

REFORESTING DEGRADED LANDS IN CHILE THROUGH THE USE OF MYCORRHIZAL INOCULATION: 2012 MONITORING AND VERIFICATION REPORT

Prepared for Mikro-Tek by TerraCarbon LLC

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1 PROJECT DETAILS

1.1 Summary Description of Project

In 2003, Mikro-Tek initiated the grouped project “Reforestation Degraded Lands in Chile through the use of Mycorrhizal Inoculation”. In this reforestation project, Mikro-Tek works with local land owners and provides an advanced propagation technology, mycorrhizal inoculation, to help restore and convert degraded grassland (Figure 1.1) into productive forests in several regions of Chile. The application of this technology, funded by Mikro-Tek’s investment, permits successful plantation establishment on sites that would otherwise not be sufficiently productive to incentivize reforestation efforts by landowners. This grouped project promotes reforestation of land that would remain as degraded grassland in the absence of carbon finance. Working with small and medium-scale landowners, Mikro-Tek’s project has so far led to the reforestation of 2,010.1 ha of land with *Pinus radiata* and an additional 996.8 ha of land with *Eucalyptus globulus* since 2003.

Figure 1.1. Photograph of Lote N°4 Fundo Nerquihue, MikroTek0048.



As discussed in Section 1.12.3 of the project description, part of the above project area was registered as part of the CDM project¹ “Nerquihue Small-Scale CDM Afforestation Project using Mycorrhizal Inoculation in Chile”. While project instances MikroTek0041 and MikroTek0048 have been registered under the CDM, no emission reductions (tCERs or ICERs) have been issued or will be applied for.

The project is situated in an extremely dry area with degraded soils due to a long history of agriculture. The project area was previously used for small-scale agriculture production, but production ceased due to soil impoverishment. Prior to project initiation, project land was unmanaged abandoned grassland where

¹ Bird, D. and M. Kean. 2010. Nerquihue Small-Scale CDM Afforestation Project using Mycorrhizal Inoculation in Chile. Version 7. CDM Executive Board.

natural seed sources were lacking and natural regeneration does not occur. The project activity creates forest plantations on land with degraded soil that is currently no longer suitable for agriculture. Although plantation establishment is practiced in Chile, it is not widespread on lands similar to the project sites due to poor soils and the dry climate. Reforestation in the project region using traditional planting techniques has a high chance of failure due to poor environmental conditions.

This project involves the application of mycorrhizal inoculants to containerized seedlings prior to planting to reduce mortality and stimulate tree growth by enhancing nutrient and water uptake. Under normal conditions, adequate mycorrhizal formation usually occurs naturally. However, many industrial sites such as forestry cutovers, heavily used agricultural soils (such as these sites), nutrient-poor industrial waste sites, or sites where natural topsoil has been over used, disturbed or eroded away, are deficient in mycorrhizal fungi. In these cases, specifically chosen strains and species of mycorrhizae can be introduced to the soil to enhance the health and growth rates of the target plant community. This technology was not commercially available in Chile prior to Mikro-Tek's initial work to isolate local mycorrhizal species and strains, screen for effectiveness for enhanced nutrient uptake and vigor, and test the species with the most beneficial effect on targeted host tree species, which began in 1999.

The grouped project area includes sites where the combination of low rainfall and degraded nutrient poor soils make the application of this mycorrhizal inoculation technology essential to establishment of plantations with sufficient productivity to be financially attractive to landowners. Mikro-Tek has invested its own funds to develop and manufacture the mycorrhizal inoculum in return for the rights to the carbon credits generated by the reforestation project (subject to revenue sharing arrangements with the landowners). This initial investment by Mikro-Tek allows for a technological (and investment) barrier to be overcome. Without Mikro-Tek's involvement, strong environmental barriers would continue to prevent plantation establishment on the project lands.

In the course of the project, small and locally operated nurseries were used to produce containerized *Pinus radiata* and *Eucalyptus globulus* seedlings, which were inoculated with mycorrhizae supplied by Mikro-Tek. Mikro-Tek also supplied the inoculation procedures and worked directly with these nurseries to train personnel in quality-control aspects of mycorrhizal inoculation.

Individual land owners are responsible for planting and forest management practices, as approved by Corporacion Nacional Forestal (CONAF). Sub-soiling is carried out using either a tractor or animals (horses or oxen), depending on the slope of the land. The mycorrhizal inoculated seedlings are then planted along the sub-soil plow lines at an overall planting density of 1,250 trees per hectare. Harvesting occurs around year 20 for *Pinus radiata* and year 10 for *Eucalyptus globulus*. As specified in the Law 701 (see Section 1.11 of the project description) which guides CONAF's approval of the forestry plans, each harvested stand must be replanted after harvest according to CONAF guidelines.

The initial project instances enrolled in the Reforesting Degraded Lands in Chile through the use of Mycorrhizal Inoculation grouped project consists of 3,007 hectares (ha) comprised of one or several fields planted for each project instance (see Table 1.1). Additional project areas will be added to this grouped project over time.

Table 1.1. Project instance information.

Project Instance-Number	Region	Province	Commune	Owner	Planting Year(s)	Species Planted	Total Area (ha)
MikroTek0001	VI	Colchagua	Lolol	Harris-Correa	2003	Pinus radiata	0.5
MikroTek0002	VI	Colchagua	Lolol	Nitsche	2003	Eucalyptus globulus	0.2
MikroTek0003	VII	Curico	Vichuquen	Toledo	2004	Eucalyptus globulus	48.9
MikroTek0004	VI	Colchagua	Pumanque	Hernandez	2004	Eucalyptus globulus	4.8
MikroTek0005	VI	Colchagua	Pumanque	Hernandez	2004	Eucalyptus globulus	9.7
MikroTek0006	VI	Cardenal Caro	Paredones	Barroiht	2004	Eucalyptus globulus	25.2
MikroTek0007	VII	Curico	Vichuquen	Cuevas	2004	Eucalyptus globulus	26.2
MikroTek0008	VI	Colchagua	Santa Cruz	Harris-Correa	2006	Pinus radiata	28.0
MikroTek0009	VI	Colchagua	Lolol	Garces	2004	Pinus radiata	299.1
MikroTek0010	VI	Colchagua	Lolol	Harris-Correa	2003	Eucalyptus globulus	24.8
MikroTek0011	VI	Colchagua	Lolol	Harris-Correa	2004	Pinus radiata	26.8
MikroTek0012	VI	Colchagua	Lolol	Harris-Correa	2003	Pinus radiata	30.4
MikroTek0013	VI	Colchagua	Lolol	Harris-Correa	2004	Eucalyptus globulus	7.1
MikroTek0014	VI	Colchagua	Pumanque	Harris-Correa	2005	Pinus radiata	17.3
MikroTek0015	VI	Colchagua	Pumanque	Harris-Correa	2005	Pinus radiata	99.0
MikroTek0016	VI	Colchagua	Pumanque	Hernandez	2004	Eucalyptus globulus	14.5
MikroTek0017	VI	Colchagua	Lolol	Giglio	2004	Eucalyptus globulus	58.8
MikroTek0018	VI	Colchagua	Pumanque	Hernandez	2004	Pinus radiata	1.5
MikroTek0019	VI	Colchagua	Lolol	Harris-Correa	2003	Eucalyptus globulus	34.8

MikroTek0020	VI	Colchagua	Lolol	Nitsche	2004	Eucalyptus globulus	16.8
MikroTek0021	VI	Colchagua	Lolol	Harris-Correa	2003	Pinus radiata	72.5
MikroTek0022	VI	Colchagua	Lolol	Giglio	2004	Pinus radiata	51.9
MikroTek0023	VI	Colchagua	Lolol	Nitsche	2004	Pinus radiata	49.3
MikroTek0024	VI	Colchagua	Lolol	Nitsche	2003	Eucalyptus globulus	63.5
MikroTek0025	VI	Colchagua	Lolol	Nitsche	2003	Pinus radiata	185.7
MikroTek0026	VI	Colchagua	Lolol	Harris-Correa	2004	Eucalyptus globulus	13.5
MikroTek0027	VI	Colchagua	Lolol	Nitsche	2003	Pinus radiata	42.1
MikroTek0028	VI	Colchagua	Lolol	Nitsche	2004	Eucalyptus globulus	36.5
MikroTek0029	VI	Colchagua	Lolol	Nitsche	2004	Pinus radiata	133.5
MikroTek0030	VI	Colchagua	Pumanque	Hernandez	2004	Eucalyptus globulus	12.3
MikroTek0031	VI	Cardenal Caro	Litueche	Bulnes	2009	Eucalyptus globulus	17.4
MikroTek0032	VI	Colchagua	Lolol	Harris-Correa	2004	Pinus radiata	113.1
MikroTek0033	VI	Cardenal Caro	Litueche	Bulnes	2007	Eucalyptus globulus	29.1
MikroTek0034	VI	Cardenal Caro	Paredones	Barroiht	2004	Eucalyptus globulus	0.8
MikroTek0035	VI	Cardenal Caro	Litueche	Bulnes	2007	Eucalyptus globulus	114.2
MikroTek0036	VI	Cardenal Caro	Litueche	Bulnes	2009	Eucalyptus globulus	37.3
MikroTek0037	VI	Cardenal Caro	Litueche	Bulnes	2006	Eucalyptus globulus	103.9
MikroTek0038	VI	Cardenal Caro	Paredones	Catalan	2004	Eucalyptus globulus	70.9
MikroTek0039	VII	Curico	Vichuquen	Cuevas	2006	Eucalyptus globulus	47.7
MikroTek0040	VIII	Bio Bio	Quilleco	Baztan	2009	Pinus radiata	473.7
MikroTek0041	VI	Colchagua	Lolol	Ulloa	2003	Pinus radiata	86.3
MikroTek0042	VI	Cardenal Caro	Litueche	Bulnes	2009	Eucalyptus globulus	6.4
MikroTek0043	VI	Cardenal Caro	La Estrella	Bulnes	2004	Eucalyptus globulus	11.8
MikroTek0044	VIII	Bio Bio	Quilleco	Baztan	2009	Pinus radiata	121.6

MikroTek0045	VI	Cardenal Caro	Paredones	Barroiher	2004	Eucalyptus globulus	0.9
MikroTek0046	VI	Cardenal Caro	La Estrella	Bulnes	2004	Eucalyptus globulus	124.6
MikroTek0047	VI	Cardenal Caro	Paredones	Barroiher	2004	Eucalyptus globulus	34.3
MikroTek0048	VI	Colchagua	Lolol	Ulloa	2003	Pinus radiata	177.8

A schedule of the important aspects of the grouped project is listed in chronological order in Table 1.2, below.

Table 1.2. Schedule of grouped project activities.

Project activity	Date	Source/Notes
Grouped project start date and start of the crediting period	June 1, 2003	Time of planting of the initial project instance.
Validation of the grouped project	Anticipated 2013	
Registration of grouped project	Anticipated 2013	
Monitoring and Verification	September/October 2012	Starting in 2012 and at least every five years thereafter
Expected grouped project longevity	40 years	June 1, 2003 to May 31, 2043
Expected grouped project termination date	May 31, 2043	

1.2 Sectoral Scope and Project Type

This project is to be registered under the Verified Carbon Standard (VCS) as an Afforestation, Reforestation and Revegetation (ARR) project and has been developed in compliance with the Verified Carbon Standard² and VCS AFOLU Requirements³. The project entitled Reforesting Degraded Lands in Chile through the use of Mycorrhizal Inoculation is a grouped project.

1.3 Project Proponent

The grouped project is implemented by Mikro-Tek in association with the land owners. Roles and responsibilities of the project proponent and supporting entities are elaborated in Tables 1.3 and 1.4 below.

Table 1.3. List of project proponents.

Roles and Responsibility	Personnel/Position	Contact Details
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² VCS. 2012 VCS Standard. Version 3.3, 04 October 2012. Verified Carbon Standard, Washington, D.C.

³ VCS. 2012 Agriculture, Forestry and Other Land Use (AFOLU) Requirements. Version 3.3, 04 October 2012. Verified Carbon Standard, Washington, D.C.

Supply the mycorrhizal inoculum, as well as the associated technologies for their application and management. Project management, implementation, and registration including budgeting, hiring of project personnel and contractors. Implement monitoring and verification plan, including the hiring of monitoring/inventory staff, technical consultants and VCS verifiers, as needed. Ensuring that offsets are registered following verification, investor relations, and marketing. Maintain electronic database of GIS coverages detailing parcel boundaries and plot locations, archive raw field measurements and analysis in hard and electronic copies.	Mark Kean, President	Mikro-Tek Inc. P.O. Box 2120 115 Sandy Falls Road, Timmins, Ontario P4N7X8Canada +705 268 3536
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1.4 Other Entities Involved in the Project

Table 1.4. List of other entities involved in the project.

Roles and Responsibility	Personnel/Position	Contact Details
Ongoing management of the project area. Oversee contracted monitoring and inventory staff in the field. Serve as a liaison and translator for the landowners and Mikro-Tek, including establishing meetings with landowners and relevant stakeholders, arranging site visits, providing information and documentation such as previous studies, photographs, and satellite images related to the project.	Alfredo Unda, Forester, Manager Chile Projects.	Diego de Almagro, 2081, Ste. #64 Providencia, Santiago Chile 562-899-69931
Develop PDD and design monitoring plan in consultation with Mikro-Tek staff.	James Eaton, Senior Manager, Forestry and Technical Services David Shoch, Senior Manager, Forestry and Technical Services	TerraCarbon LLC 5901 N. Sheridan Rd. Peoria, Illinois 61614 U.S.A. +434 326 1144
Owners of project property responsible for managing and conducting all silvicultural and forestry aspects of the project in accordance with the approved CONAF Forestry Plan and the Business Collaboration Agreement with Mikro-Tek, the Project Proponent.	Individual property owners	Located in project database in the Business Collaboration Agreement.

1.5 Project Start Date

The grouped project has a project start date of June 1, 2003 marking the start of planting of the first project instance by Mikro-Tek.

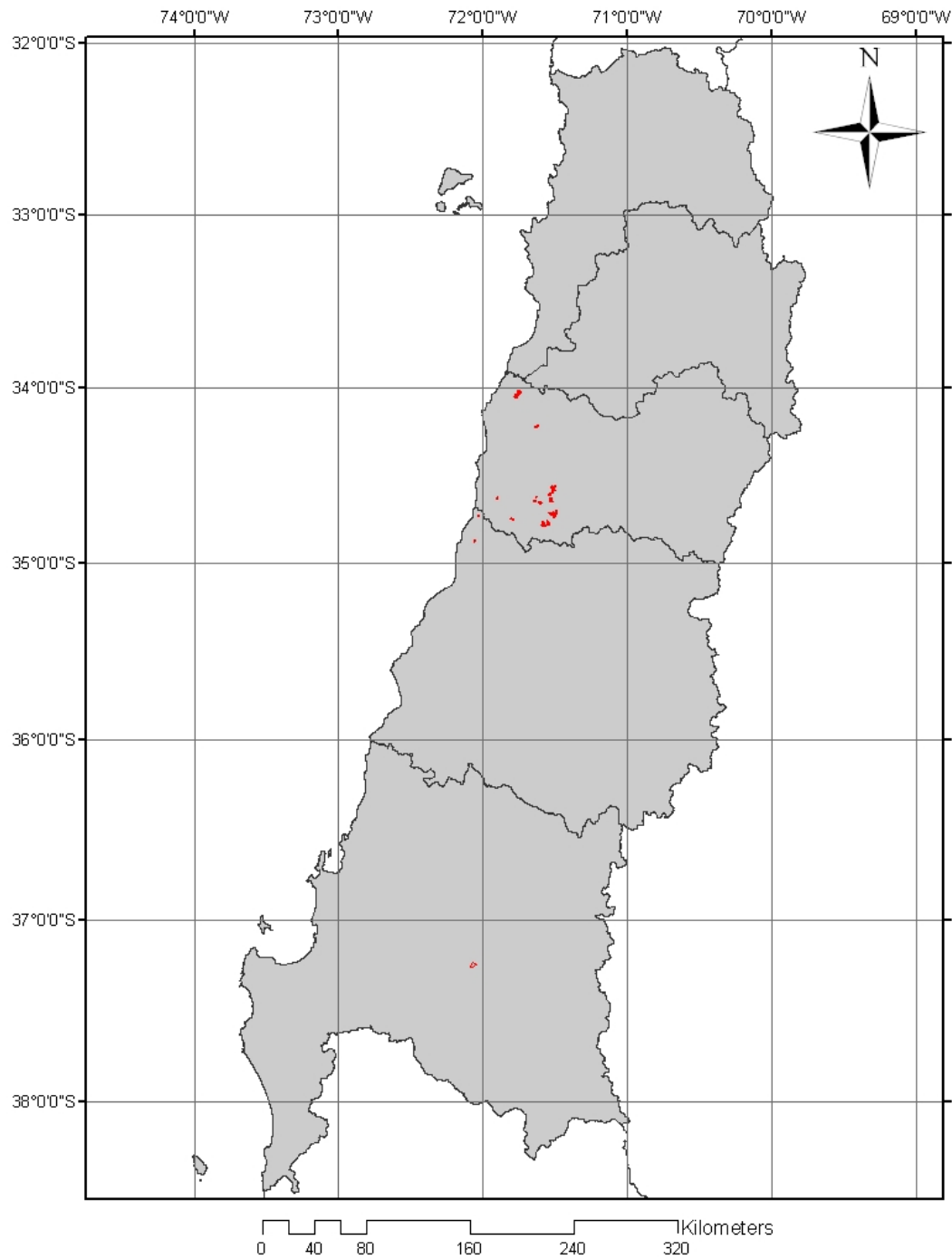
1.6 Crediting Period

The Reforesting Degraded Lands in Chile through the use of Mycorrhizal Inoculation project has a crediting period of 40 years. It is set to start June 1, 2003 and continue through May 31, 2043.

1.7 Project Location

The initial project instances are located in Region VI, VII, and VIII in the communes of Lolol, Estrella, Vichuquen, Pumanque, Quilleco, Hualane, and Chepica. The entire grouped project area will be located within Region RM, V, VI, VII, and VIII. An overview of the geographic boundary of the grouped project can be found in Figure 1.2 below. Detailed project instance boundaries for all sites will be archived as GIS files located in the project database.

Figure 1.2. Grouped project geographic region (in gray) and current project instances (in red).



1.8 Title and Reference of Methodology

This project uses approved Clean Development Mechanism (CDM) afforestation/reforestation methodology AR-ACM0003 “Afforestation and reforestation of lands except wetlands” – Version 1.0, together with the following tools:

- Approved CDM “Combined tool to identify the baseline scenario and demonstrate the additionality in A/R CDM project activities, Version 1”;
- Approved CDM tool “Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity”;
- Approved CDM tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities”; Version 3.0;
- Approved CDM tool “Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities and and”;
- Approved CDM “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”, Version 01.1.0.

The following tool was also used:

- Approved CDM “Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities”, Version 1.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

While the project activity, planting of trees, is ongoing in this grouped project, there are no additional project instances to add to the project as part of this monitoring report. Management and implementation of the tree plantings are consistent with that described in the project description and in Section 1.1 of this report.

As described in the project description document, there is no leakage expected as no agricultural products are expected to be displaced due to implementation of the project.

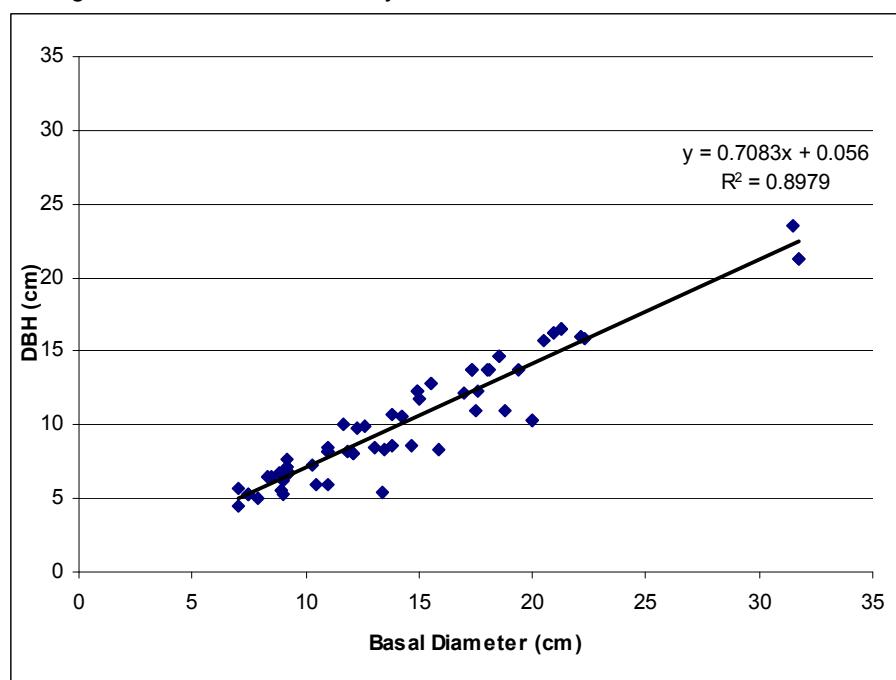
A non-permanence buffer withholding of 10% had been calculated and justified in the project description. Further justification is not warranted at this time, as the “Reforestation Degraded Lands in Chile through the use of Mycorrhizal Inoculation” project is being validated and verified at the same time

2.2 Project Description Deviations

In order to estimate belowground biomass for harvested *Eucalypts globulus* stands, a project specific diameter at breast height to basal diameter relationship was developed and used. This relationship was developed by measuring⁴ both diameter at breast height and basal diameter for 68 trees in the EUC-2003/2004 strata or the “pre-harvested” strata. This proposed deviation allows for the monitoring of belowground biomass in the “EUC04-Harvest” strata where DBH data is not available, yet required to estimate live aboveground biomass from which belowground biomass is then calculated. While belowground biomass is retained when Eucalyptus is coppiced, aboveground biomass is not and hence DBH measurements are not possible and the aboveground biomass pool is not included in biomass estimates for this strata.

⁴ This information was collected during the course of the 2012 forest inventory.

Figure 2.1. DBH to basal diameter relationship used to estimate belowground biomass when aboveground biomass has already been harvested.



2.3 Grouped Project

No new project instances are added to the grouped project at this time.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

The following data and parameters are available prior to or calculated during the course of preparing this monitoring report.

Table 3.1. Key data /parameters used for monitoring project activity

Parameter	Data	Data unit	Measured, calculated, default, other	Measurement frequency (if measured)	Source of data
A	Total area of A/R VCS project activity	Ha	Measured	Once, at beginning of project	GIS
A _i	(a) Area of tree biomass stratum i; (b) Area of SOC stratum i of the land meeting the applicability conditions of the SOC tool	Ha	Measured	Once, at beginning of project	GIS
a _{pi}	Total area of sample plots in tree biomass stratum i	Ha	Calculated		
CF _j	Carbon fraction of biomass for tree species j	0.5 t C t ⁻¹ d.m.	Default		CDM Tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; Version 2.1.0"
LK _{Agric,t}	Leakage due to the displacement of agricultural activities in year t	t CO ₂ -e	Calculated		
D _t	Fraction of the total area of A/R VCS project activity subject to displacement of agricultural activities in year t	dimensionless	Measured	Once at beginning of project	landowner

Ad_t	Area subject to pre-project agricultural activities that are displaced during year t since the start of the A/R project activity	ha	Measured	Once at beginning of project	landowner
ΔCd_t	Annual change in carbon stock in all selected carbon pools for year t	$t \text{ C yr}^{-1}$	Calculated		Inventory results
$\Delta C_{t=t_{\text{ver}}}$	Sum of annual changes in carbon stock in all selected carbon pools since the start of the A/R VCS project activity to the year of verification t_{ver}	$t \text{ C}$	Calculated		Inventory results
ΔCd_{t^*}	Sum of annual changes in carbon stock in all selected carbon pools since the start of the A/R VCS project activity to the year of verification t_{ver} attributable to the area subject to pre-project agricultural activities that are displaced during year t since the start of the A/R project activity	$t \text{ C}$	Calculated		
f	Fraction of land covered by forest (according to the national definition of forest) in the region containing the A/R VCS project activity	dimensionless	Measured	Once at beginning of project	
$bm_{\text{Eucalyptus}}$	total aboveground biomass for trees, $bm = \text{Exp}(2.3177 + 0.1303 * \text{dbh})$, where $n = 107$, $r^2 = 96.29$	kg	Calculated		Gayoso 2008a; Gayoso et al., 2002
bm_{Pinus}	total aboveground biomass for trees, $bm = -5.0506 + 0.8173 * (\text{dbh}^2)$, where $n = 58$, $r^2 = 97.65$	kg	Calculated		Gayoso 2008b; Gayoso et al., 2002
$R_{\text{Eucalyptus}}$	root to shoot ratio for <i>Eucalyptus globulus</i> = 0.2159	dimensionless	Default		Gayoso 2008a
R_{Pinus}	root to shoot ratio for <i>Pinus radiata</i> = 0.2543	dimensionless	Default		Gayoso 2008b
CDM Executive Board. 2009. Estimation of the increase in GHG emissions attributable to displacement of pre-					

project agricultural activities in A/R CDM project activity - Version 1. EB51. UNFCCC, Bonn, Germany.
CDM Executive Board. 2012. AR-ACM0003 Afforestation and reforestation of lands except wetlands - Version 1.0. UNFCCC, Bonn, Germany.
Gayoso, J. 2008a. Eucalyptus sp. Resultados Proyecto FONDEF D98i1076 "Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono". Bosque PROCarbono, Universidad Austral de Chile. http://www.uach.cl/procarbono/pdf/fichas/ficha_eucalyptus_sp.pdf Accessed 21 July 2011.
Gayoso, J.; Guerra, J.; Alarcón, D. 2002. Contenido de carbono y funciones de biomasa en especies nativas y exóticas. Proyecto FONDEF D98i1076 Medición de la capacidad de captura de carbono en bosques de Chile y promoción en el mercado mundial. 157 p.
Gayoso, J. 2008b. Pinus radiata. Resultados Proyecto FONDEF D98i1076 "Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono". Bosque PROCarbono, Universidad Austral de Chile. http://www.uach.cl/procarbono/pdf/fichas/ficha_pinus_radiata.pdf Accessed 21 July 2011.

3.2 Data and Parameters Monitored

The following data and parameters have been monitored in September/October 2012.

Table 3.2 List of data to be monitored.

Parameter	Data	Data unit	Measured, calculated, default, other	Measurement frequency (if measured)	Source of data
dbh	Diameter at breast height of tree	cm	Measured	Every 5 years after first verification	Directly measured
Ai	(a) Area of tree biomass stratum i; (b) Area of SOC stratum i of the land meeting the applicability conditions of the SOC tool	Ha	Measured	Once, at beginning of project	GIS
a _{pi}	Total area of sample plots in tree biomass stratum i	Ha	Calculated	Every 5 years after first verification	GIS

3.3 Description of the Monitoring Plan

This grouped project uses the Clean Development Mechanism (CDM) approved consolidated afforestation and reforestation baseline and monitoring methodology "AR-ACM0003 Afforestation and reforestation of lands except wetlands (Version 1.0)".

Over the life of the project, carbon stock and stock change estimates will be derived from direct measurements thus satisfying the IPCC Tier 3 highest level of accuracy criteria. Direct estimates of live and dead biomass have been generated from data collected during the course of a forest biomass inventory. Soil carbon while not monitored has been accounted for using the CDM “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”, as permitted by the CDM Methodology AR-ACM0003, Version 1.0.

While the complete monitoring plan is listed in section 4.0 of the project description, this section details the specifics of the monitoring plan and random stratified sampling design as implemented in the 2012 forest inventory.

Mikro-Tek was responsible for all monitoring aspects including planning, fieldwork, reporting, and data archiving.

3.3.1 Monitoring approach

3.3.1.1 Precision target

The monitoring plan was designed to produce biomass stock estimates with a precision level of +/-10% of the mean with 90% confidence. As biomass estimates yielded a precision exceeding $\pm 10\%$ of the mean at a 90% confidence level, an appropriate confidence deduction was applied, as allowed by VCS⁵.

3.3.1.2 Carbon pools

Project monitoring measured and quantified carbon stocks in terrestrial carbon pools including aboveground biomass and belowground biomass. Soil carbon stocks were not monitored; changes in soil carbon stocks instead were determined using the approved CDM “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”.

3.3.1.3 Definition and delineation of strata

As stratification of the project area can increase the precision of biomass estimation without increasing the cost unduly or reduce the cost without reducing the precision of biomass estimation, the project area has been stratified based on planting year, dominant species, and forest management activities for biomass monitoring (Table 3.3). For the purpose of calculation of changes in SOC, the project area was stratified by planting year and soil type (Table 3.4).

Table 3.3. List of strata for monitoring and quantification of biomass carbon stocks in 2012.

2012STRATA	Live Aboveground and/or Belowground Biomass Monitored	Soil Monitored	Stratum Areas (ha)
EUC04-Harvest	Yes	Yes	144.42
PINE-DENSE	Yes	Yes	250.88
EUC-2006-2007	Yes	Yes	294.87
EUC-2003/2004	Yes	Yes	496.39

⁵ VCS. 2012 VCS Standard. Version 3.3, 04 October 2012. Verified Carbon Standard, Washington, D.C.

Young ¹	No	Yes	656.39
Pine-2003/2004	Yes	Yes	1163.98
Total			3006.9

¹Live aboveground biomass was not sampled in the young stratum as all trees were ≤ 3 years old and trees were not expected to have achieved a dbh ≥ 5 cm, the minimum dbh sampled. Live aboveground and belowground biomass stocks in the young stratum was therefore conservatively set to zero for the 2012 monitoring event.

Table 3.4. List of strata for quantification of soil carbon stocks.

Planting Year(s)	Area with High Activity Clay Soils (ha)	Area with Volcanic Soils (ha)
2003	718.5	0.0
2004	1192.8	0.0
2005	116.4	0.0
2006	179.6	0.0
2007	143.3	0.0
2008	0.0	0.0
2009	61.1	595.3
2010	0.0	0.0
2011	0.0	0.0
2012	0.0	0.0
Total	2411.7	595.3

3.3.1.4 Sampling design

The project employed stratified random sampling using permanent 10-meter radius circular (fixed area) plots for live aboveground biomass. Cluster sampling was employed to improve precision.

Calculation of the required sample size referenced data from survival assessment plots gathered in 2012 (TerraCarbon data unpublished). Based on analysis of the referenced data available, a sample size of 70 clusters of five 10-meter radius plots was estimated to target a precision of $\pm 10\%$ of the mean with 90% confidence.

Sample units were allocated at random within strata using ArcGIS. The location of each primary monitoring plot is detailed in Table 3.5.

Table 3.5. GPS coordinates and location of permanently monumented primary sampling plots.

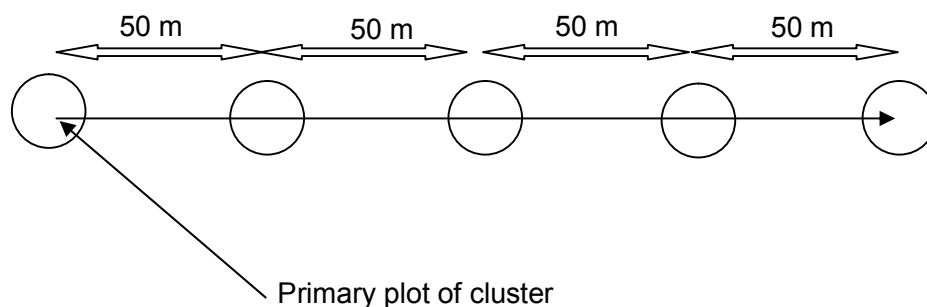
Cluster ID	Location	X (UTM19S;WGS84)	Y (UTM19S;WGS84)
MT-E04-001	Hijuela Tercera y Cuarta del Fundo El Llope	258679	6162781
MT-E04-002	El Llano	258020	6210000
MT-E04-003	Los Chacayes N°1	267124	6148356
MT-E04-004	Los Chacayes N°1	266670	6148349

MT-E04-005	Hijuela 5-A o Cimarrón	233453	6164417
MT-E04-006	Hijuela 5-A o Cimarrón	233555	6164143
MT-E04-007	Lote 2 A Los Cerros, La Sirena, El Alto y del Tranque	267914	6155350
MT-E04-008	Los Laureles Lote C	268760	6170792
MT-E04-009	Lote 2 A Los Cerros, La Sirena, El Alto y del Tranque	268567	6154831
MT-E04-010	El Llano	258948	6210336
MT-E04-011	Zapallar-Mataquiro	222430	6152277
MT-E04-012	Zapallar-Mataquiro	222739	6153067
MT-E04-013	Los Laureles Lote C	268898	6170788
MT-E04-014	El Llano	257558	6210305
MT-E04H-001	Seg. Hij. del Fundo Llope y Potreros La Vega, El Llano y El Cerrito	258639	6165166
MT-E04H-002	San Pedro de Alcántara - Barroilhet 2	244629	6150619
MT-E04H-003	San Pedro de Alcántara - Barroilhet	242975	6151352
MT-E04H-004	Seg. Hij. del Fundo Llope y Potreros La Vega, El Llano y El Cerrito	258776	6165512
MT-E07-001	Fundo Carrizalillo II	246536	6231454
MT-E07-002	Fundo Carrizalillo	243868	6228889
MT-E07-003	Fundo Carrizalillo	244417	6229480
MT-E07-005	El Huiñe	220756	6137137
MT-E07-006	Fundo Carrizalillo	243453	6230245
MT-E07-008	Fundo Carrizalillo	243770	6229514
MT-E07-009	Fundo Carrizalillo I (Hijuela de Cerro)	247141	6231714
MT-E07-010	Fundo Carrizalillo II	245544	6231985
MT-P04-001	Lote N°4 Fundo Nerquihue	267956	6165226
MT-P04-002	Hijuela Las Casas de Nerquihue	269625	6155423
MT-P04-003	Lote 2 A Los Cerros, La Sirena, El Alto y del Tranque	267798	6154891
MT-P04-004	Lote N°2 del Bien Común N°1	264713	6147019
MT-P04-005	Lote N°2 del Bien Común N°1	263714	6146919
MT-P04-006	Hijuela Las Casas de Nerquihue	269481	6154622
MT-P04-007	Lote N°2 del Bien Común N°1	266006	6149021
MT-P04-008	Lote N°4 Fundo Nerquihue	268454	6164076
MT-P04-009	Lote N°4 Fundo Nerquihue	267883	6163915
MT-P04-010	Lote N°3 Fundo Nerquihue	267506	6163618
MT-P04-011	Hijuela Las Casas de Nerquihue	271949	6155502
MT-P04-012	Hijuela Las Casas de Nerquihue	271283	6155305
MT-P04-013	Los Laureles Lote D	269218	6169102
MT-P04-014	Hijuela Las Casas de Nerquihue	269404	6154733
MT-P04-015	Lote 2 A Los Cerros, La Sirena, El Alto y del Tranque	268472	6154274
MT-P04-016	Hijuela Las Casas de Nerquihue	269626	6155317
MT-P04-017	Lote N°4 Fundo Nerquihue	268891	6163945
MT-P04-018	Lote N°3 Fundo Nerquihue	267298	6164911
MT-P04-019	Lote N°4 Fundo Nerquihue	268871	6163465
MT-P04-020	Los Robles - La Escuela	263446	6148967
MT-P04-021	Hijuela Las Casas de Nerquihue	270810	6153065
MT-P04-022	Lote 2 A Los Cerros, La Sirena, El Alto y del Tranque	269212	6154709
MT-P04-023	Lote N°3 Fundo Nerquihue	267621	6163380
MT-P04-024	Hijuela Las Casas de Nerquihue	271110	6153665

MT-P04-025	Lote N°4 Fundo Nerquihue	267855	6164923
MT-P04-026	Los Robles - La Escuela	263383	6149779
MT-P04-027	Los Laureles Lote D	269500	6168842
MT-P04-028	Lote N°3 Fundo Nerquihue	267177	6164641
MT-P04-029	Lote N°3 Fundo Nerquihue	267468	6163657
MT-P04-030	Lote N°2 del Bien Común N°1	264351	6148568
MT-P04-031	Lote N°2 del Bien Común N°1	266352	6149538
MT-P04-032	Hijuela Las Casas de Nerquihue	271766	6155395
MT-P04-033	Hijuela Las Casas de Nerquihue	269533	6155873
MT-P04-034	Los Robles - La Escuela	263475	6149817
MT-PD-001	Los Laureles Lote B	268549	6173081
MT-PD-002	Los Chacayes N°1	266901	6147979
MT-PD-003	Los Chacayes N°1	266827	6148014
MT-PD-004	Los Laureles Lote C	270349	6170122
MT-PD-005	Los Laureles Lote B	268647	6172320
MT-PD-006	La Punta Alta	261352	6161230
MT-PD-007	La Punta Alta	261683	6160806
MT-PD-008	Los Laureles Lote C	269529	6169879
MT-PD-009	Los Laureles Lote C	269082	6170226
MT-PD-013	Los Laureles Lote C	269290	6171066

Each cluster sample was composed of a string of five ten-meter radius plots, with the first plot permanently monumented (Figure 3.1). The secondary plots were un-marked temporary plots expanding the sample unit to a cluster. Sample units were allocated at random within strata using ArcGIS. GPS coordinates correspond with the center point of the primary plot. The direction of the string cluster was random and was assigned prior to arriving at the sampling plot.

Figure 3.1. Diagram of cluster monitoring plot design with the permanently monumented plot as the initial plot in the cluster.

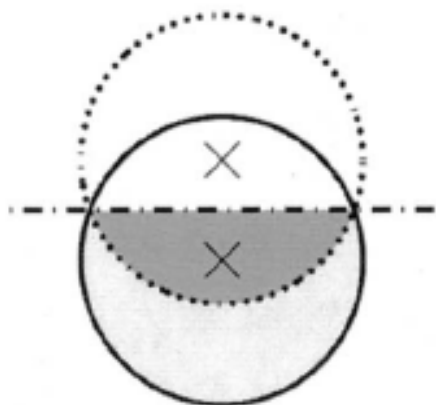


When issues of boundary overlap were encountered in the field, plots that overlap the project boundary were corrected using the mirage method^{6, 7} (Figure 3.2). The solid-lined circle represents the actual plot

⁶Avery, T.E. and H.E. Burkhart. 1994. Forest Measurements. Fourth Edition. McGraw Hill, Boston, Massachusetts, USA. 408 pp.

border. The portion of the circle above the horizontal line is outside of the forest strata being sampled. After sampling all the trees within the sampling circle within the forest strata (e.g. below the line), the trees within the grey shaded area were registered twice on the data sheet to account for the same area which is above the horizontal line and outside the plot.

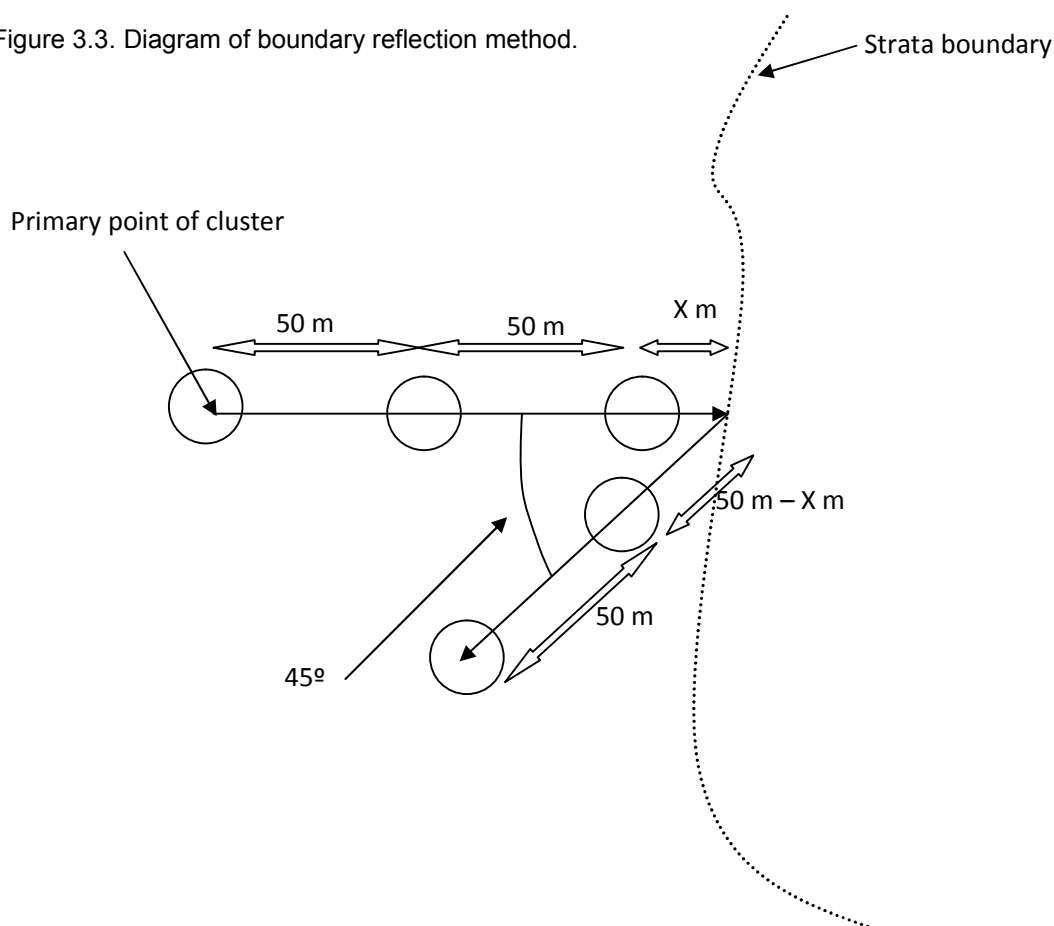
Figure 3.2. Diagram of mirage method (Avery and Burkhardt, 1994)



Where the 50 meter lines of transit from the direction of the primary plot center crossed the strata boundary prior to terminating, lines were deflected from the boundary back into the project area using a "ricochet" method to complete the 50 m, where the line of transit ricocheted back into the project area to the right of the original bearing at a 45 degree angle.

⁷Ducey, M.J., J.H. Gove, and H.T. Valentine. 2004. A Walkthrough Solution to the Boundary Overlap Problem. *Forest Science*, 50: 427-435.

Figure 3.3. Diagram of boundary reflection method.



3.3.2 Field measurement protocols

Direct field measurements of aboveground biomass followed standard forest inventory best practices outlined in Avery and Burkhart (1994). As allowed under methodology AR-ACM0003, deadwood, litter and soil organic carbon were not measured and monitored.

3.3.2.1 Establishment of measurement plots

Once the plot center location was reached, the plot was marked by hammering a 1 cm diameter metal rebar into the ground. The metal rebar was approximately 1.5 m in length. An aluminum tag, labeled with a unique monitoring plot identification name, was attached to each primary plot center.

Coordinates of all secondary sample plots were recorded with a GPS.

3.3.2.2 Layout of measurement plots

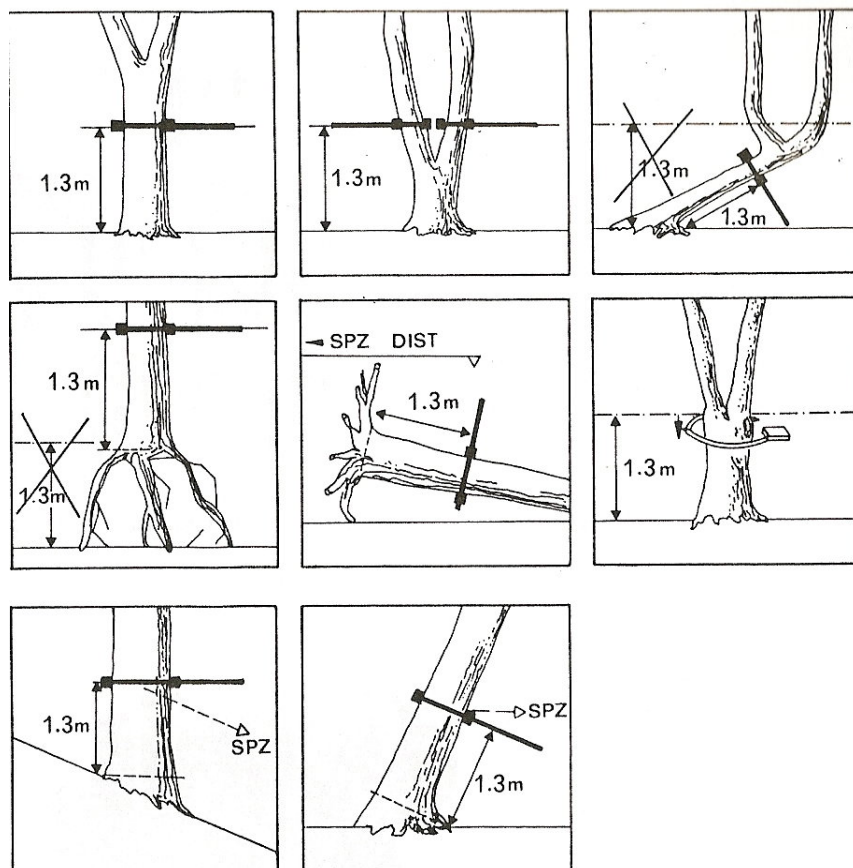
The slope of each monitoring plot (both permanent and temporary plots) was taken using a clinometer and recorded.

3.3.2.3 Measurement of live trees

Within each sampling plot all planted stems (e.g., *Pinus radiata*, *Eucalyptus globulus*, etc.) ≥ 5 cm dbh were measured. Native woody species are not included in the project and hence were not measured if encountered in the field. Diameter of trees was measured at breast height (1.3 m above ground level, see Figure 3.4).

To avoid either missed trees or double recording, the point of initiation of measurement will be noted, and measurement proceeded in a consistent clockwise or counter-clockwise fashion.

Figure 3.4. Point of measurement of diameter at breast height (from Pancel⁸, 1993).



3.3.2.4 Measuring distance

When sonic measuring equipment, such as Haglof DMEs, was used in the field (to check plot radii and borderline trees) they were calibrated before each use and allowed 10+ minutes prior to use to equilibrate the unit to ambient conditions.

3.3.3 Data analysis and results for aboveground and belowground biomass

Field data, including the diameter at breast height and species, were used to generate estimates of biomass stocks in live aboveground and belowground trees. Aboveground live tree biomass was

⁸ Pancel, L., ed. 1993. Tropical forestry handbook. Berlin, Germany, Springer-Verlag. Volume 1, 738 pp.

estimated from dbh applying allometric equations found in Gayoso (2008a)⁹ for *Eucalyptus globulus* and Gayoso (2008b)¹⁰ for *Pinus radiata* as found in Section 3.1. The appropriateness¹¹ of these allometric equations is demonstrated by the fact that each equation was derived from a data set of at least 30 sample trees, and the value of coefficient of determination (R²) obtained was not less than 0.85, as noted in Table 3.1. Root to shoot ratios for calculating belowground biomass are found in Gayoso (2008a) for *Eucalyptus globulus* ($R_{\text{Eucalyptus}} = 0.2159$) and Gayoso (2008b) for *Pinus radiata* ($R_{\text{Pinus}} = 0.2543$), which are also found in Section 3.1.

Belowground biomass was calculated by multiplying the root to shoot ratio by the aboveground biomass. Biomass estimates were converted to carbon stocks using a carbon fraction of 0.5.

Detailed cluster level estimates of biomass, carbon, and CO₂ stocks by cluster and strata are provided in Table 5.1. Statistical analysis was performed on the data found in Table 5.2. Results are found in Table 3.6 and 3.7, below.

Table 3.6. Results of descriptive statistics for biomass carbon stocks in the 2012 forest biomass inventory by stratum.

Strata	EUC-2003/2004 Biomass Carbon (t C/ha)	EUC-2006- 2007 Biomass Carbon (t C/ha)	Pine-2003/2004 Biomass Carbon (t C/ha)	PINE-DENSE Biomass Carbon (t C/ha)	EUC04-Harvest Biomass Carbon (t C/ha)
Mean (t C/ha)	18.3	9.6	77.4	54.6	4.0
Variance	74.3	74.7	1646.9	1441.9	0.5
Standard Deviation	8.6	8.6	40.6	38.0	0.7
Coefficient of Variation (%)	47.0	89.6	52.5	69.5	17.0
Standard Error (t C/ha)	2.3	3.1	7.0	12.0	0.3
Number of Samples	14.0	8.0	34.0	10.0	4.0

Overall, the inventory produced an estimate of biomass carbon stocks at the project level of 49.49 t C/ha (i.e. 181.48 t CO₂/ha) with a precision level of +/- 12.58% of the mean at the 90% confidence level (Table 3.7). As the precision level of estimates of aboveground and belowground biomass carbon stocks exceed the required $\pm 10\%$ of the mean at a 90% confidence level, a confidence deduction was applied, as allowed by VCS¹² (see Section 4.2).

⁹Gayoso, J. 2008a. Eucalyptus sp. Resultados Proyecto FONDEF D98i1076 "Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono". Bosque PROCARBONO, Universidad Austral de Chile.

http://www.uach.cl/procarbano/pdf/fichas/ficha_eucalyptus_sp.pdf Accessed 21 July 2011.

¹⁰ Gayoso, J. 2008b. Pinus radiata. Resultados Proyecto FONDEF D98i1076 "Medición y Monitoreo de la Captura de Carbono en Ecosistemas Forestales y Promoción en el Mercado Mundial del Carbono". Bosque PROCARBONO, Universidad Austral de Chile.

http://www.uach.cl/procarbano/pdf/fichas/ficha_pinus_radiata.pdf Accessed 21 July 2011.

¹¹ See the CDM tool "Demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities" for details.

¹² VCS. 2012 VCS Standard. Version 3.3, 04 October 2012. Verified Carbon Standard, Washington, D.C.

Table 3.7. Project level descriptive statistics for total biomass carbon stocks in the 2012 forest inventory employing stratified random sampling.

Descriptive Statistic	Project Level
Mean (t C/ha)	49.49
Standard Error (t C/ha)	3.73
90% Confidence Interval	6.23
90% Confidence Interval as % of mean	12.58%

An opportunistic sample of monitoring plots (primary plots only) was re-measured to appraise field crews and check systematic sampling bias when collecting field measurements. Plot biomass estimates per unit area are reported in Table 3.8. No systematic bias in dbh measurements was observed. Measurement error is estimated as 1/2 the percent difference between Estimate 1 and Estimate 2 (a valid assumption where teams are equally experienced and there are no systematic errors in measurement). The measurement error is calculated to be 1.2%.

Table 3.8. Comparison of biomass estimates calculated for different field personnel.

Plot Identification	Estimate 1: Live aboveground and belowground biomass (t /ha)	Estimate 2: Live aboveground and belowground biomass (t /ha)	Percent difference (%)
MT-E04-012	56.62	57.22	1.1
MT-E07-003	68.15	68.05	0.1
MT-P04-007	288.78	283.32	1.9
MT-P04-019	119.94	119.08	0.7
MT-P04-020	241.07	239.40	0.7
MT-P04-033	111.49	113.33	1.7
MT-PD007	35.55	39.26	10.4
Average			2.4

3.3.4 Leakage monitoring

Leakage is calculated ex-post using the approved CDM A/R Methodological Tool, "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity." Leakage calculations and parameters are detailed in Section 3.3 of the project description.

3.3.5 Quality control and data archiving

During implementation of the monitoring plan QA/QC procedures were applied as outlined here to minimize errors in measurement and data analysis, to provide documentation and consistency in data archiving. The plan covers procedures for: (1) collecting reliable field measurements, (2) documenting data entry and analysis techniques and (3) data maintenance and archiving.

The grouped project maintains an electronic database of GIS coverages detailing parcel boundaries, and will record and archive raw field measurements and analyses to permit independent review of source data over the life of the project.

3.3.5.1 Field measurements

Field crews were fully trained in all aspects of the field data collection and adhered to field measurement protocols. Field crew leaders were responsible for ensuring that field protocols were followed to ensure accurate and consistent measurement. Pilot sample plots were measured before the initiation of formal measurements to appraise field crews and identify and correct any errors in field measurements. During measurement, a consistency check of an opportunistic sample of plots was re-measured to determine measurement error. Re-measurement for this purpose was done by different field personnel. This internal check cruise served to quantify measurement error and allowed for the identification and correction of any field measurement issues arising during implementation of the monitoring plan.

All equipment used in the course of field measurements was calibrated according to the equipment's specifications or national/international standards.

3.3.5.2 Data entry

Data was recorded on field sheets and then transcribed to electronic media. To minimize errors in data entry, where they are not the same, personnel involved in data analysis was consulted with personnel involved in measurement to clarify any anomalous values or ambiguities in transcription.

3.3.5.3 Data archiving

Because of the long-term objective of the monitoring plan, data archiving is essential. Field measurement data was recorded on field sheets, which have been duplicated and archived. Field data was entered in an electronic database. Copies of all raw data, reports of analysis and supporting spreadsheets will be stored in a dedicated long-term electronic archive. All documents and records are kept in a secure and retrievable manner for at least two years after the end of the project crediting period. Given the extended timeframe and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications. Adherence to these procedures will also ensure smooth transitions and maintain “institutional memory” in the event of changes in personnel responsible for the monitoring plan.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline net GHG removals by sinks ($\Delta C_{BSL,t}$) equals the sum of changes in carbon stocks in tree ($\Delta C_{TREE-BSL,t}$) and shrub ($\Delta C_{SHRUB-BSL,t}$) biomass. Dead wood ($\Delta C_{DW-BSL,t}$), and litter ($\Delta C_{LI-BSL,t}$) biomass are excluded from the project boundary.

There are four native woody species encountered in and around abandoned pastures in the project region including: *Acacia caven* (Espino), *Peumus boldus* (Boldo), *Cryptocarya alba* (Peumo), and *Quillaja saponaria* (Quillay). *Peumus boldus*, *Cryptocarya alba*, and *Quillaja saponaria* are native trees protected by CONAF agreements, typically growing in discrete copses and were readily delineated and removed from the project boundary. Thus, tree biomass is zero in the project area.

The fourth woody species, *Acacia caven* is a woody species sparsely encountered in the project area. It does not exceed the stature of a shrub not exceeding 2-3 m height in the project region^{13, 14}. Due to its dispersed occurrence in abandoned pasture, it was not possible to delineate the project boundaries to exclude every instance of the species. *Acacia caven* stem density¹⁵ is estimated at 2.6 stem/ha, accounts for less than 5% crown cover¹⁶, and is not expected to grow beyond its current stature in the baseline scenario. Shrub biomass can be considered negligible as per the CDM tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” and the sum of changes in baseline shrub biomass is therefore zero.

As each of these components is equal to zero in the baseline, baseline net GHG removals by sinks are also considered to be zero for the life of the project.

4.2 Project Emissions

The Reforesting Degraded Lands in Chile through the use of Mycorrhizal Inoculation project sequesters carbon in aboveground biomass, belowground biomass, and soil. The amount of carbon sequestered in aboveground biomass and belowground biomass has been assessed directly in 2012. The estimate for aboveground biomass and belowground biomass carbon is 46.53 t C/ha. Aboveground and belowground biomass estimates applied an uncertainty deduction because the results of the biomass inventory yielded a precision exceeding $\pm 10\%$ of the mean at a 90% confidence level. As the mean biomass carbon stock 49.49 t C/ha, found in Section 3.3, was estimated with a precision level of $\pm 12.6\%$ of the mean at the 90% confidence, this value has been revised downward to 46.53 t C/ha and is reflected in Table 4.2. This

¹³ Donoso Zegers, C. 2007. Árboles Nativos de Chile- Guía de Reconocimiento. 12th edition. Marisa Cuneo Ediciones, Valdivia, Chile, p 48-49.

¹⁴ Donoso Zegers, C. 1993. Bosques templados de Chile y Argentina: Variación, estructura y dinámica. 1st edition. Editorial Universitaria, Santiago, Chile, p 102.

¹⁵ Data on stem density counts were collected in 49 5-m radius plots in June/July 2012, where only 1 native stem was encountered.

¹⁶ Crowns were estimated as 3-3.5 meters in width by Donoso Zegers (1993). Even if crowns were assumed to be 4 meter wide, crown cover is less than 2% given 3 stems/ha.

value has been reduced by 6% in line with the confidence deduction set out in the CDM tool “Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities” version 3.0 and allowed by AR-ACM0003.

Reported soil carbon stocks are calculated using the CDM “Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities”, as permitted by the CDM Methodology AR-ACM0003, Version 1.0. While no monitoring is required to estimate soil carbon accumulation as per the above tool, each project instance was visited during the course of 2012 to assess plantation establishment and stem density thus ensuring the use of the default SOC accumulation rate is appropriate. This above approach allows for reporting 0.57 tonnes C per year for 20 years for grassland with high activity clay soils and 1.05 tonnes C per year for grassland with volcanic soils (as detailed in section 3.2 of the project description). Carbon sequestered in soil is estimated by planting year and soil type in Table 4.3.

Table 4.2. Gross estimates of total sequestered biomass carbon due to project implementation.

2012 STRATA	Live Aboveground and Belowground Biomass Monitored	Soil Monitored	Stratum Areas (ha)	Live Aboveground and Belowground Biomass Carbon stocks (t C/ha)	Live Aboveground and Belowground Biomass Carbon stocks (t C)	Metric tonnes of CO ₂ in Live Aboveground and Belowground Biomass (t CO ₂ e)
EUC04-Harvest, PINE-DENSE, EUC-2006-2007, EUC-2003/2004, Pine-2003/2004	Yes	Yes	2350.5	46.53	109,359	400,983
Young	No	Yes	656.39	0.00	0	0
Total			3006.9		109,359	400,983

The project level mean carbon stock for live aboveground and belowground biomass as found for the 2012 monitoring period was 49.5 tonnes C/ha. As the confidence interval as a percentage of the mean was estimated at 12.58%, thus exceeding the allowable 10% at 90% confidence, the mean has been conservatively adjusted downward by 6.0%.

Table 4.3. Estimates of soil carbon sequestered due to project implementation.

Planting Year(s)	Area with High Activity Clay Soils (ha)	Area with Volcanic Soils (ha)	SOC stocks in areas with High Activity Clay Soils (ton C/ha)	SOC stocks in areas with Volcanic Soils (ton C/ha)	SOC stocks (ton C)	Metric tons of CO ₂ in Soil (t CO ₂ e)
2003	718.5	0.0	3686.1	0.0	3,686.1	13,516
2004	1192.8	0.0	5439.1	0.0	5,439.1	19,943
2005	116.4	0.0	464.2	0.0	464.2	1,702

2006	179.6	0.0	614.1	0.0	614.1	2,252
2007	143.3	0.0	408.4	0.0	408.4	1,498
2008	0.0	0.0	0.0	0.0	0.0	0
2009	61.1	595.3	104.5	1875.0	1,979.6	7,258
2010	0.0	0.0	0.0	0.0	0.0	0
2011	0.0	0.0	0.0	0.0	0.0	0
2012	0.0	0.0	0.0	0.0	0.0	0
Total	2411.7	595.3	10,716.5	1,875.0	12,591.6	46,169

The total carbon sequestered by the project activity to date is 121,951 tonnes C. When converted to carbon dioxide, the project has sequestered 447,152 tonnes of CO₂.

As a grouped project, with new project instances added over time, the long term average GHG benefit at the project level will change relative to composition of species and the total area of the project. For this monitoring report, the long term average GHG benefit at the project level can be computed by calculating the area weighted long-term average per hectare, 249.3 tCO₂e, using the species specific long-term average parameters, LA_{Pinus} = 283.2 tCO₂e/ha and LA_{Eucalypts} = 180.8 tCO₂e/ha, as stated in the project description, and their respective areas 2010.1 ha and 996.8 ha. This value (249.3 tCO₂e) is then multiplied by total area 3,006.93 ha to determine the long-term average GHG benefit at the project level, 749,504 tCO₂e. As the amount sequestered in the project is less than the long-term average, the full amount sequestered is eligible for crediting.

4.3 Leakage

Leakage due to displacement of agricultural activities was calculated using the approved CDM A/R Methodological Tool, "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity".

The above CDM tool uses the following equation, as listed in Section 3.3 of the project description, to calculate leakage.

$$LK_{Agriculture, i} = \frac{44}{12} * \frac{f}{T_{cred}} * \Delta C d_i$$

Equation 4.1.

The values for the above equations are listed below in Table 4.4. Section 3.3 of the project description provides greater detail on these values.

Table 4.4. Ex post leakage calculation.

Year of verification	Conversion factor (tC to t CO ₂)	Forest cover (% f)	Crediting period (yr, Tcred)	Dt (fraction of project area subject to displacement)	Delta Ct (t C) sum of annual changes (i.e. stocks) through year of verification 2012	Leakage (t CO ₂)
2012	3.67	0.202	40	0	121,951	0

4.4 Summary of GHG Emission Reductions and Removals

Net emission reductions are calculated by subtracting the baseline carbon stocks, the buffer pool contribution, any emissions from project implementation activities, and leakage from the total amount of carbon sequestered. As of 2012, the total amount of emission reductions generated is 402,475 tCO₂-e.

Table 4.5. Emissions reductions (t CO₂-e) generated by the Reforesting Degraded Lands in Chile through the use of Mycorrhizal Inoculation project.

Aspect of emission reductions estimate	t CO ₂ -e
Net forest carbon sequestration (t CO ₂) (With project scenario- baseline)	447,152
Buffer pool contribution	44,715
¹ Implementation of Project Activity	0
² Leakage	0
Total Emission Reductions	402,437

¹As per the CDM Executive Board decision in September 2008 (CDM EB 42, Paragraph 35), which applies to AR-ACM0003. "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."

²Leakage was calculated as per the CDM tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity" (CDM Executive Board 2009).

5 ADDITIONAL INFORMATION

Table 5.1. Cluster level estimates of biomass, carbon, and CO2 stocks for the 2012 forest inventory.

Cluster ID	Strata	Live Aboveground and Belowground Biomass Stock (t /ha)	Live Aboveground and Belowground Carbon Stock (t C/ha)	Live Aboveground and Belowground CO2 Stock (t CO2 /ha)
MT-E04-001	EUC-2003/2004	26.5	13.2	48.5
MT-E04-002	EUC-2003/2004	11.8	5.9	21.6
MT-E04-003	EUC-2003/2004	46.1	23.0	84.5
MT-E04-004	EUC-2003/2004	62.8	31.4	115.1
MT-E04-005	EUC-2003/2004	36.5	18.3	67.0
MT-E04-006	EUC-2003/2004	14.1	7.1	25.9
MT-E04-007	EUC-2003/2004	48.3	24.1	88.5
MT-E04-008	EUC-2003/2004	43.1	21.6	79.1
MT-E04-009	EUC-2003/2004	62.6	31.3	114.8
MT-E04-010	EUC-2003/2004	11.2	5.6	20.5
MT-E04-011	EUC-2003/2004	38.8	19.4	71.2
MT-E04-012	EUC-2003/2004	49.2	24.6	90.1
MT-E04-013	EUC-2003/2004	39.8	19.9	73.0
MT-E04-014	EUC-2003/2004	23.0	11.5	42.1
MT-E04H-001	EUC04-Harvest	6.4	3.2	11.8
MT-E04H-002	EUC04-Harvest	7.3	3.6	13.4
MT-E04H-003	EUC04-Harvest	8.5	4.2	15.5
MT-E04H-004	EUC04-Harvest	9.5	4.7	17.4
MT-E07-001	EUC-2006-2007	4.7	2.4	8.7
MT-E07-002	EUC-2006-2007	13.0	6.5	23.8
MT-E07-003	EUC-2006-2007	48.2	24.1	88.3
MT-E07-005	EUC-2006-2007	39.8	19.9	72.9
MT-E07-006	EUC-2006-2007	7.3	3.6	13.4
MT-E07-008	EUC-2006-2007	26.3	13.2	48.3
MT-E07-009	EUC-2006-2007	0.0	0.0	0.0
MT-E07-010	EUC-2006-2007	15.0	7.5	27.5
MT-P04-001	Pine-2003/2004	87.2	43.6	159.8
MT-P04-002	Pine-2003/2004	143.0	71.5	262.1
MT-P04-003	Pine-2003/2004	9.6	4.8	17.5
MT-P04-004	Pine-2003/2004	157.0	78.5	287.9
MT-P04-005	Pine-2003/2004	274.8	137.4	503.8
MT-P04-006	Pine-2003/2004	8.7	4.3	15.9
MT-P04-007	Pine-2003/2004	247.5	123.7	453.7
MT-P04-008	Pine-2003/2004	206.0	103.0	377.7
MT-P04-009	Pine-2003/2004	246.7	123.3	452.2
MT-P04-010	Pine-2003/2004	204.2	102.1	374.4
MT-P04-011	Pine-2003/2004	147.7	73.9	270.8
MT-P04-012	Pine-2003/2004	46.1	23.0	84.5
MT-P04-013	Pine-2003/2004	60.6	30.3	111.1
MT-P04-014	Pine-2003/2004	145.5	72.7	266.7
MT-P04-015	Pine-2003/2004	46.4	23.2	85.1
MT-P04-016	Pine-2003/2004	64.7	32.4	118.7

MT-P04-017	Pine-2003/2004	250.6	125.3	459.5
MT-P04-018	Pine-2003/2004	156.9	78.4	287.6
MT-P04-019	Pine-2003/2004	149.8	74.9	274.6
MT-P04-020	Pine-2003/2004	219.2	109.6	401.8
MT-P04-021	Pine-2003/2004	143.9	72.0	263.9
MT-P04-022	Pine-2003/2004	164.3	82.1	301.2
MT-P04-023	Pine-2003/2004	161.7	80.9	296.5
MT-P04-024	Pine-2003/2004	22.2	11.1	40.7
MT-P04-025	Pine-2003/2004	223.4	111.7	409.5
MT-P04-026	Pine-2003/2004	135.4	67.7	248.3
MT-P04-027	Pine-2003/2004	178.5	89.3	327.3
MT-P04-028	Pine-2003/2004	212.1	106.0	388.8
MT-P04-029	Pine-2003/2004	286.0	143.0	524.4
MT-P04-030	Pine-2003/2004	272.7	136.3	499.9
MT-P04-031	Pine-2003/2004	272.4	136.2	499.5
MT-P04-032	Pine-2003/2004	85.7	42.8	157.1
MT-P04-033	Pine-2003/2004	118.2	59.1	216.6
MT-P04-034	Pine-2003/2004	111.8	55.9	204.9
MT-PD-001	PINE-DENSE	196.8	98.4	360.9
MT-PD-002	PINE-DENSE	129.0	64.5	236.5
MT-PD-003	PINE-DENSE	118.7	59.4	217.6
MT-PD-004	PINE-DENSE	52.9	26.4	96.9
MT-PD-005	PINE-DENSE	188.8	94.4	346.2
MT-PD-006	PINE-DENSE	13.5	6.7	24.7
MT-PD-007	PINE-DENSE	25.3	12.7	46.4
MT-PD-008	PINE-DENSE	140.8	70.4	258.1
MT-PD-009	PINE-DENSE	205.4	102.7	376.6
MT-PD-013	PINE-DENSE	21.0	10.5	38.5

Table 5.2. Cluster level estimates of carbon stocks by strata for the 2012 forest inventory.

Number of samples in strata	EUC-2003/2004 Biomass Carbon (t C/ha)	EUC-2006-2007 Biomass Carbon (t C/ha)	Pine-2003/2004 Biomass Carbon (t C/ha)	PINE-DENSE Biomass Carbon (t C/ha)	EUC04-Harvest Biomass Carbon (t C/ha)
1	13.2	2.4	43.6	98.4	3.2
2	5.9	6.5	71.5	64.5	3.6
3	23.0	24.1	4.8	59.4	4.2
4	31.4	19.9	78.5	26.4	4.7
5	18.3	3.6	137.4	94.4	
6	7.1	13.2	4.3	6.7	
7	24.1	0.0	123.7	12.7	
8	21.6	7.5	103.0	70.4	
9	31.3		123.3	102.7	
10	5.6		102.1	10.5	
11	19.4		73.9		
12	24.6		23.0		
13	19.9		30.3		

14	11.5		72.7		
15			23.2		
16			32.4		
17			125.3		
18			78.4		
19			74.9		
20			109.6		
21			72.0		
22			82.1		
23			80.9		
24			11.1		
25			111.7		
26			67.7		
27			89.3		
28			106.0		
29			143.0		
30			136.3		
31			136.2		
32			42.8		
33			59.1		
34			55.9		