Monitoring report form (Version 03.0)

Monitoring report

Title of the project activity	Reforestation of grazing Lands in Santo Domingo, Argentina
Reference number of the project activity	4127
Version number of the monitoring report	01
Completion date of the monitoring report	26/12/2012
Registration date of the project activity	11/02/2011
Monitoring period number and duration of this monitoring period	Monitoring period 01, 02/05/2007 – 15/10/2012
Project participant(s)	Novartis Argentina S.A., Novartis Pharma AG
Host Party(ies)	Argentina
Sectoral scope(s) and applied methodology(ies)	Sectoral scope: 14, afforestation and reforestation Methodology: AR-AM0005, version 03
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	149,393 tCO_2e
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	111,417 tCO_2e (lCERs)

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The project activity "Reforestation of grazing Lands in Santo Domingo, Argentina" is a FSC certified reforestation project using native and exotic species which aims at credible carbon sequestration and generating high value forestry products. The project activity fosters application of native species in forestry plantations in northern Argentina and hence contributes to environmental and social benefits in the region.

The project activity has a project area of 2,290.3 ha which has been planted completely. The planting of trees started in June 2007 and ended in 2009. In certain sections of the plantation, enrichment plantings were conducted between 2009 and 2012. The main species planted on the project area are *Peltophorum dubium* and *Tabebuia* which are native species, and *Grevillea robusta*, *Pinus elliottii* and *Pinus taeda* which are exotic species.

In this first monitoring period from 02/05/2007 to 15/10/2012, the project activity achieved net anthropogenic GHG removals by sinks amounting to 111,417 t CO_2e.

A.2. Location of project activity

The project activity is located at Santo Domingo, Ituzaingó Department, Province of Corrientes, Argentina, between latitudes 27°37'25" S and 27°42'12" S and longitudes 56°12'10" W and 56°07'40" W.

A.3. Parties and project participant(s)

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 project participant (Yes/No)**
Argentina (host)	Novartis Argentina S.A.	No
Switzerland	Novartis Pharma AG	No

A.4. Reference of applied methodology

The AR-AM0005 "Afforestation and reforestation project activities implemented for industrial and/or commercial uses" (Version 03) was applied in combination with the following tools:

- "Tool for the demonstration and assessment of additionality in A/R CDM project activities" (Version 02),
- "Estimation of GHG emissions related to displacement of grazing activities in A/R CDM project activity" (Version 2), and
- "Tool for testing significance of GHG emissions in A/R CDM project activities" (Version 01)

In addition, the following tools and guidelines are applied in this monitoring report:

- "Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities" (Version 1.0.1)
- „Guidelines on application of specified versions of A/R CDM methodologies in verification of registered A/R CDM project activities" (Version 01.1)

A.5. Crediting period of project activity

Crediting period of the project activity: 02/05/2007 – 01/05/2027 (20 years, renewable)

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

Project area

The project activity has a total project area of 2,290.3 ha which has been planted completely (**Figure 1**). The planting of trees started in June 2007 and ended in 2009. In 2010, additional areas were planted within the project boundary, mainly small patches and roads which were not used any more, with a total area of approximately 120 ha. These additional areas were not included in the project area and are also not considered in the calculation of the net anthropogenic GHG removals by sinks.

In certain sections of the project area, enrichment plantings were conducted between 2009 and 2012. Mainly native species were used for the enrichment plantings.

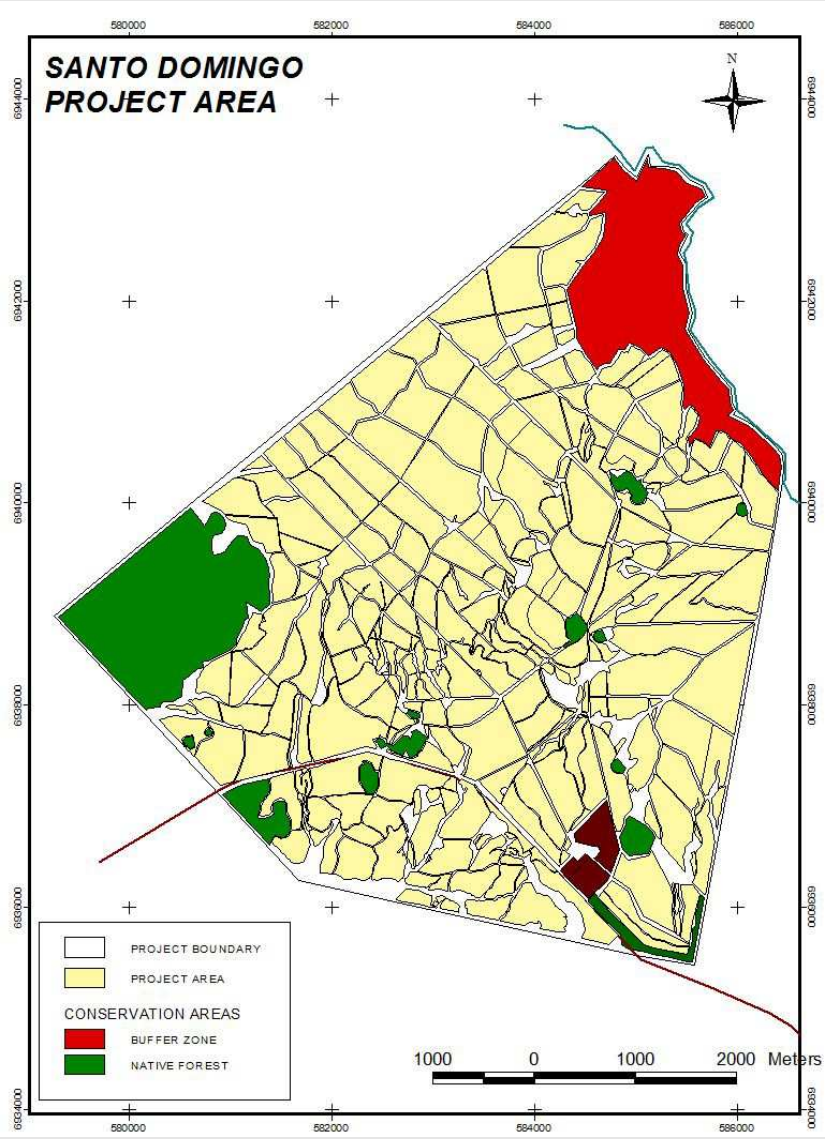

Figure 1: Project area and project boundary

Project boundary

The coordinates of the corners of the project boundary indicated in section A.2 above were confirmed during the monitoring event in October 2012.

Ownership

The owner rights of the land within the project boundary had been transferred to Novartis Argentina S.A.

Species

The following native and exotic species were planted on the project area:

Table 1: Native species planted on the project area

Species	Nitrogen-fixing species
Tabebuia heptaphylla/impetiginosa	No
Peltophorum dubium	Yes
Tabebuia ochracea/pulcherrima	No
Cedrela fissilis	No
Cordia trichotoma	No
Enterolobium contortisiliquum	Yes
Myrocarpus frondosus	Yes
Jacarandá micantha	Yes
Pterogyne nitens	Yes
Parapiptadenia rigida	Yes
Araucaria angustifolia	No
Apidosperma australe	No
Patagonula americana	No
Inga uruguensis	Yes
Bastardiopsis densiflora	No
Cabralea canjerana	No
Nectandra megapotamica	No
Ruprechtia laxiflora	No

Table 2: Exotic species planted on the project area

Species	Nitrogen-fixing species
Grevillea robusta	No
Pinus elliottii	No
Pinus taeda	No
Pinus elliottii x Pinus caribaea var. hondurensis	No

Peltophorum dubium and *Tabebuia* are the most planted native species, making up approx. 52% and 28%, respectively, of all planted native trees. The share of native and exotic species planted on the project area is in line with the registered PDD where initially 25% native and 75% exotic species were foreseen.

Forest establishment and management

Site and soil preparation: No burning was applied for the site preparation and the soil was prepared as described in the registered PDD by drilling and forming of small heaps in the low lands and by applying tillage on the hillocks. No irrigation and no nitrogenous fertilizer are applied.

Weeding: In the case of native species and *Grevillea robusta*, weeding is done mechanically. The herbicide Glyphosphate is only applied in *Pinus* plantations.

Survival rate: In the first year after plantation, the survival rate was checked and replanting was conducted in the first or second year after plantation in case the survival rate was less than 90%. Whenever feasible, the same species used in the original plantation were used for replanting. During the monitoring event in October 2012, the current survival rate was monitored in each sample plot by counting the amount of trees missing compared to the original plantation design. An average survival rate of 82% was observed in the sample

plots. The main reasons for lower survival rates were low temperatures which affected mainly the low lands.

Thinning and harvesting: No thinning and harvesting was performed during the monitoring period.

Diseases and pest: There are no discrete areas affected by a disease or pest. Individual trees have been affected by ants which are controlled by means of chemical pesticides in accordance with FSC principles and criteria.

Fire and fire breaks: To protect the plantation from fire, fire breaks were established according to Argentinean law. During the monitoring period, the plantation was affected by one fire event in September 2012 which affected 23 ha. Since the planted trees survived the fire event, the original stratum allocation was maintained for this area.

Plantation year and design: Plantation year and plantation design were checked in each sample plot between March and October 2012 in order to verify that the information contained in the GIS corresponds to the actual plantation design. Where the information in the GIS did not correspond to the implemented design, the plantation design of the entire section was checked again and the information in the GIS was updated accordingly.

Sample plots: The sample plots were established between August 2011 and October 2012.

Stratification of the project area

The stratification made in the registered PDD for the ex-ante calculation was slightly adapted for this monitoring period in order to consider the enrichment plantings conducted between 2009 and 2012. New cases were created for areas with enrichment plantings, and these cases were grouped to a new stratum (stratum 6). Table 3 and Table 4 provide an overview on cases and stratum allocation.

Table 3: Cases

Case	Species	Plantation Year	Interpl.	Config. Pinus	Config. Native**	Config. Interpl.*	Config. Grevillea	Area (ha)
1	Pinus	2007		5 x 2.5				106.12
2	Pinus	2008		4 x 2				465.25
2.1	Pinus	2008		3 x 2				6.39
3	Pinus	2008		5 x 2				211.26
3.1	Pinus -> Mixed Bajos	2008	2012	5 x 2		5 x 3		66.42
4	Mixed Loma	2007		5 x 2.5	5 x 7.5			0.00
4.1	Mixed Loma	2007	2010	5 x 2.5	5 x 7.5	5 x 3		38.58
4.2	Mixed Loma	2007	2012	5 x 2.5	5 x 7.5	5 x 3		23.85
5	Mixed Loma	2008		3 x 2	3 x 8			267.19
6	Mixed Loma	2008	2009	5 x 2	5 x 6	5 x 3		77.20
7	Mixed Bajos	2007-08		5 x 2.5	5 x 7.5			450.09
7.1	Mixed Bajos	2007-08	2010	5 x 2.5	5 x 7.5	5 x 3		12.43
7.2	Mixed Bajos	2007-08	2012	5 x 2.5	5 x 7.5	5 x 3		80.46
8	Mixed Bajos	2008		4 x 2	4 x 8			32.17
9	Mixed Bajos	2008		5 x 2	5 x 8			0.00
9.1	Mixed Bajos	2008	2012	5 x 2	5 x 8	5 x 3		8.12
10	Grevillea/ Native	2009			3 x 2		3 x 2	113.82
11	Grevillea/ Native	2009			3 x 2.5		3 x 2.5	159.84
11.1	Grevillea/ Native	2009			4 x 2.5		4 x 2.5	10.60
12	Pinus	2009		4 x 2.5				92.76
13	Mixed media loma	2009		4 x 2	4 x 2			67.71

* The configuration of the enrichment plantings can vary between 5x2, 5x2.5 and 5x3.

** The configuration 5x7.5 for native species was in few areas adapted to 5x10 or to 5x5.

Table 4: Stratum allocation

Stratum	Cases	Species	Area (ha)	Plantation Year	Enrichment Planting
1	1	Pinus	106.12	2007	
2	2, 2.1, 3, 12	Pinus	775.66	2008, 2009	
3	4, 7	Mixed	450.09	2007, 2008	
4	5, 8, 9, 13	Mixed	367.08	2008, 2009	
5	10, 11, 11.1	Grevillea/Native	284.26	2009	
6	3.1, 4.1, 4.2, 6, 7.1, 7.2, 9.1	Mixed (Enrichment plantings)	307.06	2007, 2008	2009, 2010, 2012
			2290.26		

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

No temporary deviations from the registered monitoring plan or applied methodology were made.

B.2.2. Corrections

One of the four geographical coordinates of the project boundary indicated in the registered PDD was wrong and is corrected in the revised PDD submitted to the verifying DOE together with this monitoring report.

- Geographical coordinates according to the registered PDD: between latitudes 27°37'25'' S and 21°41'42'' S and longitudes 56°12'10'' W and 56°07'40'' W
- Corrected geographical coordinates in the revised PDD, version 06, 26/12/2012: between latitudes 27°37'25" S and 27°42'12" S and longitudes 56°12'10" W and 56°07'40" W

B.2.3. Permanent changes from registered monitoring plan or applied methodology

No permanent changes from registered monitoring plan or applied methodology were made.

B.2.4. Changes to project design of registered project activity

No changes to the project design of the registered project activity were made.

B.2.5. Changes to start date of crediting period

No changes to the start date of crediting period were made.

B.2.6. Types of changes specific to afforestation or reforestation project activity

Changes in year-wise areas planted: The project area was planted as planned. The planted project area (2290.26 ha) is only slightly smaller than the planned project area (2291.88 ha). The fact that the project area is slightly smaller than planned does however not affect the baseline identification or the additionality demonstration made at validation stage as it does not affect the share of native and exotic species planted on the project area.

Changes in species composition: The same native species as mentioned in the registered PDD were planted, and *Peltophorum dubium* is the most planted native species as already foreseen in the registered PDD. *Grevillea robusta*, *Pinus elliottii* and *Pinus taeda* are the most planted exotic species as foreseen in the registered PDD. A small part of planned *Pinus elliotii* and *Pinus taeda* plantations were replaced by *Pinus elliottii x Pinus caribaea var. hondurensis*. As indicated in section B.1, the share of native and exotic species planted on the project area is in line with the initial 25% native and 75% exotic species mentioned in the registered PDD.

Changes in stocking density: In certain sections of the project area (stratum 6), enrichment plantings were conducted for which mainly native species were used. The enrichment plantings did therefore not lead to an increase in the percentage of exotic species on the project area, and baseline identification and additionality demonstration made at validation stage are not affected by the enrichment plantings.

Changes in stratification for sampling: The stratification is adapted ex post prior to each monitoring event according to the applied A/R baseline methodology. For this monitoring event, the stratification was adapted

by adding an additional stratum number 6 in order to group the areas with enrichment plantings in one stratum (section B.1).

Changes in number of sample plots and their allocation to strata: The number of sample plots and their allocation to strata is adapted ex post prior to each monitoring event in accordance with the ex-post stratification. In this monitoring event, a total of 116 sample plots were allocated to the six strata (section D.3).

Changes in the project boundary: The project boundary did not change compared to the project boundary mentioned in the registered PDD. The final project area (planted area) is slightly smaller (2290.26 ha) than the planned area according to the registered PDD (2291.88 ha). The fact that the project area is slightly smaller than planned does however not affect the baseline identification or the additionality demonstration made at validation stage as it does not affect the share of native and exotic species planted on the project area.

Changes in parameters, equations, or methods used in tree biomass estimation: For the ex-ante estimation of net GHG removals by sinks, age-dependent volume equations were used for native species and *Grevillea robusta,* and the SISPINUS model for *Pinus*. For the ex-post calculation of actual net GHG removals by sinks, species-specific volume equations which use the diameter at breast height (DBH) and tree height as variables were applied, as required by the applied A/R baseline methodology. These equations were taken from most recent publications or created based on measurements, and are in compliance with the tool "Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities" (Appendix 2). It will be evaluated at each monitoring event whether the volume equations need to be updated, considering most recent publications and the plantation age.

SECTION C. Description of monitoring system

Baseline net GHG removals by sinks

The baseline net GHG removals by sinks were determined ex-ante in the registered PDD and do not need to be monitored.

Actual net GHG removals by sinks

Monitoring

During the monitoring event in October 2012, the DBH of all trees within the 116 sample plots and the total tree height for trees with a DBH ≥ 2 cm were measured by the monitoring team. In addition, the plantation year and design, topography, soil preparation, presence of pests/diseases/fire, number of missing trees and replanting were observed in each sample plot.

The monitoring team was composed of experienced staff from GMF (company in charge of the plantation management) and the National University of La Plata. All members of the monitoring team were trained accordingly prior to the monitoring event. Measurements and observations made in each sample plot were recorded in the field (paper or electronically) and transferred to a central excel table on a personal computer at the end of each monitoring day where the leader of the monitoring team checked the data for consistency and completeness. In case data was missing or did not seem to be realistic, the data was verified again in the respective sample plot.

No GHG emissions by sources are generated in the project activity and they do not need to be monitored according to the registered PDD.

Quality control / quality assurance

In order to verify that the measurements by the monitoring team were performed correctly, 10% of the sample plots were measured again (DBH, total tree height, species) few days after the monitoring by experts who were not involved in the monitoring. The same experts verified also plot location (coordinates), plantation year and plantation design in those sample plots. The total biomass per plot measured during the quality control was on average slightly higher (2.5%) than the total biomass per plot measured by the monitoring team. It can therefore be concluded that the measurements by the monitoring team were performed correctly and the monitoring data do not present measurement errors which would lead to an overestimation of the biomass.

In order to minimize errors at data entry and transfer, the monitoring data were reviewed by the same team of experts who performed the control measurements. They concluded that the monitoring data were realistic and coherent.

Data were archived electronically and in paper form, and copies were provided to each project participant.

Leakage

Animals (cattle) which were managed on the project area prior to the project start were slaughtered or sold to entities not involved in the project activity. As mentioned in the registered PDD, leakage emissions from activity displacement is therefore zero.

The entities involved in the project activity confirmed in writing that they were not managing animals which had formerly been managed on the project area.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data / Parameter:	**$\Delta C_{BSL,t}$**
Unit:	tCO_2e/yr
Description:	Baseline net GHG removals by sinks in tonnes of CO_2e/year for year t
Source of data:	Registered PDD
Value(s) applied):	Year 2007: 5 Year 2008: 22 Year 2009: 35 Year 2010: 85 Year 2011: 180 Year 2012: 256 (9.5 months)
Purpose of data:	Calculation of baseline net GHG removals by sinks
Additional comment:	

Data / Parameter:	**CF_j**
Unit:	tC / t dry matter
Description:	Carbon fraction of species j
Source of data:	IPCC (2006) Guidelines for National Greenhouse Gas Inventory. Volume 4, Table 4.3.
Value(s) applied):	0.47 (for all species)
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

Data / Parameter:	**$GHG_{E,t}$**
Unit:	tCO2/year
Description:	Annual GHG emissions as a result of the implementation of the A/R CDM project activity within the project boundary in year t
Source of data:	Registered PDD (page 52)
Value(s) applied):	0
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

D.2. Data and parameters monitored

Data / Parameter:	**BEF_j**
Unit:	-

Description:	Biomass expansion factor for species j
Measured/ Calculated / Default:	Default
Source of data:	IPCC (2003) Good Practice Guidance for LULUCF. Volume 3, Tables 3A.1.10.
Value(s) of monitored parameter:	Pines: 1.3 Broadleaf: 3.4
Monitoring equipment:	not applicable
Measuring/ Reading/ Recording frequency:	not applicable
Calculation method (if applicable):	not applicable
QA/QC procedures:	not applicable
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	The same values are used for the ex-post calculation as in the PDD for the ex-ante estimation of the actual net GHG removals by sinks since no specific data is available for individual species and age classes.

Data / Parameter:	**D_j**
Unit:	t dry matter / m^3
Description:	Basic wood density for species j
Measured/ Calculated / Default:	Default
Source of data:	Table 10 and Table 11 in Appendix 1
Value(s) of monitored parameter:	Table 10 and Table 11 in Appendix 1
Monitoring equipment:	not applicable
Measuring/ Reading/ Recording frequency:	not applicable
Calculation method (if applicable):	not applicable
QA/QC procedures:	not applicable
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

Data / Parameter:	**R_j**
Unit:	-
Description:	Root-to-shoot ratio for species j
Measured/ Calculated / Default:	Default
Source of data:	IPCC (2006) Guidelines for National Greenhouse Gas Inventory. Volume 4, Table 4.4.
Value(s) of monitored parameter:	above-ground biomass < 125 t/ha: 0.2 above-ground biomass > 125 t/ha: 0.24
Monitoring equipment:	not applicable

Measuring/ Reading/ Recording frequency:	not applicable
Calculation method (if applicable):	not applicable
QA/QC procedures:	not applicable
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	The same reference is used for the ex-post calculation as in the PDD for the ex-ante estimation of the actual net GHG removals by sinks as no species-specific data is available.

Data / Parameter:	**DBH**
Unit:	cm
Description:	Diameter at breast height (at 1.30 m)
Measured/ Calculated / Default:	Measured
Source of data:	Measurements
Value(s) of monitored parameter:	Measurement results are presented in the ER calculation sheet (Excel).
Monitoring equipment:	Diameter tape (Lufkin Executive), precision 0.1 cm
Measuring/ Reading/ Recording frequency:	DBH of all trees within the sample plots were measured during the monitoring event in October 2012.
Calculation method (if applicable):	not applicable
QA/QC procedures:	10% of all sample plots were measured again by an independent team of experts.
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

Data / Parameter:	**HT**
Unit:	m
Description:	Total tree height
Measured/ Calculated / Default:	Measured
Source of data:	Measurements
Value(s) of monitored parameter:	Measurement results are presented in the ER calculation sheet (Excel).
Monitoring equipment:	Metric bars, precision 0.1 m
Measuring/ Reading/ Recording frequency:	Total height of all trees with DHB ≥ 2 cm within the sample plots were measured during the monitoring event in October 2012.
Calculation method (if applicable):	not applicable
QA/QC procedures:	10% of all sample plots were measured again by an independent team of experts.
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

Data / Parameter:	**$A_{i,m}$**
Unit:	ha
Description:	Area of stratum i at monitoring time m
Measured/ Calculated / Default:	Calculated
Source of data:	GIS of the project activity
Value(s) of monitored parameter:	Stratum i: $A_{i,m}$ (ha) 1: 106.12 2: 775.66 3: 450.09 4: 367.08 5: 284.26 6: 307.06
Monitoring equipment:	not applicable
Measuring/ Reading/ Recording frequency:	not applicable
Calculation method (if applicable):	The area of each stratum is calculated by the GIS software.
QA/QC procedures:	The correct stratum allocation was checked on-site in each sample plot and compared with the information in the GIS.
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

Data / Parameter:	**P_i**
Unit:	-
Description:	Total number of plots in stratum i
Measured/ Calculated / Default:	Default
Source of data:	Defined by project participants prior to the monitoring event in October 2012.
Value(s) of monitored parameter:	Stratum i: P_i 1: 8 2: 34 3: 19 4: 18 5: 15 6: 22
Monitoring equipment:	not applicable
Measuring/ Reading/ Recording frequency:	not applicable
Calculation method (if applicable):	not applicable

QA/QC procedures:	Compliance with required precision and confidence level is demonstrated in section D.3.
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

Data / Parameter:	t_α
Unit:	-
Description:	t value for the required significance level α or confidence level
Measured/ Calculated / Default:	Calculated (confidence level of 90%)
Source of data:	Calculated for a confidence level of 90% („Guidelines on application of specified versions of A/R CDM methodologies in verification of registered A/R CDM project activities“)
Value(s) of monitored parameter:	1.67
Monitoring equipment:	not applicable
Measuring/ Reading/ Recording frequency:	not applicable
Calculation method (if applicable):	Excel function
QA/QC procedures:	not applicable
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

Data / Parameter:	**E**
Unit:	%
Description:	Allowable error
Measured/ Calculated / Default:	Default
Source of data:	Applied approved A/R baseline methodology
Value(s) of monitored parameter:	10%
Monitoring equipment:	not applicable
Measuring/ Reading/ Recording frequency:	not applicable
Calculation method (if applicable):	not applicable
QA/QC procedures:	not applicable
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

Data / Parameter:	C_i
Unit:	-
Description:	Cost to select a plot of the stratum i

Measured/ Calculated / Default:	Default
Source of data:	Registered PDD
Value(s) of monitored parameter:	1
Monitoring equipment:	not applicable
Measuring/ Reading/ Recording frequency:	not applicable
Calculation method (if applicable):	not applicable
QA/QC procedures:	not applicable
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

D.3. Implementation of sampling plan

Sampling was applied for the estimation of the actual net GHG removals by sinks by measuring DBH and total tree height in sample plots distributed over the whole project area.

Sample plots

The sample plots are circular plots with an area of 400 m^2. They were installed between August 2011 and October 2012. The distribution of the sample plots over the project area was defined in GIS by a regular grid with a random start. 101 sample plots were distributed in this way. In order to ensure compliance with the required confidence level and precision, 15 additional plots were installed which were distributed randomly within the stratum. The sample plots are invisible and only marked with an iron bar buried in the center of the sample plot in order to facilitate its locating during the monitoring event by means of a metal detector.

Table 5 provides an overview on the number of sample plots per stratum.

Table 5: Number of sample plots per stratum

Stratum	Number of sample plots
1	8
2	34
3	19
4	18
5	15
6	22
Total	**116**

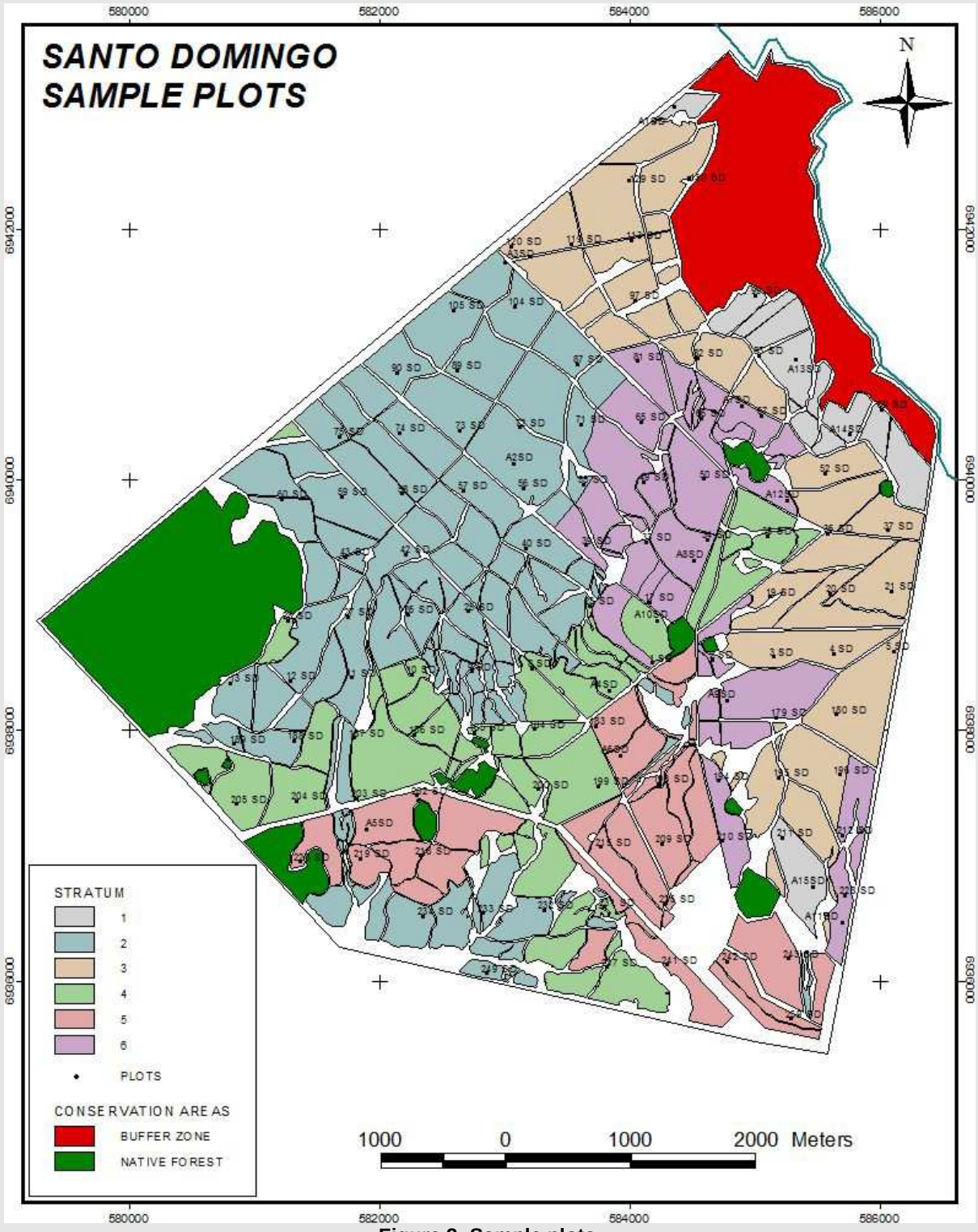

Figure 2: Sample plots

Collected data

The measurement results (DBH and total tree heights) are listed in the ER calculation sheet (excel).

Data analysis

Based on the measured DBH and total tree heights, tree biomass and t C per tree were calculated and later summarized at plot and stratum level according to the applied approved A/R methodology (ER calculation

sheet (excel)).

Demonstration on whether the required confidence/precision has been met

For the demonstration of compliance with the required confidence/precision, equations M.1 and M.2 of the applied approved A/R methodology are applied:

$$n = \left(\frac{t_\alpha}{E}\right)^2 \cdot \left(\sum_{i=1}^{I} W_i \cdot s_i \cdot \sqrt{C_i}\right) \cdot \left(\sum_{i=1}^{I} W_i \cdot \frac{s_i}{\sqrt{C_i}}\right) \quad (1)$$

$$n_i = n \cdot \frac{W_i \cdot \frac{s_i}{\sqrt{C_i}}}{\sum_{i=1}^{I} W_i \cdot \frac{s_i}{\sqrt{C_i}}} \quad (2)$$

Where:

n	Sample size (number of sample plots required for monitoring)
t_α	t value for the required significance level α or confidence level
N_i	Number of sample plot units for stratum i, calculated by dividing the area of stratum i by the area of each plot
N	Total number of sample units of all stratum levels, $N=\sum N_i$
s_i	Standard deviation of stratum i
E	Allowable error (±10% of the mean)
C_i	Cost to select a plot of the stratum i
i	Stratum i (total number of strata I)
W_i	$W_i=N_i/N$
n_i	Number of sample units (permanent sample plots) per stratum, that are allocated proportional to $W_i \cdot \frac{s_i}{\sqrt{C_i}}$

Table 6 shows the amount of sample plots installed per stratum and the minimum number of sample plots required per stratum, applying a confidence level of 90% (in accordance with the „Guidelines on application of specified versions of A/R CDM methodologies in verification of registered A/R CDM project activities“), an allowable error of ±10% (in accordance with the applied approved A/R methodology) and C_i =1 (according to the registered PDD).

Table 6: Installed number of sample plots vs. required number of sample plots per stratum

Stratum	Installed sample plots per stratum	Minimum number of sample plots required per stratum (n_i)
1	8	3
2	34	16
3	19	11
4	18	10
5	15	9
6	22	10

For each of the six strata, more sample plots were installed and measured than required. The required confidence level and precision are therefore met.

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

The baseline net GHG removals by sinks were determined ex-ante in the registered PDD.

Table 7: Baseline net GHG removals by sinks according to the registered PDD

Year	Baseline net GHG removals by sinks, $\Delta C_{BSL,t}$ (tCO_2e)
2007	5
2008	22
2009	35
2010	85
2011	180
2012 (9.5 months)	256
Total	**583**

E.2. Calculation of project emissions or actual net GHG removals by sinks

The actual net GHG removals by sinks are calculated by applying the equations below. These equations correspond to the equations used in the applied methodology but with the following simplifications:

- The index k is not used as no sub-strata were defined.
- The index j is only used where the parameter is a species-specific parameter, i.e. the plot level carbon stock in above-ground biomass is named as $PC_{AB,i,plot,m}$ instead of $PC_{AB,iik,plot,m}$ since the strata and sample plots contain different tree species and are not species-specific.

$$TB_{AB,ij,tree,m} = V_{ij,m} \times D_j \times BEF_j \quad (3) \qquad \text{and} \qquad TB_{BB,ij,tree,m} = TB_{AB,ij,tree,m} \times R_j \quad (4)$$

Where:

$TB_{AB,ij,tree,m}$	Above-ground biomass per tree of stratum i, species j; tonnes d.m. per tree at monitoring time m
$TB_{BB,ij,tree,m}$	Below-ground biomass per tree of stratum i, species j; tonnes d.m. per tree at monitoring time m
$V_{ij,m}$	Stem volume per tree in stratum i, species j; m^3/tree at monitoring time m
D_j	Basic wood density for species j; tonnes d.m./m^3
BEF_j	Biomass expansion factor for conversion of stem volume to aboveground tree biomass for species j , sub-stratum k; dimensionless
R_j	Root-to-shoot ratio appropriate for species j; dimensionless

The stem volume $V_{ii,m}$ is calculated from DBH and total tree height by applying the species-specific volume equations listed in Table 12, Appendix 2.

$$PC_{AB,i,plot,m} = \sum_{tr=1}^{TR} TB_{AB,ij,tree,m} \times CF_j \quad (5) \qquad \text{and} \qquad PC_{BB,i,plot,m} = \sum_{tr=1}^{TR} TB_{BB,ij,tree,m} \times CF_j \quad (6)$$

Where:

$PC_{AB,i,plot,m}$	Plot level carbon stock in above-ground biomass for stratum i; tonnes C/ha at monitoring time m
$PC_{BB,i,plot,m}$	Plot level carbon stock in below-ground biomass for stratum i; tonnes C/ha at monitoring time m
CF_j	Carbon fraction of species j, tonnes C per tonne d.m.;

$$MC_{AB,i,m} = \frac{\sum_{p_i=1}^{P_i} PC_{AB,i,plot,m}}{P_i} \quad (7) \qquad \text{and} \qquad MC_{BB,i,m} = \frac{\sum_{p_i=1}^{P_i} PC_{BB,i,plot,m}}{P_i} \quad (8)$$

Where:

$MC_{AB,i,m}$	Mean carbon stock in above-ground biomass for stratum i; tonnes C/ha at monitoring time m
$MC_{BB,i,m}$	Mean carbon stock in below-ground biomass for stratum i; tonnes C/ha at monitoring time m
P_i	Total number of plots in stratum i; dimensionless

$$C_{AB,i,m} = A_{i,m} \times MC_{AB,i,m} \quad (9) \qquad \text{and} \qquad C_{BB,i,m} = A_{i,m} \times MC_{BB,i,m} \quad (10)$$

Where:

$C_{AB,i,m}$	Carbon stock in above-ground biomass for stratum i; tonnes C at monitoring time m
$C_{BB,i,m}$	Carbon stock in below-ground biomass for stratum i; tonnes C at monitoring time m
$A_{i,m}$	Area of stratum i; hectare (ha) at monitoring time m

$$\Delta C_{i,t} = \left(\Delta C_{AB,i,t} + \Delta C_{BB,i,t}\right) \times \frac{44}{12} \quad (11)$$ with

$$\Delta C_{AB,i,t} = \frac{C_{AB,i,m_2} - C_{AB,i,m_1}}{T} \quad (12)$$ and $$\Delta C_{BB,i,t} = \frac{C_{BB,i,m_2} - C_{BB,i,m_1}}{T} \quad (13)$$

Where:

$\Delta C_{i,t}$	Verifiable changes in carbon stock in living biomass of trees for stratum i; tonnes CO_2/yr in year t
$\Delta C_{AB,i,t}$	Changes in carbon stock in above-ground biomass of trees for stratum i; tonnes C/yr in year t
$\Delta C_{BB,i,t}$	Changes in carbon stock in below-ground biomass of trees for stratum i; tonnes C/yr in year t
$C_{AB,i,m2}$	Carbon stock in above-ground biomass of trees for stratum i, calculated at monitoring point m2; tonnes C
$C_{AB,i,m1}$	Carbon stock in above-ground biomass of trees for stratum i, calculated at monitoring point m1; tonnes C
$C_{BB,i,m2}$	Carbon stock in below-ground biomass of trees for stratum i, calculated at monitoring point m2; tonnes C
$C_{BB,i,m1}$	Carbon stock in below-ground biomass of trees for stratum i, calculated at monitoring point m1; tonnes C
T	Number of years between monitoring point m2 and m1
44/12	Ratio of molecular weights of CO_2 and carbon; dimensionless

$$\Delta C_{ACTUAL,t} = \sum_{i=1}^{I} \Delta C_{i,t} - GHG_{E,t} \quad (14)$$

Where:

$\Delta C_{ACTUAL,t}$	Actual net GHG removals by sinks; tonnes CO_2e/yr for year t
$GHG_{E,t}$	Annual GHG emissions as a result of the implementation of the A/R CDM project activity within the project boundary; tonnes CO_2e/yr in year t

The calculation of the actual net GHG removals by sinks is provided in the ER calculation sheet (excel). No sample calculations or tables are included in this monitoring report due to the large amount of data used for the calculation. The actual net GHG removals by sinks are presented in Table 8.

Table 8: Actual net GHG removals by sinks

Year	Actual net GHG removals by sinks, $\Delta C_{ACTUAL,t}$ (tCO_2e)
2007	13,705
2008	20,558
2009	20,502
2010	20,502
2011	20,502
2012 (9.5 months)	16,233
Total	**112,000**

E.3. Calculation of leakage

$$LK_t = LK_{Displacement\_grazing,t} + LK_{Fuelwood,t} \quad (15)$$

Where:

LK_t	Increase of GHG emissions outside the project boundary; tonnes CO_2e/yr in year t
$LK_{Displacement\_grazing,t}$	Increase in GHG emissions outside the project boundary resulting from displacement of grazing activities; tonnes CO_2e/yr in year t
$LK_{Fuelwood,t}$	Increase in GHG emissions outside the project boundary resulting from displacement of fuel wood collection; tonnes CO_2e/yr in year t

$LK_{Displacement\ grazing,t}$ = 0 as demonstrated in section C of this monitoring report.

No fuel wood is collected within the project area. Therefore, $LK_{Fuelwood,t}$ = 0.

Table 9: Leakage

Year	Leakage, LK_t (tCO_2e)
2007	0
2008	0
2009	0
2010	0
2011	0
2012 (9.5 months)	0
Total	**0**

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	583	112,000	-	111,417

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	149,393	111,417

E.6. Remarks on difference from estimated value in registered PDD

The actual values achieved during this monitoring period are lower than the values estimated in the ex-ante calculation of the registered PDD.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	111,417	0

Appendix 1

Table 10: Wood densities

Species	Density (t/m^3)	Source #	Page
Parapiptadenia rigida	0.975	1	396
Araucaria angustifolia	0.5	1	246
Peltophorum dubium	0.85	1	442
Grevillea robusta	0.55	2	16
Patagonula americana	0.8	1	616
Myrocarpus frondosus	0.845	1	465
Inga uruguensis	0.62	1	376
Tabebuia ochracea/pulcherrima	0.992	1	629
Tabebuia heptaphylla	0.992	1	629
Tabebuia impetiginosa	0.992	1	629
Bastardiopsis densiflora	0.6	6	1
Cordia trichotoma	0.6	1	613
Pinus elliottii	0.57	3	330
Pinus elliottii x Pinus caribaea var. hondurensis	0.409	4	36
Pinus taeda	0.349	5	491
Enterolobium contortisiliquum	0.336	1	373
Pterogyne nitens	0.8	1	447

Table 11: Wood densities - sources

#	Source
1	Tortorelli, L. A. 2009. Maderas y Bosques Argentinos (Argentinean Woods and Forests). Edit. Orientación Gráfica
2	Bobadilla E. A., Pereyra Obdulio, Silva Fidelina. (2004): Durabilidad Natural de la Madera de cinco especies aptas para la Industria de la Construcción. (Natural wood durability of five species suitable for the construction industry.)
3	Moura Dias, Fabricio, et al. (2005): Relation between the Compaction Rate and Physical and Mechanical Properties of Particleboards. Materials Research, Vol. 8, No. 3, 329-333, 2005.
4	Toon, P G. 2004. Wood Properties of Pinus caribaea hybrids in Queensland. Submitted in fulfillment of the degree of Masters of Science by Research, University of the Sunshine Coast.
5	E. M. Weber (2005). DENSIDAD BÁSICA DE MADERA DE Pinus taeda L. MARION DE DIFERENTES EDADES (Basic wood density of Pinus taeda L. Marion of different ages), MISIONES, ARGENTINA. FLORESTA, Curitiba, PR, v. 35, n. 3. p 487-494.
6	H. G. Richter y M. J. Dallwitz (1993). Maderas comerciales (Commercial woods). Bastardiopsis densiflora (Hook. & Arn.) Hassler (Loro blanco). http://delta-intkey.com/wood/es/index.htm and http://delta-intkey.com/wood/es/www/malbaden.htm

Appendix 2

Table 12: Volume equations

Species	DAP (cm)	Volume equation	Sample size	R^2	Source	Page
Peltophorum dubium	2 to 14	Vcc = 0.0000314497*DAP^1.71029*HT^1.47905 Vcc = V (m^3), DAP (cm), HT (m)	55	97.38%	Equation generated by the National University of La Plata based on measurements within the project boundary. 2012.	
Grevillea robusta	2 to 10	Vcc = 0.000186887*DAP^1.63238*HT^0.697754 Vcc = V (m^3), DAP (cm), HT (m)	30	99.15%	Equation generated by the National University of La Plata based on measurements within the project boundary. 2012.	
	>10 to 50	ln(Vcc) = -8.03857+1.62345*ln(dap)+0.040050*(ln(dap))^2-0.138165*ln(h)+0.221404*(ln(h))^2 Vcc = V (m^3), dap = DAP (cm), h = HT (m)	95	99.70%	F. Moscovich, et al. Funciones de volúmen y forma para Grevillea robusta A. en Misiones, Argentina. Volumetric and forms functions of Grevillea robusta A. in Misiones, Argentina. 11as Jornadas Técnicas Forestales y Ambientales (11th Conference on Forest and Environmental Techniques) - FCF, UNaM - EEA Montecarlo, INTA	4
Tabebuia ochracea/ pulcherrima/ heptaphylla/ impetiginosa	2 to 11.5	Vcc = 0.000125457*DAP^1.44807*HT^1.11701 Vcc = V (m^3), DAP (cm), HT (m)	52	97.05%	Equation generated by the National University of La Plata based on measurements within the project boundary. 2012.	
Pinus elliottii	2 to 17.7	Vcc = 0.000132256*DAP^1.79756*HT^0.721076 Vcc = V (m^3), dap = DAP (cm), h = HT (m)	47	99.04%	Equation generated by the National University of La Plata based on measurements within the project boundary. 2012.	

	>17.7 to 42.3	ln(Vcc) = (-12.7392+4.49971*ln(dap)-0.39361*(ln(dap))^2+0.18591*(ln(h))^2)*1.00346749 Vcc = V (m^3), dap = DAP (cm), h = HT (m)	81	97.92%	Hugo E. Fassola, et al. 2007. Funciones y Algoritmos dasométricos para manejo silvícola intensivo, de aplicación en plantaciones forestales orientadas a producción de madera de alto valor agregado. Región Mesopotámica. Pinus elliottii y Eucalyptus grandis, parcial para Pinus taeda. Informe técnico N° 61. (Dasometric equations and algorithms for intensive silivcultural management, to be applied in forest plantations with an orientation to production of wood with high added value. Mesopotamic region. Pinus elliottii and Eucalyptus grandis, partially for Pinus taeda. Technical report N° 61.) INTA EEA Montecarlo.	18
Pinus elliottii x Pinus caribaea var. hondurensis	2 to 10	Vcc = 0.000178228*DAP^1.88131*HT^0.446681 Vcc = V (m^3), DAP (cm), HT (m)	31	99.51%	Equation generated by the National University of La Plata based on measurements within the project boundary. 2012.	
	>10 to 43.5	V(t) = 0.0478*d^1.7203*h^1.2434 V(t) = V (dm^3), dap = DAP (cm), h = HT (m)	88	99.28%	Rubén A. Costas, et al. 2006. Funciones de volúmenes del híbrido Pinus elliottii var. elliottii x Pinus caribaea var. hondurensis. 12as Jornadas Técnicas Forestales y Ambientales - FCF, UNaM - EEA Montecarlo, INTA, 8, 9 y 10 de Junio de 2006 - Eldorado, Misisiones, Argentina. (Volume functions of hibrid Pinus elliottii var. elliottii x Pinus caribaea var. hondurensis. 12th Conference on Forest and Environmental Techniques - FCF, UNaM - EEA Montecarlo, INTA, 8-10 June 2006 - Eldorado, Misiones, Argentina.)	9
Pinus taeda	2 to 10	Vcc = 0.000161896*DAP^1.85831*HT^0.518328 Vcc = V (m^3), DAP (cm), HT (m)	31	98.79%	Equation generated by the National University of La Plata based on measurements within the project boundary. 2012.	

	>10 to 53	ln(Vcc) = (-9.52543+2.42573*ln(dap)-0.07546*(ln(dap))^2+0.19513*(ln(h))^2)*1.00364003 Vcc = V (m^3), dap = DAP (cm), h = HT (m)	282	99.35%	Hugo E. Fassola, et al. 2007. Funciones y Algoritmos dasométricos para manejo silvícola intensivo, de aplicación en plantaciones forestales orientadas a producción de madera de alto valor agregado. Región Mesopotámica. Pinus elliottii y Eucalyptus grandis, parcial para Pinus taeda. Informe técnico N° 61. (Dasometric equations and algorithms for intensive silivcultural management, to be applied in forest plantations with an orientation to production of wood with high added value. Mesopotamic region. Pinus elliottii and Eucalyptus grandis, partially for Pinus taeda. Technical report N° 61.) INTA EEA Montecarlo.	14

Since from the remaining native species, apart from *Peltophorum dubium and Tabebuia,* only very few trees were present in the sample plots and those native species were also planted in much lower percentages than *Peltophorum dubium* and *Tabebuia*, it was not considered reasonable to develop separate volume equations for those species. Hence, for the remaining native species the volume equation of *Peltophorum dubium* was applied which provides more conservative results than the volume equation of *Tabebuia.*

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Document information

Version	*Date*	*Description*
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
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