*	74° 38' 49.63"	10° 11' 25.74"
7	*SM2 P_L*	74° 34' 21.86"	9° 56' 48.73"	51	*SM1 P_L*	74° 35' 1.23"	10° 14' 30.01"
8	*SM2 P_L*	74° 40' 45.72"	10° 10' 50.42"	52	*SM1 P_L*	74° 37' 52.26"	10° 9' 58.63"
9	*SM2 P_E*	74° 40' 16.08"	10° 10' 55.41"	53	*SM1 P_L*	74° 40' 23.64"	10° 9' 41.44"
10	*SM2 P_E*	74° 39' 22.30"	10° 11' 24.70"	54	*SM1 P_E*	74° 37' 31.77"	10° 11' 23.04"
11	*SM2 P_E*	74° 39' 20.56"	10° 11' 21.17"	55	*SM1 P_E*	74° 34' 33.34"	10° 15' 16.09"
12	*SM2 P_E*	74° 36' 51.35"	9° 41' 15.88"	56	*SM1 P_E*	74° 41' 14.98"	10° 12' 44.00"
13	*SM2 P_E*	74° 38' 41.22"	10° 17' 1.18"	57	*SM1 P_E*	74° 40' 17.40"	10° 15' 22.76"
14	*SM1 R*	74° 37' 28.94"	10° 21' 5.42"	58	*SM1 P_E*	74° 39' 57.65"	10° 10' 46.35"
15	*SM1 R*	74° 38' 11.71"	10° 20' 52.95"	59	*SM1 P_E*	74° 39' 48.22"	10° 10' 56.37"
16	*SM1 R*	74° 26' 2.71"	9° 54' 45.37"	60	*SM1 P_E*	74° 34' 38.74"	10° 13' 37.66"
17	*SM1 R*	74° 37' 27.90"	10° 21' 22.69"	61	*SM1 P_E*	74° 39' 58.25"	10° 13' 29.17"
18	*SM1 R*	74° 35' 33.78"	9° 36' 5.53"	62	*SM1 P_E*	74° 35' 2.82"	10° 14' 10.99"
19	*SM1 R*	74° 39' 41.49"	10° 13' 5.88"	63	*SM1 P_E*	74° 34' 25.64"	9° 57' 10.71"
20	*SM1 R*	74° 40' 1.38"	10° 13' 4.85"	64	*SM1 P_E*	74° 37' 28.23"	10° 12' 24.09"
21	*SM1 P_L*	74° 37' 37.36"	10° 5' 57.56"	65	*SM1 P_E*	74° 35' 31.83"	10° 15' 1.64"
22	*SM1 P_L*	74° 39' 54.26"	10° 12' 40.68"	66	*SM1 P_E*	74° 33' 50.49"	10° 14' 34.97"
23	*SM1 P_L*	74° 34' 53.61"	10° 13' 46.75"	67	*SM1 P_E*	74° 39' 49.24"	10° 15' 33.24"
24	*SM1 P_L*	74° 40' 14.37"	10° 15' 14.05"	68	*SM1 P_E*	74° 33' 55.79"	9° 57' 15.55"
25	*SM1 P_L*	74° 39' 50.77"	10° 14' 46.88"	69	*SM1 P_E*	74° 35' 23.16"	10° 13' 54.24"
26	*SM1 P_L*	74° 39' 22.99"	10° 11' 3.55"	70	*SM1 P_E*	74° 34' 18.74"	10° 12' 57.99"
27	*SM1 P_L*	74° 34' 31.98"	9° 54' 36.66"	71	*SM1 P_E*	74° 37' 28.36"	10° 9' 55.52"
28	*SM1 P_L*	74° 35' 37.05"	9° 35' 59.48"	72	*SM1 P_E*	74° 34' 33.81"	10° 15' 7.76"

29	*SM1 P_L*	74° 34' 55.16"	10° 14' 38.38"	73	*SM1 P_E*	74° 38' 39.82"	10° 11' 0.12"
30	*SM1 P_L*	74° 34' 16.39"	10° 14' 43.20"	74	*SM1 P_E*	74° 38' 49.43"	10° 11' 10.33"
31	*SM1 P_L*	74° 38' 39.98"	9° 52' 5.35"	75	*SM1 P_E*	74° 38' 12.81"	10° 5' 12.61"
32	*SM1 P_L*	74° 35' 15.46"	10° 13' 57.83"	76	*SM1 P_E*	74° 35' 38.24"	9° 36' 17.70"
33	*SM1 P_L*	74° 34' 39.18"	10° 13' 31.97"	77	*SM1 P_E*	74° 35' 14.38"	9° 35' 51.30"
34	*SM1 P_L*	74° 38' 40.35"	10° 11' 5.37"	78	*SM1 P_E*	74° 37' 27.39"	10° 13' 0.16"
35	*SM1 P_L*	74° 34' 58.00"	10° 14' 41.95"	79	*SM1 P_E*	74° 26' 22.90"	9° 54' 46.70"
36	*SM1 P_L*	74° 34' 56.07"	10° 13' 42.04"	80	*SM1 P_E*	74° 35' 15.40"	9° 54' 42.09"
37	*SM1 P_L*	74° 35' 46.52"	9° 36' 48.91"	81	*SM1 P_E*	74° 35' 5.41"	9° 54' 42.30"
38	*SM1 P_L*	74° 42' 40.13"	10° 3' 56.31"	82	*SM1 P_E*	74° 37' 53.47"	10° 20' 41.05"
39	*SM1 P_L*	74° 40' 17.78"	10° 15' 10.66"	83	*SM1 P_E*	74° 38' 4.52"	10° 9' 36.14"
40	*SM1 P_L*	74° 33' 59.31"	10° 14' 25.83"	84	*SM1 P_E*	74° 35' 4.39"	9° 54' 38.51"
41	*SM1 P_L*	74° 40' 48.11"	10° 13' 26.49"	85	*SM1 P_E*	74° 38' 12.70"	10° 9' 28.57"
42	*SM1 P_L*	74° 39' 45.21"	10° 15' 14.42"	86	*SM1 P_E*	74° 37' 36.74"	10° 11' 10.20"
43	*SM1 P_L*	74° 35' 37.01"	10° 14' 31.92"				

Where: Stand model. *SM1*: Stand model 1 Baseline: *R*: Fallow *P_E*: Pastos enrastrojados
SM2: Stand model 2 *P_L*: Pastos limpios

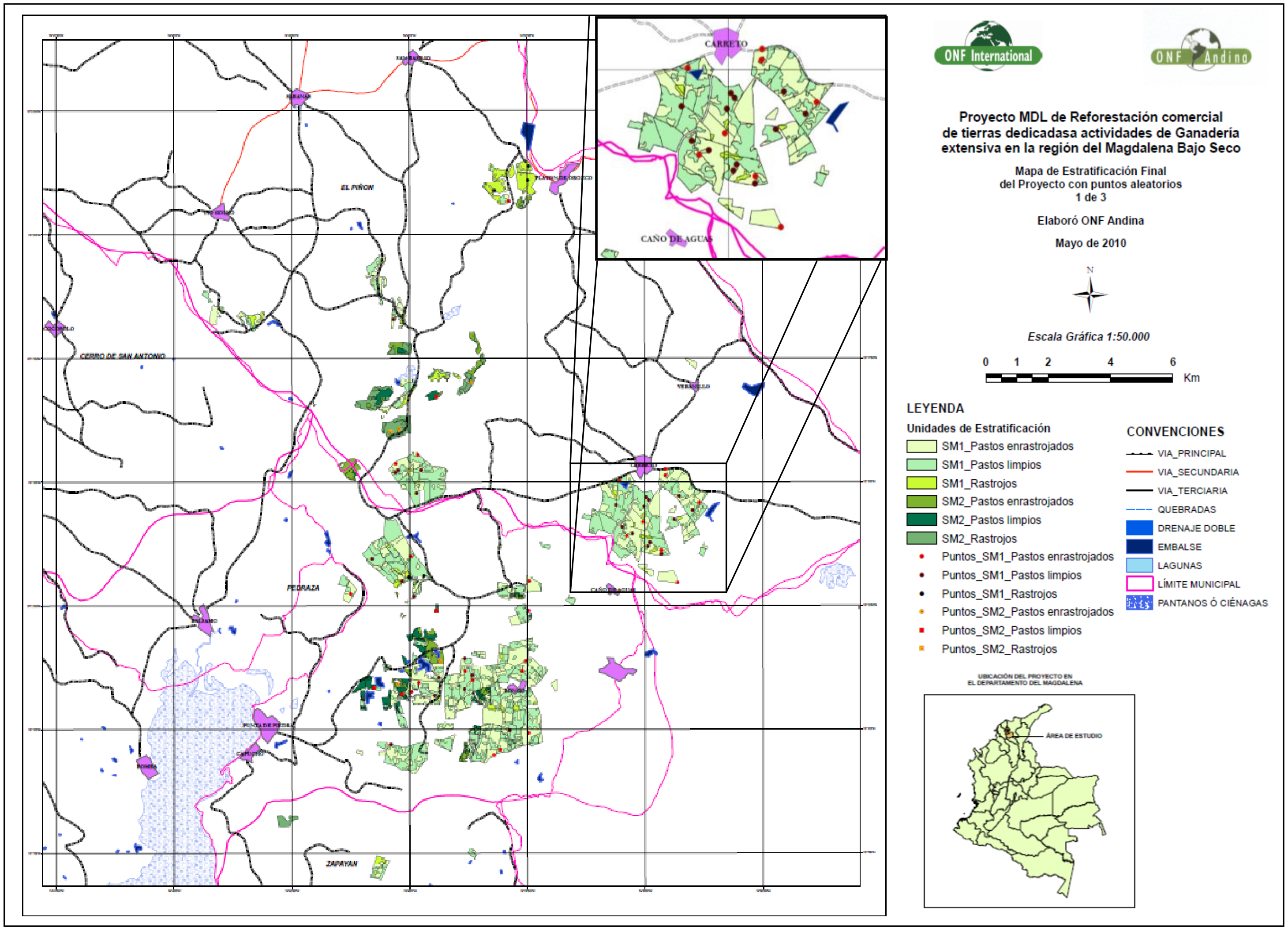

Figure 1. Distribution of monitoring plots, within the project boundary. Example given: monitoring plots near the Carreto town.

The trees which are considered within a monitoring plot, are all the trees which present at least half of its rayon at Breast Height inside the monitoring plot. Each tree within the monitoring plot will be given a unique number for precise identification. The numeration process will start from the centre of the plot looking at the trees located on the north of the plot and turn round the plot on the right side until all trees inside the plot have been given a number (see Figure 2).

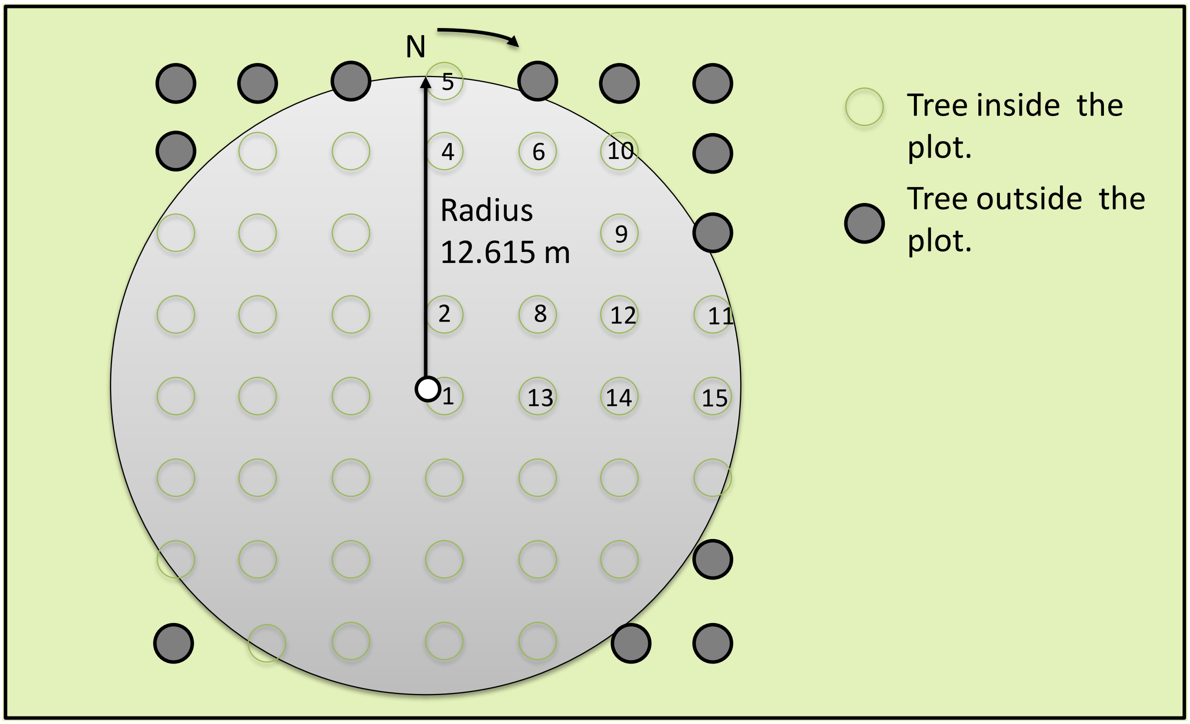

Figure 26: Scheme of permanent sample plots.

5. SCHEDULING OF MEASUREMENT, REPORTING AND VERIFICATION EVENTS

Frequency of monitoring is related to expected changes in the carbon stocks through time—the smaller the expected change the greater potential for less frequent monitoring to detect significant changes in carbon stocks and vice versa. Monitoring intervals reflect the sequence of verification events over the first crediting period of the project. Table 5 outlines the proposed monitoring events over the project period.

The project will be verified at the end of each measurement period (*i.e.* at 5-year intervals after the first verification).

The verification has several components: verification of field data collection, data analyses, documentation and record keeping, data storage protocols, and project compliance. The Quality Assurance / Quality Control (QA/QC) plan is designed to provide internal verification, whereas DOE verification is the external auditing of the measurements and the calculations of net GHG removals by sinks.

The first monitoring will be carried out during the second semester of the year 2011 and there will be subsequent monitoring every 5 years (see Table 5). And additionally, accordance with paragraph 12 of

Appendix B to decision 19/CP.9., it is established that the monitoring must not be carried out during the maximum carbon content peaks in the tree stands. An effort should be made to avoid said situation. Nevertheless, the maximum carbon content peaks are difficult to establish and will possibly not coincide with the monitoring periods.

Table 55: Schedule of carbon measurement events through 2029

Year	Measurement and verification activity
2011	Above ground biomass
2016	Above ground biomass
2021	Above ground biomass
2026	Above ground biomass

6. MONITORING OF THE FOREST ESTABLISHMENT AND MANAGEMENT

As described in the PDD, the monitoring of the forest establishment and management will be carried out as follow.

Monitoring of the project boundary

This is meant to demonstrate that the actual area afforested is consistent with the afforestation area outlined in the PDD. The following activities are foreseen:

- Field surveys concerning the actual project boundary within which A/R activity has occurred, site by site;
- Measuring geographical positions (latitude and longitude of each corner polygon sites) using GPS;
- Checking whether the actual boundary is consistent with the description given in section A.4.2.;
- Input the measured geographical positions that are in conformity with the description given in section A.4.2. of the PDD into the GIS system and calculate the area of each stratum and stand;
- The project boundary will be monitored periodically throughout the crediting period. If the forest area changes during the crediting period, for instance, because deforestation occurs in the project area, the specific location and area of the deforested land will be identified. Similarly, if the planting on certain lands within the project boundary fails these lands will be documented;
- Staff involved in the monitoring will be trained to identify the changes within project boundary and to record changes in the project database for reporting at project verification.

Table 56: Monitoring of project boundary

ID area	Municipality	Finca (ranch)	Parcel denomination	Longitude *(UTM)*	Latitude *(UTM)*

Periodical verifications will be performed to control that the plantation management labours are conducted according to the prescriptions mentioned in the PDD regarding fertilization, pruning, sanitary control, thinning and final harvest.

The regular field reports set up for each area of plantation per specie and per year of establishment will be used to conduct such analysis. The entity in charge of conducting the plantation monitoring plan will get someone with capacity in forest management select randomly some plantation plots and check on field that the labour reported on the regular reports have effectively been carried on. Eventually, this internal auditor with report on the corresponding forms any discrepancy.

- Techniques for thinning:
  - Realized by local manpower
  - Realized at years 3 and 7 for *Eucalyptus tereticornis*
  - Realized at years 3 and 7 for *Gmelina arborea*
  - Realized at years 5, 12 and 19, for *Tectona grandis*
  - Realized at years 6 and 13 for *Bombacopsis quinata*
  - Realized at years 6, 11 and 15 for *Tabebuia rosea*

For all stands, maintenance will consist in eliminating manually, by local manpower, the competitive vegetation (see Table 7).

Timing of planting

The area managed under the project from 2000 to 2029 is presented in Table 7.

Table7. *Planting and harvesting cycle for pure plantation stands*

Stand Model / Baseline Strata	Short rotation / Clean pasture	Long rotation / Clean pasture	Short rotation / Pastures with fallows	Long rotation / Pastures with fallows	Short rotation / fallows	Long rotation / fallows			
	A1	A2	B1	B2	C1	C2	Total	**Thinning or harvesting**	
Year of project	Area planted A_{ikt} ha	Area planted A_{ikt} ha	Area planted A_{ikt} ha	Area planted A_{ikt} ha	Area planted A_{ikt} ha	Area planted A_{ikt} ha	Area planted A_t ha	Short rotation	Long[290] rotation
2000	45.04	-	113.80	-	2.30	-	161.15	-	-
2001	93.81	60.94	106.79	66.70	91.97	21.81	442.02	-	-
2002	189.95	66.07	171.25	102.66	100.94	65.76	696.63	X	-
2003	143.34	30.00	254.37	37.60	129.94	159.66	754.90	-	-
2004	145.94	48.26	69.82	26.08	1.00	1.61	292.71	-	X
2005	94.82	6.10	83.70	6.62	2.62	-	193.86	-	X
2006	28.81	6.24	45.44	2.49	0.46	3.04	86.48	X	-
2007	7.99	-	2.58	-	-	-	10.56	-	-
2008	-	-	-	-	-	-	-	-	-
2009	58.51	-	52.59	-	5.95	-	117.05	X	-
2010	192.36	-	270.56	-	16.89	-	479.82	-	X
2011	163.67	-	215.60	-	-	-	379.26	-	X
2012	163.67	-	215.60	-	-	-	379.26	-	X
2013	163.67	-	215.60	-	-	-	379.26	-	-
2014	-	-	-	-	-	-	-	-	X
2015	-	-	-	-	-	-	-	-	-
2016	-	-	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-	-	X
2019	-	-	-	-	-	-	-	-	X
2020	-	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	-	-
2022	-	-	-	-	-	-	-	-	-
2023	-	-	-	-	-	-	-	-	-
2024	-	-	-	-	-	-	-	-	X
2025	-	-	-	-	-	-	-	-	-
2026	-	-	-	-	-	-	-	-	-
2027	-	-	-	-	-	-	-	-	-
2028	-	-	-	-	-	-	-	-	-
2029	-	-	-	-	-	-	-	-	-
Total	**1,491.56**	**217.62**	**1,817.70**	**242.14**	**352.08**	**251.87**	**4,372.97**		

[290] The three species of long rotation not to have the same years of management and Thinning, from there to be activities of Thinning or harvest in consecutive years.

The monitoring of the forest establishment will cover site preparation, planting and establishment of the forest.

- The monitoring of site preparation activities covers the identification and recording of the area under site preparation. The area affected by site preparation will be measured using the GPS. These data are the basis for calculation of project emissions from the loss of biomass during site preparation (see also section 8);
- Information on planting schedule, location, area, species planted, and spacing will be recorded in plot journals and archived in the project database ;
- Survival rates of planted trees are counted during the three months of the planting and replanting is done to fill the gaps and the area and location of supplemental plantings undertaken to fill the gaps is recorded in the project database and identified on the strata maps. Re-planting will be conducted if the survival rate is lower than 90 percent of the final planting density expected.

Table 8: Monitoring of planting activities

ID area	**Area** *(ha)*	**Activity**	**Date** *(dd/mm/yyyy)*	**Duration*** *(hours)*	**Comments**

** used for staff management and calculation of project emissions*

<u>*Monitoring of forest management*</u>

The monitoring of forest management will cover maintenance of plantation and firebreaks, harvesting of trees and replanting or sowing actions.

- Date, location and type of weeding actions in pure plantation will be recorded and archived in the project database;
- Date, location and type of maintenance actions for firebreaks will be recorded and archived in the project database;
- Date, location and type of thinning actions will be recorded and archived in the project database;
- Date, location, volume of tree harvested will be recorded and archived in the project database ;
- Re-planting and re-sowing actions will be checked. Date, location and type of stand will be recorded and archived in the database ;
- Deviations in the forest management activities implemented in the field and the ones outlined in section A.4.2 of the PDD will be monitored, and reasons for deviations will be recorded.

Table 9: Monitoring of forest management

ID area	**Area** *(ha)*	**Activity** *(weeding, thinning, harvesting, planting, sowing)*	**Date** *(dd/mm/yyyy)*	**Duration*** *(hours)*	**Comments**

** used for staff management and calculation of project emissions*

7. MONITORING AND MEASUREMENT OF CARBON POOLS

Tree biomass

Permanent sample plots located in the plantation plots will be located systematically with a random start (see section 4 above). All data (location, stratum, sub-stratum) and coordinates will be recorded and archived. Those sample plots, accurately located by GPS, will not present any specific visible display in order to avoid discriminately treatment.

The project designs circular sample plots of 500 m^2. The growth of individual trees in sample plots will be measured at each monitoring event. Non-tree vegetation such as herbaceous plants, grasses, and shrubs will not be measured and accounted as per methodology applied.

Diameter at breast height (DBH, 1.3 m above ground) of all the trees within each permanent sample plot (500 m^2; radius = 12.6156 m) above a minimum DBH (2 cm) will be measured, and height will be measured every four trees.

The DBH position should take into account the tree form and topography. The procedures to be followed for DBH measurements of trees on different topographic setting and with different irregularities are summarized in the figure below.

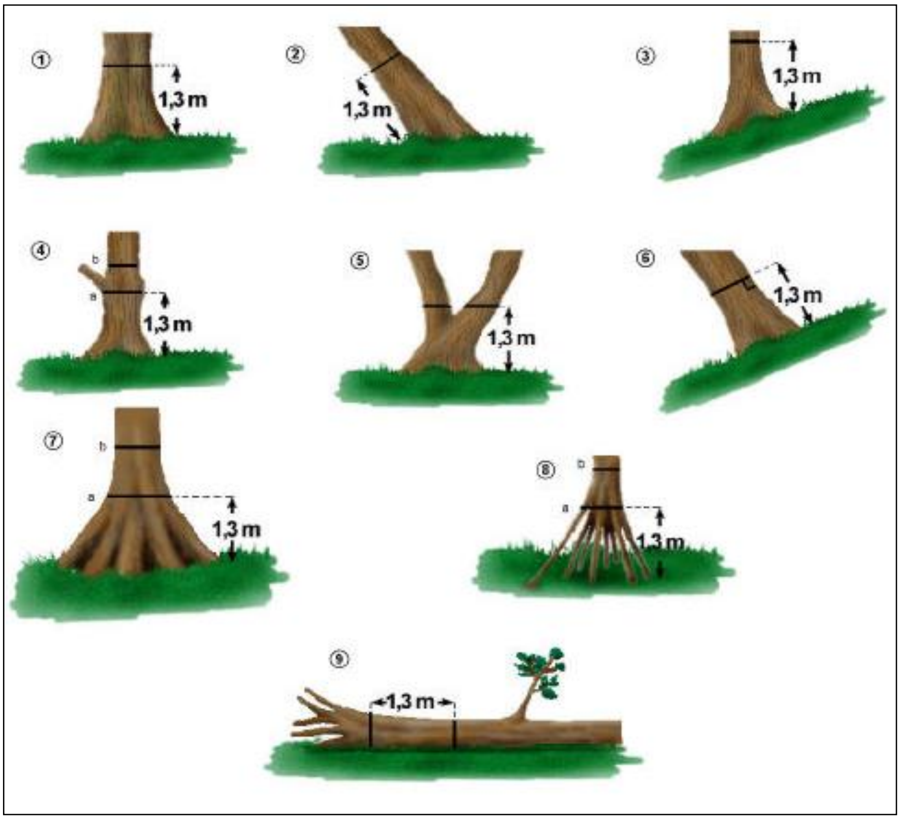

Figure 27. Implementation of DBH measurements taking into account the topography or tree irregularities; in the situations 4, 7 y 8 the measurement ***a*** move at new position ***b***, based on Schlegel *et al*.[291] (2001)

[291] Schlegel B., Gayoso J., and J. Guerra. 2001. Manual de procedimientos para Inventarios de carbono en ecosistemas forestales. Universidad Austral de Chile. Valdivia. 17 pág.

Date *(dd/mm/yyyy)*:
Crew *(names)*:
Type of stand/stratum:
Species planted:
Date of planting *(mm/yyyy)*:
Slope *(%)*:
Comments:

ID Plot	**ID Tree**	**Line**	**Tree Number**	**CBH** *(cm)*	**Total height** *(m)*	**Living/ dead**	**Health** *(optimal, good, regular, bad)*	**Form**	**Comments**

7

Figure 28: Form for tree monitoring

If the permanent plot is located on a slope that is >10%, the slope should be measured and an adjustment made to the plot diameter using the formula:

$$D = Ds / \cos S$$

Where *D* is the plot diameter to be measured in the field along the slope, *Ds* is the standard (true horizontal distance), *S* is the slope in degrees or percent (which must be converted to radians), and *cos* is the cosine of the angle. The adjusted diameter will be permanently marked in the field to guide future monitoring efforts in delimiting plot boundaries.

All trees measured will be permanently marked at the first aboveground biomass measurement with the placement of a tag inscribed with a unique number nailed into the stem at 1.2 meters height (10 cm below breast height); the DBH will then be measured at exactly 10 cm above the nail. If stems are not of sufficient size to support a nail (i.e. < 10 cm DBH), plastic ribbon will be tied around the base of the stem with a numbered tag. A mark will be made to indicate where DBH is measured, to ensure that future measurements will be done at the same place.

For *Gmelina arborea*, step-wise procedures for BEF method and equation (67)-(70) in Section II.5.1 of the approved baseline and monitoring methodology (AR-AM0004/version 04) will be followed to monitor the verifiable carbon stock changes in the above-ground and below-ground living biomass within the project boundary.

The above-ground biomass ($MC_{AB,ijt}$) in equation (67) of the methodology will be estimated using the following equation for determining MV_{ijt} :

Melina	$Age \leq 4\ year$ $V = \left[\sum_{i=1}^{n} v_i\right].F_e$ $where$ $v_i = 0.022894 + 0.0000149.d^{2.163941}.h^{1.0327856}$ $F_e = \frac{10000}{Size\ plot}$	López *et al.* (2011)[292]
	$Age \geq 5\, años$ $v = \frac{0.32932 \cdot (d/100)^2.(h-0.1)^{2.62}}{(h-1.3)^{1.62}}$	Vallejo (1991)[293]

In equations v_i corresponds to MV_{ijt}, d corresponds to DBH and *h* to total height

Where:
MV_{ijt} Mean merchantable volume per tree of species j, m^3
DBH Diameter at breast height, in cm

MC_{ABij} and MC_{BBij} will then be determined by using MV_{ijt} in the equations (67) and (68) of the applied methodology:

$$MC_{ABj} = MV_j \cdot D_j \cdot BEF_j \cdot CF_j$$
$$MC_{BBj} = MC_{ABj} \cdot R_j$$

Where:
MC_{ABij} Mean carbon stock in the above-ground biomass per unit of area for stratum i and species j t C
MV_j Mean merchantable volume per tree of species j, m^3
D_j Volume weighted average wood density, t d.m. m^3 merchantable volume
BEF_j Biomass expansion factor for conversion of biomass of merchantable volume to above-ground biomass, dimensionless
CF_j Carbon fraction, t C (t d.m)$^{-1}$
R_j Root-shoot ratio, dimensionless

The following parameters will be used:

Table 10: Parameters used to calculate ex-post carbon stocks in A/R CDM project activities

Parameter	Value	Source
D_j	0.53	Trujillo, 2007[294]

[292] LÓPEZ A.M.; BARRIOS, A.; NIETO V.; TRINCADO G. 2011. Monitoreo y modelamiento de crecimiento como herramienta para el manejo de plantaciones forestales comerciales. Corporación Nacional de Investigación y Fomento Forestal CONIF® – Ministerio de Agricultura y Desarrollo Rural. Bogotá D.C. 100p

[293] Vallejo, A. ,1991. Ecuaciones de conicidad y volumen para Bombacopsis quinata y Gmelina arbórea. Informe de Investigación No. 16 . Monterrey Forestal., Colombia

BEF_j	2.7	Table A1.3.10 of IPCC GPG LULUCF 2003
CF_j	0.5	According to the applied methodology, IPCC default value
R_j	0.27	Table A1.3.8 of IPCC GPG LULUCF 2003

These values shall be updated every five years if the values from the national inventory or literature are updated for more accuracy.

For this species, the parameters monitored will be therefore: DBH and H

IPCC default value (0.5) for the carbon fraction (CF_j) will be used. These values shall be updated every five years if the values from the national inventory are updated in the future.

For *Tectona grandis*, step-wise procedures for allometric method and equations (73)-(86) in Section II.5.1 of the approved baseline and monitoring methodology (AR-AM0004/version 04) will be followed to monitor the verifiable carbon stock changes in the above-ground and below-ground living biomass within the project boundary.

The above-ground biomass (TB_{AB}) in equation (74) of the methodology will be estimated using the following equation:

***Tectona grandis*[297].** $TB_{AB} = 0.131748 \cdot d^{2.406413}$

Where:

TB_{ABj} Above-ground biomass of a tree; kg tree^{-1}
d Diameter at breast height (DBH), in cm

Step 3: Carbon stock in above-ground biomass per tree is estimated according to the following equation

$$TC_{ABj} = TB_{ABj} \cdot CF_j \quad \textbf{(74)}$$

where:

TC_{AB} Carbon stock in above-ground biomass per tree; kg C tree^{-1} (*Spreadsheet SM8, SM9*)

TB_{ABj} Above-ground biomass of a tree of species *j*; kg tree^{-1}

CF Carbon fraction (IPCC default value = 0.5); t C (t d.m.)$^{-1}$

Step 4: Calculate the increment of above-ground biomass carbon accumulation at the tree level. As explained in BEF Method, t_1=0 then $TC_{ABj,t1}$=0. And equation 75 can be expressed as follow[298]:

[294] Trujillo Navarrete, Enrique (2007). Guía de Reforestación, Primera Edición 2007. Bogotá Colombia. 267 p

[297] Tabares J., 2002. Modelos de crecimiento de las cinco especies forestales (*Tectona grandis*, *Gmelina arborea*, *Bombacopsis quinata*, *Eucalyptus tereticornis* y *Tabebuia rosea*) contempladas en el proyecto piloto "SIG reforestación productiva". ONF Andina, Bogotá D.C, Colombia. 65p.

$$\Delta TC_{ABjT} = TC_{ABj,t2} \quad (75)$$

where:

ΔTC_{ABjT}	Carbon stock change in above-ground biomass per tree of species *j* between two monitoring events; kg C tree^{-1}
$TC_{ABj,t2}$	Carbon stock change in above-ground biomass per tree of species *j* at monitoring event t_2; kg C tree^{-1}

Step 5: Calculate the above-ground biomass carbon per plot on a per area basis. Since, to obtain carbon on a per area basis is just necessary to multiply for a constant value, this step is applied for total carbon stock (above-ground and below-ground) instead for tree individually.

$$\Delta PC_{ABikT} = \frac{XF \cdot \sum_{tr=1}^{TR} \Delta TC_{ABjT,tr}}{1000} \quad (76)$$

$$XF = \frac{10{,}000}{AP} \quad (77)$$

where:

$\Delta PC_{AB,ijT}$	Plot level carbon stock change in above ground biomass in stratum *i*, species *j*, between two monitoring events; t C ha^{-1}
ΔTC_{ABjT}	Carbon stock change in above-ground biomass per tree of species *j* between two monitoring events; kg C tree^{-1}
XF	Plot expansion factor from per plot values to per hectare values
AP	Plot area; m^2
tr	Tree (*TR* = total number of trees in the plot)

Step 6*:* Calculate mean carbon stock within each stratum. Calculate by averaging across plots in a stratum:

$$\Delta MC_{ABikT} = \frac{\sum_{pl=1}^{PL_{ik}} \sum_{j}^{J} \Delta PC_{ABikT,pl}}{PL_{ik}} \quad (78)$$

where:

ΔMC_{ABikT}	Mean carbon stock change in above-ground biomass in stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1}.
ΔPC_{ABijT}	Plot level mean carbon stock change in above-ground biomass in stratum *i*, species *j*, between two monitoring events; t C ha^{-1}.
pl	Plot number in stratum *i*, species *j*; dimensionless

[298] This assumption is only valid in first monitoring period, for subsequent monitoring events eq 75 will remains as established in methodology.

PL_{ik} Total number of plots in stratum *i*, stand model *k*; dimensionless

j Species *j* (*J* = total number of species)

In the tool CAMARA, this estimation is done for mean carbon stock in total biomass (above-ground + below-ground) which is equivalent because of is just to divide for a constant per stratum. (*Spreadsheet Removals 1, cells AL8 and AQ8*)

Step 7: Estimate carbon stock in below-ground biomass using root-shoot ratios and above-ground carbon stock and apply Steps 4 and 5 to below-ground biomass.

$$TC_{BBj} = TC_{ABj} \cdot R_j \quad \textbf{(79)}$$

$$\Delta TC_{BBjT} = TC_{BBj,t2} - TC_{BBj,t1} \quad \textbf{(80)}$$

$$\Delta PC_{BB,ikT} = \frac{XF \cdot \sum_{tr=1}^{TR} \Delta TC_{BBjT}}{1000} \quad \textbf{(81)}$$

$$\Delta MC_{BB,ikT} = \frac{\sum_{pl=1}^{PL_{ik}} \Delta PC_{BBikT,pl}}{PL_{ik}} \quad \textbf{(82)}$$

where:

TC_{BBj} Carbon stock in below-ground biomass per tree of species *j*; kg C tree^{-1}

TC_{ABj} Carbon stock in above-ground biomass per tree of species *j* as calculated in Step 1; kg C tree^{-1}

R_j Root-shoot ratio appropriate to increments for species *j*; dimensionless

ΔTC_{BBjT} Carbon stock change in below-ground biomass per tree of species *j* between two monitoring events; kg C tree^{-1}

$\Delta PC_{BB,\ ijT}$ Plot level carbon stock change in below-ground biomass of species *j* between two monitoring events; t C ha^{-1}

XF Plot expansion factor from per plot values to per hectare values (see equation 80); dimensionless

tr Tree (*TR* = total number of trees in the plot)

ΔMC_{BBikT} Mean carbon stock change in below-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1}

ΔPC_{BBikT} Plot level carbon stock change in below-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1} *pl* = plot number in stratum *i*, stand model *k*; dimensionless

PL_{ik} Total number of plots in stratum *i*, stand model *k*; dimensionless

On the same way, for *Bombacopsis quinata*, step-wise procedures for BEF method and equation (67)-(70) in Section II.5.1 of the approved baseline and monitoring methodology (AR-AM0004/version 04) will be followed to monitor the verifiable carbon stock changes in the above-ground and below-ground living biomass within the project boundary.

The above-ground biomass (MC_{ABij}) in equation (67) of the methodology will be estimated using the following equation for determining MV_{ijt} :

Bombacopsis quinata[300] $MV_{ijt} = 0.910.H^{0.620}.G^{0.965}$

Where:
MV_j Mean merchantable volume per ha of species *j*, m^3
G Basal area , m²/ha
H Dominant Height of trees, meter

MC_{ABij} and MC_{BBij} will then be determined by using MV_{ijt} in the equations (67) and (68) of the applied methodology:

$$MC_{ABj} = MV_j \cdot D_j \cdot BEF_j \cdot CF_j$$

$$MC_{BBj} = MC_{ABj} \cdot R_j$$

Where:
MC_{ABij} Mean carbon stock in the above-ground biomass per unit of area for stratum i and species j t C
MV_j Mean merchantable volume per tree of species j, m^3
D_j Volume weighted average wood density, t d.m. m^3 merchantable volume
BEF_j Biomass expansion factor for conversion of biomass of merchantable volume to above-ground biomass, dimensionless
CF_j Carbon fraction, t C (t d.m)$^{-1}$
R_j Root-shoot ratio, dimensionless

The following parameters can be used:

Table 11: Parameters used to calculate ex-post carbon stocks in A/R CDM project activities

Parameter	Value	Source
D_j	0.45	Coredero & Boshier, 2003[301]
BEF_j	2.7	Table A1.3.10 of IPCC GPG LULUCF 2003
CF_j	0.5	According to the applied methodology, IPCC default value
R_j	0.27	Table A1.3.8 of IPCC GPG LULUCF 2003

These values shall be updated every five years if the values from the national inventory or literature are updated for more accuracy.

For this species, the parameters monitored will be therefore: DBH and H

[300] CIRAD-Forêt, 2003. Capacidad del programa de reforestación comercial realizado en la zona Atlántica de Colombia de generar empleo y fomentar el desarrollo rural, desde la plantación hasta la transformación y comercialización de los productos. Consultoría para ONF-I y CORMAGDALENA, Colombia

[301] Cordero, J y Boshier, D. 2003. Bombacopsis quinata un árbol maderable para reforestar. Tropical Forestry Papers no.39. Oxford Forestry Institute, Oxford, UK. 182 pp.

All calculations to estimate tree biomass, using the above equations and parameters, are realized in an Excel spreadsheet. Such an excel spreadsheet was developed by ONF International through the form of an Excel tool named CAMARA (Carbon Accounting and Monitoring of Afforestation and Reforestation Activities). All equations and parameters are entered in the tool that estimates directly the actual net GHG removals by sinks:

- First stratification parameters are entered in the tool that calculates the number of sample plots required, in accordance with the AR-AM0004 Version 4.
- For each stratum, equations and parameters are entered in CAMARA, as presented in the monitoring plan
- Then data monitored are entered in CAMARA for each sample plot of each stratum
- Results are then given by the tool CAMARA

8. MONITORING OF PROJECT EMISSIONS

The GHG emissions that will occur during the implementation of the A/R CDM project activity are:

- CO_2 losses from pre-existing vegetation removal.

Emissions from site preparation activities would be assessed by monitoring the area affected in the site preparation filling Table annually after each plantation campaign. This monitoring will be done based on field surveys. Amount of biomass lost is calculated by multiplying the area affected in the site preparation with the biomass of the unit area affected by the site preparation and the carbon fraction of the biomass.

Table 12: Monitoring of site preparation

ID area	**Area** *(ha)* **A_S**	**Activity**	**Date** *(dd/mm/yyyy)*	**Duration**	**Comments**

As explained in the PDD, by equation (15), emissions from site preparation activities are equal to:

$$E_{biomasslos} = A_{ik} \cdot B_{pre,ik} \cdot CF_{pre} \cdot \frac{44}{12}$$

Where:

$E_{biomass}$ Decrease in the carbon stocks in the living biomass carbon pools of non-tree vegetation in the year of site preparation, t CO_2-e

A_{ik} Area of stratum i, stand model k, ha

$B_{pre,ik}$ Average pre-existing stock of non-tree pre-project biomass on land to be planted before the start of the proposed A/R CDM project activity for baseline stratum i and stand model k, t d.m. ha^{-1}

CF_{pre} Carbon fraction of dry biomass in pre-existing vegetation, t C (t d.m)$^{-1}$

The following parameters will be used:

Table 13: Parameters used to calculate ex-post carbon stocks in A/R CDM project activities

Parameter	Value	Source
$B_{cleanpasture}$	1.81	Pre-existing stock of non-tree project biomass for clean pasture, from Dufour (2005) including 0.72 t d.m of AGB and 1.09 t d.m of BGB
$B_{pasturewithfallow}$	17.18	Pre-existing stock of non-tree project biomass for rastrojo, from Dufour (2005) including 14.09 t d.m of AGB and 3.09 t d.m of BGB
$B_{fallows}$	21.49	Pre-existing stock of non-tree project biomass for rastrojo, from Dufour (2005) including 18.17 t d.m of AGB and 3.32 t d.m of BGB
CF_j	0.5	According to the applied methodology, IPCC default value

These values shall be updated every five years if the values from the national inventory or literature are updated for more accuracy.

The procedures for using the formulas and parameters, in order to estimate project emissions, are realized automatically the Excel tool CAMARA. All equations and parameters are entered in the tool that estimates directly the actual net GHG removals by sinks:

- Parameters related to GHG emissions are then entered and CAMARA calculate the actual net GHG removals by sinks

All calculations made in CAMARA respect the methods end formulas of the methodology applied. CAMARA is just made to realize calculations automatically. Therefore, there is no loss of accuracy in using the tool.

9. PROCEDURES IN PROJECT IMPLEMENTATION AND MONITORING

For the purpose of project monitoring and inventory, field crew should be organized into teams with one person assigned as a team leader. The number of members in a team and number of teams depends on the strata, administrative unit and sample size. Team leaders should be made responsible for organizing the field work. The overall organization of monitoring team is the responsibility of the project coordinator.
The monitoring will be based on the project data and information collected from project operations. The procedures to be followed in project implementation and monitoring are outlined in the sections below.

Procedures for training of monitoring personnel

Training of project monitoring personnel is a key step in ensuring the quality of data collection and accurate assessment of *ex post* carbon stock. Training helps in improving the technical skills of the project personnel. The training of monitoring personnel should cover the following technical aspects.

- The monitoring teams should be trained in the use of maps such as topographic and stratification maps and other physical and vegetation maps. The training should cover interpretation of maps and conversion of map scales to actual measurements on the ground.
- The training would cover the use of Global Positioning System (GPS), and instructions in the use of GPS, creating waypoints and data collection and use of the GPS in conjunction with compass, maps and field data collection techniques.
- Training to monitoring teams would be provided on the procedures for measuring forest growth and yield using permanent sample plots (PSPs).
- Training should also cover skills in identifying vegetation, species characteristics, sample plot location, codes and recommended practices of the inventory.
- Monitoring team members should be trained in the use of safety features such as the use of safety glasses, first aid kit, hand radio etc.
- The training should also cover the assessment of natural and anthropogenic risks and activities to be implemented in response to the risks of fire, droughts, pests etc.
- Training would cover the significance of meteorological data, such as maximum and minimum temperature, humidity, maximum wind velocity and average rainfall, interpretation of meteorological information and response to be implemented to address weather related emergencies.

Procedures to assessment GHG emissions due to fire inside project boundary

The project would implement fire management plan. The fire management plan would implement prevention measures such as establishment of firelines, clearance of bushwood and dry vegetation close to the project parcels. The project would further implement rapid response fire suppression measures.

In case of accidental fires, the area affected would be assessed by surveying the area and carbon stock affected. The procedures used for calculation of GHG emissions from natural fires under the project emissions would adopted to account the emissions and recorded in the project database.

Procedures to assess the impact of pests and disease on the carbon stock of the project

In case of pest or disease, monitoring team would assess the area and carbon stock of the affected area and implement pest/disease management measures to minimize negative impacts on the remaining carbon stock inside project boundary and to prevent the spread of infestation/disease to areas outside project boundary.

Impact of droughts on carbon stocks in the project boundary

Procedures would be implemented to assess the weather related natural hazard events such as droughts in the project area and survival of plantations in the affected areas. The data from field surveys of the affected areas would be used to assess the impact of droughts on the carbon stocks of the project.

Equipment used in inventories and calibration procedures for measurement accuracy

The equipment to be used in fieldwork should withstand the rigors of field use under adverse conditions. To avoid errors in the measurement of carbon stock, the following equipment used in monitoring and inventory activities would be calibrated using standard forest management and inventory operating procedures.

- Maps of the project area, stratum and planting site with GPS coordinates
- Compass for measuring bearings
- Fibreglass or metal tapes (100m and 30m) for measuring distances
- Global Positioning System (GPS) for locating plots
- Plot markers for marking plots
- Nails and number tags for marking trees
- Tree diameter at breast height (dbh) tape for measuring trees
- Diameter tape
- Pocket calculator
- Clinometers (percent scale) for measuring tree height and slope
- Coloured rope and pegs or a digital for marking plot boundaries measuring device (DME)
- Soil sampling probes for sampling soil
- Rubber mallet for inserting soil probes
- Cloth (for example, Tyrek) or paper bags for collecting soil and under storey samples
- Plastic file folder to put essential inventory documents, tables of correction for slope, etc,
- Pencil of average hardness (HB), a gum, and a penknife

Procedures for maintenance of monitoring equipment and installations

The common procedures to be followed in the maintenance of monitoring equipment are outlined below.

- When compass is used in the field, it is calibrated to compensate for the local difference between magnetic and true north (magnetic declination) and adjustment is made in order to facilitate the recording of accurate bearing.
- The aspect measurements should be recorded to the nearest eight directions: N, S, E, W, NE, SE, NW and SW. The same procedure is used to determine the azimuth to any desired target object such as a tree and the azimuth value should be recorded to the nearest percent, The azimuth direction is expressed in degrees: North at 360 (zero) degrees, East at 90, South at 180, and West at 270.
- It is recommended to use DBH tapes made of steel or aluminium. Cloth tapes should be avoided considering their propensity for wear and tear that could result in measurement inaccuracies.
- Pacing can be useful to establish the relationship between map and photo information with the measurements on the ground. One step represents half of a pace, two steps is one pace. Therefore, crew should be trained in pacing on flat ground.
- For collecting soil samples, cloth bags should be used and the use of plastic bags is avoided as they do not allow for the samples to dry, which can result in inaccurate results.

Procedures for handling of records and storage and process performance documentation

The project information is stored in paper and electronic formats. Among the information, the Standard Operating Procedure shall be carefully stored in order to implement rigorous and similar monitoring through crediting period. The reporting arrangements for handling of project documents and communications is aimed at continuous update of the operating procedures and communicating them widely to the project staff in the field so that project information is regularly updated and procedures for data storage and retrieval are updated as per the project requirements.

Procedures identified for review of reported results/data

The project implementation unit is expected to verify the plot data and decide on the need to return to the plot to re-measure the carbon pools. Prior to leaving a completed plot, the monitoring team would

review plot data form to insure all data are properly collected and recorded. The review would include checks of equipment calibration to ensure accurate measurements and random checks of the collected data to ensure the accuracy of reported measurements in the project database. Besides, at the end of the field works, 10% of the measurements will be independently checked by different personnel. Field data collected at this stage will be compared with the original data
The reviewers of the data are expected to present their independent report to the project coordinator so that review feedback is shared with the monitoring team and suitable corrective measures are implemented.

Procedures identified for internal audits of GHG project compliance with operational requirements
The monitoring unit of the project developer, supported by ONFI will implement the internal audit in order to ensure that the project complies with the regulatory requirements in terms of meeting the requirements of approved methodology AR AM0004-version 4 and the guidance of the CDM Executive Board. The internal audits would focus on the following aspects of the project

- Semi-annual and annual assessment of project documentation and reporting requirements to ensure compliance with the regulatory requirements.
- Arrangements for independent checks of the monitoring and inventory fieldwork over 10 % of the plots to ensure that the project data are collected and archived consistently following the standard procedures and the errors noticed are corrected and recorded.
- Audit of the procedures used in assessing the carbon stock changes based on the field data measurements
- Analysis of the effectiveness of the leakage prevention measures and improvements implemented to enhance the efficacy of leakage prevention measures.

Procedures identified for project performance reviews before data is submitted for verification
The monitoring unit is expected to review the project performance based on the reports of project implementation and inventory. The project coordinator in charge of the monitoring unit is expected to certify the compliance of the project with the steps of the approved methodology AR AM0004 and guidance of the CDM Executive Board.

Procedures identified for corrective actions in order to provide for more accurate future monitoring and reporting
The corrective action procedures ensure accurate monitoring and reporting on the project. The following procedures illustrate the corrective action procedures envisaged under the project.
The project coordinator or staff of the monitoring unit could accompany monitoring teams to assist in the field measurements. The coordinator is expected to conduct random inspections to identify errors and make decisions on the re-measurement of sample plots in case errors are observed. Disagreements on inventory approaches would be discussed among the monitoring teams and consensus on monitoring and inventory procedures achieved would be implemented throughout the project area. The procedures at each inventory are recorded in the project database
The flora that is difficult to identify at the time of inventory, would be recorded based on its characteristics, and a leaf/branch sample is collected and its identification is undertaken after the plot inventory.
At each monitoring event, data from previous and current inventories would be compared in order to make an accurate assessment of in-growth, existing trees, and mortality.

10. QUALITY ASSURANCE AND QUALITY CONTROL PLAN

To develop a credible plan for measuring and monitoring carbon on the afforestation sites, steps must be taken to control for errors in sampling and data analysis. To provide confidence to all stakeholders that the reported carbon credits are reliable and meet minimum measurement standards, a quality assurance and quality control (QA/QC) plan is necessary. This plan includes formal procedures to verify methods used to collect field data and the techniques to enter and analyze data. To ensure continuity it is important that all data collected use the same procedures during the project life. Adhering to these procedures will ensure that in the event there is a change in personnel among project developers, or if any of the people involved are questioned about any aspect of the project, all will be well informed. In addition to following the procedures outlined below, it is also important that a record be maintained to demonstrate that the steps are being followed; this needs to be done by developing a series of check sheets for each step.

For this purpose, procedures have been developed for:

- collecting reliable field measurements
- verifying methods used to collect field data
- verifying data entry and analysis techniques
- data maintenance and archiving

Procedures to ensure reliable field measurements

Collecting reliable field measurement data is an important step in the quality assurance plan. Those responsible for the measurement work shall be fully trained in all aspects of the field data collection and data analyses. Standard operating procedures for each step of the field measurements will be adhered to at all times so that future field personnel can check past results and repeat the measurements in a consistent fashion.

- Field-team members are fully cognizant of all procedures and the importance of collecting data as accurately as possible; Before field measurements all procedures are reviewed with the whole monitoring team
- All field measurements are properly supervised by a project coordinator fully aware of all monitoring procedures, and any errors in techniques are corrected;
- The field forms are filed in accordance with the standard operating procedures. The document will list all names of the field team and the project leader will certify that the team is trained;
- New staff is adequately trained by its homologue fully aware of all procedures.

Verification of field data collection

To verify that plots have been installed and the measurements taken correctly :

- All measurements are observed by two persons for cross-checking
- At the end of the field works, 10% of the measurements will be independently checked by different personnel. Field data collected at this stage will be compared with the original data. Any errors found will be corrected and recorded. Any errors discovered will be expressed as a percentage of all plots that have been rechecked to provide an estimate of the measurement error.

Verification of data entry and analysis

Surveys data are entered into a computer-based information system especially designed for the project. Reliable estimates require proper entry of data into the data analysis spreadsheets. Possible errors are minimized by reviewing entries using expert judgment, where necessary and comparison with independent data to ensure that the data are realistic. Communication between all personnel involved in measuring and analyzing data allow resolving any apparent anomalies before the final analysis of the monitoring data is completed. If there are any problems with the monitoring plot data that cannot be resolved, the plot is not used in the analysis.

- data entry is made by two trained persons for cross-checking
- final analysis is made by the person who prepared the monitoring

- minimum files shall be used in order to avoid losses of data in time and to facilitate data analysis

The following elements shall be particularly considered :

- Stratum ID: cross-check with previous monitoring and management plans
- Age of plantations: shall be integrated to GIS
- Number of trees: shall be integrated to the GIS for initial plantations as for natural regeneration
- Diameter at breast height (DBH): circumference shall be preferred. Measurements shall be cross-checked by two trained persons
- Wood density shall be updated by the project coordinator on scientific studies improving knowledge on wood density
- Biomass expansion factor (BEF) shall be updated by the project coordinator on scientific studies improving knowledge on BEF
- Carbon fraction shall be updated by the project coordinator on scientific studies improving knowledge on carbon fraction
- Root-shoot ratio shall be updated by the project coordinator on scientific studies improving knowledge on root-:shoot ratio

Data maintenance and archiving

Data will be archived in both electronic and paper forms, and conserved at least two years after the end of the crediting period. All electronic data and reports will be copied on durable media and update format, such as compact discs (CDs), and copies of the CDs will be stored in multiple locations. The archives include:

- Copies of all original field measurement data, laboratory data, data analysis spreadsheets;
- Estimates of the carbon stock changes in all chosen carbon pools and non-CO_2 GHG sources and corresponding calculation spreadsheets;
- GIS products and update software ;
- Copies of the measuring and monitoring reports.

History of the document

Version	Date	Nature of revision
04	EB35, Annex 20	• Restructuring of section A;

	19 October 2007	• Section "Monitoring of forest establishment and management" replaces sections: "Monitoring of the project boundary", and "Monitoring of forest management"; • Introduced a new section allowing for explicit description of SOPs and quality control/quality assurance (QA/QC) procedures if required by the selected approved methodology; • Change in design of the section "Monitoring of the baseline net GHG removals by sinks" allowing for more efficient presentation of data.
03	EB26, Annex 19 29 September 2006	Revisions in different sections to reflect equivalent forms used by the Meth Panel and assist in making more transparent the selection of an approved methodology for a proposed A/R CDM project activity.
02	EB23, Annex 15a/b 24 February 2006	Inclusion of a section on the assessment of the eligibility of land and the Sampling design and stratification during monitoring
01	EB15, Annex 6 03 September 2004	Initial adoption