Draft revision to the A/R Methodological Tool

"Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"

(Version 02)

I. SCOPE, APPLICABILITY AND ASSUMPTIONS

Scope

1. This tool can be used for estimation of carbon stocks and change in carbon stocks of trees and shrubs in the baseline and project scenarios of an A/R CDM project activity.

Applicability

2. This tool has no internal applicability conditions.

Assumptions

3. This tool makes the following assumptions:

(a) Linearity of biomass growth for trees and shrubs;

Growth of biomass in trees and shrubs may be assumed to proceed on average at an approximately constant rate between two points in time for which change in biomass is being estimated.

(b) Appropriateness of root-shoot ratios;

Root-shoot ratios appropriate for estimation of below-ground biomass from above-ground biomass under forest/continuous-cover conditions are appropriate for all trees and shrubs within the project boundary.

(c) Determination of shrub and tree vegetation classes;

A practical criterion or definition to distinguish trees and shrubs as two distinct vegetation classes exists or project participants provide in PDD an unambiguous criterion allowing such distinction.

Parameters

4. This tool provides procedures to determine the following parameters:

Table 1: Parameters determined by the tool

Parameter	SI Unit	Description
$C_{TREE,t}$	t CO_2-e	Carbon stock in tree biomass within the project boundary at a given point of time in year *t*
$\Delta C_{TREE,t}$	t CO_2-e	Change in carbon stock in tree biomass within the project boundary in year *t*

Parameter	SI Unit	Description
$C_{SHRUB,t}$	t CO_2-e	Carbon stock in shrub biomass within the project boundary at a given point of time in year *t*
$\Delta C_{SHRUB,t}$	t CO_2-e	Change in carbon stock in shrub biomass within the project boundary in year *t*

5. While applying this tool in a methodology, the following notation should be used:

In the baseline scenario:

$C_{TREE\_BSL,t}$ for $C_{TREE,t}$ and $C_{SHRUB\_BSL,t}$ for $C_{SHRUB,t}$

$\Delta C_{TREE\_BSL,t}$ for $\Delta C_{TREE,t}$ and $\Delta C_{SHRUB\_BSL,t}$ for $\Delta C_{SHRUB,t}$

In the project scenario:

$C_{TREE\_PROJ,t}$ for $C_{TREE,t}$ and $C_{SHRUB\_PROJ,t}$ for $C_{SHRUB,t}$

$\Delta C_{TREE\_PROJ,t}$ for $\Delta C_{TREE,t}$ and $\Delta C_{SHRUB\_PROJ,t}$ for $\Delta C_{SHRUB,t}$

II. ESTIMATION OF C STOCK AND CHANGE IN C STOCK IN TREES AND SHRUBS

Estimation of carbon stock in trees (C_{TREE})

6. Carbon stock in tree biomass is estimated on the basis of tree biomass density strata. Carbon stock in tree biomass is related to the species of trees and the tree biomass in each stratum.

7. While applying this tool a biometric parameter (such as growth rate, bole shape/form factor, biomass expansion factor, root-shoot ratio, basic wood density, carbon fraction, etc) applicable to a species may also be applied to a group of species having similar biometric characteristics.

8. While applying this tool an allometric equation or volume table developed for a species may also be applied to a group of species having similar characteristics.

9. Biomass of trees of species *j* per unit area in stratum *i* at a given point of time in year *t* is calculated on the basis of one or more dimensions (e.g. diameter, height) of trees of the species.

10. These tree dimensions, i.e. diameter and/or height of trees, are obtained using one of these procedures:

(a) For *ex ante* estimation, the tree diameter and/or tree height values are read from existing data sources such as yield tables or tree growth curves or tree growth models;

(b) For *ex post* estimation, the tree diameter and/or tree height values are measured. Measurements are carried out on all the trees in sample plots laid down in each stratum. In exceptional situations, measurements may be carried out on all the trees in the stratum where trees are few and scattered out.

11. Tree dimensions (i.e. diameter and/or height, whether measured or estimated *ex ante*) are converted to tree biomass by applying one of the following two methods:

(a) The biomass expansion factor (*BEF*) method; or

(b) The allometric method.

Estimation of tree biomass using BEF method

12. Under this method volume tables are used to convert tree dimensions to stem volume of trees. Stem volume of trees is converted to above-ground tree biomass using basic wood density and biomass expansion factors and the above-ground tree biomass is expanded to total tree biomass using root-shoot ratios. Thus, biomass of trees of species *j* in sample plot *p* is calculated as:

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

where:

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

13. The volume table (or volume equation) applicable to a species or a group of species shall be selected from the following sources (the most preferred source being listed first):

(a) Existing local data;

(b) National data (e.g. from national forest inventory or national GHG inventory);

(c) Data from neighbouring countries with similar conditions;

(d) Globally available data.

Estimation of tree biomass using allometric method

14. Under this method allometric equations are used to convert tree dimensions to above-ground biomass of trees and the above-ground tree biomass is expanded to total tree biomass using root-shoot ratios. Thus, biomass of trees of species *j* in sample plot *p* is calculated as:

$$B_{TREE,j,p,i,t} = f_j(DBH_t, H_t) * (1 + R_j) \quad \textbf{(2)}$$

where:

$B_{TREE,j,p,i,t}$	Biomass of trees of species *j* in sample plot *p* of stratum *i* at a given point of time in year *t*; t d.m.
$f_j(DBH_t, H_t)$	Above-ground biomass of trees of species *j* in sample plot *p* of stratum *i* at a given point of time in year *t* calculated using allometric function returning total above-ground tree biomass on the basis of tree dimensions as entry data; t d.m.
R_j	Root-shoot ratio for tree species *j*; dimensionless
j	*1, 2, 3, …* tree species in the project scenario
p	*1, 2, 3, …* sample plots in stratum *i*
i	*1, 2, 3, …* tree biomass density strata

15. The allometric equation applicable to a species shall be selected as explained in paragraph 12 above.

16. In both the *BEF* method and the allometric method, the carbon stock in tree biomass of species *j* in sample plot *p* of stratum *i* calculated as follows:

$$C_{TREE,j,p,i,t} = \frac{44}{12} * B_{TREE,j,p,i,t} * CF_j \quad \textbf{(3)}$$

where:

$C_{TREE,j,p,i,t}$	Carbon stock in trees of species *j* in sample plot *p* in stratum *i* at a given point of time in year *t*; t CO_2-e
$B_{TREE,j,p,i,t}$	Biomass of trees of species *j* in sample plot *p* of stratum *i* at a given point of time in year *t*; t d.m.
CF_j	Carbon fraction of tree biomass of species *j*; dimensionless
j	*1, 2, 3, …* species or group of species of trees in stratum *i*
p	*1, 2, 3, …* sample plots in stratum *i* in the baseline scenario
i	*1, 2, 3, …* tree biomass density strata

17. The carbon stock in tree biomass in a stratum is then calculated as:

$$C_{TREE,i,t} = \frac{A_i}{A_{p,i}} \sum_{p=1}^{P_i} \sum_{j=1}^{J_i} C_{TREE,j,p,i,t} \quad \textbf{(4)}$$

where:

$C_{TREE,i,t}$	Carbon stock in tree biomass in stratum *i* at a given point of time in year *t*; t CO_2-e
$C_{TREE,j,p,i,t}$	Carbon stock in trees of species *j* in sample plot *p* in stratum *i* at a given point of time in year *t*; t CO_2-e
$A_{p,i}$	Total area of sample plots in stratum *i*; ha
A_i	Total area of stratum *i*; ha
j	*1, 2, 3, …* J_i tree species in stratum *i*
p	*1, 2, 3, …* P_i sample plots in stratum *i*
i	*1, 2, 3, …* tree biomass strata

18. Finally, the carbon stock in tree biomass within the project boundary at a given point of time in year *t* is calculated by summing up $C_{TREE,i,t}$ over all the strata, that is:

$$C_{TREE,t} = \sum_i C_{TREE,i,t} \quad \textbf{(5)}$$

where

$C_{TREE,t}$	Carbon stock in tree biomass within the project boundary at a given point of time in year t ; t CO_2-e
$C_{TREE,i,t}$	Carbon stock in tree biomass in stratum i at a given point of time in year t; t CO_2-e
i	*1, 2, 3, …* tree biomass strata

Estimation of change in carbon stock in trees (ΔC_{TREE})

19. The rate of change of tree biomass over a period of time is calculated assuming a linear growth (see assumption under paragraph 3a). Therefore, the rate of change in carbon stock in tree biomass over a period of time is calculated as:

$$dC_{TREE,(t_1,t_2)} = \frac{C_{TREE,t_2} - C_{TREE,t_1}}{T} \quad \textbf{(6)}$$

where:

$dC_{TREE,(t_1,t_2)}$	Rate of change in carbon stock in tree biomass within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; t CO_2-e yr^{-1}
C_{TREE,t_2}	Carbon stock in tree biomass within the project boundary at a point of time in year t_2; t CO_2-e
C_{TREE,t_1}	Carbon stock in tree biomass within the project boundary at a point of time in year t_1; t CO_2-e
T	Time elapsed between two successive estimations (T=$t_2 - t_1$); yr

20. Change in carbon stock in tree biomass within the project boundary in year t ($t_1 \leq t \leq t_2$) is given by:

$$\Delta C_{TREE,t} = dC_{TREE,(t_1,t_2)} * 1year \text{ for } t_1 \leq t \leq t_2 \quad \textbf{(7)}$$

where:

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

Default methods for estimation of C stock and change in C sock in trees in baseline

21. If no data are available for any of the above methods to be applied (that is, neither volume tables nor allometric equations nor yield tables nor tree growth curves are available), then the following default methods may be used for estimation of C stock and change in C stock of the living trees in the baseline:

$$C_{TREE\_BSL,i} = \frac{44}{12} * CF_{TREE\_BSL} * B_{FOREST} * (1 + R_{TREE\_BSL}) * CC_{TREE\_BSL,i} * A_{BSL,i} \quad \textbf{(8)}$$

and

$$\Delta C_{TREE\_BSL,i} = \frac{44}{12} * CF_{TREE\_BSL} * \Delta B_{FOREST} * (1 + R_{TREE\_BSL}) * CC_{TREE\_BSL,i} * A_{BSL,i} \quad \textbf{(9)}$$

where:

$C_{TREE\_BSL,i}$	Carbon stock in living trees in the baseline, in baseline stratum *i*; t CO_2-e. Baseline strata are delineated on the basis of tree crown cover
CF_{TREE_BSL}	Default carbon fraction of tree biomass in the baseline; dimensionless. A default value of 0.50 may be used
B_{FOREST}	Default above-ground biomass content in forest in the region/country where the A/R CDM project is located; t d.m. ha^{-1}
R_{TREE_BSL}	Default root-shoot ratio for the trees in the baseline; dimensionless. A default value of 0.25 may be used
$CC_{TREE\_BSL,i}$	Crown cover of trees in the baseline, in baseline stratum *i*, expressed as a fraction (e.g. 10% crown cover implies $CC_{TREE\_BSL,i}$=0.10)
$\Delta C_{TREE\_BSL,i}$	Average annual change in carbon stock in tree biomass in the baseline; t CO_2-e yr^{-1}
ΔB_{FOREST}	Default average annual increment of above-ground biomass in forest in the region/country where the A/R CDM project is located; t d.m. ha^{-1} yr^{-1}
$A_{BSL,i}$	Area of stratum *i* in the baseline, delineated on the basis of crown cover; ha

Estimation of carbon stock in shrubs (C_{SHRUB})

22. Carbon stock in shrub biomass is estimated for each shrub biomass stratum delineated on the basis of shrub crown cover. Once the area within the project boundary has been stratified on the basis of shrub crown cover, carbon stock in shrub biomass within the project boundary at a given point of time in year *t* is calculated as:

$$C_{SHRUB,t} = \frac{44}{12} * CF_S * (1 + R_S) * \sum_i A_{SHRUB,i,t} * B_{SHRUB,i,t} \quad \textbf{(10)}$$

where:

$C_{SHRUB,t}$	Carbon stock in shrub biomass within the project boundary at a given point of time in year *t*; t CO_2-e
CF_S	Carbon fraction of shrub biomass; dimensionless
R_S	Root-shoot ratio for shrubs; dimensionless
$A_{SHRUB,i,t}$	Area of shrub biomass stratum *i* at a given point of time in year *t*; ha
$B_{SHRUB,i,t}$	Shrub biomass per unit area in shrub biomass stratum *i* at a given point of time in year *t*; t d.m. ha^{-1}
i	*1, 2, 3, …* shrub biomass strata delineated on the basis of shrub crown cover
t	*1, 2, 3, ...* years elapsed since the start of the A/R CDM project activity

23. Shrub biomass per unit area ($B_{SHRUB,i,t}$) is estimated as follows:

(a) For those areas where the shrub crown cover is less than 5%, the shrub biomass per unit area is considered negligible and hence accounted as zero;

(b) For those areas where the shrub crown cover is 5% or more, shrub biomass per unit area is calculated as:

$$B_{SHRUB,i,t} = BDR_{SF} * B_{FOREST} * CC_{SHRUB,i,t} \quad \textbf{(11)}$$

where:

$B_{SHRUB,i,t}$	Shrub biomass per unit area in shrub density stratum *i*, at a given point of time in year *t*; t d.m. ha^{-1}
BDR_{SF}	Ratio of biomass per unit area in land having a shrub crown cover of 1.0 and biomass per unit area in a fully stocked forest in the region/country where the A/R CDM project is located; dimensionless
B_{FOREST}	Default above-ground biomass content in forest in the region/country where the A/R CDM project is located; t d.m. ha^{-1}
$CC_{SHRUB,i,t}$	Crown cover of shrubs in shrub biomass stratum *i* at a given point of time in year *t* expressed as a fraction; dimensionless

24. The value of default above-ground biomass content in forest (B_{FOREST}) to be used in equation 9 shall be determined according to guidelines laid down under the description of this parameter in Section III.

Estimation of change in carbon stock in shrubs (ΔC_{SHRUB})

25. The rate of change of shrub biomass over a period of time is calculated assuming a linear growth (see assumption under paragraph 3a). Therefore, the rate of change in carbon stock in shrub biomass over a period of time is calculated as:

$$dC_{SHRUB,(t_1,t_2)} = \frac{C_{SHRUB,t_2} - C_{SHRUB,t_1}}{T} \quad \textbf{(12)}$$

where:

$dC_{SHRUB,(t_1,t_2)}$	Rate of change in carbon stock in shrub biomass within the project boundary during the period between a point of time in year t_1 and a point of time in year t_2; t CO_2-e yr^{-1}
C_{SHRUB,t_2}	Carbon stock in shrub biomass within the project boundary at a point of time in year t_2; t CO_2-e
C_{SHRUB,t_1}	Carbon stock in shrub biomass within the project boundary at a point of time in year t_1; t CO_2-e
T	Time elapsed between two successive estimations (T=$t_2 - t_1$); yr

26. Change in carbon stock in shrub biomass within the project boundary in year t ($t_1 \leq t \leq t_2$) is given by:

$$\Delta C_{SHRUB,t} = dC_{SHRUB,(t_1,t_2)} * 1year \text{ for } t_1 \leq t \leq t_2 \quad \textbf{(13)}$$

where

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

III. DATA AND PARAMETERS USED IN THE TOOL

27. The following tables describe the data and parameters that this tool uses. The guidelines contained in these tables regarding selection of data sources and procedures to be followed in measurement, where applicable, should be treated as an integral part of this tool.

Data and parameters not measured

Data / Parameter:	$BEF_{2,j}$
Data unit:	Dimensionless
Used in equations:	1
Description:	Biomass expansion factor for conversion of stem biomass to above-ground biomass for tree species *j*

Source of data:	The source of data shall be selected, in order of preference, from the following: (a) Local sources of species-specific data; (b) National sources of species-specific data (e.g. national forest inventory or national GHG inventory); (c) Species-specific data from neighbouring countries with similar conditions; (d) Globally available data applicable to the species; (e) IPCC default values (e.g. Table 3A.1.10 of IPCC GPG-LULUCF 2003)[1]
Comments:	*BEFs* in IPCC literature and national inventory are usually applicable to closed canopy forest. If applied to individual trees growing in an open field it is recommended that the selected *BEF* be increased by 30%

Data / Parameter:	BDR_{SF}
Data unit:	Dimensionless
Used in equations:	11
Description	Ratio of biomass per unit area in land having a shrub crown cover of 1.0 and biomass per unit area in a fully stocked forest in the region/country where the A/R CDM project is located
Source of data:	A default value of 0.10 should be used unless transparent and verifiable information can be provided to justify a different value

Data / Parameter:	B_{FOREST}
Data unit:	t d.m. ha^{-1}
Used in equations:	11
Description:	Default above-ground biomass content in forest in the region/country where the A/R CDM project is located
Source of data:	The source of data shall be selected, in order of preference, from the following: (a) Regional/national inventories e.g. national forest inventory, national GHG inventory; (b) Inventory from neighbouring countries with similar conditions; (c) Globally available data applicable to the project site or to the region/country where the site is located (e.g. latest data from FAO); (d) IPCC default values from Table 3A.1.4 of IPCC GPG-LULUCF 2003

Data / Parameter:	ΔB_{FOREST}
Data unit:	t d.m. ha^{-1} yr^{-1}
Used in equations:	9
Description:	Default average annual increment in above-ground biomass in forest in the region/country where the A/R CDM project is located

[1] Although the *BEFs* in Table 3A.1.10 apply to biomass, the dimensionless factors can be equally applied for wood volume expansions.

Source of data:	The source of data shall be selected, in order of preference, from the following: (a) Regional/national inventories e.g. national forest inventory, national GHG inventory; (b) Inventory from neighbouring countries with similar conditions; (c) Globally available data applicable to the project site or to the region/country where the site is located (e.g. latest data from FAO); (d) IPCC default values from Table 3A.1.5 of IPCC GPG-LULUCF 2003

Data / Parameter:	CF_j
Data unit:	t C t^{-1} d.m.
Used in equations:	3
Description:	Carbon fraction of tree biomass for species *j*
Source of data:	The source of data, in order of preference, shall be the following: (a) National level species-specific data (e.g. from national GHG inventory); (b) Species-specific data from neighbouring countries with similar conditions; (c) Globally available species-specific data (e.g. IPCC GPG-LULUCF 2003); (d) The IPCC default value of 0.5 t C t^{-1} d.m.

Data / Parameter:	CF_S
Data unit:	t C t^{-1} d.m.
Used in equations:	10
Description:	Carbon fraction of shrub biomass
Source of data:	IPCC default value of 0.50 t C t^{-1} d.m. may be used

Data / Parameter:	D_j
Data unit:	t d.m. m^{-3}
Used in equations:	1
Description:	Basic wood density for species *j*
Source of data:	The source of data, in order of preference, shall be any of the following: (a) National and species-specific data (e.g. from national GHG inventory); (b) Species-specific data from neighbouring countries with similar conditions; (c) Globally available species-specific data (e.g. Table 3A.1.9 IPCC GPG-LULUCF 2003)

Data / Parameter:	R_j
Data unit:	dimensionless
Used in equations:	1, 2
Description:	Root-shoot ratio for species *j*

Source of data:	The source of data, in order of preference, shall be any of the following: (a) Existing local species-specific data; (b) National species-specific data (e.g. national forest inventory or national GHG inventory); (c) Species-specific data from neighbouring countries with similar conditions; (d) Globally available species-specific data. If none of the above sources are available, then the value of R_j may be calculated as $R = exp[-1.085+0.9256*ln(A)]/A$, where A is above-ground biomass (t d.m. ha^{-1}) [Source: Table 4.A.4 of IPCC GPG-LULUCF 2003]

Data / Parameter:	R_S
Data unit:	dimensionless
Used in equations:	10
Description:	Root-shoot ratio for shrubs
Source of data:	The source of data, in order of preference, shall be any of the following: (a) Existing local species-specific data; (b) National species-specific data (e.g. national forest inventory or national GHG inventory); (c) Species-specific data from neighbouring countries with similar conditions; (d) Globally available species-specific data. If none of the above sources are available, then a default value of 0.40 may be used [Source: Table 4.4 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories]

Data and parameters measured

Data / Parameter:	A_i
Data unit:	ha
Used in equations:	4
Description:	Area of stratum *i*
Source of data:	Field measurement
Measurement procedures:	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In absence of these, SOPs from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied. Delineation of strata boundaries should preferably be done in such way that it can be easily migrated to a Geographical Information System (GIS) which facilitates integration of data from different sources (including GPS coordinates and remotely sensed data)
Monitoring frequency:	Every five years since the year of the initial verification
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the IPCC GPG LULUCF 2003, may be applied

Data / Parameter:	$A_{p,i}$
Data unit:	ha
Used in equations:	4
Description:	Total area of sample plots in stratum *i*
Source of data:	Field measurement
Measurement procedures:	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In absence of these, SOPs from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied
Monitoring frequency:	Every five years since the year of the initial verification
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In absence of these, QA/QC procedures from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied
Comments:	Sample plot location is registered with a GPS and marked on the project map

Data / Parameter:	$A_{SHRUB,i,t}$
Data unit:	ha
Used in equations:	10
Description:	Area of shrub biomass stratum *i* at a given point of time in year *t*
Source of data:	Field measurement
Measurement procedures:	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In absence of these, SOPs from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied
Monitoring frequency:	Every five years since the year of the initial verification
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In absence of these, QA/QC procedures from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied

Data / Parameter:	$CC_{SHRUB,i,t}$
Data unit:	Dimensionless
Used in equations:	11
Description:	Crown cover of shrubs in shrub biomass stratum *i* at a given point of time in year *t*
Source of data:	Field measurement
Measurement procedures :	Considering that the biomass in shrubs is smaller than the biomass in trees, a simplified method of measurement may be used for estimating shrub crown cover. Ocular estimation of crown cover may be carried out or any other method such as the line transect method or the relascope method may be applied
Monitoring frequency:	Every five years since the year of the initial verification

QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In absence of these, QA/QC procedures from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied

Data / Parameter:	$CC_{TREE\_BSL,i}$
Data unit:	Dimensionless
Used in equations:	9
Description:	Crown cover of trees in the baseline, in baseline stratum *i*, expressed as a fraction (e.g. 10% crown cover implies $CC_{TREE\_BSL,i}$=0.10)
Source of data:	Field measurement
Measurement procedures :	Considering that the biomass in trees in the baseline is smaller compared to the biomass in trees in the project, a simplified method of measurement may be used for estimating tree crown cover. Ocular estimation of tree crown cover may be carried out or any other method such as the line transect method or the relascope method may be applied
Monitoring frequency:	NA
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In absence of these, QA/QC procedures from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied

Data / Parameter:	*DBH*
Data unit:	cm or any unit of length
Used in following equations:	Implicitly used in equation 2
Description:	Usually the diameter at breast height of the tree; but it could be any other diameter or dimensional measurement (e.g. basal diameter, root-collar diameter, basal area, etc.) applicable for the model or data source used
Source of data:	Field measurements in sample plots. For *ex ante* estimations, *DBH* values should be estimated using a growth curve, a growth model, or a yield table that gives the expected tree dimensions as a function of tree age
Measurement procedures (if any):	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In absence of these, SOPs from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied
Monitoring frequency:	Every five years since the year of the initial verification
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In the absence of these, QA/QC procedures from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied

Data / Parameter:	*H*
Data unit:	m or any other unit of length
Used in equations:	Implicitly used in equation 2
Description:	Height of tree

Source of data:	Field measurements in sample plots. For *ex ante* estimations, *H* values should be estimated using a growth curve, a growth model, or a yield table that gives the expected tree dimensions as a function of tree age
Measurement procedures (if any):	Standard operating procedures (SOPs) prescribed under national forest inventory are applied. In the absence of these, SOPs from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied
Monitoring frequency:	Every five years since the year of the initial verification
QA/QC procedures:	Quality control/quality assurance (QA/QC) procedures prescribed under national forest inventory are applied. In absence of these, QA/QC procedures from published handbooks, or from the *IPCC GPG LULUCF 2003*, may be applied
Comments:	Models used may be based on total tree height (top height) or height of stem (clear bole height). The relevant height should be measured/estimated and used

Data / Parameter:	*T*
Data unit:	year
Used in equations:	6, 12
Description:	Time period elapsed between two successive estimations of carbon stock in trees and shrubs
Source of data:	Recorded time
Measurement procedures :	N/A
Comments:	If the two successive estimations of carbon stock in trees are carried out at different points of time in year t_2 and t_1, (e.g. in the month of April in year t_1 and in the month of September in year t_2), then a fractional value shall be assigned to *T*

IV. References

All references are quoted in footnotes.

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History of the document

Version	Date	Nature of revision(s)
02	EB 56, Annex # 17 September 2010	In this revision: (i) Scope of the tool has been expanded so that it can be applied in both baseline scenario and project scenario; (ii) Procedure for estimation of shrub biomass has been simplified by adopting a default estimation approach based on a fraction of forest biomass; (iii) The mathematical notation and equations have been changed so to streamline these; (iv) General layout and style of the document has been changed so as to make it in conformity with other documents such as the recently approved A/R methodologies; and (v) The title was changed to "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"from the previous title "Estimation of changes in the carbon stocks of existing trees and shrubs within the boundary of an A/R CDM project activity". Due to the overall modification of the document, no highlights of the changes are provided.
01	EB 46, Annex 18 25 March 2009	Initial adoption.