The Chairman and the Members of the CDM Executive Board
c/o UNFCCC Secretariat
P. O. Box 260124
D-53153 Bonn
Germany

Dear Madam or Sir,

RE: Comments on Simplified Baseline and Monitoring Methodologies for Small-scale CDM Afforestation or Reforestation Project activities Applied on Wetlands (Especially on Intertidal zones)

We welcome efforts made by the AR Working Group and the Executive Board to develop simplified baseline and monitoring methodologies for small-scale afforestation and reforestation project activities under the clean development mechanism applied on wetlands and settlement. To respond to call for public input, we would like to make comments on the simplified baseline and monitoring methodologies for small-scale A/R CDM project activities applied on wetlands.

Our comments are focusing on a methodology used for the small-scale A/R CDM project activities applied especially in intertidal zones.

Afforestation or reforestation in intertidal zones should be promoted because it has benefit not only of GHG removals but also of adaptation. We believe that an A/R CDM project in intertidal zones is one of the most effective tools to promote adaptation with economic incentives, and this is one of the few mechanisms to encourage involvement of low income communities.

The processes of GHG removals/emissions related to afforestation or reforestation in intertidal zones are complicated, therefore, it has been taking much time to complete the methodologies. In view of promoting A/R CDM project activities in intertidal zones and encouraging use of the methodologies, we propose minimum requirements to simplify methodologies for small-scall A/R CDM project activities applied on wetlands.

Our submission is focused on project emissions from A/R CDM project activities in intertidal zones which could reduce removals achieved by the project activities, however, this is not to encourage strict and detailed rules for the same. Instead, we propose this based on assumptions that GHGs emissions from project activities is one of the barriers hampering the development of the methodologies and solving this would move things forward.

Existing simplified baseline and monitoring methodologies for small-scale CDM afforestation or reforestation project activities are applied on grassland and cropland. As to a methodology applied on intertidal zones, we propose to revise the exiting baseline and monitoring methodologies as follows:

(a) **To identify CO_2 and N_2O emissions from desiccation of soil due to sedimentation by afforestation or reforestation on intertidal zones as the project emissions, and**
(b) **To add "size of the desiccated project area" as an item to be monitored.**

Our proposals are based on the following consideration of difference between afforestation or reforestation on intertidal zones and grassland/cropland in terms of GHG emissions/removals.

(a) To identify CO₂ and N₂O emissions from desiccation of soil due to sedimentation by afforestation or reforestation on intertidal zones as the project emissions

If afforestation or reforestation takes place on intertidal zones, sediments such as leaves, twigs and branches would be accumulated in the project site trapped in roots and stems of the trees. It will lead to increase the elevation of the land and desiccate the soil in the project site.   When the project site is elevated with sedimentation and dried, CO_2 and N_2O could be emitted from the desiccated soil.   Therefore, we propose to identify them as project emissions.

While the proposed project site is submerged, GHGs could be emitted from the soil in the proposed project site, however, this happens with or without the proposed project activity.   In other words, GHGs could be emitted from the submerged soil in the proposed project site in both baseline scenraio and project scenario.   Therefore, we consider that it is not necessary to regard these emissions as the project emissions.

The methods to estimate CO_2 and N_2O emissions from the desiccated soil are as follows:

$$N_{E(t)} = \left(EF_{drain\_C} * 44/12 + EF_{drain\_N} * (44/28) * 310/1000 \right) * A_{drain(t)}$$

where:

$N_{E(t)}$	=	GHG emissions from desiccation of soil at time t under the project scenario (t $CO_{2\text{-}e}$/yr)
EF_{drain_C}	=	C emission from desiccation of soil (t-C/ha/yr)
EF_{drain_N}	=	N emission as N_2O from desiccation of soil (kg-N_2O-N/ha/yr)
$A_{drain(t)}$	=	Desiccated project activity area at time t under the project scenario (ha)
44/12	=	Conversion factor from ton C to ton CO_2 equivalent (t CO_2/t C)
44/28	=	Conversion factor from ton N to ton N_2O equivalent (t N_2O/t N)
310	=	GWP for N_2O (t CO_2/t N_2O)

Documented local values for EF_{drain_C} and EF_{drain_N} should be used.   In the absence of such values, national default values should be used.   If national values are also not available, the values should be obtained from table 3.2.3 and table 3a.2.1 of the IPCC GPG for LULUCF.
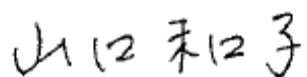
(b) To add "size of the desiccated project area" as an item to be monitored

As discussed in the item (a) above, CO_2 and N_2O will be emitted from the desiccated soil.   For the ex post estimation of them, the size of the desiccated project area should be monitored. Therefore, we propose to add "size of the desiccated project area" as an item to be monitored. At the same time, we propose that the "desiccated area" is defined as the area which is not submerged even during high tide except in the event of typhoons or hurricanes.   This definition is proposed in order to simplify the procedure to determine the desiccated area as this is the methodologies for small scale A/R CDM project activities which are developed by low income communities.

Draft methodologies for small-scale A/R CDM project activities on intertidal zones are attached to this submission as a reference.   The revised paragraphs from the exiting methodologies are highlighted in the attached draft methodologies.

We would greatly appreciate if the AR Working Group and the CDM Executive Board could consider abovementioned comments at their next meetings.

Sincerely yours,

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Kazuko YAMAGUCHI
Tatsushi HEMMI
Global Environment Department,
Pacific Consultants Co., Ltd.

In collaboration with Mr. Namio TANI, Taishi Design Office

These comments are based on the results of the feasibility study conducted on a small-scale A/R CDM project in an intertidal zone as a part of the "CDM/JI Feasibility Study Programme" funded by the Ministry of the Environment, Japan.

Revised simplified baseline and monitoring methodologies for selected small-scale afforestation and reforestation project activities under the clean development mechanism

I. Introduction

1. This document contains simplified baseline and monitoring methodologies for selected small-scale afforestation and reforestation (A/R) clean development mechanism (CDM) project activities. Specifically it covers:

    (a) A simplified baseline methodology and default factors for small-scale A/R project activities implemented in intertidal zones (wetlands);

    (b) A simplified monitoring methodology, based on appropriate statistical methods, to estimate, measure and monitor the actual net greenhouse gas (GHG) removals by sinks and leakage.

2. The most likely baseline scenario of the small-scale A/R CDM project activity implemented in intertidal zones is considered to be the land-use prior to the implementation of the project activity.

3. These simplified baseline and monitoring methodologies are not applicable to intertidal zones that have been ploughed before the plantation is established. Also, they do not apply to project activities where the displacement of households or activities, due to the implementation of the A/R CDM project activity, is estimated to be larger than 50 per cent.

4. In accordance with decision 14/CP.10, project participants may propose new simplified methodologies or amendments to these simplified monitoring methodologies for project activities for which these would not be applicable. Such proposed new methodologies would be submitted to the CDM Executive Board for consideration and approval.

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

    (a) The land of the project activity is eligible, using procedures for the demonstration of land eligibility contained in **appendix A**;

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

II. General guidance

6. **Carbon pools** to be considered by these methodologies are above-ground biomass, below-ground biomass and soil organic carbon. Hereinafter, above-ground biomass and below-ground biomass are referred to collectively as "living biomass pool". Values chosen for parameters to estimate changes in carbon stocks in the baseline and monitoring methodologies, as well as the choice of approach, shall be justified and documented (including sources and references) in the clean development mechanism small-scale afforestation and reforestation project design document (CDM-SSC-AR-PDD). The choice of equations and values for parameters shall be conservative, i.e., the net anthropogenic GHG removals by sinks shall not be overestimated.

III. Simplified baseline methodologies for small-scale afforestation and reforestation project activities under the clean development mechanism

7. Simplified methodologies for estimating the baseline net GHG removals by sinks are based on the baseline approach specified by paragraph 22 (a) of the modalities and procedures for afforestation and reforestation project activities under the clean development mechanism: "Existing or historical, as applicable, changes in carbon stock in the carbon pools within the project boundary."

8. According to decision 14/CP.10, annex, appendix B, paragraphs 2 and 3:

"If project participants can provide relevant information that indicates that, in the absence of the small-scale afforestation or reforestation project activity under the CDM, no significant changes in the carbon stocks within the project boundary would have occurred, they shall assess the existing carbon stocks prior to the implementation of the project activity. The existing carbon stocks shall be considered as the baseline and shall be assumed to be constant throughout the crediting period.

"If significant changes in the carbon stocks within the project boundary would be expected to occur in the absence of the small-scale afforestation or reforestation project activity, project participants shall" use the simplified baseline methodology contained in this document.

9. In order to assess if significant changes in the baseline carbon stocks within the project boundary would have occurred in absence of the project activity, project participants shall assess whether changes in carbon stocks in the baseline land-use type (wetlands), in particular the living biomass pool of woody perennials[1] and the below-ground biomass of wetlands, are expected to be significant. They shall provide documentation to prove this, for example, by including expert judgment, and proceed as follows:

   (a) If significant changes in the carbon stocks, in particular the living biomass pool of woody perennials and the below-ground biomass of wetlands, are not expected to occur in the absence of the project activity, the changes in carbon stocks shall be assumed to be zero;

   (b) If the carbon stock in the living biomass pool of woody perennials or in below-ground biomass of grasslands is expected to decrease in the absence of the project activity, the baseline net GHG removals by sinks shall be assumed to be zero. In the above case, the baseline carbon stocks in the carbons pools is constant at the level of the existing carbon stock measured at the start of the project activity;

   (c) Otherwise, baseline net GHG removals by sinks shall be equal to the changes in carbon stocks from the living biomass pool of woody perennials or from below-ground biomass of wetlands that are expected to occur in the absence of the project activity and shall be estimated using the methodology in section III.A below.

A. Estimating baseline net greenhouse gas removals by sinks

10. Baseline net GHG removals by sinks will be determined by the equation:

$$B_{(t)} = \sum_{i}^{I} (B_{A(t)i} + B_{B(t)i}) * A_i \qquad (1)$$

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[1] Woody perennials refers to the non-tree vegetation (for example coffee, tea, rubber or oil palm) and shrubs that are present in croplands and grasslands below the thresholds (of canopy cover, minimum area and tree height) used to define forests.

where:

$B_{(t)}$ = carbon stocks in the living biomass pools within the project boundary at time t in the absence of the project activity (t C)

$B_{A(t)\ i}$ = carbon stocks in above-ground biomass at time t of stratum i in the absence of the project activity (t C/ha)

$B_{B(t)\ i}$ = carbon stocks in below-ground biomass at time t of stratum i in the absence of the project activity (t C/ha)

A_i = project activity area of stratum i (ha)

i = stratum i (I = total number of strata)

11. Stratification of the project activity for the purposes of estimating the baseline net GHG removals by sinks shall proceed in accordance with section 4.3.3.2 of the *Good Practice Guidance for Land Use, Land-Use Change and Forestry* of the Intergovernmental Panel on Climate Change (IPCC) (hereinafter referred to as the IPCC GPG for LULUCF). For each stratum, the following calculations shall be performed as shown below.

For above-ground biomass

12. $B_{A(t)}$ is calculated per stratum i as follows:

$$B_{A(t)} = M_{(t)} * 0.5 \tag{2}$$

where:

$B_{A(t)}$ = carbon stocks in above-ground biomass at time t in the absence of the project activity (t C/ha)

$M_{(t)}$ = above-ground biomass at time t that would have occurred in the absence of the project activity (t dm/ha)[2]

0.5 = carbon fraction of dry matter (t C/t dry matter)

Values for $M_{(t)}$ shall be estimated using average biomass stock and growth rates specific to the region using the following equation, taking into account the provisions of paragraph 9.

13. If living biomass carbon pools are expected to be constant according to paragraph 9.a and 9.b, the average above-ground biomass stock is estimated as the above-ground biomass stock in grass and woody perennials:

$$M_{(t=0)} = M_{(t)} = M_{grass} + M_{woody(t=0)} \tag{3}$$

where:

$M_{(t)}$ = above-ground biomass at time t that would have occurred in the absence of the project activity (t dm/ha)

M_{grass} = above-ground biomass in grass on grassland at time t that would have occurred in the absence of the project activity (t dm/ha)

$M_{woody(t)}$ = above-ground woody biomass of woody perennials at time t that would have occurred in the absence of the project activity (t dm/ha)

If living biomass carbon pools are expected to increase according to paragraph 9.c, the average biomass stock is estimated as the above-ground biomass stock in grass plus the age-dependent above-ground biomass stock in woody vegetation:

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[2] dm = dry matter

$$M_{(t=0)} = M_{grass} + M_{woody(t=0)} \quad (4)$$

if: $M_{woody(t=n-1)} + g * \Delta t < M_{woody\_max}$ then

$$M_{(t=n)} = M_{grass} + M_{woody(t=n-1)} + g * \Delta t \quad (5)$$

if: $M_{woody(t=n-1)} + g * \Delta t \geq M_{woody\_max}$ then

$$M_{(t=n)} = M_{grass} + M_{woody\_max} \quad (6)$$

where:

$M_{(t)}$ = above-ground biomass at time t that would have occurred in the absence of the project activity (t dm/ha)

M_{grass} = above-ground biomass in grass on grassland at time t that would have occurred in the absence of the project activity (t dm/ha)

$M_{woody\ (t)}$ = above-ground woody biomass of woody perennials at time t that would have occurred in the absence of the project activity (t dm/ha)

M_{woody_max} = maximal above-ground woody perennials at time t that would have occurred in the absence of the project activity (t dm/ha)

g = annual biomass growth rate of woody perennials (t dm/ha/year)

Δt = time increment = 1 (year)

n = running variable that increases by $\Delta t = 1$ for each iterative step, representing the number of years elapsed since the project start (years)

14. Documented local values for g should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3.3.2 of the IPCC GPG for LULUCF.

15. Documented local values for M_{woody_max} should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3A.1.8 of the IPCC GPG for LULUCF.

For below-ground biomass

16. $B_{B(t)}$ is calculated per stratum i as follows:

If living biomass carbon pools are expected to be constant according to paragraph 9.a and 9.b, the average below-ground carbon stock is estimated as the below-ground carbon stock in grass and in woody biomass:

$$B_{B(t=0)} = B_{B(t)} = 0.5 * \left(M_{grass} * R_{grass} + M_{woody(t=0)} * R_{woody} \right) \quad (7)$$

where:

$B_{B(t)}$ = carbon stocks in below-ground biomass at time t that would have occurred in the absence of the project activity (t dm/ha)

M_{grass} = above-ground biomass in grass on grassland at time t that would have occurred in the absence of the project activity (t dm/ha)

$M_{woody\ (t)}$ = above-ground woody biomass at time t that would have occurred in the absence of the project activity (t dm/ha)

R_{woody} = root to shoot ratio of woody perennials (t dm/t dm)

R_{grass} = root to shoot ratio for grassland (t dm/t dm)

If living biomass carbon pools are expected to increase according to paragraph 9.c, the average

below-ground carbon stock is estimated as the above-ground carbon stock in grass plus the age-dependent above-ground carbon stock in woody vegetation:

$$B_{B(t=0)} = 0.5 * \left(M_{grass} * R_{grass} + M_{woody(t=0)} * R_{woody} \right)$$ (8)

if: $M_{woody(t=n-1)} + g * \Delta t < M_{woody\_max}$ then
$$B_{B(t=n)} = 0.5 * \left[M_{grass} * R_{grass} + \left(M_{woody(t=n-1)} + g * \Delta t \right) * R_{woody} \right]$$ (9)

if: $M_{woody(t=n-1)} + g * \Delta t \geq M_{woody\_max}$ then
$$B_{B(t=n)} = 0.5 * \left(M_{grass} * R_{grass} + M_{woody\_max} * R_{woody} \right)$$ (10)

where:

$B_{B(t)}$	=	carbon stocks in below-ground biomass at time t that would have occurred in the absence of the project activity (t dm/ha)
M_{grass}	=	above-ground biomass in grass on grassland at time t that would have occurred in the absence of the project activity (t dm/ha)
$M_{woody\ (t)}$	=	above-ground woody biomass of woody perennials at time t that would have occurred in the absence of the project activity (t dm/ha)
R_{woody}	=	root to shoot ratio for woody perennial (t dm/t dm)
R_{grass}	=	root to shoot ratio for grassland (t dm/t dm)
g	=	annual biomass growth rate of woody perennials (t dm/ha/year)
Δt	=	time increment = 1 (year)
n	=	running variable that increases by $\Delta t = 1$ year for each iterative step, representing the number of years elapsed since the project start (years)
0.5	=	carbon fraction of dry matter (t C/t dm)

17. Documented local values for R_{grass} and R_{woody} should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3.4.3 of the IPCC GPG for LULUCF.

B. Actual net greenhouse gas removals by sinks

18. Actual net GHG removals by sinks consider the changes in living biomass pools and CO$_2$ and N$_2$O emission from desiccation of soil for the project scenario. The stocks of carbon for the project scenario at the starting date of the project activity[3](t=0) shall be the same as the baseline stocks of carbon at the starting date of the project (t=0). Therefore:

$$N_{(t=0)} = B_{(t=0)}$$ (11)

For all other years, the carbon stocks within the project boundary at time t ($N_{(t)}$) shall be calculated as follows:

$$N_{(t)} = \sum_{i}^{I} (N_{A(t)i} + N_{B(t)i}) * A_i$$ (12)

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[3] The starting date of the project activity should be the time when the land is prepared for the initiation of the afforestation or reforestation project activity under the CDM. In accordance with paragraph 23 of the modalities and procedures for afforestation and reforestation project activities under the CDM, the crediting period shall begin at the start of the afforestation and reforestation project activity under the CDM (see UNFCCC web site at <http://unfccc.int/resource/docs/cop9/06a02.pdf#page=21>).

where:

$N_{(t)}$ = total carbon stocks in biomass at time t under the project scenario (t C)

$N_{A(t)\ i}$ = carbon stocks in above-ground biomass at time t of stratum i under the project scenario (t C/ha)

$N_{B(t)\ i}$ = carbon stocks in below-ground biomass at time t of stratum i under the project scenario (t C/ha)

A_i = project activity area of stratum i (ha)

i = stratum i (I = total number of strata)

19. GHG emissions from desiccation of soil shall be estimated through the following equations:

$$N_{E(t)} = \left(EF_{drain\_C} * 44/12 + EF_{drain\_N} * (44/28) * 310/1000 \right) * A_{drain(t)} \qquad (13)$$

where:

$N_{E(t)}$ = GHG emissions from desiccation of soil at time t under the project scenario (t CO$_{2\text{-e}}$/yr)

$EF_{drain\ C}$ = C emission from desiccation of soil (t-C/ha/yr)

$EF_{drain\ N}$ = N emission as N$_2$O from desiccation of soil (kg-N$_2$O-N/ha/yr)

$A_{drain(t)}$ = Desiccated project activity area at time t under the project scenario (ha)

44/12 = Conversion factor from ton C to ton CO$_2$ equivalent (t CO$_2$/t C)

44/28 = Conversion factor from ton N to ton N$_2$O equivalent (t N$_2$O/t N)

310 = GWP for N$_2$O (t CO$_2$/t N$_2$O)

20. Documented local values for $EF_{drain\ C}$ and $EF_{drain\ N}$ should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3.2.3 and table 3a.2.1of the IPCC GPG for LULUCF.

21. Stratification for the project scenario shall be undertaken in accordance with section 4.3.3.2 of the IPCC GPG for LULUCF. The calculations shown below shall be performed for each stratum.

For above-ground biomass

22. $N_{A(t)}$ is calculated per stratum i as follows:

$$N_{A(t)} = T_{(t)} * 0.5 \qquad (14)$$

where:

$N_{A(t)}$ = carbon stocks in above-ground biomass at time t under the project scenario (t C/ha)

$T_{(t)}$ = above-ground biomass at time t under the project scenario (t dm/ha)

0.5 = carbon fraction of dry matter (t C/t dm)

$$T_{(t)} = SV_{(t)} * BEF * WD \qquad (15)$$

where:

$T_{(t)}$ = above-ground biomass at time t under the project scenario (t dm/ha)

$SV_{(t)}$ = stem volume at time t for the project scenario (m^3/ha)

BEF = biomass expansion factor (over bark) from stem volume to total volume (dimensionless)

WD = basic wood density (t dm/m^3)

23. Values for $SV_{(t)}$ shall be obtained from national sources (such as standard yield tables). Documented local values for BEF should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3A.1.10 of the IPCC GPG for LULUCF. Documented local values for WD should be used. In the absence of such values, national default values shall be consulted. If national default values are also not available, the

values should be obtained from table 3A.1.9 of the IPCC GPG for LULUCF.

For below-ground biomass

24. $N_{B(t)}$ is calculated per stratum i as follows:

$$N_{B(t)} = T_{(t)} * R * 0.5 \tag{16}$$

where:
$N_{B(t)}$ = carbon stocks in below-ground biomass at time t under the project scenario (t C/ha)
$T_{(t)}$ = above-ground biomass at time t under the project scenario (t dm/ha)
R = root to shoot ratio (dimensionless)
0.5 = carbon fraction of dry matter (t C/t dm)

25. Documented national values for R should be used. If national values are not available, appropriate values should be obtained from table 3A.1.8 of the IPCC GPG for LULUCF.

C. Leakage

26. According to decision 14/CP.10, annex, appendix B, paragraph 9: "If project participants demonstrate that the small-scale afforestation or reforestation project activity under the CDM does not result in the displacement of activities or people, or does not trigger activities outside the project boundary, that would be attributable to the small-scale afforestation or reforestation project activity under the CDM, such that an increase in greenhouse gas emissions by sources occurs, a leakage estimation is not required. In all other cases leakage estimation is required."

27. In regions where the lands surrounding the project activity contain no significant biomass (i.e. degraded land with no or only a few trees or shrubs per hectare) and if evidence can be provided that these lands are likely to receive the shifted activities without causing further activity shifting, leakage can be considered insignificant. Such evidence can be provided e.g. by demonstrating based on experts' judgment or scientific literature that these lands have the biophysical potential to receive the shifting pre-project activities and that the legal status of these lands or local tradition allows their use for shifting pre-project activities.

28. In all other cases, project participants should assess the possibility of leakage from the displacement of activities or people by considering the following indicators:

    (a) Percentage of families/households of the community involved in or affected by the project activity displaced due to the project activity;

    (b) Percentage of total production of the main produce within the project boundary displaced due to the project activity;

29. If the value of each of these indicators is lower than 10 per cent, then

$$L_{(t)} = 0 \tag{17}$$

where:
$L_{(t)}$ = leakage attributable to the project activity within the project boundary at time t (t C)

30. If the value of one of these indicators is higher than 10 per cent and less than or equal to 50 per cent, then leakage shall be equal to 15 per cent of the actual net GHG removals by sinks, that is:

$$L_{(t)} = N_t * 0.15 \tag{18}$$

where:

$L_{(t)}$ = leakage attributable to the project activity within the project boundary at time t (t C)

$N_{(t)}$ = carbon stocks in the living biomass pools within the project boundary at time t under the project scenario (t C)

31. As indicated in paragraph 3 above, if the value of any of these indicators is larger than 50 per cent, net anthropogenic removals by sinks cannot be estimated.

32. If project participants consider that the use of fertilizers would be significant leakage of N_2O (>10 per cent of the net anthropogenic GHG removals by sinks) emissions should be estimated in accordance with the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as IPCC GPG).

D. Ex ante estimation of net anthropogenic greenhouse gas removals by sinks

33. 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.

34. The resulting temporary certified emission reductions (tCERs) at the year of verification tv are calculated as follows:

$$tCER_{(tv)} = 44/12 * \left(N_{(tv)} - B_{(tv)} - L_{(tv)} \right) - N_{E(tv)} \tag{19}$$

if changes in carbon stock are considered to be equal to zero, then $B_{(tv)} = B_{(t=0)}$ and

$$L_{(tv)} = 0.15 * N_{(tv)} \quad \text{(if required, see paragraph 30 above)} \tag{20}$$

where:

$tCER_{(tv)}$ = tCERs emitted at year of verification tv (t CO_2)

$N_{(tv)}$ = carbon stocks in the living biomass pools within the project boundary at year of verification tv under project scenario (t C)

$B_{(tv)}$ = carbon stock in the living biomass pools within the project boundary at year of verification tv that would have occurred in the absence of the project activity (t C)

$L_{(tv)}$ = leakage attributable to the project activity within the project boundary at year of verification tv (t C)

$N_{E(tv)}$ = GHG emission from desiccation of soil within the project boundary at year of verification tv under project scenario (t $CO_{2\text{-e}}$)

tv = year of verification

$44/12$ = conversion factor from t C to t CO_2 equivalent (t CO_2/t C)

35. The resulting long-term certified emission reductions (lCERs) at the year of verification tv are calculated as follows:

$$lCER_{(tv)} = 44/12 * \left[\left(N_{(tv)} - N_{(tv-\kappa)} \right) - L_{(tv)} \right] - \sum_{tv-\kappa}^{tv} \left(N_{E(tv)} \right) \tag{21}$$

$$L_{(tv)} = 0.15 * \left(N_{(tv)} - N_{(tv-\kappa)} \right) \quad \text{(if required, see paragraph 30 above)} \tag{22}$$

$$N_{(tv-\kappa)} = N_{(t=0)} \quad \text{for the first verification} \tag{23}$$

where:

$lCER_{(tv)}$ = lCERs emitted at year of verification tv (t CO_2)

$N_{(tv)}$ = carbon stocks in the living biomass pools within the project boundary at year of verification tv under project scenario (t C)

$L_{(tv)}$ = leakage attributable to the project activity within the project boundary at year of verification tv (t C)

$N_{E(tv)}$ = GHG emission from desiccation of soil within the project boundary at year of verification tv under project scenario (t CO_{2-e})

tv = year of verification

κ = time span between two verifications

44/12 = conversion factor from t C to t CO_2 equivalent (t CO_2/t C)

36. Project participants should provide in the CDM-SSC-AR-PDD a projection of the net anthropogenic GHG removals as tCERs or lCERs for all crediting periods.

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

A. Ex post estimation of the baseline net greenhouse gas removals by sinks

37. In accordance with decision 14/CP.10, 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 III. A above.

B. Ex post estimation of the actual net greenhouse gas removals by sinks

38. Before performing the sampling to determine any changes in carbon stocks, project participants need to measure and monitor the area that has been planted. This can be performed through, for example, on-site visits, analysis of cadastral information, aerial photographs or satellite imagery of adequate resolution.

39. Once project participants have selected the method to monitor the area that has been planted, this method should be used to monitor the performance of the planted areas throughout the project activity. If significant underperformance is detected, changes in carbon stocks from such areas shall be assessed as a separate stratum.

40. Carbon stocks shall be estimated through stratified random sampling procedures and the following equations:

$$P_{(t)} = \sum_{i}^{I} (P_{A(t)i} + P_{B(t)i}) * A_i \qquad (24)$$

where:

$P_{(t)}$ = carbon stocks within the project boundary at time t achieved by the project activity (t C)

$P_{A(t)i}$ = carbon stocks in above-ground biomass at time t of stratum i achieved by the project activity during the monitoring interval (t C/ha)

$P_{B(t)i}$ = carbon stocks in below-ground biomass at time t of stratum i achieved by the project activity during the monitoring interval (t C/ha)

A_i = project activity area of stratum i (ha)
i = stratum i (I = total number of strata)

41. GHG emissions from desiccation of soil shall be estimated through the following equations:

$$P_{E(t)} = \left(EF_{drain\_C} * 44/12 + EF_{drain\_N} * (44/28) * 310/1000\right) * A_{drain(t)} \tag{25}$$

where:
$P_{E(t)}$ = GHG emissions from desiccation of soil at time t by the project activity (t CO_{2-e}/yr)
$EF_{drain\ C}$ = C emission from desiccation of soil (t-C/ha/yr)
$EF_{drain\ N}$ = N emission as N_2O from desiccation of soil (kg-N_2O-N/ha/yr)
$A_{drain(t)}$ = Desiccated project activity area at time t under the project scenario (ha)
44/12   = Conversion factor from ton C to ton CO_2 equivalent (t CO_2/t C)
44/28   = Conversion factor from ton N to ton N_2O equivalent (t N_2O/t N)
310   = GWP for N_2O (t CO_2/t N_2O)

42. Stratification for sampling shall be the same as the stratification for the ex ante estimation of the actual net GHG removals by sinks (section III.B above). The calculations shown below will be performed for each stratum.

For above-ground biomass

43. $P_{A(t)}$ is calculated per stratum i as follows:

$$P_{A(t)} = E_{(t)} * 0.5 \tag{26}$$

where:
$P_{A(t)}$ = carbon stocks in above-ground biomass at time t achieved by the project activity during the monitoring interval (t C/ha)
$E_{(t)}$ = estimate of above-ground biomass at time t achieved by the project activity (t dm/ha)
0.5   = carbon fraction of dry matter (t C/t dm)

44. $E_{(t)}$ shall be estimated through the following steps:

   (a) **Step 1:** Design a statistically sound sampling procedure. Such procedures should be designed according to the standard methods described in section 4.3.3.4. of the IPCC GPG LULUCF. Additional strata should be considered subsequently for areas affected by fires and pests. This procedure includes the specification of the number, type and size of permanent plots and should be described in the CDM-SSC-AR-PDD. The allowed precision target for monitoring shall be not larger than $\pm$ 10 per cent, at a 95 per cent confidence level for the mean;

   (b) **Step 2:** Establish and mark permanent plots and document their location in the first monitoring report;

   (c) **Step 3:** Measure the diameter at breast height (*DBH*) or *DBH* and tree height, as appropriate; this measure which should be stated in the monitoring reports;

   (d) **Step 4:** Estimate the above-ground biomass (AGB) using allometric equations developed locally or nationally. If these allometric equations are not available:

      (i) Option 1: Use allometric equations included in **appendix C** to this report or in annex 4A.2 of the IPCC GPG for LULUCF;

(ii) Option 2: Use biomass expansion factors and stem volume as follows:

$$E_{(t)} = SV * BEF * WD \qquad (27)$$

where:

$E_{(t)}$ = estimate of above-ground biomass at time t achieved by the project activity (t dm/ha)
SV = stem volume (m^3/ha)
WD = basic wood density (t dm/m^3)
BEF = biomass expansion factor (over bark) from stem volume to total volume (dimensionless)

45. Project participants shall use the default BEF proposed by the IPCC GPG for LULUCF, specifically for tropical broad-leaved species, in order to obtain a conservative estimate of total biomass.

46. SV shall be estimated from on-site measurements using the appropriate parameters (such as DBH or DBH and height). Consistent application of BEF should be secured on the definition of stem volume (e.g. total stem volume or thick wood stem volume requires different BEFs).

47. Documented local values for WD should be used. In the absence of such values, national default values should be used. If national values are also not available, the values should be obtained from table 3A.1.9 of the IPCC GPG for LULUCF.

For below-ground biomass

48. $P_{B(t)}$ shall be estimated for each stratum i as follows:

$$P_{B(t)} = E_{(t)} * R * 0.5 \qquad (28)$$

where:

$P_{B(t)}$ = carbon stocks in below-ground biomass at time t achieved by the project activity during the monitoring interval (t C/ha)
R = root to shoot ratio (dimensionless)
0.5 = carbon fraction of dry matter (t C/t dm)

49. Documented national values for R should be used. If national values are not available, the values should be obtained from table 3A.1.8 of the IPCC GPG for LULUCF.

50. If root to shoot ratios for the species concerned are not available, project proponents shall use the allometric equation developed by Cairns et al. (1997) or a more representative equation taken from the IPCC GPG for LULUCF, Table 4.A.4:[4]

$$P_{B(t)} = \exp\left(-1.085 + 0.9256 * \ln E_{(t)}\right) * 0.5 \qquad (29)$$

where:

$P_{B(t)}$ = carbon stocks in below-ground biomass at time t achieved by the project activity during the monitoring interval (t C/ha)
$E_{(t)}$ = estimate of above-ground biomass at time t achieved by the project activity (t dm/ha)
0.5 = carbon fraction of dry matter (t C/t dm)

[4] Cairns, M.A., S. Brown, E.H. Helmer, G.A. Baumgardner (1997). Root biomass allocation in the world's upland forests. Oecologia (1):1–11.

C. Ex post estimation of leakage

51. In order to estimate leakage, project participants shall monitor, for each monitoring period, each of the following indicators:

    (a) Percentage of families/households of the community involved in or affected by the project activity displaced due to the implementation of the project activity;

    (b) Percentage of total production of the main produce within the project boundary displaced due to the project activity.

52. If the values of these indicators for the specific monitoring period is lower than 10 per cent, then

$$L_{(t)} = 0 \tag{30}$$

where:

$L_{(t)}$ = Leakage attributable to the project activity within the project boundary at time t (t C)

53. If the value of one of these indicators is higher than 10 per cent and less than or equal to 50 per cent, then leakage shall be equal to 15 per cent of the actual net GHG removals by sinks, that is:

$$L_{(t)} = P_{(t)} * 0.15 \tag{31}$$

where:

$L_{(t)}$ = Leakage attributable to the project activity within the project boundary at time t (t C)
$P_{(t)}$ = Carbon stocks in the living biomass pools within the project boundary at time t under project scenario (t C)

54. As indicated in chapter I, paragraph 3, if the value of one of these indicators is larger than 50 per cent net anthropogenic GHG removals by sinks cannot be estimated.

55. If project participants consider that the use of fertilizers would be significant, leakage of N_2O emissions (>10 per cent of the net anthropogenic removals by sinks) should be estimated in accordance with the IPCC GPG.

D. Ex post estimation of the net anthropogenic GHG removals by sinks

56. Net anthropogenic greenhouse gas removals by sinks is the actual net greenhouse gas removals by sinks minus the baseline net greenhouse gas removals by sinks minus leakage.

57. The resulting tCERs at the year of verification tv are calculated as follows:

$$tCER_{(tv)} = 44/12 * \left(P_{(tv)} - B_{(tv)} - L_{(tv)} \right) - P_{E(tv)} \tag{32}$$

if the changes in carbon stock in the baseline are considered to be zero, then $B_{(tv)} = B_{(t=0)}$ and $L_{(tv)} = 0.15 * P_{(tv)}$ (if required; see paragraph 53)

58. The resulting lCERs at the year of verification tv are calculated as follows:

$$lCER_{(tv)} = 44/12 * \left[\left(P_{(tv)} - P_{(tv-\kappa)} \right) - L_{(tv)} \right] - \sum_{tv-\kappa}^{tv} \left(P_{E(tv)} \right) \qquad (33)$$

$$L_{(tv)} = 0.15 * \left(P_{(tv)} - P_{(tv-\kappa)} \right) \quad \text{(if required; see paragraph 53)} \qquad (34)$$

$$P_{(tv-\kappa)} = P_{(t=0)} = B_{(t=0)} \quad \text{for the first verification} \qquad (35)$$

where:

$tCER_{(tv)}$	=	tCERs emitted at year of verification tv (t CO_2)
$lCER_{(tv)}$	=	lCERs emitted at year of verification tv (t CO_2)
$P_{(tv)}$	=	carbon stocks in the living biomass pools within the project boundary at year of verification tv by the project activity (t C)
$B_{(tv)}$	=	carbon stock in the living biomass pools within the project boundary at year of verification tv that would have occurred in the absence of the project activity (t C)
$L_{(tv)}$	=	leakage attributable to the project activity within the project boundary at year of verification tv (t C)
$P_{E(tv)}$	=	GHG emission from desiccation of soil within the project boundary at year of verification tv by the project activity (t CO_{2-e})
tv	=	year of verification
κ	=	time span between two verifications (years)
44/12	=	conversion factor from t C to t CO_2 equivalent (t CO_2/t C)

E. Monitoring frequency

59. A five-year monitoring frequency of the permanent sample plots established within the project boundary is needed for an appropriate monitoring of above-ground and below-ground biomass.

F. Data collection

60. Data collection shall be organized taking into account the carbon pools measured, the sample frame used and the number of permanent plots to be monitored in accordance with the section on quality assurance/quality control (QA/QC) below. Tables 1 and 2 outline the data to be collected to monitor the actual net GHG removals by sinks and leakage.

G. Quality control and quality assurance

61. As stated in the IPCC GPG LULUCF (page 4.111), monitoring requires provisions for quality assurance (QA) and quality control (QC) to be implemented via a QA/QC plan. The plan shall become part of project documentation and cover procedures as described below for:

    (a) Collecting reliable field measurements;

    (b) Verifying methods used to collect field data;

    (c) Verifying data entry and analysis techniques;

    (d) Data maintenance and archiving. This point is especially important, also for small-scale A/R CDM project activities, as timescales of project activities are much longer than those of technological improvements of electronic data archiving. Each point of importance for small-scale A/R CDM project activities is treated in the following section.

H. Procedures to ensure reliable field measurements

62. Collecting reliable data from field measurements is an important step in the quality assurance plan. Those responsible for the measurement work should be trained in all aspects of the field data collection and analysis. It is good practice to develop standard operating procedures (SOPs) for each step of the field measurements, which should be adhered to at all times. These SOPs describe in detail all steps of the field measurements and contain provisions for documentation for verification purposes so that future field personnel can check past results and repeat the measurements in a consistent fashion. To ensure the collection and maintenance of reliable field data, it is good practice to ensure that:

    (a) Field-team members are fully aware of all procedures and the importance of collecting data as accurately as possible;

    (b) Field teams install test plots if needed in the field and measure all pertinent components using the SOPs to estimate measurement errors;

    (c) The document will list all names of the field team and the project leader will certify that the team is trained;

    (d) New staff are adequately trained.

I. Procedures to verify field data collection

63. To verify that plots have been installed and the measurements taken correctly, it is good practice to remeasure independently every 10 plots and to compare the measurements. The following quality targets should be achieved for the remeasurements, compared to the original measurements:

    (a) Missed or extra trees: no error within the plot

    (b) Tree species or groups: no error

    (c) DBH: $< \pm$ 0.5 cm or 3 % whichever is greater

    (d) Height:$< + 10/$ and - 20%

64. At the end of the field work 10–20 per cent of the plots shall be checked independently. Field data collected at this stage will be compared with the original data. Any errors found should be corrected and recorded. Any errors discovered should be expressed as a percentage of all plots that have been rechecked to provide an estimate of the measurement error.

J. Procedures to verify data entry and analysis

65. In order to obtain reliable estimates data must be entered into the data analysis spreadsheets correctly. Errors in this process can be minimized if the entry of field data and laboratory data are cross-checked and, where necessary, internal tests are incorporated into the spreadsheets to ensure that the data are realistic. All personnel involved in measuring and analysing data should communicate to resolve any apparent anomalies before the final analysis of the monitoring data is completed. If there are any problems with the monitoring plot data that cannot be resolved, the plot should not be used in the analysis.

K. Data maintenance and storage

66. Due to the long-term nature of A/R project activities under the CDM, data archiving (maintenance and storage) is an important component of the work. Data archiving should take several forms and copies of all data should be provided to each project participant.

67. The following shall be stored in a dedicated and safe place, preferably offsite:

   (a) Copies (electronic and/or paper) of all field data, data analyses, and models; estimates of the changes in carbon stocks and corresponding calculations and models used;

   (b) Any geographical information system (GIS) products;

   (c) Copies of the measuring and monitoring reports.

68. Given the time frame over which the project activity will take place and the pace of updating of software and hardware for storing data, it is recommended that the electronic copies of the data and the report be updated periodically or converted to a format that could be accessed by any future software application.

Table 1. Data to be collected or used in order to monitor the verifiable changes in carbon stock in the carbon pools within the project boundary from the proposed afforestation and reforestation project activity under the clean development mechanism, and how these data will be archived.

Data variable	Source	Data unit	Measured, calculated or estimated	Frequency (years)	Proportion	Archiving	Comment
Location of the areas where the project activity has been implemented	Field survey or cadastral information or aerial photographs or satellite imagery	latitude and longitude	Measured	5	100 per cent	Electronic, paper, photos	GPS can be usedfor field survey
A_i - Size of the areas where the project activity has been implemented for each type of strata	Field survey or cadastral information or aerial photographs or satellite imagery or GPS	ha	Measured	5	100 per cent	Electronic, paper, photos	GPS can be used for field survey
Location of the permanent sample plots	Project maps and project design	latitude and longitude	Defined	5	100 per cent	Electronic, paper	Plot location is registered with a GPS and marked on the map
Diameter of tree at breast height (1.30 m)	Permanent plot	cm	Measured	5	Each tree in the sample plot	Electronic, paper	Measure diameterat breast height (DBH) for each tree that falls within the sample plot and applies to size limits
Height of tree	Permanent plot	m	Measured	5	Each tree in the sample plot	Electronic, paper	Measure height (H) for each tree that falls within the sample plot and applies to size limits
A_{drain} - Size of the desiccated project activity area	Field survey or cadastral information or aerial photographs or satellite imagery or GPS	ha	(m)	5	100%	Electronic, paper, photos	GPS can be used for field survey.
Basic wood density	Permanent plots, literature	tonnes of dry matter per m3 fresh volume	Estimated	Once	3 samples per tree from base, middle and top of the stem of three individual	Electronic, paper	

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Data variable	Source	Data unit	Measured, calculated or estimated	Frequency (years)	Proportion	Archiving	Comment
					s		
Total CO_2	Project activity	Mg	Calculated	5	All project data	Electronic	Based on data collected from allplots and carbon pools

Table 2. Data to be collected or used in order to monitor leakage and how these data will be archived.

Data variable	Source	Data unit	Measured, calculated or estimated	Frequency (years)	Proportion	Archiving	Comment
Percentage of families/ households of the community involved in or affected by the project activity displaced due to the implementation of the project activity	Participatory survey	Number of families or households	Estimated	5	per cent	Electronic	
Percentage of total production of the main produce (e.g. meat, corn) within the project boundary displaced due to the CDM A/R project activity.	Survey	Quantity (volume or mass)	Estimated	5	per cent	Electronic	

Table 3. Abbreviations and parameters (in order of appearance).

Parameter or abbreviation	Refers to	Units
$B_{(t)}$	Carbon stocks within the project boundary at time t that would have occurred in the absence of the project activity	t C
$B_{A(t)\,i}$	Carbon stocks in above-ground biomass at time t of stratum i that would have occurred in the absence of the project activity	t C/ha
$B_{B(t)\,i}$	Carbon stocks in below-ground biomass at time t of stratum i that would have occurred in the absence of the project activity	t C/ha
A_i	Project area of stratum i	ha
$A_{drain(t)}$	Desiccated project activity area at time t under the project scenario	ha
EF_{drain_C}	C emission from desiccation of soil	t-C/ha/yr
EF_{drain_N}	N emission as N_2O from desiccation of soil	kg-N_2O-N/ha/yr
$M_{(t)}$	Above-ground biomass at time t that would have occurred in the absence of the project activity	t dm/ha
M_{grass}	Above-ground biomass in grass on grassland at time t that would have occurred in the absence of the project activity	t dm/ha
$M_{woody\,(t)}m$	Above-ground woody biomass at time t that would have occurred in the absence of the project activity	t dm/ha Time
R_{woody}	Root to shoot ratio of woody perennials	t dm/t dm
$R_{grass}\,R$	Root to shoot ratio for grassland	t dm/t dm
g	Annual biomass growth rate of woody perennials	t dm/ha/year
i	Stratum i (I = total number of strata)	
n	Running variable that increases by $\Delta t = 1$ year for each iterative step, representing the number of years elapsed since the project start	years
$N_{(t)}$	Carbon stocks within the project boundary at time t under project scenario	t C
$N_{A(t)\,i}$	Carbon stocks in above-ground biomass at time t of stratum i from project scenario	t C/ha
$N_{B(t)\,i}$	Carbon stocks in below-ground biomass at time t of stratum i from project scenario	t C/ha
$N_{E(t)}$	GHG emissions from desiccation of soil at time t under the project scenario	t $CO_{2\text{-}e}$/yr
$T_{(t)}$	Above-ground biomass at time t for the project scenario	t dm/ha
$SV_{(t)}$	Stem volume at time t for the project scenario	m^3/ha
WD	Basic wood density	t of dm/m³ (fresh volume)
BEF	Biomass expansion factor (over bark) from stem volume to total volume	Dimensionless
L_t	Leakage for the project scenario at time t	t C
$P_{(t)}$	Carbon stocks within the project boundary at time t achieved by the project activity	t C
$P_{A(t)\,i}$	Carbon stock in above-ground biomass at time t of stratum i achieved by the project activity	t C/ha
$P_{B(t)\,i}$	Carbon stocks in below-ground biomass at time t of stratum i achieved by the project activity during the monitoring interval	t C/ha
$P_{E(t)}$	GHG emissions from desiccation of soil at time t by the project activity	t $CO_{2\text{-}e}$/yr
$E_{(t)}$	Above-ground biomass at time t achieved by the project activity	t of dm/ha
DBH	Diameter at breast height (130 cm or 1.30 m)	cm or m
$L_{p(t)}$	Leakage resulting from the project activity at time t	t C
$tCER_{(tv)}$	tCERs emitted at year of verification tv (t CO_2)	t CO_2
$lCER_{(tv)}$	lCERs emitted at year of verification tv (t CO_2)	t CO_2
t_0	Year of the project start	
tv	Year of verification	
κ	Time span between two verifications (years)	years
Δt	Time increment = 1 (year)	year

<u>Appendix A</u>

Demonstration of land eligibility

1. Eligibility of the A/R CDM project activities under Article 12 of the Kyoto Protocol shall be demonstrated based on definitions provided in paragraph 1 of the annex to the Decision 16/CMP.1 ("Land use, land-use change and forestry"), as requested by Decision 5/CMP.1 ("Modalities and procedures for afforestation and reforestation project activities under the clean development mechanism in the first commitment period of the Kyoto Protocol"), until new procedures to demonstrate the eligibility of lands for afforestation and reforestation project activities under the clean development mechanism are recommended by the EB.

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.

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	$AGB = 4.5 + 7.7 * WDH$	0.90	Brown (1997)

Note: AGB = above-ground biomass; *DBH* = diameter at breast height; *H* = height; *WD* = basic wood density

References:
Brown, S. 1997. *Estimating biomass and biomass change of tropical forests. A primer.* FAO Forestry Paper 134. Food and Agriculture Organization of the United Nations, Rome, Italy.
Brown, S., A.J.R. Gillespie, and A.E. Lugo. 1989. Biomass estimation methods for tropical forests with applications to forest inventory data. *Forest Science* 35: 881–902.
Martínez-Y., A.J., J. Sarukhan, A. Perez-J., E. Rincón, J.M. Maas, A. Solis-M, and L. Cervantes. 1992. Above-ground phytomass of a tropical deciduous forest on the coast of Jalisco, Mexico. *Journal of Tropical Ecology* 8: 87–96.

Appendix D (deleted)