



ANNEX 1

MAPPING TABLES



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Annex 1 Relating 2019 Refinement to the 2006 IPCC Guidelines

This annex provides a road map for relating sections, equations, tables, figures and boxes in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Type of Refinement: E – Elaboration, U – Update, NG – New Guidance.

CHAPTER 1, INTRODUCTION

No Refinement to Chapter 1

CHAPTER 2, GENERIC METHODS

Sections

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Introduction	NR	2.1	2.1
Inventory Framework	NR	2.2	2.2
Overview of carbon stock change estimation	NR	2.2.1	2.2.1
Overview of non-CO ₂ emission estimation	NR	2.2.2	2.2.2
Conversion of C stock changes to CO ₂ emissions	NR	2.2.3	2.2.3
Generic methods for CO ₂ emissions and removals	NR	2.3	2.3
Change in biomass carbon stocks (above-ground biomass and below-ground biomass)	NR	2.3.1	2.3.1
Land remaining in a land-use category	NR	2.3.1.1	2.3.1.1
Land converted to a new land-use category	NR	2.3.1.2	2.3.1.1
Additional generic guidance for tier 2 methods	NG	-	2.3.1.3
Change in dead organic matter	NR	2.3.2	2.3.2
Land remaining in a land-use category	E?	2.3.2.1	2.3.2.1
Land converted to a new land-use category	U	2.3.2.2	2.3.2.2
Change in carbon stocks in soils	NR	2.3.3	2.3.3
Soil organic C estimation methods (Land remaining in a Land-use category and land conversion to a new land use)	U NG E	2.3.3.1	2.3.3.1
Non-CO ₂ emissions	U	2.4	2.4



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Additional generic guidance for tier 3 methods	E	2.5	2.5
Measurement-based tier 3 inventories	E	2.5.1	2.5.1
Model-based tier 3 inventories	E	2.5.2	2.5.2
Inter-annual variability	NG	-	2.6
Definitional issues	NG	-	2.6.1
Direct and indirect human effects, and natural effects	NG	-	2.6.1.1
Natural disturbances	NG	-	2.6.1.2
Relationship between different methodological approaches and the representation of emissions and removals from inter-annual variability	NG	-	2.6.2
Methodological approaches to estimating the contribution of ND to the emissions and removals reported for managed land	NG	—	2.6.3
Reporting the contribution of natural disturbances to the emissions and removals for managed lands	NG	-	2.6.4
Default Mineral Soil Reference C Stocks	NG	-	Annex 2A.1
Supporting Material for the Estimation of Soil Carbon Stock Change from Biochar Amendments to Mineral Soils	NG	-	Annex 2A.2
Consistency between AFOLU projects or activities and IPCC inventory guidelines	NG	-	Annex 2A.3

Discussion:

A paragraph was inserted to define why a term for biochar application to soil was added to equation 2.24.

A section was added describing the biochar method.

A sentence was added to indicate where information pertaining to soil sampling strategies could be found in chapter 2 of volume 1 and two general references on soil sampling and analysis were inserted. This was completed in response to a request in the internal review.

A section has been inserted to describe the new Tier 2 three-pool steady-state carbon model for mineral soils.

A section providing a step-by-step procedure for implementing the three-pool steady-state soil carbon model for mineral soils was added.

40 **Equations**

Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
Annual carbon stock changes for the entire AFOLU Sector estimated as the sum of changes in all land-use categories	NR	2.1	2.1
Annual carbon stock changes for a land-use category as a sum of changes in each stratum within the category	NR	2.2	2.2
Annual carbon stock changes for a stratum of a land-use category as a sum of changes in all pools	NR	2.3	2.3
Annual carbon stock change in a given pool as a function of gains and losses (Gain-Loss Method)	NR	2.4	2.4
Carbon stock change in a given pool as an annual average difference between estimates at two points in time (Stock-Difference Method)	NR	2.5	2.5
Non-CO ₂ emissions to the atmosphere	NR	2.6	2.6
Annual change in carbon stocks in biomass in land remaining in a particular land-use category (Gain-Loss Method)	NR	2.7	2.7
Annual change in carbon stocks in biomass in land remaining in the same land-use category (Stock-Difference Method)	NR	2.8	2.8
Annual increase in biomass carbon stocks due to biomass increment in land remaining in same category	NR	2.9	2.9
Average annual increment in biomass	NR	2.10	2.10
Annual decrease in carbon stocks due to biomass losses in land remaining in same category	NR	2.11	2.11
Annual carbon loss in biomass of wood removals	NR	2.12	2.12



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Annual carbon loss in biomass of fuelwood removal.	NR	2.13	2.13
Annual carbon losses in biomass due to disturbances	NR	2.14	2.14
Annual change in biomass carbon stocks on land converted to other land-use category (Tier 2)	NR	2.15	2.15
Initial change in biomass carbon stocks on land converted to another land category	NR	2.16	2.16
Annual change in carbon stocks in dead organic matter	NR	2.17	2.17
Annual change in carbon stocks in dead wood or litter (Gain-Loss Method)	NR	2.18	2.18
Annual change in carbon stocks in dead wood or litter (Stock-Difference Method)	NR	2.19	2.19
Annual carbon in biomass transferred to dead organic matter	NR	2.20	2.20
Annual biomass carbon loss due to mortality	NR	2.21	2.21
Annual carbon transfer to slash	NR	2.22	2.22
Annual change in carbon stocks in dead wood and litter due to land conversion	NR	2.23	2.23
Annual change in carbon stocks in soils	NR	2.24	2.24
Annual change in organic carbon stocks in mineral soils	NR	2.25	2.25
Annual carbon loss from drained organic soils (CO ₂)	NR	2.26	2.26
Annual change in organic carbon stocks in mineral soils with biochar additions	NG	-	2.27
Annual SOC stock change for mineral soils using three-pool steady-state C model	NG	-	2.28
Active Pool SOC Stock for Three-Pool Steady-State C Model	NG	-	2.29
Slow Pool SOC Stock for Three-Pool Steady-State C Model	NG	-	2.30

Passive Pool SOC Stock for Three-Pool Steady-State C Model	NG	-	2.31
Temperature Impact on Decomposition for Three-Pool Steady-State C Model	NG	-	2.32
Water Effect on Decomposition for Three-Pool Steady-State C Model	NG	-	2.33
C input to the Active SOC Pool for Three-Pool Steady-State C Model	NG	-	2.34
Estimation of greenhouse gas emissions from fire	NR	2.27	2.35

Discussion:

Equation 2.24. A term representing the change in soil carbon stocks due to biochar application was added.

A series of equations (2.28– 2.34) were added for the calculations required in the new Tier 2 three-pool steady-state soil carbon model.

Tables

Table Title	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
Example of a simple matrix (Tier 2) for the impacts of disturbances on carbon pools	NR	2.1	2.1
Tier 1 default values for litter and dead wood carbon stocks	U	2.2	2.2
Default reference (under native vegetation) soil organic C stocks (SOC_{REF}) for mineral soils (tonnes C ha^{-1} in 0-30 cm depth)	U	2.3	2.3
Default values for organic carbon content factor of biochar by production type (F_{C_p}).	NG	-	2.4
Default values for F_{perm_p} (fraction of biochar C remaining after 1000 years)	NG	-	2.5
Model parameters used to estimate steady state soil organic carbon pools (slow, active, and passive)	NG	-	2.6
Fuel (dead organic matter plus live biomass) biomass consumption values (tonnes dry matter ha^{-1}) for fires in a range of vegetation types.	U	2.4	2.7



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Emission factors for various types of burning	NR	2.5	2.8
Combustion factor values (proportion of prefire fuel biomass consumed) for fires in a range of vegetation types	U	2.6	2.9
Summarises of how the choice of estimation method and data affect the ability to quantify IAV of emissions and removals from forest carbon stock changes resulting from the four drivers in the table.	NG	-	2.10
Example of the table format that could be used for voluntary disaggregation of reported fluxes on Managed Lands due to [predominantly] anthropogenic and [predominantly] natural causes, and their totals.	NG	-	2.11

Discussion

Table 2.3. Reference soil organic carbon stocks were updated using data presented in Batjes (2011). Where data was lacking, values from previous IPCC guidance documents were inserted. A new series of footnotes have been provided. Updated 95% confidence interval limits expressed as a percentage of the mean organic carbon stock were provided. Where the number of samples used to calculate the mean and confidence limits was known it was added to provide an indication of the level of data support for the values in the table.

Tables 2.4 and 2.5 provide the parameters for estimating the change in soil C with biochar amendments.

Table 2.6: The default values for a series of parameters required for the calculations that make up the Tier 2 three-pool steady-state soil carbon model are presented in this table.

Tables 2.7 and 2.9 provides updated information for estimating non-CO₂ emissions from agricultural residues burning.

Figures

Figure Title	Type of Refinement	2006 Guidelines Figure Number	2019 Refinement Figure Number
Generalized carbon cycle of terrestrial AFOLU ecosystems showing the flows of carbon into and out of the system as well as between the five C pools within the system	NR	2.1	2.1
Generic decision tree for identification of appropriate tier to estimate changes in carbon stocks in biomass in a land-use category	NR	2.2	2.2

Generic decision tree for identification of appropriate allometric models to estimate biomass or carbon stocks in organic matter	NG	-	2.3
Generic decision tree for identification of appropriate tier to estimate changes in carbon stocks in dead organic matter for a land-use category	NR	2.3	2.4
Generic decision tree for identification of appropriate tier to estimate changes in carbon stocks in mineral soils by land-use category	U	2.4	2.5
Generic decision tree for identification of appropriate tier to estimate changes in carbon stocks in organic soils by land-use category	NR	2.5	2.6
Generic decision tree for identification of appropriate tier to estimate greenhouse gas emissions from fire in a land-use category	NR	2.6	2.7
Steps to develop a Tier 3 model-based inventory estimation system	U (removed figure)	2.7	-
Conceptual illustration of how various anthropogenic (direct and indirect) and natural factors simultaneously affect land-related GHG emissions and removals	NG	-	2.8
Example of the disaggregation of fire emissions in Australia into natural 'background' emissions and fires due to human activity.	NG	-	2.9
Example of the separation of Canada's FL-FL emissions and removals into those due to predominantly anthropogenic causes and those due to predominantly natural disturbances. Note the low IAV in the anthropogenic fluxes and the high IAV in the natural disturbance fluxes (exceeding 250 Mt CO ₂ e/yr).	NG	-	2.10

Discussion:

Figure 2.4: The text "method" was added to the end of the first diamond. A second diamond was added to indicate the inclusion of the addition three-pool steady-state Tier 2 modelling approach for soil carbon stock change.



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65 **Boxes**

Box Title	Type of Refinement	2006 Guidelines Box Number	2019 Refinement Box Number
Allometric Definitions	NG	-	2.1
New Technology: Terrestrial LIDAR	NG		2.2
Alternative Formulations of Equation 2.25 for Approach 1 Activity Versus Approach 2 or 3 Activity Data with Transition Matrices	E	2.1	2.3
Comparison between use of approach 1 aggregate statistics and approach 2 or 3 activity data with transition matrices	U	2.2	2.4
GHG emission sources with biochar production	NG	-	2.5
Description of the Tier 2 three-pool steady-state soil carbon model for estimating mineral soil organic carbon stock changes	NG	-	2.6
Examples of Tier 3 mineral soil C stock change methods	E	-	2.7
Examples of integration frameworks/coupling	NG	-	2.8
Model calibration through data assimilation	E	-	2.9
Model evaluation and improvement	E	-	2.10
Quantification of uncertainty	E	-	2.11
List of examples of natural disturbances (from the IPCC 2013 KP Supplement)	NG	-	2.12
Australian approach to managing interannual variability due to natural disturbances	NG	-	2.13
Canada's approach to managing interannual variability from natural disturbances	NG	-	2.14
Summary of possible methodologies based on analysis of historical emissions from NDs (i.e., the KP Supplement methodologies)	NG	-	2.15

66 Discussion:

67 Box 2.4 provides an elaboration with a definition for a parcel.



68 Box 2.5: The assumption made on when the land use change occurred was added to help compilers derive that
69 values presented in the approach 1 and approach 2 examples. Mistakes found in the values presented for approach
70 1 and approach 2 were corrected.

71 Box 2.6 provides an explanation of greenhouse gas emissions from biochar production.

72 Box 2.7: This box was added to describe the Tier 2 three-pool steady-state soil carbon model for estimating
73 mineral soil organic carbon stock changes.

74 Box 2.8 provides examples of the Tier 3 methods that compilers have developed and used for reporting soil C
75 stock changes.

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CHAPTER 3, CONSISTENT REPRESENTATION OF LANDS

Sections

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Introduction	NR	3.1	3.1
Land use categories	E	3.2	3.2
Representing land areas	E	3.3	3.3
Three approaches	NR	3.3.1	3.3.1
Using the data	E, U	3.3.2	3.3.2
Matching land areas with factors for estimating greenhouse gas emissions and removals	NG	3.4	3.4
Uncertainties associated with the Approaches	E	3.5	3.5
Examples of international land cover dataset	U	Annex 3A.1	Annex 3A.1
Development of land-use databases	E,U	Annex 3A.2	Annex 3A.2
Sampling	NR	Annex 3A.3	Annex 3A.3
Overview of potential methods for developing Approach 3 datasets	NR	Annex 3A.4	Annex 3A.3
Default climate and soil classifications	NR	Annex 3A.5	Annex 3A.5

Discussion:

While No Refinement was mandated to Section 3.2, an elaboration (E) is introduced on the clarification of the managed land proxy. In addition, there is a placeholder to further revise the text pending on the outcome of the refinement proposed for interannual variability (IAV) in Chapter 2

The refinement on section 3.3.2 includes new guidance on how to combine the data, how to derive IPCC land-use categories (including land-use classification and stratification processes) and tracking and distinguishing land-use changes.

Section 3.4 provide new guidance on how to use, combine and integrate different approaches and tiers to derive consistent emissions and removals estimated from land-use change. A special reference is made to the use of biomass maps

Even though “No Refinement” was mandated in Section 3.5 authors have decided to include the proposed refinement on Activity Data uncertainty (as requested) in this section. The elaborated text in this Section is to be read in conjunction with Vol. 1_Ch 3 Uncertainties.

Annex 3.A.1 has been updated with new land-use datasets

Annex 3.A.2 have been refined, including the elaboration and updating of the existing text (e.g. RS data preprocessing and classification methods) and new guidance on time series consistency in data processing).

Equations

Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
ANNUAL CHANGE IN CARBON STOCKS IN POOLS DUE TO CONVERSION	NG	-	3.1
ANNUAL CHANGE IN CARBON STOCKS IN POOLS DUE TO CONVERSION	NG	-	3.2

Discussion:

New equations were introduced as part of new guidance

Tables

Table Title	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
Example stratifications with supporting data for Tier 1 emissions estimation methods	NR	3.1	3.1
Example of Approach 1: Available land use data with complete national coverage	NR	3.2	3.2
Illustrative example of stratification of data for Approach 1	NR	3.3	3.3
Illustrative example of tabulating all land-use conversion for Approach 2 including nationally defined Strata	NR	3.4	3.4
Illustrative example of Approach 2 data in a land-use conversion matrix with category stratification	NR	3.5	3.5
Simplified land-use conversion matrix for Approach 2 example	NR	3.6	3.6
Example of data combination for the attribution of land use change.	E	-	3.7
Rules in the IPCC guidelines for classifying land use	E	-	3.8
Examples of auxiliary data and possible assumptions that can help with land use stratification (based on (GFOI 2016)).	E	-	3.9
Examples of rules to apply for land-use change categorization.	E	-	3.10



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Summary of uncertainties under Approaches 1 to 3	NR	3.7	3.11
Summary of remote sensing activities to determine change in LULC at various uncertainty levels (Kearney & Smukler 2016)	E	-	3.12
Examples of international land cover dataset	U	3A.1.1	3A.1.1
Example of area estimation via proportions	NR	3A.3.1	3A.3.1

Discussion

Additional tables were included as part of the elaboration on existent guidance

Figures

Figure Title	Type of Refinement	2006 Guidelines Figure Number	2019 Refinement Figure Number
Decision tree for preparation of land-use area data	NR	3.1	3.1
Example of decision tree for land-use change classification with combination of 1) RS data, 2) National Statistics and 3) Attribution rules.	E	-	3.2
Decision tree for classifying land use and land use change through time (see description for process).	E	-	3.3
Example of potential double counting of land using Approach 2 or map/sample differencing methods.	E	-	3.4

Discussion:

Additional figures were included as part of the elaboration on existent guidance

Boxes

Box Title	Type of Refinement	2006 Guidelines Box Number	2019 Refinement Box Number
CASE STUDY 1: ESTIMATING LAND USE AND LAND-USE CHANGE FROM GROUND MEASUREMENTS (SWEDEN)	E	-	3.1
CASE 2: STRATIFICATION AND MODEL-ASSISTED APPROACHES WHERE AUXILIARY INFORMATION FROM RS E.G. PIXELS (WALL-TO-WALL OR SAMPLE) IS USED TO IMPROVE THE ESTIMATES.	E	-	3.2
CASE 3: COMBINING INCOMPLETE SPATIALLY-EXPLICIT DATA AND ANCILLARY INFORMATION FOR LAND-USE CHANGE ATTRIBUTION AND CATEGORIZATION (ARGENTINA)	E	-	3.3
APPROACH TO DISTINGUISH TEMPORARY AND PERMANENT FOREST LAND CONVERSIONS (KENYA)	E	-	3.4

Discussion:

Case study examples have been incorporated demonstrating how countries have combined and worked with different types of data and sources of information in order to classify land use and attribute land-use conversions.



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CHAPTER 4, FOREST LANDS

Tables - Biomass

Ratio of below-ground biomass to above-ground biomass (R)	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
Climate domains (FAO, 2001), climate regions (Chapter 3), and ecological zones (FAO 2001)	NR	4.1	4.1
Forest and land cover classes	NR	4.2	4.2
Carbon fraction of aboveground forest biomass	NR	4.3	4.3
Ratio of below-ground biomass to above-ground biomass (R)	U	4.4	4.4
Default biomass conversion and expansion factors (BCEF), tonnes biomass (m ³ of wood volume) ⁻¹	U	4.5	4.5
	NR	4.6	4.6
Above-ground biomass in natural forests	E	4.7	4.7
Above-ground biomass in plantation forest	E	4.8	4.8
Above-ground net biomass growth in natural forests	E	4.9	4.9
Above-ground net biomass growth in plantation forests	E	4.10	4.10
Reported Mean Annual Increment (growth rate of merchantable volume) values for some plantation forest species [m ³ ha ⁻¹ yr ⁻¹]	E	4.11A, 4.11B	4.11
Tier 1 estimated biomass values from Tables 4.7–4.11 (except Table 4.11B) (values are approximate; use only for Tier 1)	U	4.12	4.12

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168 **CHAPTER 5, CROPLANDS**169 **Sections**

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Introduction	NR	5.1	5.1
Cropland Remaining Cropland	NR	5.2	5.2
Biomass	-	5.2.1	5.2.1
Choice of methods	E, U	5.2.1.1	5.2.2.1
Choice of emission factors	E, U	5.2.1.2	5.2.1.2
Choice of activity data	E	5.2.1.3	5.2.1.3
Calculations steps for Tier 1 and Tier 2	NR	5.2.1.4	5.2.1.4
Uncertainty assessment	NR	5.2.1.5	5.2.1.5
Dead organic matter	NR	5.2.2	5.2.2
Choice of methods	NR	5.2.2.1	5.2.2.1
Choice of emission/removal factors	NR	5.2.2.2	5.2.2.2
Choice of activity data	NR	5.2.2.3	5.2.2.3
Calculations steps for Tier 1 and Tier 2	NR	5.2.2.4	5.2.2.4
Uncertainty assessment	NR	5.2.2.5	5.2.2.5
Soil carbon	NR	5.2.3	5.2.3
Choice of methods	E, U, NG	5.2.3.1	5.2.3.1
Choice of stock change and emission factors	E, U, NG	5.2.3.2	5.2.3.2
Choice of activity data	E, U, NG	5.2.3.3	5.2.3.3
Calculations steps for Tier 1	U, NG	5.2.3.4	5.2.3.4
Uncertainty assessment	NR	5.2.3.5	5.2.3.5
Non-CO ₂ greenhouse gas emissions from biomass burning	NR	5.2.4	5.2.4
Choice of methods	NR	5.2.4.1	5.2.4.1
Choice of emission factors	NR	5.2.4.2	5.2.4.2
Choice of activity data	NR	5.2.4.3	5.2.4.3
Uncertainty assessment	NR	5.2.4.4	5.2.4.4
Land Converted to Cropland	NR	5.3	5.3



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Biomass	E	5.3.1	5.3.1
Choice of methods	E	5.3.1.1	5.3.1.1
Choice of emission factors	E, U	5.3.1.2	5.3.1.2
Choice of activity data	E	5.3.1.3	5.3.1.3
Calculations steps for Tier 1 and Tier 2	NR	5.3.1.4	5.3.1.4
Uncertainty assessment	NR	5.3.1.5	5.3.1.5
Dead organic matter	NR	5.3.2	5.3.2
Choice of methods	NR	5.3.2.1	5.3.2.1
Choice of emission/removal factors	NR	5.3.2.2	5.3.2.2
Choice of activity data	NR	5.3.2.3	5.3.2.3
Calculations steps for Tier 1 and Tier 2	NR	5.3.2.4	5.3.2.4
Uncertainty assessment	NR	5.3.2.5	5.3.2.5
Soil carbon	NR	5.3.3	5.3.3
Choice of methods	E, NG	5.3.3.1	5.3.3.1
Choice of stock change and emission factors	E, NG	5.3.3.2	5.3.3.2
Choice of activity data	E, NG	5.3.3.3	5.3.3.3
Calculations steps for Tier 1	U, NG	5.3.3.4	5.3.3.4
Uncertainty assessment	NR	5.3.3.5	5.3.3.5
Non-CO ₂ greenhouse gas emissions from biomass burning	NR	5.3.4	5.3.4
Choice of methods	NR	5.3.4.1	5.3.4.1
Choice of emission factors	NR	5.3.4.2	5.3.4.2
Choice of activity data	NR	5.3.4.3	5.3.4.3
Uncertainty assessment	NR	5.3.4.4	5.3.4.4
Completeness, time series, QA/QC, and reporting	NR	5.4	5.4
Completeness	NR	5.4.1	5.4.1
Developing a consistent time series	NR	5.4.2	5.4.2
Quality assurance and quality control	NR	5.4.3	5.4.3
Reporting and documentation	NR	5.4.4	5.4.4
Methane emissions from rice cultivation	NR	5.5	5.5

Choice of methods	NR	5.5.1	5.5.1
Choice of emission factors	U, NG	5.5.2	5.5.2
Choice of activity data	E	5.5.3	5.5.3
Uncertainty assessment	NR	5.5.4	5.5.4
Completeness, time series, QA/QC, and reporting	NR	5.5.5	5.5.5
Estimation of default stock change factors for mineral soil C emissions/removals for cropland	U	Annex 5A.1	Annex 5A.1
Estimation of Default Emission Factors and Scaling Factors for CH ₄ Emission from Rice Cultivation	NG	-	Annex 5A.2
Estimation of Coefficients and Factors for biomass C emissions and removals in cropland	NG	-	Annex 5A.3

Discussion:

The rice cultivation section updates the 2006 Guidelines for the: (i) baseline emission factor for continuously flooded rice fields without organic amendments (EF_c); (ii) scaling factor to account for the differences in water regimes during the cultivation period (SF_w); (iii) scaling factors to account for the differences in water regimes in the pre-season -before the cultivation period (SF_p); and (iv) scaling factors to account for the organic amendments applied (SF_o).

This rice cultivation section includes good practice guidance for developing a baseline emission factor. An example of how to apply the Tier 1 method for estimating methane emission from rice cultivation is also added. The revised guidelines also maintain the separate calculation of N₂O emission from rice cultivation (as one form of managed soil) which is dealt with in Chapter 11.

The biomass C section refines guidance by clarifying how to use default factors, and also provides updated factors. This section also provides additional examples of perennial cropland subcategories. This section also provides elaboration on activity data required for carbon gain estimation.

This biomass C section refines guidance by elaborating on how to calculate ΔC_G for *Land converted to Cropland*.

Updates in the soil C sections are mostly associated with new stock changes factors based on a new literature review and analysis.

New guidance in the soil C sections is associated with the Tier 2 three-pool steady-state carbon model for mineral soils and biochar amendments to mineral soils.



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Equations

Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
Cropland Litter Carbon Input for Three-Pool Steady-State C Model	NG	-	5.1
CH ₄ emissions from rice cultivation	NR	5.1	5.2
Adjusted daily emission factor	NR	5.2	5.3
Adjusted CH ₄ emission scaling factors for organic amendments	NR	5.3	5.4

Discussion:

Equation added to estimate the cropland litter C input for the three pool steady-state C model in the soil C section. More information on the model is provided in Chapter 2.

Tables

Table Title	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
Default coefficients for above-ground woody biomass and harvest cycles in cropping systems containing perennial species	U	5.1	5.1
Potential C storage for agroforestry systems in different ecoregions of the world	U	5.2	5.2
Examples of Classification of agroforestry system	NG	-	5.3
Default above-ground biomass for various types of perennial croplands	U	5.3	5.4
Examples of perennial cropland subcategories which a country may have	U	5.4	5.5
Relative stock change factors (FLU, FMG, and FI) (over 20 years) for different management activities on cropland	U	5.5	5.6
Default values for Nitrogen and Lignin Contents in Crops for Three-Pool Steady-State C Model	NG	-	5.7
Annual emission factors (EF) for cultivated organic soils	NR	5.6	5.8

Example of a simple disturbance matrix (Tier 2) for the impacts of land conversion activities on carbon pools	NR	5.7	5.9
Default biomass carbon stocks removed due to land conversion to cropland	U	5.8	5.10
Default biomass carbon stocks present on Land Converted to Cropland in the year following conversion	U	5.9	5.11
Soil stock change factors (FLU, FMG, FI) for land-use conversions to Cropland	NR	5.10	5.12
Default CH ₄ baseline emission factor assuming no flooding for less than 180 days prior to rice cultivation, and continuously flooded during rice cultivation without organic amendments	U	5.11	5.13
Default CH ₄ emission scaling factors for water regimes during the cultivation period relative to continuously flooded fields	U	5.12	5.14
Default CH ₄ emission scaling factors for water regimes before the cultivation period	U	5.13	5.15
Default conversion factor for different types of organic amendment	U	5.14	5.16

Discussion

Biomass C tables include updated default biomass parameters of biomass stocks and growth rates in Table 5.1, Table 5.2 and Table 5.3, as well as the explanation of how to use the updated values. Updated default parameters are also provided in Table 5.8 and Table 5.9, with explanation about how to use the updated tables. Table 5.8 is updated to provide more complete information on how to use B_{Before} to be consistent with assumptions in other chapters. Table 5.9 is updated with default values consistent with Tables 5.1 to 5.3 in *Cropland Remaining Cropland*.

Updated stock changes factors in soil C sections are based on a new literature review and analysis.

New table in soil C section provided lignin and nitrogen content values for cropland, which is needed for the Tier 2 three-pool steady-state carbon model for mineral soils.

Emission and scaling factors for methane emissions from rice cultivation are updated based on a new literature review and analysis.



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Figures

Figure Title	Type of Refinement	2006 Guidelines Figure Number	2019 Refinement Figure Number
Classification scheme for cropland systems	NR	5.1	5.1
Decision tree for CH ₄ emissions from rice production	NR	5.2	5.2

Boxes

Box Title	Type of Refinement	2006 Guidelines Box Number	2019 Refinement Box Number
Relevant carbon pools for cropland	NR	5.1	5.1
Conditions influencing CH ₄ emissions from rice cultivation	NR	5.2	
Good Practice Guidance for Developing Baseline Emission Factor (EF _C) for Methane Emission from Rice Cultivation	NG	-	5.3
Example of how to estimate Methane Emission from Rice Cultivation using Tier 1 Method	NG	-	5.4

Discussion:

Added guidance for developing Tier 2 emission factors and an example of the Tier 1 calculation in the rice cultivation section.

230 **CHAPTER 6, GRASSLANDS**231 **Sections**

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Introduction	NR	6.1	6.1
Grassland Remaining Grassland	NR	6.2	6.2
Biomass	NR ¹	6.2.1	6.2.1
Choice of methods	NR ¹	6.2.1.1	6.2.1.1
Choice of emission factors	NR ¹	6.2.1.2	6.2.1.2
Choice of activity data	NR ¹	6.2.1.3	6.2.1.3
Calculations steps for Tier 1 and Tier 2	NR ¹	6.2.1.4	6.2.1.4
Uncertainty assessment	NR	6.2.1.5	6.2.1.5
Dead organic matter	NR	6.2.2	6.2.2
Choice of methods	NR	6.2.2.1	6.2.2.1
Choice of emission/removal factors	NR	6.2.2.2	6.2.2.2
Choice of activity data	NR	6.2.2.3	6.2.2.3
Calculations steps for Tier 1 and Tier 2	NR	6.2.2.4	6.2.2.4
Uncertainty assessment	NR	6.2.2.5	6.2.2.5
Soil carbon	NR	6.2.3	6.2.3
Choice of methods	E, U, NG	6.2.3.1	6.2.3.1
Choice of stock change and emission factors	E, U, NG	6.2.3.2	6.2.3.2
Choice of activity data	E, U, NG	6.2.3.3	6.2.3.3
Calculations steps for Tier 1	U	6.2.3.4	6.2.3.4
Uncertainty assessment	NR	6.2.3.5	6.2.3.5
Non-CO ₂ greenhouse gas emissions from biomass burning	NR	6.2.4	6.2.4
Choice of methods	NR	6.2.4.1	6.2.4.1
Choice of emission factors	NR	6.2.4.2	6.2.4.2
Choice of activity data	NR	6.2.4.3	6.2.4.3
Uncertainty assessment	NR	6.2.4.4	6.2.4.4
Land Converted to Grassland	NR	6.3	6.3
Biomass	NR ¹	6.3.1	6.3.1
Choice of methods	NR ¹	6.3.1.1	6.3.1.1
Choice of emission factors	NR ¹	6.3.1.2	6.3.1.2
Choice of activity data	NR ¹	6.3.1.3	6.3.1.3
Calculations steps for Tier 1 and Tier 2	NR ¹	6.3.1.4	6.3.1.4
Uncertainty assessment	NR ¹	6.3.1.5	6.3.1.5
Dead organic matter	NR	6.3.2	6.3.2
Choice of methods	NR	6.3.2.1	6.3.2.1
Choice of emission/removal factors	NR	6.3.2.2	6.3.2.2
Choice of activity data	NR	6.3.2.3	6.3.2.3
Calculations steps for Tier 1 and Tier 2	NR	6.3.2.4	6.3.2.4
Uncertainty assessment	NR	6.3.2.5	6.3.2.5
Soil carbon	NR	6.3.3	6.3.3
Choice of methods	E, NG	6.3.3.1	6.3.3.1



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Choice of stock change and emission factors	E, NG	6.3.3.2	6.3.3.2
Choice of activity data	E, NG	6.3.3.3	6.3.3.3
Calculations steps for Tier 1	U, NG	6.3.3.4	6.3.3.4
Uncertainty assessment	NR	6.3.3.5	6.3.3.5
Non-CO ₂ greenhouse gas emissions from biomass burning	NR	6.3.4	6.3.4
Choice of methods	NR	6.3.4.1	6.3.4.1
Choice of emission factors	NR	6.3.4.2	6.3.4.2
Choice of activity data	NR	6.3.4.3	6.3.4.3
Uncertainty assessment	NR	6.3.4.4	6.3.4.4
Completeness, time series, QA/QC, and reporting	NR	6.4	6.4
Completeness	NR	6.4.1	6.4.1
Developing a consistent time series	NR	6.4.2	6.4.2
Quality assurance and quality control	NR	6.4.3	6.4.3
Reporting and documentation	NR	6.4.4	6.4.4
Estimation of default stock change factors for mineral soil C emissions/removals for grassland	U	Annex 6A.1	Annex 6A.1

Discussion:

Lead authors are reviewing the literature and planning to update the factors in the biomass C section.

Updates in the soil C sections are mostly associated with new stock changes factors based on a new literature review and analysis.

New guidance in the soil C sections is associated with the Tier 2 three-pool steady-state carbon model for mineral soils, and biochar amendments to mineral soils.

Equations

Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
Grassland Litter Carbon Input for Three-Pool Steady-State C Model	NG	-	6.1

Discussion:

New equation added in this section to estimate grassland litter C input for three-pool steady-state carbon model for mineral soils.

Tables

Table Title	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
Default expansion factors of the ratio of below-ground biomass to aboveground biomass (R) for the major grassland ecosystems of the world	NR ¹	6.1	6.1
Relative stock change factors for grassland management	U	6.2	6.2
Default values for Nitrogen and Lignin Contents in Crops for Three-Pool Steady-State C Model	NG	-	6.3
Annual emission factors (EF) for drained grassland organic soils	NR	6.3	-
Default biomass stocks present on grassland, after conversion from other land use	NR ¹	6.4	6.4

Discussion

Lead authors are reviewing the literature and planning to update the factors in the biomass C tables.

Updated stock changes factors in soil C sections are based on a new literature review and analysis.

New table in soil C section provided lignin and nitrogen content values for grassland, which is needed for the Tier 2 three-pool steady-state carbon model for mineral soils.

Figures

Figure Title	Type of Refinement	2006 Guidelines Figure Number	2019 Refinement Figure Number
Classification scheme for grassland/grazing systems	NR	6.1	6.1



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CHAPTER 7, FLOODED LANDS**Sections**

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Introduction	E	7.1	7.1
Managed Peatlands	NR	7.2	7.2
Peatlands Remaining Peatlands	NR	7.2.1	7.2.1
CO ₂ emissions from Peatlands Remaining Peatlands	NR	7.2.1.1	7.2.1.1
Non-CO ₂ emissions from Peatlands Remaining Peatlands	NR	7.2.1.2	7.2.1.2
Uncertainty assessment	NR	7.2.1.3	7.2.1.3
Land Being Converted for Peat Extraction	NR	7.2.2	7.2.2
CO ₂ emissions on lands being converted for peat extraction	NR	7.2.2.1	7.2.2.1
Non-CO ₂ emissions from lands being converted to managed peatlands	NR	7.2.2.2	7.2.2.2
Uncertainty assessment	NR	7.2.2.3	7.2.2.3
Flooded Land	NG	7.3	7.3
Flooded Land Remaining Flooded Land	NG	7.3.1	7.3.1
CO ₂ emissions from Land Remaining Flooded Land	NG	-	7.3.1.1
Non-CO ₂ emissions from Flooded Land remaining Flooded Land	NG	-	7.3.1.2
Land Converted to Flooded Land	NG	7.3.2	7.3.2
CO ₂ emissions from Land Converted to Flooded Land	NG	7.3.2.1	7.3.2.1
Non-CO ₂ emissions from Land Converted to Flooded Land	NG	7.3.2.2	7.3.2.2
Uncertainty assessment	E	7.3.2.3	7.3.3
Wetland Mineral Soils	NG	-	7.4
Choice of method	NG	-	7.2.3.1
Choice of emission/removal factors	NG	-	7.2.3.2
Choice of activity data	NG	-	7.2.3.3
Uncertainty Assessment	NG		
Completeness, Time series consistency, and QA/QC	NR	7.4	7.5
Completeness	NR	7.4.1	7.5.1
Developing a consistent time series	NR	7.4.2	7.5.2
Quality Assurance and Quality Control (QA/QC)	NR	7.4.3	7.5.3
Reporting and Documentation	NR	7.4.4	7.5.4
Future methodological development	R	7.5	-
Estimation of Default Emission Factor(s) for greenhouse gas emissions from flooded lands	NG	-	Annex 7.1
Sedimentation and carbon burial in reservoirs	NG	-	Annex 7.2

Discussion:

Most of the refinements in this chapter are associated with new guidance for Flooded Lands.

A new section, Section 7.4, has been included to provide guidance for the Tier 2 three-pool steady-state carbon model for mineral soils

Section 7.5, Future Methodological Development was removed from the guidance because the methods have been developed in the 2013 IPCC Wetlands Supplement and in this refinement.

Equations

Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
CO ₂ emissions from wetlands	NR	7.1	7.1
CO ₂ emissions in peatlands during peat extraction	NR	7.2	7.2
CO ₂ –C emissions from managed peatlands (Tier 1)	NR	7.3	7.3
On-site soil CO ₂ –C emissions from managed peatlands (Tier 1)	NR	7.4	7.4
Off-site CO ₂ –C emissions from managed peatlands (Tier 1)	NR	7.5	7.5
On-site CO ₂ –C emissions from managed peatlands (Tiers 2 and 3)	NR	7.6	7.6
N ₂ O emissions from peatlands during peat extraction	NR	7.7	7.7
CO ₂ –C emissions in peatland being drained for peat extraction	NR	7.8	7.8
CO ₂ –C emissions from soils in peatland being drained for peat extraction	NR	7.9	7.9
Annual CH ₄ emissions for Reservoirs >20 years old (Flooded land Remaining Flooded Land) and < 20 years old (Land converted to flooded land)	NG	-	7.10
Equation used to scale CH ₄ emission factors for the influence of eutrophication using measured values of chlorophyll a	NG	-	7.11
Annual CH ₄ emission from human-made ponds and channels	NG	-	7.12
Annual on-site CO ₂ –C emissions/removals from newly flooded land	NG	-	7.13
Annual change in carbon stocks in living biomass on land converted to permanently Flooded Land	R	7.10	-

Discussion:

New equations are added associated with new guidance for Flooded Lands.

Annual change in carbon stocks in living biomass on land converted to permanently Flooded Land has been removed due to changes in the methods associated with estimating the CO₂ emissions from Flooded Lands.



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Tables

Table Title	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
Sections addressing major greenhouse gas emissions from managed wetlands	U	7.1	7.1
Guidance on emissions from wetlands managed for other uses	NR	7.2	7.2
Ramsar classes of human-made wetlands	U	7.3	7.3
Emission factors for CO ₂ -C and associated uncertainty for lands managed for peat extraction, by climate zone	NR	7.4	7.4
Conversion factors for CO ₂ -C for volume and weight production data	NR	7.5	7.5
Default emission factors for N ₂ O emissions from managed peatlands	NR	7.6	7.6
Types of flooded land and their human uses	NG	-	7.7
CH ₄ Emissions for reservoirs	NG	-	7.8
Ratio of total degassing flux of methane (kg CH ₄ -C ha ⁻¹ yr ⁻¹) to the flux of methane from a reservoir's surface to the atmosphere (kg CH ₄ -C ha ⁻¹ yr ⁻¹) – R _{dgas}	NG	-	7.9
Default CH ₄ emission factors for human-made ponds and channels	NG	-	7.10
CO ₂ Emission factors for soils after flooding of land	NG	-	7.11

Discussion

New tables are added associated with the guidance for Flooded Lands.

Figures

Figure Title	Type of Refinement	2006 Guidelines Figure Number	2019 Refinement Figure Number
Decision tree to estimate CO ₂ -C and N ₂ O emissions from Peatlands Remaining Peatlands	NR	7.1	7.1
Decision tree to estimate CO ₂ and CH ₄ emissions from <i>Flooded Land remaining Flooded Land</i> and <i>Land Converted to Flooded Land</i> .	NG	-	7.2

Discussion:

Figure 7.2 is included to assist compilers with factoring out emissions associated with Flooded Lands prior to flooding.

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300 **CHAPTER 8, SETTLEMENTS**301 **Sections**

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Introduction	NR	8.1	8.1
Settlements Remaining Settlements	NR	8.2	8.2
Biomass	NR	8.2.1	8.2.1
Choice of method	NR	8.2.1.1	8.2.1.1
Choice of emission/removal factors	U, E	8.2.1.2	8.2.1.2
Choice of activity data	NR	8.2.1.3	8.2.1.3
Uncertainty assessment	E	8.2.1.4	8.2.1.4
Dead Organic Matter	NR	8.2.2	8.2.2
Choice of method	NR	8.2.2.1	8.2.2.1
Choice of emission/removal factors	NR	8.2.2.2	8.2.2.2
Choice of activity data	NR	8.2.2.3	8.2.2.3
Uncertainty assessment	NR	8.2.2.4	8.2.2.4
Soil Carbon	NG, E	8.2.3	8.2.3
Choice of method	NG, E	8.2.3.1	8.2.3.1
Choice of stock change and emission factors	NG, E	8.2.3.2	8.2.3.2
Choice of activity data	NG, E	8.2.3.3	8.2.3.3
Uncertainty assessment	NR	8.2.3.4	8.2.3.4
Land Converted to Settlements	NR	8.3	8.3
Biomass	NR	8.3.1	8.3.1
Choice of method	U	8.3.1.1	8.3.1.1
Choice of emission/removal factors	U	8.3.1.2	8.3.1.2
Choice of activity data	E	8.3.1.3	8.3.1.3
Uncertainty assessment	NR	8.3.1.4	8.3.1.4
Dead organic matter	NR	8.3.2	8.3.2
Choice of method	NR	8.3.2.1	8.3.2.1
Choice of emission/removal factors	NR	8.3.2.2	8.3.2.2
Choice of activity data	NR	8.3.2.3	8.3.2.3
Uncertainty assessment	NR	8.3.2.4	8.3.2.4
Soil carbon	NG, E	8.3.3	8.3.3
Choice of method	NG	8.3.3.1	8.3.3.1
Choice of stock change and emission factor	NG	8.3.3.2	8.3.3.2
Choice of activity data	NG, E	8.3.3.3	8.3.3.3
Uncertainty assessment	NR	8.3.3.4	8.3.3.4
Completeness, time series consistency, QA/QC and reporting	NR	8.4	8.4
Completeness	NR	8.4.1	8.4.1
Developing a consistent time series	NR	8.4.2	8.4.2
Inventory quality assurance/quality control	NR	8.4.3	8.4.3
Reporting and documentation	NR	8.4.4	8.4.4



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Basis for future methodological development	U	8.5	8.5
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Discussion:

- (i) Section 8.2.1.2 includes refinement of guidance to update default values in Table 8.1 and Table 8.2 and includes elaborate explanations on how to apply the default values.
- (ii) In section 8.2.1.4, new information may be added after updating Tables 8.1 and 8.2
- (iii) New guidance on the new Tier 2 three-pool steady-state carbon model for mineral soils in sections 8.2.3 and 8.3.3
- (iv) A section, providing step-by-step procedures for implementing the three-pool steady-state soil carbon model for mineral soils, was added.
- (v) Section 8.3.1.1 provides guidance by clarifying how to apply terms of B_{Before} , B_{After} , ΔC_G and ΔC_L for Equation 2.15 and 2.16 in each Tier.
- (vi) In section 8.3.1.2, new guidance, based on an updated Table 8.4 and explanations on Tier 2 and Tier 3 were included. The guidance on Tier 2 and Tier 3 are enhanced to clarify choice and use of emission/removal factors under higher tiers.
- (vii) In section 8.3.1.3, new guidance was elaborated by adding a few sentences explaining data acquisition for Tier 2 and 3.
- (viii) New guidance on the new Tier 2 three-pool steady-state carbon model for mineral soils in section 8.3.3
- (ix) No refinements were done for organic soils in sections 8.3.3.1, 8.3.3.2 and 8.3.3.3; but reference was made to the 2013 Wetlands supplement
- (x) In section 8.5, details of the basis for future methodological development which were no longer relevant were deleted

Equations

Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
Annual carbon change in live biomass pools in Settlements Remaining Settlements	NR	8.1	8.1
Annual biomass increment based on total crown cover area	NR	8.2	8.2
Annual biomass growth based on number of individual woody plants in broad classes	NR	8.3	8.3

Tables

Table title	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
Tier 2A default crown cover area-based growth rates (CRW) for urban tree crown cover by region	U	8.1	8.1
Tier 2B default average annual carbon accumulation per tree in urban trees by species classes	U	8.2	8.2
Default activity data by potential natural vegetation (PNV) type for percent tree cover	NR	8.3	8.3
Default biomass carbon stocks removed due to Land conversion to settlements	U	8.4	8.4

Discussion



- 327 1. Updated tables 8.1 and 8.2 will potentially provide new default values
- 328 2. Uncertainty ranges for carbon stock in biomass before conversion will potentially be updated based on updates
- 329 in Tables 6.4 and 5.9.
- 330 3. Updated Table 8.4 provides more information on how to use B_{Before} .
- 331
- 332



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CHAPTER 9, OTHER LANDS**Sections**

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Introduction	NR	9.1	9.1
Other Land Remaining Other Land	NR	9.2	9.2
Land Converted to Other Land	NR	9.3	9.3
Biomass	NR	9.3.1	9.3.1
Choice of method	NR	9.3.1.1	9.3.1.1
Choice of stock change and emission factors	NR	9.3.1.2	9.3.1.2
Choice of activity data	NR	9.3.1.3	9.3.1.3
Uncertainty assessment	NR	9.3.1.4	9.3.1.4
Dead organic matter	NR	9.3.2	9.3.2
Choice of method	NR	9.3.2.1	9.3.2.1
Choice of stock change and emission factors	NR	9.3.2.2	9.3.2.2
Choice of activity data	NR	9.3.2.3	9.3.2.3
Uncertainty assessment	NR	9.3.2.4	9.3.2.4
Soil carbon	NG, E	9.3.3	9.3.3
Choice of method	NG	9.3.3.1	9.3.3.1
Choice of stock change and emission factors	NG	9.3.3.2	9.3.3.2
Choice of activity data	NG	9.3.3.3	9.3.3.3
Uncertainty assessment	NR	9.3.3.4	9.3.3.4

Discussion:

- 1) New guidance and elaborations were included in section 9.3.3 and were mostly centered on the new Tier 2 three-pool steady-state carbon model for mineral soils.
- 2) Step-by-step procedure for implementing the three-pool steady-state soil carbon model for mineral soils were added in sections 9.3.3.1, 9.3.3.2, 9.3.3.3

342 **CHAPTER 10, LIVESTOCK AND MANURE MANAGEMENT**343 **Sections**

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Introduction	NR	10.1	10.1
LIVESTOCK POPULATION AND FEED CHARACTERISATION	U/E	10.2	10.2
Steps to define categories and subcategories of livestock	NR	10.2.1	10.2.1
Choice of method	U/E	10.2.2	10.2.2
Uncertainty assessment	NR	10.2.3	10.2.3
Characterisation for livestock without species: Specific emission estimation methods	NR	10.2.4	10.2.4
Methane emissions from enteric fermentation	U/E	10.3	10.3
Choice of method	U/E	10.3.1	10.3.1
Choice of emission factors	U/E	10.3.2	10.3.2
Choice of activity data	NR	10.3.3	10.3.3
Uncertainty assessment	NR	10.3.4	10.3.4
Completeness, Time series, Quality Assurance/Quality Control and Reporting	NR	10.3.5	10.3.5
Methane emissions from manure management	U/E	10.4	10.4
Choice of method	U/E	10.4.1	10.4.1
Choice of emission factors	U/E	10.4.2	10.4.2
Choice of activity data	E	10.4.3	10.4.3
Uncertainty assessment	NR	10.4.4	10.4.4
Completeness, Time series, Quality Assurance/Quality Control and Reporting	NR	10.4.5	10.4.5
N ₂ O emissions from manure management	U/E	10.5	10.5
Choice of method	NR	10.5.1	10.5.1
Choice of emission factors	U/E	10.5.2	10.5.2



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Choice of activity data	NR	10.5.3	10.5.3
Coordination with reporting for N ₂ O emissions from managed soils	U/E	10.5.4	10.5.4
Uncertainty assessment	NR	10.5.5	10.5.5
Completeness, Time series, Quality Assurance/Quality Control and Reporting	E	10.5.6	10.5.6
Use of worksheets	NR	10.5.7	10.5.7
Data underlying methane default emission factors for Enteric Fermentation	U/E	Annex 10A.1	Annex 10A.1
Data underlying methane default emission factors for Manure Management	U/E	Annex 10A. 2	Annex 10A. 2
Data underlying N ₂ O default emission factors for Manure Management			Annex 10A.3
Set of equations relating all direct and indirect N ₂ O emissions from manure along all stages in agricultural production for livestock species/category T			Annex 10A4.
Description and Discussion of Proposed Changes to MCF Calculations for Liquid/Slurry			Annex 10A.5
Describe the monthly temperature of each climate zones according to chapter XX			Annex 10A.6

344

345 Discussion:

346 10.2.2: Choice of Method. The Tier 1 method was elaborated upon through the development of an additional
 347 livestock characterization was added in order to improve guidance for countries in which there are large differences
 348 in the types of production systems, either because their agricultural sectors are transitioning from a local food
 349 production system model to a more commercial model, or simply that distinct low production food systems exist
 350 in parallel to high production agricultural systems. In these cases, countries have an intermediary option to
 351 customize their emission estimates between the traditional Tier 1 method and the more data intensive Tier 2
 352 methods. Production systems were defined for different animal categories.

353 Various updates were made to certain sections of text, where references were dated and the symbol used for
 354 digestibility was modified from DE to DC to avoid confusion with digestible energy. Digestibility is the fraction
 355 of digestible energy to gross energy and the use of this symbol can cause confusion who are used to seeing DE as
 356 digestible energy and not digestibility.

357 The Tier 2 method was elaborated upon through the addition of parameters for a Tier 2 characterisation of goat
 358 production resulting in modifications to many Tables and Figures.

359 The Simplified Tier 2 approach was elaborated to include dairy cattle specific equations and more up to date
 360 equations for the non-dairy sector.

In Section 10.3.1 elaboration to text were integrated to maintain consistency with elaborations carried out in Section 10.2.2. In Section 10.3.2,

Equations

Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
ANNUAL AVERAGE POPULATION	NR	10.1	10.1
Coefficient for calculating net energy for maintenance	NR	10.2	10.2
Net energy for maintenance	E	10.3	10.3
Net energy for activity (for cattle and buffalo)	NR	10.4	10.4
Net energy for activity (for sheep and goats)	E	10.5	10.5
Net energy for growth (for cattle and buffalo)	NR	10.6	10.6
Net energy for growth (for sheep and goats)	E	10.7	10.7
Net energy for lactation (for beef cattle, dairy cattle and buffalo)	NR	10.8	10.8
Net energy for lactation for sheep and goats (milk production known)	E	10.9	10.9
Net energy for lactation for sheep and goats (milk production unknown)	E	10.10	10.10
Net energy for work (for cattle and buffalo)	NR	10.11	10.11
Net energy to produce wool (for sheep and goats)	E	10.12	10.12
Net energy for pregnancy (for cattle/buffalo, sheep and goats)	E	10.13	10.13
Ratio of net energy available in a diet for maintenance to digestible energy consumed	E	10.14	10.14
Ratio of net energy available for growth in a diet to digestible energy consumed	E	10.15	10.15
Gross energy for cattle/buffalo, sheep and goats	E	10.16	10.16



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Estimation of dry matter intake for calves	E		10.17
Estimation of dry matter intake for growing cattle	E	10.17	10.18
Estimation of dry matter intake for Steers	N	-	10.19
Estimation of dry matter intake for Heifers	N	-	10.19
Estimation of dry matter intake for mature beef cattle	E	10.18a	Table form
Estimation of dry matter intake for mature dairy cows	E	10.18b	10.20
Tier 1A Enteric fermentation emissions from a livestock category	NR	10.19	10.21
Tier 1B Enteric fermentation emissions from a livestock category	N		10.22
Tier1 Total emissions from livestock enteric fermentation	NR	10.20	10.23
CH ₄ emission factors for enteric fermentation from a livestock category	NR	10.21	10.24
CH ₄ emission factors for enteric fermentation from a livestock category	N		10.25
Methane emissions from manure management	U	10.22	10.26
Annual vs excretion rates			10.27
Methane emission factor from manure management	U	10.23	10.28
Volatile solid excretion rates	NR	10.24	10.29
Methane conversion factor for manure based biogas digester			10.30
Methane conversion factor for co digestion biogas digester			10.31
Direct nitrous oxide emissions from manure management	NR	10.25	10.32
N losses due to volatilisation from manure management	NR	10.26	10.33
Indirect nitrous oxide emissions due to volatilisation of N from manure management	NR	10.27	10.34



N losses due to leaching from manure management systems	NR	10.28	10.35
Indirect nitrous oxide emissions due to leaching from manure management	NR	10.29	10.36
Annual N excretion rates	NR	10.30	10.37
Annual N excretion rates (tier 2)	NR	10.31	10.38
N intake rates for cattle	NR	10.32	10.39
N retained rates for cattle	NR	10.33	10.40
Managed manure N available for application to managed soils, feed, fuel or construction uses	U	10.34	10.41
Correction factor to estimate direct n ₂ o emissions and indirect n ₂ o emissions via leaching and run-off for situations where ammonia emissions from managed soils have been reduced as a consequence of mitigation technologies			10.42
Total nitrous oxide emissions for animal type t			A4-1
Total nitrous oxide emissions from manure management for animal type t			A4-2, A4-3
Total, direct and indirect nitrous oxide emissions from the application of manure to managed soils for animal type t			A4-4, A4-5, A4-6
Total amount of animal manure n applied to soils other than by grazing animals for animal type t			A4-7
Fraction of animal manure n available for application to managed soils, applied to managed soils for animal type t			A4-8
Total, direct and indirect n ₂ o emissions from n in urine and dung deposited by grazing animals on pasture, range and paddock (tier 1) for animal type t			A4-9, A4-10, A4-11
Relationship between average annual nitrogen flows associated with an individual animal and the annual nitrogen flow for the animal population of livestock category/species t in a country			A4-12



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Total manure-n excreted			A4-13
Nitrogen excretion calculated either using a default fraction of retention (tier 1) or directly from retention data			A4-14, A4-15
Total manure-n in manure management and storage systems			A4-16
Manure-n managed in system s			A4-17
Manure-n deposited by grazing animals, with $x=c_{pp,so}$			A4-18
N in bedding material added to managed manure			A4-19

366

367 Discussion: All equations for calculating net energy were modified by adding parameters required to carry out
 368 Tier 2 emission factor development for goats. The equations used in the calculation of gross energy were not
 369 modified with the exception of the nomenclature used for digestibility, changing from DE to DC, for reasons
 370 explained above.

371 Equations required to carry out Tier 1b calculations were added.

372 Equations for calculating the simplified Tier 2 were updated and elaborated upon. Finally, an equation was added
 373 to calculate an emission factor directly from dry matter intake estimates (DMI).

374 **Tables**

375

Table Title	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
Representative livestock categories	E	10.1	10.1
Representative feed digestibility for various livestock categories	U	10.2	10.2
Summary of the equations used to estimate daily gross energy intake for cattle, buffalo and sheep and goats	E	10.3	10.3
Coefficients for calculating net energy for maintenance (NE_m)	U /E	10.4	10.4
Activity coefficients corresponding to animal's feeding situation	U/E	10.5	10.5
Constants for use in calculating NE_g for Sheep and Goats	U/E	10.6	10.6
Constants for use in calculating NE_p in equation 10.13	E	10.7	10.7
Examples of NE_{ma} content of typical diets fed to Cattle for estimation of dry matter intake in Equations 10.17 and 10.18	E	10.9	10.9



Suggested emissions inventory methods for enteric fermentation	E	10.10	10.10
Enteric fermentation emission factors for Tier 1 method	U/E	10.11	10.11
Tier 1a Enteric fermentation emission factors for Cattle and Buffalo	U	-	10.12
Tier 1b Enteric fermentation emission factors for Cattle	E	—	10.13
Cattle/Buffalo CH ₄ conversion factors (Y _m)	U/E	10.12	10.14
Sheep and goats CH ₄ conversion factors (Y _m)	U/E	10.13	10.15
Default values for volatile solid excretion rate			10.16
Average regional CH ₄ emission factors of cattle by climate zone			10.17
Average regional CH ₄ emission factors of swine by climate zone			10.18
Manure management methane emission factors by temperature for Cattle, Swine, and Buffalo		10.14	
Manure management methane emission factors by temperature for Sheep, Goats, Camels, Horses, Mules and Asses, and Poultry	U/E	10.15	10.19
Manure management methane emission factors for Deer, Reindeer, Rabbits, and fur-bearing animals	U/E	10.16	10.20
MCF values by temperature for manure management system (IPCC 2019 MCF values for climate zone)	U/E	10.17	10.21
Definitions of manure management systems	E	10.18	10.22
Default values for nitrogen excretion rate	U/E	10.19	10.23
Default values for the fraction of nitrogen in feed intake of livestock that is retained by the different livestock species/categories (fraction N-intake retained by the animal)	U/E	10.20	10.24
Default emission factors for direct N ₂ O emissions from manure management	U/E	10.21	10.25



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Default values for nitrogen loss due to volatilisation of NH ₃ and NO _x from manure management	U/E	10.22	10.26
Default values for total nitrogen loss from manure management		10.23	
Default values for molecular nitrogen (N ₂) loss from manure management			10.27
Data for estimating tier 1 enteric fermentation CH ₄ emission factors for dairy cows in table 10.12 and 10.13 and nitrogen excretion factor	U/E	10A.1	10A.1a /10A.1b
Data for estimating tier 1 enteric fermentation CH ₄ emission factors for other cattle in table 10.12 and 10.13 and nitrogen excretion factor	U/E	10A.2	10A.2a/A.2b
Data for Estimating Enteric Fermentation Emission Factors for Dairy Buffalo and nitrogen excretion factor	U	-	10.A.3a
Data for Estimating Enteric Fermentation Emission Factors for Other Buffalo and nitrogen excretion factor	U	-	10.A.3b
Manure Management Methane Emission Factor Derivation for Dairy Cattle	U/E	10A-4	10A-4
Manure Management Methane Emission Factor Derivation for Non-dairy Cattle	U/E	10A-5	10A-5
Manure Management Methane Emission Factor Derivation for Meat-Buffer and Dairy-Buffer	U/E	10A-6	10A-6, 10A-7
Manure Management Methane Emission Factor Derivation for Market-industrial Swine and Market-intermediate Swine and Market-backyard Swine	U/E	10A-7	10A-8, 10A-10, 10A-12
Manure Management Methane Emission Factor Derivation for Breeding-industrial Swine and Breeding-intermediate Swine and Breeding-backyard Swine	U/E	10A-8	10A-9, 10A-11, 10A-13
Manure Management Methane Emission Factor Derivation for Meat Sheep			10A-14
Manure Management Methane Emission Factor Derivation for Dairy Sheep			10A-15
Manure Management Methane Emission Factor Derivation for Goat			10A-16



Manure Management Methane Emission Factor Derivation for Chicken Layer			10A-17
Manure Management Methane Emission Factor Derivation for Broiler			10A-18
Manure Management Methane Emission Factor Derivation for Backyard Chicken			10A-19
Manure management methane emission factor derivation for Other Animals	U/E	10A-9	10A-20
Default Tier 1 EF (EF _{NH3}) for calculation of NH ₃ emissions from manure management			10A-21
Default Tier 1 EFs for NO from stored manure			10A-22
Default Tier 2 NH ₃ -N EFs and associated parameters for the Tier 2 methodology for the calculation of the NH ₃ -N emissions from manure management			10A-23
Default values for other losses needed in the mass-flow calculation			10A-24
Comparison of manure storage type definitions used here and those used by the IPCC			10A-25
IPCC 2006 Table of MCF values for Liquid/Slurry			10A-26
MCFs calculated for each retention time and climate			10A-27

Discussion:

Table 10.1 added high and low productivity systems and identified the enhanced livestock definitions that would go with them while Table 10.2 was modified to update information in it, such that the values were consistent with production systems in 2019.

Modifications to Tables 10.3 to 10.7 provide additional values required to calculate Tier 2 estimates for goat production.

The simplified Tier 2 methodology was elaborated with new equations and some new parameters were added to Tables. In Section 10.3.2, Tier 1a emission factors were updated and Tier 1b emission factors were developed. The methane conversion rate (Y_m) Table was expanded to increase the number of animal categories and improve consistency with feed quality as well as factors to calculate emissions directly from the DMI estimate using the simplified Tier 2 approach.



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Figures

Figure Title	Type of Refinement	2006 Guidelines Figure Number	2019 Refinement Figure Number
Decision tree for livestock population characterisation	NR	10.1	10.1
Decision Tree for CH ₄ Emissions from Enteric Fermentation	E	10.2	10.2
Decision tree for CH ₄ emissions from Manure Management	NR	10.3	10.3
Decision tree for N ₂ O emissions from Manure Management (Note 1)	NR	10.4	10.4
Processes leading to the emission of gaseous N species from manure			10.5
Accounting for N-flow in estimating direct N ₂ O emissions and indirect N ₂ O emissions from leaching and runoff from managed soils			10.6

Discussion: Modification of decision tree for inclusion of Tier 1b concept.

CHAPTER 11, N₂O EMISSIONS FROM MANAGED SOILS AND CO₂ EMISSIONS FROM LIME AND UREA APPLICATIONS

Sections

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Introduction	NR	11.1	11.1
N ₂ O emissions from managed soils	NR	11.2	11.2
Direct N ₂ O emissions	NR	11.2.1	11.2.1
Choice of method	U	11.2.1.1	11.2.1.1
Choice of emission factors	U	11.2.1.2	11.2.1.2
Choice of activity data		11.2.1.3	11.2.1.3
<i>Applied synthetic fertiliser (F_{SN})</i>	NR		
<i>Applied organic N fertilisers (F_{ON})</i>	NR		
<i>Urine and dung from grazing animals (F_{PRP})</i>	NR		
<i>Crop residue N, including N-fixing crops and forage/pasture renewal, returned to soils, (F_{CR})</i>	U		
<i>Mineralised N resulting from loss of soil organic C stocks in mineral soils through land-use change or management practices (F_{SOM})</i>	NR		
<i>Calculation steps for estimating changes in N supply from mineralization</i>	NR		
<i>Area of drained/managed organic soils (F_{OS})</i>	NR		
Uncertainty assessment	NR	11.2.1.4	11.2.1.4
Indirect N ₂ O emissions	NR	11.2.2	11.2.2
Choice of method	U	11.2.2.1	11.2.2.1
Choice of emission, volatilisation and leaching factors	U	11.2.2.2	11.2.2.2
Choice of activity data	NR	11.2.2.3	11.2.2.3
Uncertainty assessment	NR	11.2.2.4	11.2.2.4
Completeness, Time series, QA/QC	NR	11.2.3	11.2.3
CO ₂ Emissions from Liming	NR	11.3	11.3



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CO ₂ Emissions from Urea Fertilization	NR	11.4	11.4
References for crop residue data in Table 11.2	NR	Annex 11A.1	Annex 11A.1
References	NR	-	-

Discussion:

11.2.1.1. Choice of method Footnote 6 was updated.

11.2.1.2. Text revised in light of updated EF1 and EF3PRP values. Footnotes 7, 9, and 10 also updated. Note that footnotes 7, 9, and 10 correspond to footnotes 8, 10, and 11 in the 2006 guidelines, given that the introduction (section 11.1) which is not refined and contained footnote 1 was suppressed.

11.2.1.3. Crop residue N, including N-fixing crops and forage/ pasture renewal, returned to soils, (FCR)

Equation 11.6 was updated as well as part of the text describing the terms of the equation. Equation 11.7A was suppressed. Table 11.2 was updated and a new Table was introduced (see more details in the Table section below).

11.2.2.1 & 11.2.2.2 Updated with minor corrections made due to EF refinement. Sentences on difference between 1996GL and 2006GL deleted (footnote 17).

Equations

Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
Direct N ₂ O emissions from managed soils (Tier 1)	NR	11.1	11.1
Direct N ₂ O emissions from managed soils (Tier 2)	NR	11.2	11.2
N from organic N additions applied to soils (Tier 1)	NR	11.3	11.3
N from animal manure applied to soils (Tier 1)	NR	11.4	11.4
N in urine and dung deposited by grazing animals on pasture, range and paddock	NR	11.5	11.5
N from crop residues and forage/pasture renewal (Tier 1)	U	11.6	11.6
Dry-weight correction of reported crop yields	NR	11.7	11.7
Alternative approach to estimate F _{CR} (using Table 11.2)	U	11.7A	Suppressed
N mineralised in mineral soils as a result of loss of soil C through change in land use or management (Tiers 1 and 2)	NR	11.8	11.8

N ₂ O from atmospheric deposition of N volatilised from managed soils (Tier 1)	NR	11.9	11.9
N ₂ O from N leaching/runoff from managed soils in regions where leaching/runoff occurs (Tier 1)	NR	11.10	11.10
N ₂ O from atmospheric deposition of N volatilised from managed soils (Tier 2)	NR	11.11	11.11

Discussion:

Equation 11.6 was updated.

Equation 11.7A was suppressed.

Tables

Table Title	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
Default emission factors to estimate direct N ₂ O emissions from managed soils	U	11.1	11.1
Default factors for estimation of N added to soils from crop residues	U	11.2	11.2
Default values for R _{AG(T)} to be used in Equation 11.6	E	n.a.	11.X
Default emission, volatilisation and leaching factors for indirect soil N ₂ O emissions	U	11.3	11.3

Discussion:

Table 11.1 contains updated EF1, EF1FR and EF3PRP. Methods, data and references used for determining updated values and their uncertainties are collated in V4_11_Ch11_N2O&CO2 - Documenting Factors.

Table 11.2 was updated. The title “Default factors for estimation of N added to soils from crop residues” was changed to “Alternative Method for Estimating Above-ground Residue (**AGR**_(T))”. The units of AGR_(T) were changed from Mg/ha to kg. d.m. ha⁻¹; in alignment with the unit in Equation 11.6. Default values for slope, intercept, errors remained unchanged. Former columns ‘Dry matter fraction of harvested product (DRY)’, ‘N content of above-ground residues (NAG)’, ‘Ratio of below-ground residues to above-ground biomass (RBG-BIO)’, and ‘N content of below-ground residues (NBG)’ were moved to new Table 11.X.

A new Table (Table 11.X) was added to the section 11.2.1.3 Choice of activity data, Crop residue N, including N-fixing crops and forage/ pasture renewal, returned to soils, (FCR). The Table reproduces default values from Table 11.2 in the 2006 guidelines for columns ‘Dry matter fraction of harvested product (DRY)’, ‘N content of above-ground residues (NAG)’, ‘Ratio of below-ground residues to above-ground biomass (RBG-BIO)’, and ‘N content of below-ground residues (NBG)’. It also introduces new default values for R_{AG(T)}, ratio of above-ground residues dry matter (AGDM(T)) to harvested yield for crop T, to be used in updated Equation 11.6.



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Table 11.3 contains updated EF₅, Frac_{GASF}, Frac_{GASM} and Frac_{LEACH-(H)}. Methods, data and references used for determining updated values and their uncertainties are collated in V4_11_Ch11_N2O&CO2 - Documenting Factors.

Figures

Figure Title	Type of Refinement	2006 Guidelines Figure Number	2019 Refinement Figure Number
Schematic diagram illustrating the sources and pathways of N that result in direct and indirect N ₂ O emissions from soils and waters	NR	11.1	11.1
Decision tree for direct N ₂ O emissions from managed soils	NR	11.2	11.2
Decision tree for indirect N ₂ O emissions from managed soils	NR	11.3	11.3

Discussion:

CHAPTER 12, HARVESTED WOOD PRODUCTS**Sections**

Section Title	Type of Refinement	2006 Guidelines Section Number	2019 Refinement Section Number
Preamble to Introduction	U	12 (before 12.1)	12.1
Introduction	U	12.1	12.1
Methodological issues	U	12.2	12.4, 12.5 & 12.6
Choice of method	U	12.2.1	12.5.1
Tier 1	U	12.2.1.1	12.5.2 & 12.6
Tier 2: Using country data	U	12.2.1.2	12.5.3
Tier 3: Country-specific methods	U	12.2.1.3	12.5.4
Estimating carbon release to the atmosphere from the HWP variables	U	12.2.1.4	12.4, 12.5 & 12.6
Estimating carbon released to the atmosphere in the form of CO ₂	U	12.2.1.5	12.4, 12.5 & 12.6
Choice of emission factors	U	12.2.2	12.5.2.2, 12.5.3.2 & 12.5.4.1
Choice of activity data	U	12.2.3	12.5.2.1, 12.5.3.1 & 12.5.4.1
Uncertainty assessment	U	12.3	12.7
Quality assurance/quality control	U	12.4	12.8
Completeness	U	12.5	12.9
Reporting and documentation	NR	12.6	No equivalent section, see note 9
Reporting tables and worksheets	NR	12.7	No equivalent section, see note 9
Some Approaches	U	Annex 12.A.1	12.3

Discussion:

1. The structure of the chapter in the draft 2019 Guidance has been changed significantly from that of the 2006 GL. This was necessary in order to permit a clear discussion of the HWP calculations, allowing for updated consideration of available activity data and updated technical parameters, also to taking into consideration more recent guidance presented in the IPCC KP Supplement, where this is relevant to Convention reporting, and reporting according to Decision 24/CP.19 Annex II. As a consequence, the mapping of sections in the 2006 GL to the updated treatment in the draft updated 2019 Guidance is somewhat complicated in some cases.
2. Section 12.2: Updated guidance on the option of not reporting emissions and removals associated with HWP is given in Section 12.5.1.2 of the draft updated 2019 Guidance; updated guidance is given in Section 12.6 of draft 2019 Guidance on the treatment of HWP in SWDS in the context of Decision 24/CP.19 Annex II; updated guidance on the three tiers of methods to compute emissions and removals associated with HWP is provided in Sections 12.5.2, 12.5.3 & 12.5.4.
3. Section 12.2.1: Updated discussion of choice of method allowing for improved understanding of available activity data.
4. Sections 12.2.1.4 & 12.2.1.5: Updated discussion allowing for updated consideration of activity data, updated technical parameters and reporting according to Decision 24/CP.19 Annex II.
5. Sections 12.2.2 & 12.2.3: Updated technical parameters and discussion of sources of activity data have been included with relevant supporting guidance in Sections 12.5.2.2, 12.5.3.2 and 12.5.4.1 of the draft updated 2019 Guidance.
6. Section 12.3: Updated guidance has been included in Section 12.7 of draft 2019 Guidance, which includes indications of uncertainties where available.
7. Section 12.4: Discussion of QA/QC has been simplified in Section 12.8 of draft 2019 Guidance, allowing for updated consideration of available activity data and updated technical parameters, also



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- to taking into consideration more recent guidance presented in the IPCC KP Supplement, where this is relevant to Convention reporting, and reporting according to Decision 24/CP.19 Annex II.
8. Section 12.5: Discussion of completeness has been simplified in Section 12.9 of draft 2019 Guidance, allowing for updated consideration of available activity data and updated technical parameters, also to taking into consideration more recent guidance presented in the IPCC KP Supplement, where this is relevant to Convention reporting, and reporting according to Decision 24/CP.19 Annex II.
 9. Sections 12.6 & 12.7: No update on reporting and documentation has been included since the reporting conventions and format are specified in Decision 24/CP.19 Annex II and the associated CRF.
 10. Annex 12.A.1: Updated discussion of HWP reporting approaches has been included in Section 12.3 of the draft updated 2019 Guidance, maintaining the approaches in the 2006 GL as also included in the CRF tables specified in Decision 24/CP.19 Annex II, also allowing for updated discussion of available activity data.

Equations

Equation Title	Type of Refinement	2006 Guidelines Equation Number	2019 Refinement Equation Number
Estimation of carbon stock and its annual change in HWP pools of the reporting country	NR	12.1	12.2
Estimation of HWP products placed in use annually from domestic consumption	U	12.2	12.3 & 12.6
Estimation of HWP products produced annually from domestic harvest	U	12.3	12.3, 12.7 & 12.8
Estimation of annual change in carbon in HWP in domestic SWDS where HWP came from harvest	U	12.4	No equivalent equation, see note 4
Estimation of carbon release using HWP variables	U	12.5	12.2 & 12.3
Equation to estimate production, imports or export variables in Table 12.5 for years before 1961	U	12.6	12.4
Emissions from AFOLU by the stock-change approach	U	12.A.1	12.1
Stock-change approach: HWP contribution	U	12.A.2	12.1
Emissions from AFOLU as by the atmospheric flow approach	U	12.A.3	12.5 & 12.10
Atmospheric flow approach: HWP contribution	U	12.A.4	12.1
Emissions from AFOLU by the production approach	U	12.A.5	12.1
Production approach: HWP contribution	U	12.A.6	12.1

Discussion:

1. Equation 12.1: Equation 12.2 in the updated draft 2019 Guidance is effectively the same as Equation 12.1 but involve updated treatment of C (1900) (see Section 12.5.2 of draft 2019 Guidance in particular discussion of Equation 12.4/Box 12.1).
2. Equation 12.2: Updated principally through Equations 12.3 & 12.6 in draft 2019 Guidance, allowing for updated consideration of activity data and updated technical parameters.
3. Equation 12.3: Updated principally through Equations 12.3 & 12.7 and 12.8 in draft 2019 Guidance, allowing for updated consideration of activity data and updated technical parameters.

4. Equation 12.4: No equation needed due to updated guidance on treatment of wood in SWDS in the context of Decision 24/CP.19 Annex II (see Section 12.6 of draft 2019 Guidance).
5. Equation 12.5: Updated principally through Equations 12.2 & 12.3 in draft 2019 Guidance, allowing for updated consideration of activity data and updated technical parameters and treatment of wood in SWDS in the context of Decision 24/CP.19 Annex II (see Section 12.6 of draft 2019 Guidance).
6. Equation 12.6: Updated principally through Equation 12.4 in draft 2019 Guidance, allowing for updated guidance in Section 12.5.2 in particular discussion accompanying Equation 12.4/Box 12.1.
7. Equations 12.A.1 to 12.A.6: Updated principally through Equation 12.1 in draft 2019 Guidance, allowing for updated consideration of activity data and updated technical parameters and reporting according to Decision 24/CP.19 Annex II (see Section 12.6 of draft 2019 Guidance).

Tables

Table Title	Type of Refinement	2006 Guidelines Table Number	2019 Refinement Table Number
HWP variables used to estimate annual HWP contribution to AFOLU CO ₂ emissions/removals	U	12.1	No equivalent table, see note 1
Default half-life for “products in use” carbon pools and associated fraction retained each year	U	12.2	12.3
Estimated annual rates of increase for industrial roundwood production (harvest) by world region for the period 1900 to 1961	U	12.3	No equivalent table, see note 3
Default factors to convert from product units to carbon	U	12.4	12.1 & 12.2
UN FAO activity data needed for Tier 1 variables, and default conversion factors	U	12.5	No equivalent table, see note 5
Uncertainty associated with activity data and parameters (emission factors) for the Tier 1 method to estimate the five annual HWP variables	U	12.6	No equivalent table, see note 6
Annual carbon HWP contribution to total AFOLU CO ₂ removals and emissions and background information	U	12.7	No equivalent table, see note 7
Summary of how to compute HWP contribution using variables in Table 12.7	U	A12.1	No equivalent table, see note 7

Discussion

1. Table 12.1: Table no longer required due to updated guidance included in Section 12.5 of draft 2019 Guidance.
2. Table 12.2: Updated (inclusion of updated technical parameters) in Table 12.3 of draft 2019 Guidance.
3. Table 12.3: Table no longer required due to updated guidance (see Section 12.5.2 in draft 2019 Guidance in particular discussion of Equation 12.4/Box 12.1).



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4. Table 12.4: Updated (inclusion of updated technical parameters) in Tables 12.1 and 12.2 of draft 2019 Guidance.
5. Table 12.5: Table no longer required due to updated guidance (see Section 12.5.1.1 in draft 2019 Guidance).
6. Table 12.6: Table no longer required due to updated guidance included in Section 12.7 of draft 2019 Guidance, which includes indications of uncertainties where available.
7. Tables 12.7 & A12.1: Table no longer required due to adoption of CRF table as agreed in Decision 24/CP.19, Annex II.

Figures

Figure Title	Type of Refinement	2006 Guidelines Figure Number	2019 Refinement Figure Number
Decision tree for reporting HWP Contribution of zero or selecting a tier	U	12.1	12.4
System boundary of the stock-change approach	U	12.A.1	12.1
System boundary of the atmospheric flow approach	U	12.A.2	12.2
System boundary of the production approach	U	12.A.3	12.3

Discussion:

1. Figure 12.1: Updated decision tree in Figure 12.4 allowing for improved understanding of available activity data.
2. Figure 12.A.1: Updated system boundary diagram in Figure 12.1 clarifying linkages to relevant updated guidance on activity data and reporting according to Decision 24/CP.19 Annex II (see Section 12.6 of draft 2019 Guidance).
3. Figure 12.A.2: Updated system boundary diagram in Figure 12.2 clarifying linkages to relevant updated guidance on activity data and reporting according Decision 24/CP.19 Annex II (see Section 12.6 of draft 2019 Guidance).
4. Figure 12.A.3: Updated system boundary diagram in Figure 12.3 clarifying linkages to relevant updated guidance on activity data and reporting according Decision 24/CP.19 Annex II (see Section 12.6 of draft 2019 Guidance).

Boxes

Box Title	Type of Refinement	2006 Guidelines Box Number	2019 Refinement Box Number
None			