GLOBAL CARBON COUNCIL

Driving Climate Actions

GCC AFOLU Methodology for Project Activities on Degraded Mangrove Habitats

GCC MA002
V1.0 - 2024

CONTENTS

1. AFOLU Baseline and Monitoring Methodologies of GCC

1. Global Carbon Council (GCC) is MENA region's first and only voluntary carbon offsetting program that contributes to a vision of sustainable and low carbon economy and catalyses climate actions on the ground. Refer www.globalcarboncouncil.com for details.

2. GCC AFOLU methodologies allow for conservative estimation of GHG emission reductions and changes in carbon stocks resulting from the project activity.

2. Source/s of this Baseline and Monitoring Methodology

3. This methodology is based on CDM A/R Large-scale Consolidated Methodology AR-AM0014: Afforestation and reforestation of degraded mangrove habitats. Version 03.0.

3. Scope, applicability, and entry into force

3.1. Scope

4. This methodology applies to projects aiming at the forestation of wetlands that constitute degraded mangrove habitat. Project activities applying this methodology may choose to exclude or include any of the carbon pools of dead wood and soil organic carbon but cannot include the litter carbon pool.

3.2. Applicability conditions

5. This methodology is applicable under the following conditions:

(a) The land subject to the project activity is a degraded mangrove habitat[1];

(b) The project activity shall not decrease the rate of accumulation of litter under baseline;

(c) The project activity does not fall into Agricultural Land Management[2] category;

(d) More than 80 percent of the project area shall be planted with mangrove species.

(e) If more than 10 percent of the project area is planted with non-mangrove species, then the project activity shall not lead to alteration of the hydrology of the project area and hydrology of connected up-gradient and down-gradient wetland areas;

(f) The project activity does not cause a significant increase in non-CO_2 emissions when compared to the baseline with the exception of burning of biomass;

(g) Soil disturbance attributable to the project activity does not cover more than 10 percent of the area[3].

(h) Soil Organic Carbon is either stable or declining in the baseline scenario.

[1] Major factors leading to the degradation of mangrove habitats are habitat destruction, conversion, pollution, and other human activities (urban development, aquaculture, mining, and overexploitation of timber, fish, crustaceans, and shellfish).

[2] Agricultural land management focuses on food production and includes e.g. crop planting and harvesting, grazing practices, tillage, and extensive fertilizer application.

[3] For example, digging pits of size 0.50 m × 0.50 m (length × width) at a spacing of 3 m × 3 m is equal to a coverage of 2.78 percent; continuous ploughing of land is equal to a coverage of 100 percent.

6. CO_2 and non-CO_2 emissions reductions (expressed as CO_2 equivalents) cannot exceed the increase in carbon stocks (expressed as CO_2 equivalents) attributable to the project.

7. A project activity applying this methodology shall also comply with the applicability conditions of the tools referred to in the methodology if applied by the project activity.

3.3. Entry into Force

8. The date of entry into force of this version of the methodology is DD MM 2024.

4. Normative references

9. The following documents are indispensable for the application of this methodology:

   (a) Global Carbon Council Project Standard[4];

   (b) GCC AFOLU methodological tools:

      (i) "Tool for estimation of soil organic carbon content in mineral soils";

      (ii) "Accounting for uncertainty in estimation of GHG emission reduction or removal in GCC project activities";

      (iii) "Non-Permanence Risk Tool".

      (iv) "Tool for estimation of GHG emissions from fertilizer use in AFOLU projects"

   (c) CDM A/R methodological tools[5]:

      (i) A/R TOOL 02: "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities";

      (ii) A/R TOOL 03: "Calculation of the number of sample plots for measurements within A/R CDM project activities"

      (iii) A/R TOOL 08: "Estimation of non-CO_2 greenhouse gas (GHG) emissions resulting from burning of biomass attributable to an A/R CDM project activity";

      (iv) A/R TOOL 12: "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities";

      (v) A/R TOOL 14: "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities";

      (vi) A/R TOOL 15: "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity".

5. Definitions

10. The definitions contained in the following documents shall apply:[6]

[4] This document is available online at http://www.globalcarboncouncil.com/resource-centre/
[5] These documents are available online at: http://cdm.unfccc.int/Reference/index.html
[6] These documents are available online at the following URLs:
(a) <http://www.globalcarboncouncil.com/resource-centre/>;
(b) <http://www.ipcc nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>;
(c) <https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html>;
(d) https://www.ipcc.ch/publication/2013-supplement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories-wetlands/
(e) <https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol4.html>.

(a) GCC definitions;

(b) IPCC (2003). IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry.

(c) IPCC (2006). Guidelines for National Greenhouse Gas Inventories.

(d) IPCC (2013). Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands

(e) IPCC (2019). 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

11. For the purpose of this methodology, the following definitions shall apply:

(a) **Degraded mangrove habitat -** refers to wetlands where, in their natural state, mangrove vegetation can grow and have soil or sediment that is usually water-logged with water that is saline or brackish, and that were subjected to impacts resulting in decrease of mangrove vegetation cover below that may occur in their natural state;

(b) **Wetland** - area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt which creates low-oxygen environments that favour plants and animals, which tolerate periods of sluggishly moving or standing water.

(c) **Soil disturbance -** refers to any activity that results in a decrease in soil organic carbon (SOC), for example ploughing, ripping, scarification, digging of pits and trenches, stump removal, etc.

6. Baseline and Monitoring Methodology

6.1. Selection of Carbon Pools and Greenhouse Gases Accounted

12. The carbon pools selected for accounting of carbon stock changes are shown in Table 1.

Table 1. Carbon pools selected for Accounting of Carbon Stock Changes under baseline and project scenarios

Carbon pool	Whether selected	Justification/Explanation
Above-ground biomass	Yes	This is the major carbon pool subjected to project activity
Below-ground biomass	Yes	Carbon stock in this pool is expected to increase due to the implementation of the project activity
Litter	No	Litter biomass is subjected to high turnover and displacement due to tidal currents. It is a conservative choice to exclude the pool from accounting because the project activity will not decrease the rate of accumulation of litter
Dead wood and Soil organic carbon	Optional	Carbon stock in these pools will not decrease due to implementation of the project activity

13. The emission sources and associated greenhouse gases (GHGs) selected for accounting are shown in Table 2.

Table 2. Emission sources and GHGs selected for accounting under baseline and project scenarios

Sources	Gas	Whether Selected	Justification/Explanation
Burning of woody biomass	CO_2	No	CO_2 emissions due to burning of biomass are accounted as a change in carbon stock
	CH_4	Yes	Burning of woody biomass as part of the baseline activities, for the purpose of site preparation, or as part of forest management, is allowed under this methodology
	N_2O	Yes	Burning of woody biomass as part of the baseline activities, for the purpose of site preparation, or as part of forest management, is allowed under this methodology

6.2. Identification of the Baseline Scenario and Demonstration of Additionality

14. Project owners (POs) shall identify the baseline and demonstrate that the project activity is additional by selecting one of the following options:

    (a) Applying the CDM A/R TOOL 02: "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities";

    (b) Applying an approved standardized baseline appropriate to their project.

6.3. Stratification

15. If biomass distribution over the project area is not homogeneous, stratification should be carried out to improve the precision of biomass and/or the change in biomass stock estimation. Different stratifications may be appropriate for the baseline and project scenarios to achieve optimal precision of estimation of net GHG emission reductions/removals. In particular:

    (a) For baseline GHG emissions and removals, it is usually sufficient to stratify the area according to major vegetation types and their crown cover and/or land use types;

    (b) For net GHG emission reductions/removals the stratification for ex-ante estimations is based on the project planting/management plan and the stratification for ex-post estimations is based on the actual implementation of the project planting/management plan. If natural or anthropogenic impacts (e.g. local fires) or other factors (e.g. soil type) significantly alter the pattern of biomass distribution in the project area, then the ex-post stratification is revised accordingly and may differ among monitoring periods.

6.4. Baseline input to the net GHG removals/reductions

16. The baseline input to the net GHG removals/reductions, in year *t*, shall be calculated as follows:

$$BI_t = \Delta C_{BSL,t} - GHG_{BSL,t} \quad \text{Equation (1)}$$

Where:

BI_t	=	Baseline input to the net GHG removals/reductions, in year *t*; t CO_2e
$\Delta C_{BSL,t}$	=	Change in carbon stock in baseline, in year *t*; t CO_2e
$GHG_{BSL,t}$	=	Non-CO_2 GHG emissions in baseline, in year *t*; t CO_2e

(a) Change in carbon stock input to baseline GHG emissions/removals, in year *t*:

$$\Delta C_{BSL\,t} = \Delta C_{TREE_{BSL}\,t} + \Delta C_{SHRUB_{BSL}\,t} + \Delta C_{DW_{BSL}\,t} \quad \text{Equation (2)}$$

Where:

$\Delta C_{BSL\,t}$	=	Change in carbon stock in baseline , in year *t*; t CO_2e
$\Delta C_{TREE_{BSL}\,t}$	=	Change in carbon stock in baseline tree biomass within the project boundary, in year *t*, as estimated in A/R TOOL 14: "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2e
$\Delta C_{SHRUB_{BSL}\,t}$	=	Change in carbon stock in baseline shrub biomass within the project boundary, in year *t*, as estimated in A/R TOOL 14: "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2e
$\Delta C_{DW_{BSL}\,t}$	=	Change in carbon stock in baseline dead wood biomass within the project boundary, in year *t*, as estimated in A/R TOOL 12: "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities" (note that implementation of the tool is limited to dead wood only); t CO_2e

Note: All references to Appendix 2 of A/R TOOL 14: "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" shall be read as references to the current version of GCC Methodological Tool: "Accounting for uncertainty in estimation of GHG emission reduction or removal in GCC project activities".

Under applicability conditions of this methodology, soil organic carbon stock doesn't increase in the baseline scenario. Consequently, the change in soil organic carbon stock is conservatively accounted for as zero.

(b) Non-CO_2 GHG emissions, in year *t*:

$$GHG_{BSL\,t} = GHG_{E\,t} \quad \text{Equation (3)}$$

Where:

$GHG_{BSL\,t}$	=	Non-CO_2 GHG emissions in baseline , in year *t*; t CO_2e
$GHG_{E\,t}$	=	Non-CO_2 GHG emissions occurring in baseline, in year *t*, as estimated in A/R TOOL 08: "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"; t CO_2e

6.5. Project input to the net GHG removals/reductions

17. GHG emissions resulting from eradication of herbaceous vegetation, use of wood (e.g., for fencing), decomposition of fine roots of N-fixing trees and shrubs attributable to the project activity shall be considered insignificant and therefore accounted as zero. Roads located within the project boundary are not considered as serving exclusively for the project purposes therefore GHG emissions related to their construction are omitted. Combustion of fossil fuel and GHG emissions from fertilizer application are accounted as zero following applicability condition contained in para 5 d) above.

18. The project input to the net GHG removals/reductions, in year *t*, shall be calculated as follows:

$$PI_t = \Delta C_{PRJ\,t} - GHG_{PRJ\,t} \qquad \text{Equation (4)}$$

Where:

PI_t	=	Project input to the net GHG removals/reductions, in year *t*; t CO_2e
$\Delta C_{PRJ\,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2e
$GHG_{PRJ\,t}$	=	Non-CO_2 GHG emissions within the project boundary because of the implementation of the A/R CDM project activity, in year *t*, as estimated in A/R TOOL 08: "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity"; t CO_2e

19. Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*, shall be calculated as follows:

$$\Delta C_{PRJ\,t} = \Delta C_{TREE_{PRJ}\,t} + \Delta C_{SHRUB_{PRJ}\,t} + \Delta C_{DW_{PRJ}\,t} + \Delta SOC_{PRJ\ t} \qquad \text{Equation (5)}$$

Where:

$\Delta C_{PRJ\,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2e
$\Delta C_{TREE_{PRJ}\,t}$	=	Change in carbon stock in tree biomass in project, in year *t*, as estimated in A/R TOOL 14: "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2e
$\Delta C_{SHRUB_{PRJ}\,t}$	=	Change in carbon stock in shrub biomass in project, in year *t*, as estimated in A/R TOOL 14: "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO_2e
$\Delta C_{DW_{PRJ}\,t}$	=	Change in carbon stock in dead wood in project, in year *t*, as estimated in A/R TOOL 12: "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities"; t CO_2e
$\Delta SOC_{PRJ,t}$	=	Change in carbon stock in the soil organic carbon (SOC) pool in project boundary, in year *t*; t CO_2e

Note: All references to Appendix 2 of A/R TOOL 14 "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R CDM project activities" shall be read as references to the current version of GCC Methodological Tool: "Accounting for uncertainty in the estimation of GHG emission reduction or removal in GCC project activities".

20. The change in carbon stock in the SOC pool within the project boundary, in year *t*, shall be estimated as follows:

$$\Delta SOC_{PRJ\,t} = \frac{44}{12} \times \sum_{t=1}^{t} A_{PLANT\,t} \times dSOC_t \times 1\ year \qquad \text{Equation (6)}$$

Where:

$\Delta SOC_{PRJ\,t}$	=	Change in SOC stock within the project boundary, in year *t*; t CO_2e
$A_{PLANT\,t}$	=	Area planted in year *t*; ha
$dSOC_t$	=	The rate of change in SOC stocks within the project boundary, in year *t*; t C ha^{-1} $yr^{-}1$.

The following default value of is used, unless transparent and verifiable information can be provided to justify a different value:

(i) $dSOC_t$= 0.50 t C ha^{-1} yr^{-1} for $t = t_{PLANT}$ to $t = t_{PLANT}$ + 20 years, where t_{PLANT} is the year in which planting takes place;

(ii) $dSOC_t$ = 0 t C ha^{-1} yr^{-1} for $t > t_{PLANT}$ +20.

21. In ex-post situation, the length of monitoring period number *k* will likely be different from one year however, for ensuring comparability among monitoring periods all data necessary for calculation of net project GHG emissions/removals and GHG emissions due to leakage shall be presented on annual basis i.e., data collected over monitoring period number *k* with start date $t_{M\_start\,k}$ and end date $t_{M\_end_k}$ shall be divided by its duration $t_{M\_end_k} - t_{M\_start\,k}$ (expressed as number of years and fraction of them, if necessary).

6.6. Leakage

22. Leakage emissions shall be estimated as follows:

$$LK_t = LK_{AGRIC\,t} \qquad \text{Equation (7)}$$

Where:

LK_t	=	GHG emissions due to leakage, in year *t*; t CO_2e
$LK_{AGRIC\,t}$	=	Leakage due to the displacement of agricultural activities, in year *t*, as estimated in the tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity"; t CO_2e

6.7. Net GHG removals/reductions

23. The net GHG removals/reductions, in year *t*, shall be calculated as follows:

$$NRR_t = PI_t - BI_t - LK_t \qquad \text{Equation (8)}$$

Where:

NRR_t	=	Net GHG removals/reductions, in year *t*; t CO_2e
PI_t	=	Project input to the net GHG removals/reductions, in year *t*; t CO_2e
BI_t	=	Baseline input to the net GHG removals/reductions, in year *t*; t CO_2e

LK_t = GHG emissions due to leakage, in year *t*; t CO_2e

7. Calculation of net GHG emissions reduction/removals eligible for crediting

24. The total of the GHG emissions reduction/removal eligible for crediting shall not exceed the mean net GHG benefit calculated over the period from the start of the first crediting period to the end year of the current crediting period.

25. Calculation of net GHG emissions reduction/removals eligible for crediting may be performed: (i) following guidance contained in this chapter; or (ii) using GCC Tool for calculation of net GHG emissions reduction/removals eligible for crediting.

7.1. Ex-ante calculation of mean net GHG benefit

26. The total number of credits issued for any project involving activities resulting in carbon accumulation must not exceed the mean net GHG benefit calculated according to the instructions in paras 26 and 27 below.

27. Aggregated net GHG emissions removals/reductions in year *t* is the sum of annual net GHG emission reductions/removals that are ex-ante expected to be achieved by the project from the start of the first crediting period to the end of the year t, hence:

$$NRR_{AGG\ t} = \sum_{t=t_{CP\_start}}^{t} NRR_t \qquad \text{Equation (9)}$$

Where:

$NRR_{AGG\ t}$ = Aggregated net GHG emissions removals/reductions up to year *t*; t CO_2e

NRR_t = Ex-ante estimate of net GHG removals/ reductions, in year *t*; t CO_2e

t_{CP_start} = The first year of the first crediting period; dimensionless

The net GHG benefit over the period from the start of the first crediting period to the end of the last year of the current crediting period is:

$$GB_{t=t_{CP\_end}} = \sum_{t=t_{CP\_start}}^{t_{CP\_end}} NRR_{AGG\ t} \qquad \text{Equation (10)}$$

Where:

$GB_{t=t_{CP\_end}}$ = Net GHG benefit over the period from the start of the first crediting period to the end year of the current crediting period; t CO_2e

$NRR_{AGG\ t}$ = Aggregated net GHG emissions removals/reductions up to year *t*; t CO_2e

t_{CP_start} = The first year of the first crediting period; dimensionless

t_{CP_end} = The last year of the current crediting period; dimensionless

Note: Annex 1 provides an example of the implementation of equations 9 and 10.

The mean net GHG benefit over the period from the start of the first crediting period to the end of the last year of the current crediting period is:

$$MGB = \frac{GB_{t=t_{CP\_end}}}{n} \qquad \text{Equation (11)}$$

Where:

MGB = Mean net GHG benefit over the period from the start of the first crediting period to the end year of the current crediting period; t CO_2e

n = The number of years (calculated as explained below),; dimensionless.

i) *n* equals to the length of crediting period if the length of production cycle is the same as the length of the crediting period),

ii) *n* equals to the length of period from first year of the first crediting period to the last year of the current production cycle if the end date of the last production cycle (initiated in the current crediting period) falls after the end date of the current crediting period (see Figure 1 below).

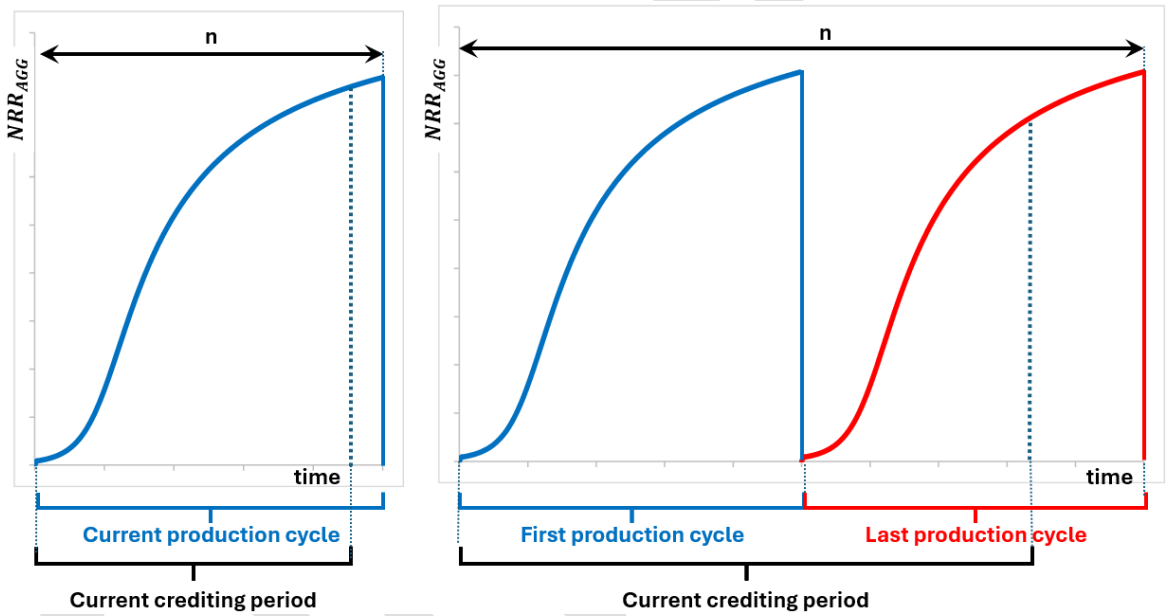

Figure 1: Explanation of calculation of the number of years *n* to be used in Equation 11.

Note that the MGB numerical value is estimated ex-ante, and it is constant for the entire crediting period.

7.2. Ex-post calculation of the net GHG benefit

28. In contrast to ex-ante projection where annual data are available, in ex-post situation only discrete data (positioned at the date of completion of monitoring reports) are recorded and duration of each monitoring period may be different.

29. In typical situation, the verified monitoring data from the past monitoring periods will remain unchanged until the end of the project crediting cycle[7]. Consequently, calculation of the net GHG benefit over the period from the start of the first crediting period to the date of completion of each monitoring report will repeat calculations performed for the preceding monitoring periods, hence a recurrence approach shall be used:

[7] The period covering all project crediting periods.

$$GB_{Ver\ k=1} = \frac{NRR_{Ver\ k=1} * (t_{k=1} - t_0)}{2}$$

$$GB_{Ver\ k\geq 2} = GB_{Ver\ k-1} + \left(\sum_{k=1}^{k-1} NRR_{Ver\ k} + \frac{NRR_{Ver\ k}}{2}\right) * (t_k - t_{k-1})$$

Equation (12)

Where:

$GB_{Ver\ k=1}$	=	Net GHG benefit over the period from the start of the first crediting period to the date of completion of the first monitoring report (*k=1)*; t CO_2e
$GB_{Ver\ k}$	=	Net GHG benefit over the period from the start of the first crediting period to the date of completion of the monitoring report number *k*; t CO_2e
$NRR_{Ver\ k}$	=	Net GHG emissions reduction/removals verified in monitoring period *k*; t CO_2e
k	=	Ex-post number of monitoring period (*k=1, 2, …,* k_{curr_mon}); dimensionless
$t_k - t_{k-1}$	=	Ex-post duration of the *k-th* monitoring period; dimensionless (expressed as number of years and fraction of them if necessary)

Note: Annex 2 provides an example of the implementation of equation 12.

7.3. Calculation of the correction factor for the mean net GHG benefit (applicable only for NR crediting)

30. For ex-ante estimations, the correction factor equals one (1). For ex-post calculations, if verified ex-post data differ from ex-ante projection, the mean net GHG benefit to be used for calculating net GHG reduction/removal eligible for NR crediting shall be corrected (at each verification) using correction factor equal to the ratio between the estimate of the net GHG benefit over the period from the start of the first crediting period to the date of completion of the current monitoring report calculated using the ex-post verified data and the same estimate calculated using the ex-ante data contained in the registered PSF. Therefore, the correction factor equals:

$$CF_{k_{curr\_mon}} = \frac{GB_{Ver\ k=k_{curr\_mon}}}{GB_{t=t_{curr\_mon}}}$$

Equation (13)

Where:

$CF_{k_{curr\_mon}}$	=	Correction factor for the current monitoring period *k* (ending at t_{curr_mon}); dimensionless
$GB_{Ver\ k=k_{curr\_mon}}$	=	Net GHG benefit over the period from the start of the first crediting period to the date of completion of the current monitoring report, calculated using the ex-post verified data; t CO_2e
$GB_{t=t_{curr\_mon}}$	=	Net GHG benefit over the period from the start of the first crediting period to the last year of the current monitoring period, calculated using the ex-ante data; t CO_2e
k	=	Ex-post number of monitoring periods; dimensionless
k_{curr_mon}	=	Ex-post number of the current monitoring period; dimensionless
t_{curr_mon}	=	The last year of the current monitoring period (i.e., ex-post monitoring period number $k = k_{curr\_mon}$); dimensionless

Note that the correction factor CF measures the difference between the ex-ante projection of project performance and the actual performance calculated using the verified monitoring data available ex-post. In general, CF may be different in each monitoring period.

31. If $0.95 \leq CF \leq 1$ then the decrease in project performance is considered immaterial and CF =1 shall be used in further calculations. Otherwise, the ex-post corrected value of MGB equals:

$$MGB_{k_{curr\_mon}} = MGB * CF_{k_{curr\_mon}} \quad \text{Equation (14)}$$

Where:

$MGB_{k_{curr\_mon}}$	=	Mean net GHG reduction/removal for the current monitoring period *k* (ending at t_{curr_mon}) corrected according to the ex-post project performance; t CO_2e
MGB	=	Mean net GHG reduction/removal for the period from the first year of the first crediting period to the last year of the current crediting period calculated using ex-ante data according to Equation 11; t CO_2e
$CF_{k_{curr\_mon}}$	=	Correction factor for the current monitoring period (ending at t_{curr_mon}); dimensionless
k_{curr_mon}	=	Ex-post number of the current monitoring period (ending at t_{curr_mon}); dimensionless

7.4. Calculation of the net GHG emissions reduction/removal eligible for NR crediting

32. For ex-ante estimations, $CF_{k_{curr\_mon}} = 1$ shall be used (i.e., for $MGB_{k_{curr\_mon}} = MGB$ calculated according to Equation 11). For ex-post calculations, verified monitored data shall be used for calculation of $MGB_{k_{curr\_mon}}$.

33. The net GHG emissions reduction/removal achieved in current monitoring period k_{curr_mon} ending on t_{curr_mon} is eligible for ex-post NR crediting when $\sum_{t=t_{curr_{mon-1}}}^{t_{curr\_mon}} NRR_t > 0$ (i.e., the net GHG emissions reduction/removal achieved in the current monitoring period is positive) and shall be calculated using the following equation:

$Ex-ante$:

$$NRR_{NR\ t=t_{curr\_mon}} = MIN\left(\sum_{t=t_{CP_{start}}}^{t_{curr\_mon}} NRR_t, MGB\right) - \sum_{t=t_{CP_{start}}}^{t_{curr\_mon}-1} NRR_t$$

$Ex-post$:

$$NRR_{NR\ k=k_{curr\_mon}} = MIN\left(\sum_{k=0}^{k=k_{curr\_mon}} NRR_{Ver\ k}, MGB_{k_{curr\_mon}}\right) - \sum_{k=0}^{k=k_{curr\_mon}-1} NRR_{Ver\ k} \quad \text{Equation (15)}$$

Where:

$NRR_{NR\ t=t_{curr\_mon}}$	=	Ex-ante net GHG emissions reduction/removal eligible for NR crediting in current monitoring period *k* (ending on t_{curr_mon}); t CO_2e
NRR_t	=	Ex-ante estimate of net GHG removals/ reductions, in year *t*; t CO_2e
MGB	=	Mean net GHG reduction/removal for the period from the first year of the first crediting period to the last year of the current crediting period calculated using ex-ante data according to Equation 11; t CO_2e
$NRR_{NR\ k=k_{curr\_mon}}$		Ex-post net GHG emissions reduction/removal eligible for NR crediting in current monitoring period *k* (ending on t_{curr_mon}); t CO_2e
$\sum_{k=0}^{k=k_{curr\_mon}} NRR_{Ver\ k}$	=	Sum of net GHG emissions reduction/removal verified ex-post for the period from the first year of the first crediting period to the end date of the current monitoring period; t CO_2e
$\sum_{k=0}^{k=k_{curr\_mon}-1} NRR_{Ver\ k}$	=	Sum of net GHG emissions reduction/removal verified ex-post for the period from the first year of the first crediting period to the end date of the previous (i.e., current – 1) monitoring period; t CO_2e
$NRR_{Ver\ k}$	=	Net GHG emissions reduction/removals verified in monitoring period *k*; t CO_2e
$MGB_{k_{curr\_mon}}$	=	Mean net GHG reduction/removal for the current monitoring period *k* (ending at t_{curr_mon}) corrected according to the ex-post project performance (calculated according to Equation 14); t CO_2e Note: For ex-post calculations, verified monitored data shall be used for calculation of $MGB_{k_{curr\_mon}}$.

7.5. Calculation of the net GHG emissions reduction/removal eligible for NR+ crediting

34. Calculate mean net GHG benefit over the period from the start of the first crediting period to the end of the last year of the current crediting period using ex-ante data (for ex-ante calculations) or verified monitored data (for ex-post calculations), as appropriate:

$$MGB_{NR^+\ t_{curr\_mon}} = \frac{GB_{t=t_{curr\_mon}}}{n}$$

Equation (16)

$$MGB_{NR^+\ k_{curr\_mon}} = \frac{GB_{Ver\ k=k_{curr\_mon}}}{n}$$

Where:

$MGB_{NR^+\ t_{curr\_mon}}$	=	Ex-ante mean net GHG benefit over the period from the start of the first crediting period to the end date of the current monitoring period ($t = t_{curr\_mon}$) for NR+ crediting; t CO_2e
$MGB_{NR^+\ k_{curr\_mon}}$	=	Mean net GHG benefit verified ex-post for NR+ crediting over the period from the start of the first crediting period to the end date of the current monitoring period *k* ($k = k_{curr\_mon}$); t CO_2e

$GB_{t=t_{curr\_mon}}$	=	Net GHG benefit over the period from the start of the first crediting period to the last year of the current monitoring period, calculated using the ex-ante data; t CO_2e
$GB_{Ver\ k=k_{curr\_mon}}$	=	Net GHG benefit over the period from the start of the first crediting period to the date of completion of the current monitoring report, calculated using the ex-post verified data; t CO_2e
t_{curr} , t_{curr_mon}	=	The end date of the current monitoring period (ex-ante and ex-post, respectively); dimensionless
n	=	The number of years elapsing from start date of the first crediting period to the end date of the current monitoring period (expressed as number of years and fraction thereof, if necessary); dimensionless
k_{curr_mon}	=	Ex-post number of the current monitoring period (ending at t_{curr_mon}); dimensionless

Note that the MGB_{NR^+} is estimated separately for each year (ex-ante) and each monitoring period (ex-post).

35. The net GHG emissions reduction/removal achieved in the current monitoring period ending on t_{curr_mon} is eligible for NR^+ crediting when $NRR_{\ NR^+\ k_{curr\_mon}} > 0$ (i.e., the net GHG emissions reduction/removal achieved in current monitoring period is positive) as calculated using the following equation:

$$Ex-ante:$$
$$NRR_{\ NR^+\ t_{curr\_mon}} = MIN\left(\sum_{t=t_{CP_{start}}}^{t_{curr\_mon}} NRR_{NR^+\ t}, MGB_{NR^+\ t_{curr\_mon}}\right) - \sum_{t=t_{CP_{start}}}^{t_{curr\_mon}-1} NRR_{NR^+t}$$

Equation (17)

$$Ex-post:$$
$$NRR_{\ NR^+\ k_{curr\_mon}} = MIN\left(\sum_{k=0}^{k_{curr\_mon}} NRR_{\ NR^+k}, MGB_{NR^+\ k_{curr\_mon}}\right) - \sum_{k=0}^{k_{curr\_mon}-1} NRR_{\ NR^+\ k}$$

Where:

$NRR_{\ NR^+\ t_{curr\_mon}}$	=	Net GHG emissions reduction/removal eligible for generating of ex-ante NR+ credits in the current monitoring period (ending on t_{curr_mon}); t CO_2e
$NRR_{NR^+\ t}$	=	NR+ credits generated ex-ante in year t; t CO_2e

$MGB_{NR^+\,t_{curr\_mon}}$	=	Ex-ante mean net GHG benefit over the period from the start of the first crediting period to the end date of the current monitoring period (t_{curr_mon}) for NR+ crediting; t CO_2e
$\sum_{t=t_{CP\_start}}^{t_{curr\_mon}} NRR_{NR^+\,t}$	=	Sum of NR+ credits accrued ex-ante during the period from the first year of the first crediting period to the end date of the current monitoring period ending in year t_{curr_mon}; t CO_2e
$\sum_{t=t_{CP\_start}}^{t_{curr\_mon}-1} NRR_{NR^+\,t}$	=	Sum of NR+ credits accrued ex-ante during the period from the first year of the first crediting period to to the end date of the previous (i.e., *current – 1*) monitoring period; t CO_2e
$NRR_{NR^+\,k_{curr\_mon}}$	=	Ex-post net GHG emissions reduction/removal eligible for NR+ crediting in current monitoring period k_{curr_mon} (ending on t_{curr_mon}); t CO_2e
$NRR_{NR^+\,k}$	=	NR+ credits verified ex-post in monitoring period k; t CO_2e
$\sum_{k=0}^{k_{curr\_mon}} NRR_{NR^+\,k}$	=	Sum of net GHG emissions reduction/removal verified ex-post for NR+ crediting accrued during the period from the first year of the first crediting period to the end date of the current monitoring period *k*; t CO_2e
$\sum_{k=0}^{k_{curr\_mon}-1} NRR_{NR^+\,k}$	=	Sum of net GHG emissions reduction/removal verified ex-post for NR+ crediting accrued during the period from the first year of the first crediting period to the end date of the previous (i.e., *current – 1*) monitoring period; t CO_2e
$MGB_{NR^+\,k_{curr\_mon}}$	=	Mean net GHG benefit verified ex-post for NR+ crediting over the period from the start of the first crediting period to the end date of the current monitoring period *k* ($k = k_{curr\_mon}$); t CO_2e

8. Calculation of the number of NR or NR+ credits to be issued in a monitoring period

36. The number of credits to be issued in a monitoring period is affected by the uncertainty of the data and the level of not mitigated non-permanence risk attributable to the project.

8.1. Deduction for the uncertainty in data

37. Deduction for uncertainty in data used in estimation of GHG emission removal or reduction ensures that the estimate of GHG emission reduction and/or removal calculated at the project level is more likely to result in underestimation rather than overestimation of the climate impact of the project.

38. GCC methodological tool “Accounting for uncertainty in estimation of GHG emission reduction or removal in GCC project activities” shall be used to determine the discount factor to be applied in the final calculation of estimate of GHG emission reduction or removal to ensure conservativeness of credits issued by the GCC.

8.2. Buffer contribution to ensure the permanence of carbon credits

39. The permanence of carbon credits issued for GCC AFOLU registered projects is ensured by a buffer mechanism capable of restoring all credits that were issued based on verified increments in carbon stocks which have been impacted by carbon reversal event. This mechanism operates through a single GCC AFOLU pooled buffer account, which is funded by carbon credits from such projects.

40. The GCC AFOLU Non-Permanence Risk Tool (NPRT) shall be used to determine the fraction of carbon credits to be deposited in the GCC AFOLU pooled buffer account.

8.3. Calculation of the number of credits issuable in a monitoring period

41. The number of NR or NR+ credits to be issued in a monitoring period *k* (ending on t_{curr_mon}) shall be calculated as follows:

(a) For NR credits:

$$NR_k = NRR_{NR\,k_{curr\_mon}} * (1 - discount\_factor_k * U_k) * (1 - buffer\_contr_k) \quad \text{Equation (18)}$$

(b) For NR+ credits:

$$NR^+_k = NRR_{NR^+\,k_{curr\_mon}} * (1 - discount\_factor_k * U_k) * (1 - buffer\_contr_k) \quad \text{Equation (19)}$$

Where:

NR_k NR^+_k	=	Number of NR or NR+ credits issuable for monitoring period number *k* discounted for uncertainty in data and non-permanence of carbon stocks; t CO_2e
$NRR_{NR\,k_{curr\_mon}}$ $NRR_{NR^+k_{curr\_mon}}$	=	Net GHG emissions reduction/removal eligible for NR or NR+ crediting in monitoring period number *k* (ending on t_{curr_mon}); t CO_2e
$discount\ factor_k$	=	Discount factor for monitoring period number *k* calculated using GCC methodological tool: Accounting for uncertainty in estimation of GHG emission reduction or removal in GCC project activities; dimensionless
U_k	=	Uncertainty in data for monitoring period number *k* calculated using GCC methodological tool: Accounting for uncertainty in estimation of GHG emission reduction or removal in GCC project activities; %
$buffer\_contr_k$	=	Buffer contribution for monitoring period number *k* calculated using GCC Non-permanence Risk Tool; dimensionless

If $ER_{NR\,k_{curr\_mon}} < 0$ or $ER_{NR^+\,k_{curr\_mon}} < 0$ then reversal occurred in monitoring period $k \geq 2$ and the absolute value of the relevant one of them shall be implemented in equation 14 or 15 (as appropriate) together with $discount\_factor_{k-1}$, U_{k-1}, and $buffer\_contr_{k-1}$ to calculate the number of buffer credits to be cancelled.

9. Monitoring procedure

9.1. Monitoring plan

42. The monitoring plan shall provide for collection of all relevant data necessary for:

(a) Verification that the applicability conditions listed under paragraphs 5, 6 and 7 have been met;

(b) Verification of changes in carbon stocks in the pools selected;

(c) Verification of baseline, project, and leakage emissions.

43. The data collected shall be archived for a period of at least two years after the end of the last crediting period of the project activity.

9.2. Monitoring of project implementation

44. Information shall be provided in the project submission form (PSF), to establish that the commonly accepted principles and practices of forest inventory and forest management in the host country are implemented. If such principles and practices are not known or available, standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures for inventory operations, including field data collection and data management, shall be identified, recorded, and applied. Use or adaptation of SOPs available from published relevant handbooks, or from the IPCC (2003) “Good Practice Guidance for Land Use, Land-Use Change and Forestry”, is recommended.

9.3. Precision requirements

45. For this methodology, the precision is established at 90% confidence level.

9.4. Data requirements under the methodology

46. Description of data and parameters can be found in the tools used in this methodology.

47. Data and parameters to be obtained from measurement shall be monitored as required in the tools.

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Annex 1: An example of the implementation of equations 9 and 10.

Aggregated net GHG emissions removals/reductions in year *t* is the sum of annual net GHG emission reductions/removals that are ex-ante expected to be achieved by the project from the start of the first crediting period to the end of the year *t*, hence Equation 9:

$$NRR_{AGG\ t} = \sum_{t=t_{CP\_start}}^{t} NRR_t$$

The net GHG benefit over the period from the start of the first crediting period to the end of the last year of the current crediting period is calculated according to Equation 10:

$$GB_{t=t_{CP\_end}} = \sum_{t=t_{CP\_start}}^{t_{CP\_end}} NRR_{AGG\ t}$$

An example of implementation of these equations using an exemplary data is presented in Table 1 below.

Table 1. An example of calculations according to equations 9 and 10.

Crediting period	Year (*t*)	NRR_t	$NRR_{AGG\ t} = \sum_{t=t_{CP\_start}}^{t} NRR_t$	$GB_{t=t_{CP\_end}} = \sum_{t=t_{CP\_start}}^{t_{CP\_end}} NRR_{AGG\ t}$
t_{CP_start}	0	0	0	
	1	1	(1+0)=1	
	2	3	(3+1)=4	
	3	5	(5+4)=9	
	4	7	(7+9)=16	
t_{CP_end}	5	9	(9+16)=25	(0+1+4+9+16+25)=55

For data contained in table above:

$$GB_{t=t_{CP\_end}} = \sum_{t=t_{CP\_start}}^{t_{CP\_end}} NRR_{AGG\ t} = 55$$

Annex 2: An example of the implementation of equation 12.

In ex-post situation the verified net GHG emissions/removals are available only for discrete points in time (the date of completion of monitoring reports). The verified data from the past monitoring periods remain unchanged until the end of the project crediting cycle[8]. Consequently, calculation of the net GHG benefit over the period from the start of the first crediting period to the date of completion of each monitoring report will repeat calculations performed for the preceding monitoring periods, hence a recurrence approach is suggested.

In Figure 2 below, points at the red broken line (black circles) represent the verified net GHG emissions reduction/removals accumulated over the period from the first to the k-th monitoring period. The net GHG benefit is represented by the area under the red broken line drawn through these points. For the first monitoring period, the figure under the red line is triangle. For the remaining monitoring periods it is trapezoid.

The net GHG benefit accumulated over the period from the first to the *k-th* monitoring period is represented by a sum of areas of the initial triangle followed by *k-1* trapezoids. Figure 2 explains calculation of area of the triangle and an exemplary trapezoid.

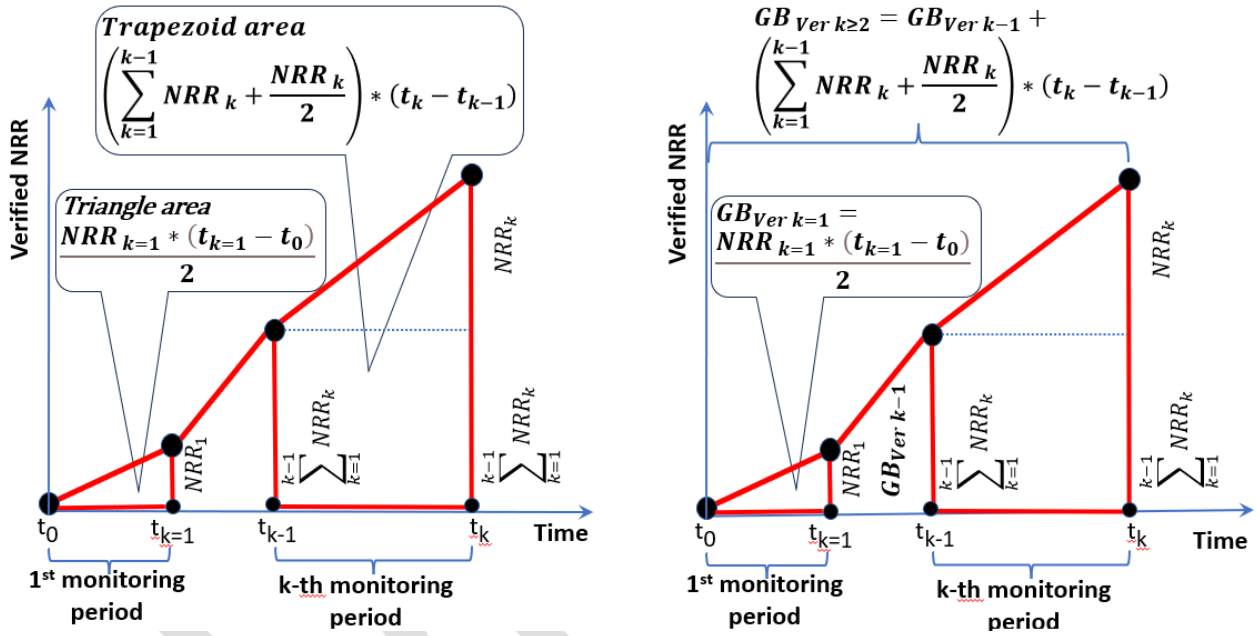

Figure 2: Explanation of ex-post calculation of the net GHG benefit.

Equation 12 is a recurrence equation:

$$GB_{Ver\ k=1} = \frac{NRR_{Ver\ k=1} * (t_{k=1} - t_0)}{2}$$

$$GB_{Ver\ k\geq 2} = GB_{Ver\ k-1} + \left(\sum_{k=1}^{k-1} NRR_{Ver\ k} + \frac{NRR_{Ver\ k}}{2}\right) * (t_k - t_{k-1})$$

Table 2 explains the implementation of Equation 12 in the form of step by step calculations (using exemplary data) leading to numerical value of the net GHG benefit accumulated over the period from the first to the end of fifth monitoring period. Arrows explain the flow of intermediate calculations and colour fonts indicate the same data.

[8] The period covering all project crediting periods.

Table 2. An example of calculations according to equation 12.

Number of monitoring period (k)	End date of monitoring period (*t*)	Duration of monitoring period (*yr*) $t_k - t_{k-1}$	$NRR_{Ver\ k}$	$\sum_{k=1}^{k-1} NRR_{Ver\ k}$ $k \geq 2$	$GB_{Ver\ k}$
CP start date	1 Jan. 2020				
1	1 Jan. 2025	5	1		(1*5)/2=2.5
2	1 Jan. 2028	3	3	1	2.5+(1+3/2)*3=10
3	1 Jan. 2030	2	5	(3+1)=4	10+(4+5/2)*2=23
4	1 Jan. 2032	2	7	(5+4)=9	23+(9+7/2)*2=48
5	1 Jan. 2035	3	9	(7+9)=16	48+(16+9/2)*3=109.5

For data contained in table above, the net GHG benefit over the period from the start of the first crediting period to the date of completion of the fifth monitoring report equals 109.5.

DOCUMENT HISTORY		
Version	**Date**	**Comment**
V 1.0	DD/MM/2024	Initial adoption by GCC Steering Committee based on following: i. Consideration by individual steering committee member, followed by evaluation of entire steering committee ii. XX days global stakeholder consultation taken place between DD/MM/2024 to DD/MM/2024

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