Simplified baseline and monitoring methodology for small-scale afforestation and reforestation project activities under the clean development mechanism implemented on lands having low inherent potential to support living biomass

I. Applicability conditions, carbon pools and project emissions

1. The simplified baseline and monitoring methodology is applicable if the following condition is met:

Project activities are implemented on areas having low inherent potential to support living biomass without human intervention. The project activities shall be implemented on areas listed in (i) to (iv) below. The project participants shall provide evidence/data to support that the selected project sites meet the local/national criteria for these categories using information from verifiable sources and/or expert opinion as appropriate:

(i) Sand dunes;

(ii) Bare lands;

(iii) Contaminated or mine spoils lands;

(iv) Highly alkaline or saline soils.

2. **Carbon pools** to be considered by the methodologies are above-and below-ground tree biomass.

3. **Project emissions** attributable to implementation of A/R project activity on areas having low potential to support living biomass without human intervention are considered to be insignificant.

4. Before using simplified methodologies, project participants shall demonstrate whether:

(a) The project area is eligible for the A/R CDM project activity. Eligibility of the A/R CDM project activities shall be demonstrated by applying the latest version of the “Procedures to demonstrate the eligibility of lands for afforestation and reforestation CDM project activities” as approved by the Executive Board”;

(b) The project activity is additional, using the procedures for the assessment of additionality contained in **Appendix A**.

II. Baseline net greenhouse gas removals by sinks

5. The most plausible baseline scenario of the small-scale A/R CDM project activity is considered to be the land-use prior to the implementation of the project activity, that is lands having low inherent potential to support living biomass. On these lands the carbon stocks in the living biomass pools of trees and non-tree vegetation under the baseline scenario are expected to be in steady state or declining or no living biomass is present in the project area. Changes in the carbon stocks in the living biomass pool of trees and non-tree vegetation in the absence of the project activity shall be assumed to be neglible and therefore sum of changes in carbon stocks in the baseline are considered to be zero.

III. Actual net greenhouse gas removals by sinks

6. Stratification of the project area should be carried out to improve the accuracy and precision of biomass estimates. Stratification should be made according to the project planting plan that is, at least by tree species (or groups of them if several tree species have similar growth habits), and age classes.

7. The actual net greenhouse gas removals by sinks shall be estimated using the equations in this section. When applying these equations for *ex ante* calculations of net anthropogenic GHG removals by sinks, project participants shall provide estimates of the values of those parameters that are not available before the start of the crediting period and commencement of the monitoring activities. Project participants should retain a conservative approach in applying these estimates.

8. The **actual net greenhouse gas removals by sinks** in year *t* are equal to:

$$\Delta C_{ACTUAL,t} = \Delta C_{PJ,t} \quad \textbf{(1)}$$

where:

$\Delta C_{ACTUAL,t}$	Actual net greenhouse gas removals by sinks in year *t*, t CO_2-e yr^{-1}
$\Delta C_{PJ,t}$	Project GHG removals by sinks in year *t*, t CO_2-e yr^{-1}

9. The actual net GHG removals by sinks consider only the changes in carbon pools for the project scenario.

$$\Delta C_{PJ,t} = \sum_{i=1}^{I} \Delta C_{project,i,t} \cdot 44/12 \quad \textbf{(2)}$$

$$\Delta C_{project,i,t} = \frac{C_{trees,i,t_2} - C_{trees,i,t_1}}{T} \quad \textbf{(3)}$$

where:

$\Delta C_{PJ,t}$	Average GHG removals by living biomass of trees for the project area, tonnes CO_2-e yr^{-1}
$\Delta C_{project,i,t}$	Average GHG removals by living biomass of trees for stratum *i*, for year *t,* tonnes C yr^{-1}
$C_{trees,i,t}$	Carbon stock in living biomass of trees for stratum *i*, at time *t*, tonnes C
T	Number of years between times t_2 and t_1

Estimation of carbon stock in living biomass of trees at the stratum level

10. The carbon stock in living biomass[1] of trees for stratum *i* ($C_{trees,i,t}$) is estimated using the following approach:

The mean carbon stock in above-ground biomass per unit area is estimated based on field measurements in permanent sample plots. Two methods are available: the Biomass Expansion Factors (*BEF*) method and the Allometric Equations method.

[1] Throughout this methodology the term 'living biomass' refers to above- and below-ground biomass.

BEF method

Step 1: Determine based on available data, e.g. volume tables (*ex ante*) and measurements (*ex post*), the diameter at breast height (*DBH,* at typically 1.3 m above-ground level), and also preferably height (*H*), of all the trees above some minimum *DBH* in the permanent sample plots.

Step 2: Estimate the volume of the commercial (merchantable) timber component of trees[2] based on available equations or yield tables (if locally derived equations or yield tables are not available use relevant regional, national or default data as appropriate). It is possible to combine Steps 1 and 2 if field instruments (e.g. a relascope) that measure the volume of each tree directly are applied.

Step 3: Choose appropriate values for *BEF*. See Section VII. for guidance on source of data.

Step 4: Convert the volume of the commercial timber component of trees into carbon stock in above-ground biomass via basic wood density *D*, the *BEF* and the carbon fraction using Equation 5. See Section VII. for guidance on source of data for wood density.

$$C_{AB,i,sp,j,l,t} = V_{i,sp,j,l,t} \cdot D_j \cdot BEF_{2,j} \cdot CF_j \quad \textbf{(4)}$$

where:

$C_{AB,i,sp,j,l,t}$	Carbon stock in above-ground biomass of tree *l* of species *j* in plot *sp* in stratum *i*, at time *t*, tonnes C
$V_{i,sp,j,l,t}$	Merchantable volume of tree *l* of species *j* in plot *sp* in stratum *i*, at time *t*, m^3 $tree^{-1}$
D_j	Basic wood density of species *j*, tonnes d.m. m^{-3}
$BEF_{2,j}$	Biomass expansion factor for conversion of merchantable biomass to above-ground tree biomass for species *j*, dimensionless
CF_j	Carbon fraction of dry matter for species or group of species type *j*, tonnes C (tonne d.m.)$^-$1, IPCC default value = 0.5

Step 5: Convert the carbon stock in above-ground biomass to the carbon stock in below-ground biomass via root-shoot ratio, given by:

$$C_{BB,i,sp,j,l,t} = C_{AB,i,sp,j,l,t} \cdot R_j \quad \textbf{(5)}$$

where:

$C_{BB,i,sp,j,l,t}$	Carbon stock in below-ground biomass of tree *l* of species *j* in plot *sp* in stratum *i* at time *t*, t C $tree^{-1}$
$C_{AB,i,sp,j,l,t}$	Carbon stock in above-ground biomass of tree *l* of species *j* in plot *sp* in stratum *i* at time *t*, t C $tree^{-1}$
R_j	Root-shoot ratio appropriate for biomass stock, for species *j*; dimensionless

See guidance in Section VII. for selection of values of *R*.

[2] For non timber species 'merchantable timber volume' may refer to the actual volume of stemwood for such species estimated using national inventory methods for which *BEFs* are applicable.

Step 6: Calculate carbon stock in above-ground and below-ground biomass of all trees present in plot *sp* in stratum *i* at time *t* (i.e. summation over all trees *l* by species *j* followed by summation over all species *j* present in plot *sp*)

$$C_{tree,i,sp,t} = \sum_{j=1}^{S_{PS}} \sum_{l=1}^{N_{j,i,sp,t}} (C_{AB,i,sp,j,l,t} + C_{BB,i,sp,j,l,t}) \quad \textbf{(6)}$$

where:

$C_{tree,i,sp,t}$	Carbon stock in living biomass of trees on plot *sp* of stratum *i* at time *t*, t C
$C_{AB,i,sp,j,l,t}$	Carbon stock in above-ground biomass of tree *l* of species *j* in plot *sp* in stratum *i* at time *t*; t C tree^{-1}
$C_{BB,i,sp,j,l,t}$	Carbon stock in below-ground biomass of tree *l* of species *j* in plot *sp* in stratum *i* at time *t*, t C tree^{-1}
$N_{j,i,sp,t}$	Number of trees of species *j* on plot *sp* of stratum *i* at time *t*
l	Sequence number of trees on plot *sp*

Step 7: Calculate the mean carbon stock in tree biomass for each stratum:

$$C_{tree,i,t} = \frac{A_i}{Asp_i} \sum_{sp=1}^{P_i} C_{tree,i,sp,t} \quad \textbf{(7)}$$

where:

$C_{tree,i,t}$	Carbon stock in living biomass of trees in stratum *i*, at time *t*; t C
$C_{tree,i,sp,t}$	Carbon stock in living biomass of trees on plot *sp* of stratum *i* at time *t*, t C
Asp_i	Total area of all sample plots in stratum *i*; ha
A_i	Area of stratum *i*; ha
sp	*1, 2, 3, …* P_i sample plots in stratum *i* in the project scenario
i	*1, 2, 3, …* M_{PS} strata in the project scenario
t	*1, 2, 3, … t* years elapsed since the start of the A/R CDM project activity

Method based on allometric equations

Step 1: As in Step 1 of *BEF* method.

Step 2: Calculate the above-ground biomass for each individual tree of a species, using allometric equations appropriate to the tree species (or groups of them if several tree species have similar growth habits) in the stratum. In the absence of species specific allometric equations use equations in accordance with guidance provided in Section VII.

Step 3: Estimate carbon stock in above-ground biomass for each individual tree *l* of species *j* in the sample plot located in stratum *i* using the selected or developed allometric equation applied to the tree dimensions resulting from Step 1, and sum the carbon stocks in the sample plot.

$$C_{AB,i,sp,j,t} = \sum_{l=1}^{N_{l,sp}} CF_j \cdot f_j(DBH,H) \qquad \textbf{(8)}$$

where:

$C_{AB,i,sp,j,t}$	Carbon stock in above-ground biomass of trees of species *j* on sample plot *sp* for stratum *i*, tonnes C
CF_j	Carbon fraction of dry matter for species or group of species type *j*, tonnes C (tonne d.m.)$^{-1}$, IPCC default value = 0.5
$f_j(DBH,H)$	An allometric equation linking aboveground biomass of living trees (d.m. tree^{-1}) to mean diameter at breast height (*DBH*) and possibly tree height (*H*) for species *j*, at time *t,* t.d.m tree^{-1} Note: for *ex ante* estimations, mean *DBH* and *H* values should be estimated for stratum *i,* at time *t* using a growth model or yield table that gives the expected tree dimensions as a function of tree age. The allometric relationship between above-ground biomass and *DBH* and possibly *H* is a function of the species considered.
i	*1, 2, 3, …* M_{PS} strata in the project scenario
j	*1, 2, 3, …* S_{PS} tree species in the project scenario
l	*1, 2, 3,…* $N_{j,sp}$ sequence number of individual trees of species *j* in sample plot *sp*
t	*1, 2, 3, … t* years elapsed since the start of the A/R CDM project activity

Step 4: Convert the carbon stock in above-ground biomass to the carbon stock in below-ground biomass via root-shoot ratio, given by:

$$C_{BB,i,sp,j,t} = C_{AB,i,sp,j,t} \cdot R_j \qquad \textbf{(9)}$$

where:

$C_{BB,i,sp,j,t}$	Carbon stock in below-ground biomass of trees of species *j* in plot *sp* in stratum *i* at time *t*, t C
$C_{AB,i,sp,j,t}$	Carbon stock in above-ground biomass of trees of species *j* in plot *sp* in stratum *i* at time *t*, t C
R_j	Root-shoot ratio appropriate for biomass stock, for species *j*; dimensionless

See guidance in Section VII. for selection of values of *R*.

Step 5: Calculate total carbon stock in the biomass of all trees present in the sample plot *sp* in stratum *i* at time *t*.

$$C_{tree,i,sp,t} = \sum_{j=1}^{S_{PS}} (C_{AB,i,sp,j,t} + C_{BB,i,sp,j,t}) \qquad \textbf{(10)}$$

where:

$C_{tree,i,sp,t}$	Carbon stock in living biomass trees on plot *sp* of stratum *i* at time *t*, t C
$C_{AB,i,sp,j,t}$	Carbon stock in above-ground biomass of trees of species *j* in plot *sp* in stratum *i* at time *t*; t C $tree^{-1}$
$C_{BB,i,sp,j,t}$	Carbon stock in below-ground biomass of trees of species *j* in plot *sp* in stratum *i* at time *t*, t C $tree^{-1}$
i	*1, 2, 3, …* M_{PS} strata in the project scenario
j	*1, 2, 3, …* S_{PS} tree species in the project scenario
t	*1, 2, 3, … t* years elapsed since the start of the A/R CDM project activity

Step 6: Calculate the mean carbon stock in living biomass of trees for each stratum, as per Equation (8) - i.e. Step 7 of the *BEF* method.

Project emissions

11. The GHG emissions by sources within the project boundary as a result of the implementation of an A/R CDM project activity are considered to be insignificant, and are therefore accounted as zero.

IV. Leakage

12. The project area consists of severely degraded lands which support low living biomass, due to which displacement of pre project activities such as grazing and agriculture in the pre project scenario can be considered as insignificant. Therefore leakage due to displacement of pre project activities can be considered as zero.

V. Net anthropogenic greenhouse gas removals by sinks

13. The actual net anthropogenic greenhouse gas removals by sinks is the actual net GHG removals by sinks minus the baseline net GHG removals by sinks minus leakage.

14. The net anthropogenic GHG removals by sinks for each year are calculated as:

$$C_{AR-CDM,t} = \Delta C_{ACTUAL,t} \tag{11}$$

where:

$C_{AR\text{-}CDM,t}$	Net anthropogenic GHG removals by sinks; t CO_2-e yr^{-1}
$\Delta C_{ACTUAL,t}$	Actual net greenhouse gas removals by sinks in year *t*, t CO_2-e yr^{-1}

VI. Certified Emission Reductions

15. The resulting temporary certified emission reductions (tCERs) , are calculated as follows:

$$tCER_{tv} = \sum_{t=0}^{tv} C_{AR-CDM,t} \cdot \Delta t \tag{12}$$

16. lCERs are calculated as follows:

$$lCER_{tv} = \sum_{t=0}^{tv} C_{AR-CDM,t} \cdot \Delta t - lCER_{tv-k} \qquad \textbf{(13)}$$

where:

$tCER_{tv}$	Units of t-CERs issued at year of verification *tv*, , t CO_2-e
$C_{AR-CDM,t}$	Net anthropogenic GHG removals by sinks; t CO_2-e yr^{-1}
$lCER_{tv}$	Units of lCERs issued at year of verification *tv*, t CO_2-e
Tv	Year of verification
K	Time span between two verifications (year)
Δt	Time increment = 1 year

VII. Data and parameters not monitored (default or possibly measured one time)

17. In choosing key parameters or making important assumptions based on information that is not specific to the project circumstances, such as in use of existing published data, project participants should retain a conservative approach: that is, if different values for a parameter are equally plausible, a value that does not lead to over-estimation of net anthropogenic GHG removals by sinks should be selected.

Data / parameter:	$BEF_{2,j}$
Data unit:	Dimensionless
Used in equations:	4
Description:	Biomass expansion factor for conversion of merchantable biomass to above-ground tree biomass for tree species *j*
Source of data:	The source of data shall be chosen with priority from higher to lower preference as follows: (a) Existing local and species-specific or group of species-specific; (b) National and species-specific or group of species-specific (e.g. from national GHG inventory); (c) Species-specific or group of species-specific from neighbouring countries with similar conditions. Sometimes c) might be preferable to b); (d) Globally species-specific or group of species-specific (e.g. Table 3A.1.10 of IPCC GPG-LULUCF 2003).[3]
Measurement procedures (if any):	

[3] Although the *BEF* in Table 3A.1.10 apply to biomass, the dimensionless factors can be equally applied for wood volume expansions. The BEF_2 values for growing stock data include bark and are given for a certain minimum diameter at breast height.

Any comment:	• Consistent application of BEF should take into account the definition of stem volume (e.g. total stem volume or thick wood stem volume requires different *BEFs*).[4] To be conservative, the lower value in the specified range of BEF_2 values should be used and the selected *BEF* values justified; • *BEFs* are age dependent, and use of average data may result in significant errors for both young and old stands—as *BEFs* are usually large for young stands and quite small for old stands.

Data / parameter:	CF_j
Data unit:	t C t^{-1} d.m.
Used in equations:	4, 8
Description:	Carbon fraction of dry matter for species of type *j*
Source of data:	The source of data shall be chosen with priority from higher to lower preference as follows: (a) Existing local and species-specific or group of species-specific; (b) National and species-specific or group of species-specific (e.g. from national GHG inventory); (c) Species-specific or group of species-specific from neighbouring countries with similar conditions. Sometimes b) might be preferable to a); (d) Globally species-specific or group of species-specific (e.g. IPCC GPG-LULUCF 2003); Alternately the default value of 0.5 t C t^{-1} d.m. may be used.
Measurement procedures (if any):	N/A
Any comment:	

Data / parameter:	D_j
Data unit:	t d.m. m^{-3}
Used in equations:	4
Description:	Basic wood density for species *j*
Source of data:	The source of data shall be chosen with priority from higher to lower preference as follows: (a) Existing local and species-specific or group of species-specific; (b) National and species-specific or group of species-specific (e.g. from national GHG inventory); (c) Species-specific or group of species-specific from neighbouring countries with similar conditions. Sometimes b) might be preferable to a); (d) Globally species-specific or group of species-specific (e.g. Table 3A.1.9 IPCC GPG-LULUCF 2003).
Measurement procedures (if any):	N/A
Any comment:	

[4] The 2006 IPCC guidelines (chapter 8.2.1.1) recommend to give preference to allometric methods based on individual tree diameter at breast height, adjusted for open grown trees, instead of unspecific *BEFs*.

Data / Parameter:	$f_j(DBH, H)$
Data unit:	t d.m. tree^{-1}
Used in equations:	8
Description:	Allometric equation for species *j* linking diameter at breast height (*DBH*) and possibly tree height (*H*) to above-ground biomass of living trees
Source of data:	Whenever available, use allometric equations that are species-specific or group of species-specific, provided the equations have been derived using a wide range of diameters and heights, based on datasets that comprise at least 20 trees. If species specific allometric equations are not available then use default allometric equations included in **Appendix B** to this report or default equations from IPCC literature, national inventory reports or published peer-reviewed studies —such as those provided in Tables 4.A.1 to 4.A.3 of the GPG-LULUCF (IPCC 2003).
Measurement procedures (if any):	
Any comment:	If default allometric equations are available for conditions that are similar to the project (same vegetation genus; same climate zone; similar forest type), then the equation may be used and considered conservative.

Data / parameter:	R_j
Data unit:	kg d.m. kg^{-1} d.m.
Used in equations:	5, 9
Description:	Root-shoot ratio appropriate for biomass stock, for species *j*
Source of data:	The source of data shall be chosen with priority from higher to lower preference as follows: (a) Local values if available; (b) If local values are not available, values should be selected from Table 3A.1.8 of the *GPG-LULUCF* (IPCC 2003), or equivalently Table 4.4 of the AFOLU Guidelines (IPCC 2006). Alternately a default value of value of 0.3 kg d.m. (kg d.m.)$^{-1}$ may be used as a conservative generic root:shoot ratio for all trees.
Measurement procedures (if any):	N/A
Any comment:	Guidelines for Conservative Choice of Default Values: 1. If in the sources of data mentioned above, default data are available for conditions that are similar to the project (same vegetation genus; same climate zone; similar forest type), then mean values of default data may be used and are considered conservative; 2. Global values may be selected from Table 3A.1.8 of the GPG-LULUCF (IPCC 2003), or equivalently Table 4.4 of the AFOLU Guidelines (IPCC 2006), by choosing a climatic zone and species that most closely matches the project circumstances.

VIII. Simplified monitoring methodology for small-scale afforestation and reforestation projects under the clean development mechanism

18. In accordance with decision 6/CMP.1, Appendix B, paragraph 6, no monitoring of the baseline is requested. Baseline net GHG removals by sinks for the monitoring methodology will be the same as using the simplified baseline methodology in Section II above.

19. All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted according to relevant standards. In addition, the monitoring provisions in the tools referred to in this methodology apply.

Sampling design and stratification

20. Stratification of the project area into relatively homogeneous units can either increase the measuring precision without increasing the cost unduly, or reduce the cost without reducing measuring precision because of the lower variance within each homogeneous unit. Project participants should present in the AR-CDM-PDD an *ex ante* stratification of the project area or justify the lack of it. The number and boundaries of the strata defined *ex ante* may change during the crediting period (*ex post*).

21. For estimation of project GHG removals by sinks, strata shall be defined by:

(i) Stratification approach that can be shown in the PDD to estimate biomass stocks according to good forest inventory practice in the Host country; or

(ii) Other stratification approach that can be shown in the PDD to estimate the project biomass stocks to targeted precision level of ±10% of the mean at a 90% confidence level.

22. The *ex post* stratification shall be updated due to the following reasons:

- Unexpected disturbances occurring during the crediting period (e.g. due to fire, pests or disease outbreaks), affecting differently various parts of an originally homogeneous stratum;
- Forest management activities (cleaning, planting, thinning, harvesting, coppicing, re-replanting) may be implemented in a way that affects the existing stratification.

23. Established strata may be merged if reasons for their establishing have disappeared.

IX. Data and parameters monitored

24. The following parameters should be monitored during the project activity. When applying all relevant equations provided in this methodology for the *ex ante* calculation of net anthropogenic GHG removals by sinks, project participants shall provide transparent estimations for the parameters that are monitored during the crediting period. These estimates shall be based on measured or existing published data where possible and project participants should retain a conservative approach: that is, if different values for a parameter are equally plausible, a value that does not lead to over-estimation of net anthropogenic GHG removals by sinks should be selected.

Data / Parameter:	A_i
Data unit:	ha
Used in equations:	7
Description:	Area of stratum *i*
Source of data:	Monitoring of strata and stand boundaries shall be done preferably using a Geographical Information System (GIS), which allows for integrating data from different sources (including GPS coordinates and Remote Sensing data)
Measurement procedures (if any):	
Monitoring frequency:	At least every 5 years from the start of the project activity
QA/QC procedures:	
Any comment:	

Data / Parameter:	$Asp_{,i}$
Data unit:	ha
Used in equations:	7
Description:	Total area of all sample plots in stratum *i*
Source of data:	Field measurement
Measurement procedures (if any):	
Monitoring frequency:	At least every 5 years from the start of the project activity
QA/QC procedures:	
Any comment:	GPS can be used for field survey. Sample Plot location is registered with a GPS and marked on the project map

Data / parameter:	*DBH*
Data unit:	cm
Used in following equations	Implicitly used in Eq. 8
Description:	Diameter breast height of tree
Source of data:	Field measurements in sample plots
Measurement procedures (if any):	Typically measured 1.3 m above-ground. Measure all the trees above some minimum *DBH* in the permanent sample plots that result from the A/R project activity. The minimum *DBH* varies depending on tree species and climate; for instance, the minimum *DBH* may be as small as 2.5 cm in arid environments where trees grow slowly, whereas it could be up to 10 cm for humid environments where trees grow rapidly
Monitoring frequency:	At least every 5 years
QA/QC procedures:	
Any comment:	Note: for *ex ante* estimations, mean *DBH* and *H* values should be estimated for tree species *j* in stratum *i*, at time *t* using a growth model or yield table that gives the expected tree dimensions as a function of tree age. The allometric relationship between above-ground biomass and *DBH* and possibly *H* is a function of the species considered.

Data / parameter:	*H*
Data unit:	m
Used in equations:	Implicitly used in Eq. 8
Description:	Height of tree
Source of data:	Field measurements in sample plots
Measurement procedures (if any):	
Monitoring frequency:	At least every 5 years
QA/QC procedures:	
Any comment:	Note: for *ex ante* estimations, mean *DBH* and *H* values should be estimated for tree species *j* in stratum *i*, at time *t* using a growth model or yield table that gives the expected tree dimensions as a function of tree age. The allometric relationship between above-ground biomass and *DBH* and possibly *H* is a function of the species considered.

Data / Parameter:	*T*
Data unit:	yr
Used in equations:	3
Description:	Number of years between monitoring time t_2 and t_1 ($T = t2 – t1$)
Source of data:	
Measurement procedures (if any):	
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

Appendix A

Assessment of additionality

1. Project participants shall provide an explanation to show that the project activity would not have occurred anyway due to at least one of the following barriers:

2. **Investment barriers, other than economic/financial barriers**, *inter alia*:

   (a) Debt funding not available for this type of project activity;

   (b) No access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented;

   (c) Lack of access to credit.

3. **Institutional barriers**, *inter alia*:

   (a) Risk relating to changes in government policies or laws;

   (b) Lack of enforcement of legislation relating to forest or land-use.

4. **Technological barriers**, *inter alia*:

   (a) Lack of access to planting materials;

   (b) Lack of infrastructure for implementation of the technology.

5. **Barriers relating to local tradition**, *inter alia*:

   (a) Traditional knowledge or lack thereof, of laws and customs, market conditions, practices;

   (b) Traditional equipment and technology.

6. **Barriers due to prevailing practice**, *inter alia*:

   (a) The project activity is the "first of its kind". No project activity of this type is currently operational in the host country or region.

7. **Barriers due to local ecological conditions**, *inter alia*:

   (a) Degraded soil (e.g. water/wind erosion, salination);

   (b) Catastrophic natural and/or human-induced events (e.g. land slides, fire);

   (c) Unfavourable meteorological conditions (e.g. early/late frost, drought);

   (d) Pervasive opportunistic species preventing regeneration of trees (e.g. grasses, weeds);

   (e) Unfavourable course of ecological succession;

   (f) Biotic pressure in terms of grazing, fodder collection, etc.

8. **Barriers due to social conditions**, *inter alia*:

(a) Demographic pressure on the land (e.g. increased demand on land due to population growth);

(b) Social conflict among interest groups in the region where the project activity takes place;

(c) Widespread illegal practices (e.g. illegal grazing, non-timber product extraction and tree felling);

(d) Lack of skilled and/or properly trained labour force;

(e) Lack of organization of local communities.

Appendix B

Default allometric equations for estimating above-ground biomass

Annual rainfall	**DBH limits**	**Equation**	**R^2**	**Author**
Broad-leaved species, tropical dry regions				
<900 mm	3–30 cm	$AGB = 10^{-0.535 + \log_{10}(\pi * DBH^2/4)}$	0.94	Martinez-Yrizar et al. (1992)
900–1500 mm	5–40 cm	$AGB = \exp\{-1.996 + 2.32 * \ln(DBH)\}$	0.89	Brown (1997)
Broad-leaved species, tropical humid regions				
< 1500 mm	5–40 cm	$AGB = 34.4703 - 8.0671*DBH + 0.6589*(DBH^2)$	0.67	Brown et al. (1989)
1500–4000 mm	< 60 cm	$AGB = \exp\{-2.134 + 2.530 * \ln(DBH)\}$	0.97	Brown (1997)
1500–4000 mm	60–148 cm	$AGB = 42.69 - 12.800*(DBH) + 1.242*(DBH)^2$	0.84	Brown et al. (1989)
1500–4000 mm	5–130 cm	$AGB = \exp\{-3.1141 + 0.9719*\ln(DBH^2*H)$	0.97	Brown et al. (1989)
1500–4000 mm	5–130 cm	$AGB = \exp\{-2.4090 + 0.9522*\ln(DBH^2*H*WD)\}$	0.99	Brown et al. (1989)
Broad-leaved species, tropical wet regions				
> 4000 mm	4–112 cm	$AGB = 21.297 - 6.953*(DBH) + 0.740*(DBH^2)$	0.92	Brown (1997)
> 4000 mm	4–112 cm	$AGB = \exp\{-3.3012 + 0.9439*\ln(DBH^2*H)\}$	0.90	Brown et al. (1989)
Coniferous trees				
n.d.	2–52 cm	$AGB = \exp\{-1.170 + 2.119*\ln(DBH)\}$	0.98	Brown (1997)
Palms				
n.d.	> 7.5 cm	$AGB = 10.0 + 6.4 * H$	0.96	Brown (1997)
n.d.	> 7.5 cm	$AGB = 4.5 + 7.7 * stem\ height$	0.90	Brown (1997)

Note: *AGB* = above-ground biomass (Kg dry matter per tree); *DBH* = diameter at breast height (cm); H = height (m); *WD* = basic wood density ($t\ m^{-3}$ or grams cm^{-3}); ln = natural logarithm; exp = "e raised to the power of"

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History of the document

Version	Date	Nature of revision
01	EB 44, Annex 15 28 November 2008	Initial adoption.